
Controversies, especially those that surround "early warnings" about impacts of a technology or a large project, may be welcomed as an informal way of technology assessment. This is not always recognized, because of ideals of consensus and context-free rationality. An alternative, rhetorical perspective is presented on controversies and their sociocognitive dynamics, in which interests and actor-strategies play an integral role besides arguments and evidence. Because of such interactions, articulation of insights and positions occurs, that is, social learning. Improvement of social learning has to take the sociocognitive dynamics into account. Absolute standards and methods are impossible, but one can take robustness of views as a realistic goal.

Controversies as Informal Technology Assessment

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*While conflict and controversy occur in any society, contemporary Western industrialized countries have become a special kind of controversy, in which science and technology are an integral part of the debate. Early warnings, like Rachel Carson's book *Silent Spring* (on the long-term effects of the use of chemical pesticides), are one example. In*

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other cases, scientific and technological expertise is drawn in as a resource in conflicts about health hazards, or about the siting of a plant, or about some large technological project. Science and technology are important to the parties in a controversy, because they embody the ideals of rationality and progress of Western societies, and confer legitimacy. At the same time, the occurrence of controversies and the impossibility of resolving them just by reference to scientific expertise, or to "the facts," threaten to delegitimize science, as well as traditional conflict-resolution institutions (Mazur, 1981; Nelkin, 1984; OECD, 1979).

This article takes the position that science and technology-related controversies are here to stay. Neither calling upon the good will of the contestants, nor hoping for science to bring out consensus of its own accord, will make them go away. But it is not necessary to go to the other extreme, and resign oneself to controversies as a minor, and sometimes major, inconvenience of modern life. In a sense, it is possible to profit from controversies. In many cases, controversies provide partly conflicting assessments of new technologies or of the impacts of actual or proposed projects, that are further articulated and consolidated in the course of a controversy. Thus, informal technology assessment occurs.

The present article develops a perspective on controversies that allows a realistic analysis of such assessment processes, as well as providing suggestions for their improvement. It will do so by discussing two examples of controversies in order to bring out some general points, and relate these points to insights from recent social studies of science. The perspective obtained in this way is used to outline how social learning may occur through controversies, especially early warning controversies, and how such learning can be conceptualized. Then, the further step can be taken to consider possible improvements to such processes of informal technology assessment.

Rhetorical Analysis of Controversies

When smoking cigarettes became popular in the late nineteenth century, it was criticized from different sides. Moral crusading even led to the prohibition of cigarettes in a number of states in the United States in the first decade of our century. Health hazards were predicted, but the debate was primarily moralistic: Cigarette smoking would lead to bad

habits, corruption and crime (or was a sign of such vices), and damage to health was added as the inevitable punishment of such sins.¹

The situation changed after the World War I, and even more after World War II, when soldiers returning home provided a link between cigarette smoking and courage and adventure. Cigarettes became part of a lifestyle. Advertisements emphasize until today how smoking and the good life go together.

In the meantime, medical data and insights started accumulating, especially about correlations between smoking and lung cancer. The controversy of the 1950s and 1960s was covered extensively by the media. Government agencies stepped in, and at present many countries require cigarette advertisements and cigarette packages to carry a warning that smoking may endanger health.

There are a number of general insights that can be derived from the controversy about cigarette smoking and cancer. The first point to be made is that scientific knowledge, in this case in the form of epidemiological data, has no impact by itself, but only when taken up by forceful actors. Troyer and Markle (1983) describe such processes, for example when the American Cancer Society argued for a cancer-link, against the position taken by the American Medical Association, or when the U.S. Surgeon General first commissioned a report on health hazards of cigarette smoking and then, in 1964, carefully orchestrated the presentation of the findings. The implication is that positions and interests of such actors play a role, not just in the use they make of available information, but also in the way research agendas are set through the commitments and problem definitions they introduce and through the selection of the points of contention in the controversy. In addition, the points of contention and the research agendas shift over time because of the evolution of the controversy. In its most recent stage, for example, the smoking-cancer link is widely accepted and more general health issues are discussed, especially in relation to the question of the rights of nonsmokers. Now that nonsmoking departments have been created in public transport, there emerges a need to justify such measures in the face of criticism: A new health hazard is discussed and researched, that of "passive" smoking. Thus, the dynamic of development of scientific insights relevant to the controversy is never exclusively cognitive. It is a sociocognitive dynamic, and the social influences extend to the content, and the distribution, of what we know and what we do not know about smoking and health.²

The second point follows from the first: If the dynamic is socio-cognitive, it is of little use to attempt the resolution of a controversy by relying on cognitive aspects alone. Presumptions like "If we only had the state-of-knowledge laid out before us, we could make the best decision, or at least agree where to disagree," are of little practical value when the state-of-knowledge cannot be given unambiguously. Not only are there always many uncertainties in the "messy" science that is relevant for controversial issues, but what is to be considered certain and what uncertain is itself part of what is at issue. For example, epidemiological data on the smoking-cancer link not only carry uncertainties, but from a traditional medical perspective they cannot provide proof of a causal link (which requires the actual production of clinical symptoms). This cognitive debate is inextricably bound up with the social dynamic, because it is in the interest of the tobacco industry to emphasize uncertainties in the smoking-cancer link.

Not that traditional medical opinion is on the payroll of the tobacco industry (although that also happens), but in the actual course of the controversy such arguments will always have an impact on positions and interests of contending parties, and receive criticisms and become further articulated from the perspectives of the parties.

If a controversy is (more or less) resolved—this is the third general point—a certain view of the issue has become dominant, and widely available: "Smoking is bad for your health, *everybody* knows that." In other words, if one wants to put forward the claim that there is a link between smoking and cancer, little effort is needed to get the claim accepted. On the other hand, the costs of going against the dominant view may become so large that actors, although not convinced, may give up the struggle. The U.S. Tobacco Institute, for instance, has stopped presenting its dissenting view to the public. As an institute funded by tobacco companies, it has a history of studies and information campaigns to show the weakness of the smoking-cancer link. But since such counter-claims now only arouse hostility in the public aimed at, the Institute has changed its strategy and started to emphasize freedom of choice (for smokers) in its campaigns. Note that the new strategy further consolidates the dominant view: "There must be a health hazard, because not even the Tobacco Institute is arguing against it."

The perspective on controversies developed here is *rhetorical*: not truth, but impact is what counts, not substance, but sociocognitive strategies and their outcomes should be the focus of the analysis. However, rhetorical analysis does not assume that anything goes. True,

views may be widespread and thus available in a (sub)culture just because they are fashionable, and it will still be difficult to go against them. Although the Tobacco Institute may describe the situation in this way, rhetorical analysis would still say that the Tobacco Institute is facing something stronger than a passing fashion. It is running up against arguments, evidence, social alignments, interests, and cultural values, many of them interrelated and therefore lending support to the dominant view. Such a view will be called "robust."³

The difference between an only fashionable and a robust view is a matter of degree, and perhaps also a matter of actual effort that actors are prepared to exert. In both cases, the views are available in the cultural repertoire, but with increasing robustness, the linkages between elements of the view and with their context increase in number and in articulation (and sometimes also in scope). For example, while the smoking-moral degradation link was probably quite strong around 1900, the link with health hazards was only incidental, and there was little incentive to make it explicit and refine it. Since then, the relation between smoking and moral degradation has not been further articulated, and at present it can easily be negated: saying so is sufficient. In contrast, to negate the smoking-cancer link now requires much effort and time, because a heterogeneous network of arguments, social alignments and interests has to be restructured. Robustness is thus a feature of a network.⁴

As the examples already indicate, there are two important properties of the networks of arguments, social alignments, and interests that contribute to robustness: articulation and consolidation. Articulation occurs when links are formed where there were none or else only weak or latent ones. When a suspected relation, for instance, between a chemical and health damage, is supported (or falsified for that matter), the network becomes more articulated. Articulation is not limited to scientific articulation: Cultural or political articulation is also possible, for instance, when alliances are formed or made explicit, or when certain value issues become detailed (as has happened in the fluoridation controversy, where the relevance of the value of freedom of choice, and the definition of fluoridation as forced medication emerged through the interactions during the controversy, and cannot be neglected anymore by the different parties). Consolidation not only indicates the solidity of linkages in the network, but also the type of solidity provided by combination of elements of the network into one black-boxed unit (as in the consolidated account of a large business firm). "Smoking is bad for

your health" labels a black box full of medical research, debates between health authorities and tobacco companies, accumulated impact of advertisements and media coverage, and so on, and because all these elements need not be specified anymore, the network becomes stronger (provided the black box may remain shut). Consolidation may be the outcome of actor strategies, as in the example of the Tobacco Institute: When it stopped arguing against the smoking-cancer link, the black box could function as a single unit in the network, with all the rhetorical force that goes with that.⁵ This example also shows that consolidation, and the resulting robustness of a view, need not be consensual.

Robustness and Relativism

A robust outcome has been achieved in another controversy, on the risks of recombinant-DNA research. The public debate has died down, after its peak during 1975-1977, and the benefits of the new technology are now at the center of the stage. Laboratory research is considered to offer no special risks. Apart from information about the low survival rates of manipulated micro-organisms (especially when "crippled"), there is also a classification of experiments requiring procedures of physical and biological containment of increasing strictness. (The latter amounts, in fact, to bureaucratic containment of risk).

Not only the acquired insights and the bureaucratic procedures, but also the fact that the risks were estimated to be much smaller than was thought originally, helped to create a robust view. These estimates have been a strong argument to relax the guidelines for recombinant-DNA research in laboratories, a step that further consolidated the view that such research is safe. To query the safety now takes an extraordinary amount of effort, it is difficult to get a hearing and critics run the (social) risk of being labeled deviants. On the other hand, the safety view is so easily available that it can be invoked without much attention to the details of its support. A typical quote is

The NIH's risk assessment program provided information on the long-term consequences of r-DNA, and largely as a result of the NIH's assessments, the risk of r-DNA research appears to be considerably less than initially believed. The remaining controversy concerns the risks attendant the commercial exploitation of r-DNA technology. [Wlodkowski, 1982: 134].

The first statements are incorrect as they stand, but widely acceptable (possible global defense of these statements is that if a risk is less than initially believed, it must be (a) negligible, and (b) well-supported by information on long-term consequences). There is little chance that public debate will focus on risks of laboratory research again, also because there are larger issues looming ahead (environmental release of genetically engineered organisms; human genetic manipulation).⁶

The safety view is a robust product of the recombinant-DNA debate and the activities of the parties, but this does not imply that it cannot be deconstructed. In fact, I am personally convinced that there *are* risks of recombinant-DNA research that are being neglected and may lead to accidents in the future. Therefore, I tend to spot gaps in arguments (as above, in commenting on the quote), and find the interests and lobbying of molecular biologists and some industrialists a likely explanation of the neglect of risks. Rhetorical analysis of controversies is sometimes taken to aim at just such explanations.

However, such an explanatory strategy assumes that somehow (by the analyst, or a privileged participant, or perhaps in retrospect, on the basis of the view that has been accepted in the long run) it is possible to identify what is the correct outcome, and explain deviations from this outcome as products of interests and ideologies at work. But the analyst of controversies should limit himself to identify robustness and trace the processes that produce it. His own view of the matter (or a participant's view with which he identifies) may sensitize him to certain aspects, but should not be part of his explanatory strategy. Such a methodological requirement has been denoted as "methodological relativism," or seen as part of a "symmetrical approach," that is, one in which (presumably) true scientific results should be analyzed and explained in the same way as (presumably) false ones.⁷ It is perhaps better, and more in line with a rhetorical approach, to see the requirement as one of maintaining distance, or anthropological "strangeness" (Lynch, 1982: 506-509). Thus, the actual social position of the analyst, not just his methodological sophistication, comes into view. Formulated in another way: using labels like "truth" (or "substantial argument," or in other contexts "important value") with their absolute connotations, implies presenting, and thus protecting certain parts of the controversy as unassailable. This is a common rhetorical tactic of participants, as is its counterpart, to label opponents' arguments or positions as "ideological" or "biased" to undermine their force. An analyst using such labels can become a participant, in principle and often also in practice, and actually has to

make efforts to keep his distance.⁸ The concept of robustness has been introduced to describe outcomes of controversies while keeping some distance. It has methodological relativism built into it.

After emphasizing the importance of methodological relativism, it is necessary to counteract the possible impression that everything is seen as socially constructed and "therefore" also relative in an ontological sense. To clarify my position, I shall briefly review the evolution in the views of the nature of science and its role in science- and technology-related controversies. In the traditional, positivist approach, facts are facts and scientists should be ideal ratiocinators. They cannot help but draw the right conclusions—or be bad scientists, for instance, because they could not bar interests or ideologies from intruding in the processes of science. Thus, scientists are viewed as puppets on a string, the string being scientific rationality or "the" scientific method.

Extensive criticism of the positivist approach has led to recognition of interpretive flexibility in scientific research (so that facts depend on interpretations for their status as facts), of the importance of cultural themes and frameworks, for instance Kuhnian paradigms, and of the role of values and interests in guiding interpretations. (For an overview, see Mulkay, 1979.) Scientists may now be seen as "paradigm dopes" (Law and Barnes, 1976: 121), or as the puppets of interests and ideologies. Especially the latter view is often adopted (explicitly or implicitly) in controversy studies, for example (and in a sophisticated way) by Mazur (1981).

In reaction to this almost social-deterministic view, with its affinity to relativism, a trend has emerged to see scientists as actively assembling and constructing, tinkering in the lab, and mobilizing resources (see for one example Callon et al., 1986). Their work is performed and their interpretations are shaped within the framework of an (evolving) problem definition, but such a problem definition is not a given paradigm or only the reflection of a given constellation of interests. It should be seen as part of a reactive network of interests, values, facts, and arguments, where a new finding may become the victim of interest struggles, but could equally well exert leverage to shift their balance.

Within science, the notion of robustness might be applied to describe the accepted facts and ruling paradigms. Recent sociology of science has indicated which processes are responsible for the creation of robust outcomes. Latour and Woolgar (1979) have shown how knowledge claims in science may shed their modalities (from speculation, to contingent finding, to a result to be reckoned with, to an accepted fact

and a part of the received wisdom of the textbooks) and how references to local and contingent production of knowledge disappear as the circulation of the "fact" becomes wider. Rhetorical analysis of the struggle for "facticity" shows how scientists make use of a dual repertoire: empiricist or positivist when promoting their own knowledge claims, that is, anticipating the hoped-for status of accepted fact, and contingent or social-constructivist and interest-related, when criticizing competing knowledge claims, in order to show why it is only a local artifact.⁹ The continuing struggles to move some claims up the ladder of "facticity," and push down others also produces further articulation and consolidation, and thus makes the eventual winners robust. This account resembles the traditional notion of "organized scepticism" in science (as it should, to capture a characteristic feature of science), but differs in two respects. The results need be "rational" or "true," they are the outcome of the struggle for facticity. And the nature of the struggle is partly determined by the institutional embedding of science, of which some features might be more conducive to the production of robustness than others. (Compare Campbell, 1979, for a related point.)

Robustness and Social Learning

Rhetorical analysis of science- and technology-related controversies is not only important for theoretical reasons, that is, to take the insights of recent sociology of science into account. There are also practical considerations: about status of scientific expertise, acceptability, and social legitimation of science and technology (Rip, forthcoming b), and about the (social) learning that may occur in the "early warning" controversies that have been taken as the focus of this article.

Society tends to "learn" through trial and error about the impacts of its activities: Damage is experienced, small (and sometimes large) disasters occur, and gradually, measures are taken to avoid them in the future. Often the social costs of such learning by trial and error have been considerable. One need only think of industrialization and its impact on the workplace and the environment. The incorporation of science and technology in activities increases the risk of unexpected impacts, and thus the social costs of learning. Increasingly, the benefits of science and technology are assessed in comparison with such costs.

Sometimes, the social costs of learning by trial and error can be

reduced by avoiding part of the trial, and thus some of the costly errors. Early warning about impacts, provided it is heard and acted upon, is one way, and there are many examples (often based on scientific insights and concerns of scientists). It is not always easy to distinguish between serious and spurious warnings, and formal technology assessment studies cannot be seen as an answer. In many cases, social resistance against taking preventive measures is so high (and views about their necessity so different) that controversies about the early warning occur, and quality control is only possible through the dynamics of the controversy. So it becomes important to inquire about the kind of learning that is possible in "early warning" controversies. (The social costs of controversies themselves, for instance, delays, litigation, the absorption and dissipation of social effort, disorder as such, should not be neglected, but controversies cannot be avoided in contemporary society, and actual societal learning may sometimes require controversies in order to have both some articulation and some hearing and consolidation of the articulated warning.)

The attempt to learn about the future is part of the culture of Western industrialized societies, and reflects its strong *Aufklärung* component: we can make our own world, and do it ever more rationally. Learning about the future, and thus the kind of social learning that may be possible in "early warning" controversies, is not a question of transferring existing knowledge, understanding or skills to people who do not yet master them. The learning is open ended, and there is no "teacher" to set standards and design a learning process. Therefore, absolute standards to measure the extent of learning, and to guide attempts at improvements, are not available. The controversy is about what the content of the learning should be, and there may well be residual controversies about whether any learning occurred at all. (For example, have we learned enough about the risks of recombinant-DNA research?)

This kind of learning that occurs can be described in terms of robustness, a concept that describes features of outcomes of a controversy (articulation and consolidation) that do not depend on the content of the learning or on absolute standards. The achievement of robustness depends on the social practices and institutions in which the possible learning processes occur, but two general requirements can be derived from the rhetorical analysis outlined in the preceding sections.

(1) There must be a sociocognitive dynamic, that is, interaction between contending parties *and* problem definitions. Otherwise, there will be no mutual articulation in the course of the controversy. Left to themselves, not being forced to defend, the parties lack stimulus to

articulate their view, so that whichever becomes dominant will not be as robust as possible. An intriguing example is the estrogen replacement therapy (for problems of menopause), where American medical opinion takes a position opposite to the British view (which can be explained in terms of the different social embedding in the two countries), but no attempt is made to resolve the contrast (McCrea and Markle, 1984).

(2) Since articulation work requires additional effort, parties will not generally do so by themselves, and a forceful focus must be present, often provided by an external actor (examples would be a government agency or the threat of market or credibility loss through publicity about a lack of effort). In the controversy about health hazards of caffeine, and especially of coffee drinking, the debate remained on a general level (for instance, about addiction to coffee) and little articulation and consolidation was visible. Interaction and learning only occurred for a short period, when the U.S. Federal Drug Administration reviewed the issue and removed caffeine from the GRAS (Generally Accepted as Safe) list (Troyer and Markle, 1984). All parties had to come to terms with its report; it was, as it were, an obligatory passageway. Such actions by federal agencies—one may also think of announcements of regulatory intent by the U.S. Environmental Protection Agency—create a forceful focus, and thus a necessary condition for social learning to occur.

If these two requirements are not fulfilled, a controversy only produces specious inflation and reduction of claims,¹⁰ and no social learning can be expected. On the other hand, if the conditions are suitable, a controversy may be a very good way to produce social learning about impacts and the way they should be assessed. One may deplore the messiness associated with such learning, but the outcomes will be diffused and utilized almost by definition.

One may be doubtful and ask whether, perhaps, cases of social learning through controversies are the exception instead of the rule. Especially from the paradigm or interest approaches in the study of controversies, it appears as if contending parties live in incommensurable worlds. Articulation, if it occurs, will then proceed in separation, and only increase the incompatibility of the ideologies or the conflict between the interests. While this may happen, it does not exclude the possibility of one position becoming dominant and strengthening its network by accommodating the relevance or legitimacy of the other position(s) to some extent. Incommensurability is only a problem when consensus is the aim.

Social learning might be the exception when the conditions for its occurrence are rarely fulfilled. This is an empirical question. But even if one tends to be pessimistic about the present situation, it need not remain so. It may be possible to improve social learning processes by the realization of the conditions conducive to it, in particular cases or by institutional design or the emergence of social practices supporting it.

The Government's Role in Improving Social Learning in Controversies

When government is seen as a cluster of governmental actors, its role with regard to controversies is threefold. Government agencies have to make authoritative decisions, for example to have health warnings on cigarette packs, or to set guidelines and require approval for recombinant-DNA research. Second, government is responsible for due process, and for the smooth functioning of administration. From this perspective, controversies appear as a disturbance, and procedural means are sought to reduce and contain them.

Third, in recent years (and increasingly so) government is expected to anticipate future developments or events, and take precautions. In order to "manage" society properly, the future has to be managed as well. It is this line of thinking that has given rise to attempts at technology assessment (TA) studies, and to specific institutionalizations of the TA function (O'Brien and Marchand, 1982; OECD, 1983). The limitations of some of the approaches and institutional forms, for example the U.S. Office of Technology Assessment, which serves the U.S. Congress, are now recognized, and are the more striking when set against the TA philosophy: to reduce the social costs of learning by error, and to do so by systematic anticipation of potential impacts of new technologies and large projects, and feedback into decision making. In such a philosophy, ongoing, pluralistic, and fragmented societal processes of assessment and control of science and technology—with early warning controversies as a prime example—should be at least as relevant as formal, commissioned TA studies (Rip, forthcoming a).

Such societal assessment processes should not only be seen as the context of utilization of formal TA studies (Whiteman, 1982, 1985), but also as an assessment activity in its own right. Increased public participation in decision making about technology and projects with a

technological component is one way in which government has come to terms with the societal processes. A further step in the reduction of the social costs of learning by error is by taking advantage of controversies. One way to profit from controversies is the same for all actors: It is to recognize that social learning may occur, and participate and take up its outcomes from this perspective. A more ambitious project is to stimulate and improve the social learning processes in controversies, and here governments may have a specific task. To be effective in such a task, simplistic notions of learning and consensus have to be overcome, and the perspective developed in this article is able to provide some guidelines. In addition, strategies of actors and mutual anticipations, mentioned before in the analysis of examples, have to be reckoned with, now that intervention, not just analysis, is the goal.

Government is always one (or more) of the actors, and others actors will try to anticipate its actions and bend them to their own ends. In general, actors will act strategically (in the economic sense: hide their preferences in order to increase their chance of reaching long-term goals, or respond to an issue not on its own terms, but based on expectations of what may happen afterward). One effect is that original objectives may well be defeated, as can be seen in the following example.

In 1973, when the U.S. EPA had announced its intent to curb the use of the herbicide 2, 4, 5-T, the proponents of the herbicide (industry, organized agriculture, and also the Department of Agriculture) started to organize a conference to consolidate their assessment of the state of knowledge about health and environmental hazards, and to be better prepared for the trial later that year. Opponents, including the EPA, when notified about the conference, wanted to be present, and were allowed to. The extended discussion of pros and cons made the EPA terminate its attempt to limit the use of 2,4,5-T.

Concern about the herbicide emerged again, and by 1979 the EPA resumed its action against it. This time, the organizers of the 1974 conference remembered its (for them, favorable) outcome, and set out to have a "dispute-resolving" conference, as they announced it. Great efforts were made to include all parties and all relevant expertise—but most of the opponents declined to participate, because they did not want to risk being held responsible for conference conclusions. The conference was held, and although participants were convinced of the value of its conclusions, the impact was negligible. Insofar as it was reported, the biased composition of participants was highlighted, and comments from opponents were invited. Strategizing of the actors (proponents, as

well as opponents) now defeated an objective, while the earlier conference, paradoxically, was "successful" because it did not pose this goal.¹¹

The example not only highlights the strategizing of actors, but also indicates how attempts of governments to organize social learning may well backfire when actors use the occasion to further their own ends. This is what happened with the official, organized societal debates on nuclear energy in Austria and the Netherlands (Hirsch and Nowotny, 1977; Nowotny, 1979; Vlek, forthcoming). Hearings and discussion sessions became occasions for proponents of nuclear energy to air their views, and it was quite difficult to attract attention from the general public, and to hold it. The basic problem with both organized debates was that they were intended to clarify a difficult political decision, and accepted as such by the Parliaments (including their considerable costs), but took place at a distance from the political struggles about nuclear energy. Thus, when the results came in (in the Dutch case in the form of a detailed report, showing that a majority preferred to postpone building of further nuclear power plants), there was little political interest and support. In fact, the Dutch government could decide to go ahead with nuclear power without raising a lot of opposition. (The situation is now different because of the accident in the Russian nuclear plant at Chernobyl.)

In general, it is not realistic to expect the parties in a controversial issue to stop their strategizing, sit down together for a *herrschaftsfreie Diskussion* (Jürgen Habermas's ideal of a dominance-free debate), and reinsert the results into the struggle so that it will be resolved. There is an arena in which the battle is fought, and creating enclaves of relative peace only means that what happens there will be irrelevant to the battle (or the products will be picked to pieces as soon as they are re-introduced into the arena). Thus, robustness cannot be created by stepping outside the arena, isolating the debate from social alignments, or neutralizing them procedurally (for instance, through representation of "all" interests and viewpoints), as is often proposed. One has to work with, and through, the strategizing of the actors.¹²

Given this premise, how can governments go about improving social learning in controversies, especially "early-warning" controversies? The chances that social learning occurs at all may be increased, and the learning process, as it occurs, may be improved. The two approaches cannot always be clearly distinguished.

Chances for social learning will be increased through the emergence of legal (and cultural) support for "early warners" and "whistle

blowers." A number of cases in which warnings were not heeded, and warners silenced, have stimulated attention and provision of protective measures in the United States (Bowman, 1983; Petersen and Farrell, 1984). While warners need not be right, and they, as well as the organizations that are tempted to repress warnings and warners, act from a range of motives and situated interests (compare Anderson et al., 1980), some support is necessary to set an "organized" controversy in motion.

When the warning is taken up in a public arena, or the debate is among different organizations and interest groups, government can support social learning by introducing a forceful focus, for instance by declaring a regulatory intent. Government agencies will often do so for their own reasons, but it may also be used as it were experimentally, to set a process of debate and learning in motion. The force of such a focus resides in the possibility of actual decisions pro or con, and in the necessity for parties to take opposing arguments into account in order to present a credible position (to the agency, in public hearings, at a trial, and so on).

In both examples, governments stimulate the occurrence of social learning, but may also influence the quality control of the debate by setting procedural rules, including rules of standing and of due process. This is especially important when public participation is considered.

Increasingly, the public has become an audience before which a controversy is staged. It can confer or withhold credibility, and thus influence what happens. Even if its actual power to do so is small, most actors dare not take the risk, and act to protect their credibility. As an American industrialist said: Winning the battle of litigation (in a controversy on health hazards of chemicals) may mean losing the war of credibility (Wessel, 1980). Public interest groups get a hearing because they present themselves, and are perceived, as spokesmen for the public, and thus function as credibility brokers. This is the context in which the question of public participation arises, and which influences the sociocognitive dynamics of the controversies.

Mazur (1981: 127) has argued, in line with the present perspective, that:

Extraparliamentary dissent may be a process of social discussion which is more effective in identifying and explicating the risks and benefits of technology, than the formal means of societal negotiation are.

The effectiveness lies in the attention given to knowledge claims in addition to negotiations between interests, and in the broadening of the

agenda that occurs by including more parties in the arena of the debate. These advantages are relevant for public participation in general, but have to be set against the disadvantage that rules for interaction and the emergence of consolidation require some boundary. Introducing a new party into the debate may offset the balance of forces; this should be done only when a gain in articulation is to be expected. Concretely, this implies that participation is not a citizen's right *per se*, but has to be earned on the basis of specific claims about the issues in the controversy. Only in this way is it possible to avoid either a purely social dynamic (for example, polarization) or isolation from the battleground (the Kindergarten aspect of citizen participation, which was also visible in the Dutch organized debate on nuclear energy discussed above).

This necessarily brief discussion of the role of public participation shows that there are two dimensions of quality improvement and control: broadening agendas, not neglecting issues, on the one hand, and the need for some limitations on and continuity of the debate in order to have robust outcomes at all, on the other hand.

Not only because of the increased role of the public, but also, and more generally, because of the importance of interaction between parties in an arena, the quality of the social learning may well be influenced by the reporting of viewpoints, arguments, and events. If consciously aimed at, one could speak of "mediation by reporting" (where mediation is now seen as a method of articulation and consolidation, not conflict resolution *per se*). Media reporting of controversial issues may act like a flywheel; indeed, complaints about inaccuracies and exaggeration are repeated *ad nauseam*, without much attempt to check what is happening.¹³ But it has also a mediating function, in the sense that it creates an arena and introduces requirements of (some) credibility.

Another kind of "mediation by reporting" can be provided by social scientists. Their skills in participant observation and in presenting views of different groups can be used to improve interactions, and the analysis of the sociocognitive dynamics of a controversy they can provide may be an incentive to further articulation. Examples of sensitive analysis of controversies have been published (for instance, Levine, 1982), but their effects are unknown (except that the authors have sometimes also been (observing) participants in the controversy).¹⁴ A more ambitious variant is that social scientists actually set up interaction between parties, offering their analysis of the controversy as a guideline. A specific example is the use of a mixed ecological-economical-sociological

systems model of the phosphate-in-detergents issue, to show the effects of alternative policies in workshops with the contending parties.¹⁵ The interest of the example is both its success, and the way justice is done to the sociocognitive dynamic of the controversy.

Governments may orchestrate public participation, and stimulate interaction between parties and mediation by reporting in particular cases, as well as attempt to develop methods to improve social learning in general. It is important to note, however, that quality improvement cannot be achieved by just applying a general rule. There cannot be any rules derived from the content of the learning to be achieved, since this is part of what is at issue in the controversy. But also procedural rules and measures to enhance quality may not be effective. Some interests will be damaged by the measures, and others will profit from them. So there will be strategizing (from outright resistance, to mobilization of new allies and other resources, to problem shifts and flexible interpretation of quality rules). In principle, ad hoc interventions in the sociocognitive dynamic of the controversy, based on a diagnosis of the forces at work, will have the most effect. In practice, accountability requirements, bureaucratic culture, and the need to be perceived as legitimate authority, make it impossible to forego rules and general guidelines. The argument of this article then implies that governmental actors (as indeed all actors) should be sensitive to dynamics of controversies and the network character of social learning.

Conclusion

The rhetorical perspective on controversies developed in this article is applicable in a wider context; examples have been given for the sociology of science. It is particularly useful for cases in which social and cognitive dynamics are inextricably mixed. The concept of robustness of outcomes, derived from this perspective, has been put forward as the only realistic goal for "early warning" controversies as informal technology assessment. It replaces truth or some other absolute standard of achievement. Thus, it introduces a certain kind of relativity: Robust is whatever holds its own.

There are other nonabsolute standards in Western societies. Decisions taken by following some democratic procedure need not to be better, in an absolute sense, than autocratic decisions (or for that matter,

decision making by lottery). But such decisions will be more robust in a political culture in which democracy is considered important, and a legitimation of decision outcomes occurs.

The higher kind of relativity introduced by the concept of robustness does not imply irrationality. Arguments and evidence are part of the network that becomes robust. How important they are in particular cases cannot be specified beforehand. In fact, the distinction between what is more or less objectified evidence and what are interests and ideologies at work, can only be made in retrospect, when such differences have crystallized out in the course of a controversy. Thus, it becomes vacuous to wish for improved social learning by increasing the "rational" part of controversies.

On the other hand, one need not be fatalistic and take controversies as they come. As long as one recognizes the sociocognitive dynamic at work, one can learn from them, and even improve the learning. It is for this reason that "early warning" controversies are an important addition to the arsenal of strategies to reduce the costs of learning by error.

Notes

1. These and following data on and insights into the cigarette-smoking controversy are all derived from Troyer and Markle (1983).

2. This point can be documented in detail for the controversy about the impact of chlorofluorocarbons, used in spray cans, on the ozone layer. See Dotto and Schiff (1978) and Rip (1983).

3. The concept of "robustness," as used here, is closely related to robustness as a property of computer (or mathematical) models: Outcomes of model runs should not change drastically if a parameter is changed only slightly—that is, a little effort cannot disturb the outcome.

4. The concept of "heterogeneous network" as an analytical tool is used (and broadened to include actors and their relations) in Callon et al. (1986) to analyze scientific and technological developments in their social contexts. For the present article, with its focus on sociocognitive dynamics of controversies, it is sufficient to take arguments, evidence, social alignments, and interests as the building blocks. The concept can then be seen as an extension of Mary Hesse's (1974) notion of scientific knowledge as a network of theories and observation. Hesse includes an epistemological point (the network is only attached to empirical reality in some places), which is not necessary for the present rhetorical analysis. See for an extended discussion of a sociologically extend network model of science, Law and Lodge, 1984.

5. Black boxing, by itself, creates rhetorical force, as is abundantly clear in political rhetoric (see especially McGee 1975, 1980). The point that actor strategies, also of

contending parties, can produce consolidation because they have to accommodate to rhetorical force and counterforce, deserves further illustration. In the controversy about lead in gasoline, the U.S. Environmental Protection Agency (EPA) stood against industrial interests, with Ethyl Company (a producer of tetra-ethyl lead) as one of the protagonists. The EPA claimed that lead should be removed from gasoline to reduce environmental damage and to protect public health in urban areas, especially children's health. Ethyl Company defended the industrial interest in continued production, but in order to maintain credibility it did admit that *if* lead in gasoline impairs the health of children, it should be removed. So children's health became consolidated as a criterion. When further medical data become available, Ethyl Company has to accommodate to this criterion, and can only defend the direct industrial interest by interpreting the data so as to minimize any health hazard. When it requires more and more effort to argue such an interpretation (for instance, for scientific or for social, credibility reasons), Ethyl Company may have to give up the battle and let lead be removed from gasoline. (The data, though not the analysis, are drawn from Collingridge, 1980: chap. 11).

6. Compare the special issue of *Chemistry and Engineering News* (August 13, 1984). The focus is on the new issues, and the presentation of material, as well as the interview with Paul Berg (a molecular biologist who raised the original warning about possible risks), clearly show that the original debate is considered to be closed.

7. In the sociology of science, the importance of methodological relativism has been argued by Collins (1981), while the term "symmetrical approach" has been introduced by Bloor (1976). Such requirements are not always easy to follow in practice. When one wants to identify robustness (or the degree of robustness), one has to find participants who have actually tried to change the view and have discovered how much effort it would take (for this reason, a lot of attention has been paid to the study of scientific controversies), or make precarious inferences from documents and interviews (as I did for the recombinant-DNA debate), or perhaps "test" the robustness by probing the solidity of the view. The last possibility resembles the way electric potentials are defined (and approximately measured) by introducing a small test charge and measuring the force exerted on it. In sociology of science and of controversies, interviews often have a component of probing robustness, for instance, by throwing up counterexamples and criticisms. As long as the interviewer is not seen as a threat, the probe may be too superficial to be a real test (although it does produce further elaborations of the network of arguments and alignments).

8. An example (from many) is the way creationists have tried to use the symmetrical analysis of the creation-evolution controversy given by Dorothy Nelkin (Nelkin, 1977; also in Nelkin, 1984) to further their own case. Nelkin had to refuse invitations from creationists in order to maintain her independence and show herself as distant. Focusing on social embeddedness instead of methodological prescriptions as such also allows one to escape from the self-destructive implications of reflexivity: The thesis of relativism or symmetry should also be applied to itself, and the argument then is that thus its strength is dissolved. As a philosophical point, it could perhaps be neglected, depending on whether one wants to bother or not. But if one wants to bring one's analysis to bear on practical issues, or perhaps let it be a contribution to the ongoing debate, one *must* bother if reflexivity, in the form of criticism of the status of the analysis, is brought up. But then one also has the opportunity actually to react, to articulate the analysis further and convince the audience, thus consolidating the contribution. In the same vein, this article should be analyzable in terms of the perspective it elaborates. In fact, the rhetorical aspects in its

presentation are intentional, and an invitation to the reader to recognize the networking that is being done.

9. This analysis is inspired by the work of Gilbert and Mulkay (1984) on the discourse of scientists, but goes further than they are prepared to do. The duality of repertoires, and the necessity of some institutional embedding to create robust outcomes, can also be used to analyze legitimation problems of modern science, as they appear for instance in controversies (Rip, forthcoming b).

10. Inflation (of own claims) and reduction (of counterclaims) is a common tactic, also within science (compare the struggle for "facticity"). McGinn (1979) has discussed the tactic in environmental controversies and suggested that speciousness cannot be avoided. Petersen and Markle (1981) show that it is a necessary tactic, but one that may backfire, that is, it depends on the sociocognitive dynamic how the outcome will look.

11. The story is told by Wessel (1980), the analysis is different however. Wessel hopes that the continued profession of good intentions will stop the strategizing. My point is that strategizing, power play, and rhetorics are unavoidable, and that one should work through them, not against them (as the proponents did, unintentionally, with the first conference).

12. The same point can be made for the practice of knowledge production in science: Isolated from the competition and interest politics, there will be little production. Or as Passmore put it, "If, in the attempt to keep science 'pure' and 'rational,' we try to exclude the effect of special interests, prevailing modes of thought, the desire to get on with a job, we destroy its vitality" (Passmore, 1968: 158, quoted after Edge, 1985: 7). Proposals like Science Courts will therefore not be realistic, already for science-internal reasons. In the reasonably successful Consensus Development Conferences of the U.S. National Institutes of Health, it is a telling feature that they are normally held only when the controversy has been resolved to a large extent. Thus, it is not the procedure, but the timing that allows authoritative statements to be made. (See for an evaluation of these conferences Ash and Lowe, 1984, and Wortman et al., 1982.)

13. See the excellent review by Dorothy Nelkin (1984), included as a background paper in Twentieth Century Fund (1984).

14. This argument is inspired by Wilkes (1983), who made a similar point in an essay review of Casper and Wellstone (1981) and Levine (1982).

15. This work has been done by Wouter Van Dieren and collaborators of the Institute for Environment and Systems Analysis, Amsterdam/Zurich, motivated by environmental concern, but also partly funded by the detergent industry. See, for example, Van Dieren and Sas, 1985, and De Man and Van Dieren, 1985.

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