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Are debatable scientific questions debatable?

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Abstract

Scientists often find difficulty in engaging in formal public debate about transcientific social issues. Although science is a highly disputatious institution, public argumentation amongst scientists follows very different conventional practices from those that rule in political and legal arenas. Amongst other differentiating features, scientific disputes are typically conducted in writing rather than orally, they are not sharply polarised or formally adversarial, they are seldom addressed to a specific proposition, and they do not reach decisive closure. As a result, the rhetorical style that scientists learn from participation in such practises is not well adapted to the established format of socio-political 'debate'. For scientists to contribute effectively to such debates, they must learn new ways of making their particular type of knowledge convincing in unfamiliar intellectual and social contexts.

1. *Introduction*

As soon as one realizes that public communication is central to science one begins to think about rhetoric (Ziman 1968). The notion that the findings of research are so rational and compelling that they 'stand to reason' is a fantasy (Ziman 2000). Scientific knowledge is the product of a 'disputatious community of truth-seekers' (Campbell 1986), where fierce argumentation is the name of the game. The art of persuasion thus plays a major role in scientific practise.

What is more, quite apart from the hubbub of informal, more or less private exchanges of opinion, scientific progress depends on formal *public* argumentation, written and verbal. The norm of 'communalism' (Merton 1942 [1973]) underpins a variety of strongly institutionalized social practises which ensure that novel research claims are offered up for expert criticism before they are accepted by a research community. The contest for credibility between claimants and their critics—in practise, all members of the same community, but adopting different roles according to the circumstances—is intrinsically so fierce that it is subject to very strict conventions.

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In other words, science is not unlike other established epistemic institutions, such as law, scholastic theology and parliamentary government. Scientific disputation, although performed for real, is highly *ritualized* and constrained to a strictly limited rhetorical armamentarium. Certain styles of persuasive discourse are customary, whilst others are strongly forbidden. This goes further than the conventional courtesies and rules for turn-taking, etc. The social context shapes the subject matter, the structure of the argument, the framework within which it is set, the vocabulary of assertion and denial, and many other features of presentation and critique.

As I have tried to show at length elsewhere (Ziman 2000) 'academic science' in its idealised traditional form is not only a peculiarly effective institution for producing a particular type of knowledge: it is also the stereotype, the paradigm, of 'science' as a way of knowing. In this sense science is different from other sources of thought and action, such as pragmatic experience, common sense, technical practise, religious belief, spiritual inspiration, moral imperative, economic necessity or political expediency. In reality, however, the notion of 'pure' science is a chimera. It is becoming less and less feasible to exclude from scientific disputation considerations that are not amenable to its traditional rhetoric, such as human values, social interests, technological capabilities, and so on. Indeed, I would argue that the academic and industrial research traditions are being transformed and merged into a new institutional form. This new institutional form—what I have called 'post-academic' science (Ziman 1996)—is characterized by a variety of new norms and practices, and is becoming the dominant mode, even in relatively 'basic' fields of research.

What this means in practise is that argumentation about 'what is known scientifically' is taking place in a variety of other fora governed by quite different rules. One way of describing such argument is that it typically involves *transcientific* issues—that is, questions that could never be resolved by established principles of scientific method, such as experimental demonstration, mathematical prediction, or other forms of overwhelming rational inference (Weinberg 1972). The debate over climate change clearly involves many such features. In any case, science can no longer isolate itself socially from other societal institutions, such as law, government, commerce, the military, etc. that operate quite different modes of argumentation, quite different styles of persuasion and quite different criteria of belief. The debate over climate change, for example, is now so deeply implanted in the womb of politics that it cannot really avoid developing in conformity to the principles of that social environment, rather than those of the scientific world where it was conceived.

This in no way implies that the argumentation then becomes 'irrational' or governed solely by brute force. In every domain of civilized life there are well-established modes of orderly deliberation. Scientific concepts and considerations are typically invoked with respect in such deliberations. Modern political processes, especially in their bureaucratic aspects, owe a great deal to the scientific style of rationality (Ezrahi 1990) ; modern economic discourse is extravagantly scientistic in its rhetorical excesses ; ethical argumentation is now much focussed on scientific issues and there is much discussion about the best way of incorporating genuine scientific evidence into legal proceedings. One might say, rather, that the problem is not the incursion of politics, law, ethics, etc. into the realm of science, but the tendency to import quasi-scientific arguments into other societal realms which do not share their premises, criteria or objectives.

Nevertheless, the argumentation rituals of these other realms, although quite distinctive, are very different from those of science, and so, therefore, are their rhetorical styles. This is a two-way differentiation. It is obvious that the peroration of a defence

lawyer in a murder trial is rhetorically inappropriate in a scientific conference. But so equally, would be the presentation of the results of a mathematical computation in a court of law. Both of these styles would fail dismally in a parliamentary debate, and all three audiences would be unmoved by delicately phrased ethical considerations that might carry much weight in a Church Assembly, and so on.

Unfortunately, the world does not carve itself up neatly into issues pre-adapted for each separate type of argumentative forum. Transcientific issues are particularly difficult because they often have significant political, legal, ethical or commercial aspects, each with their own argumentation rituals and rhetorics. The question is whether a new format can be devised, such as a 'Science Policy Forum' (Mitchell and Paroske 2000) where these different rhetorics can operate simultaneously, or even combine into a new mode of argumentation in keeping with the new mode of knowledge production (Gibbons *et al.* 1994) characteristic of post-academic science. This is the spirit in which I have prepared this contribution to the discussion.

2. *The 'debate' format*

The *adversarial debate* format is, of course, perfectly familiar. It is ritualized in modern legislative assemblies, such as those modelled on the British Parliament and the United States Congress, and is imitated in innumerable debating societies all over the world. Its roots in European culture go back at least to the ancient Greeks—for example, in Thucydides' accounts of the tense political debates amongst the Athenians at critical historical junctures of war and peace. In the format proposed it also borrows from Anglo-Saxon legal procedures, such as the formalization of 'cross-examination' and the notion of an inexpert 'jury' to whom the argumentation is addressed and who will eventually 'determine' the issue.

I shall use this word 'debate' as a term of art for an argumentation ritual defined by the following features:

- A debate is a one-off, *public* event, initiated and completed within a limited period of time. Typically, it is conducted in a *forum* before an *audience*, most of whom take no direct part in the proceedings and may be quite ill-informed on the topic. It is designed as a focused occasion, often dramatized by the participants and sometimes attended to with great interest by the world at large.
- A debate is conducted orally, in direct speech, by named participants. Written material may only be introduced into the proceedings as subsidiary evidence, not as primary discourse.
- A debate has a specific *topic*, in the form of a 'black or white' *proposition*. This is typically understood to be a 'question' to be answered 'yes' or 'no'—ranging from 'shall we go to war with the French?' or 'shall the King be executed?' to 'shall the proposed clause imposing Value Added Tax on printed books stand part of the Bill before the House?'.
- The argumentation is *polarized*, and balanced ritually between a *protagonist* and an *antagonist*, (proponent' *vs* 'opponent': 'plaintiff' *vs* 'defendant', etc.) each of whom is privileged to speak both at the beginning and the end of the proceedings.

The other active participants often identify themselves as being 'for' or 'against' the proposition, although they may also be permitted to question the principal speakers on significant points.

- The proceedings are *adversarial*, in that each 'party' endeavours not only to make their own case but also to negate the case of their opponents, even to the extent of attacking their credibility as expert advocates or cross-examining them severely on disputable points.
- A debate is normally conducted by a *chair* (or 'speaker'), who simply ensures that the rules are observed. If it is designated a 'trial' it may be conducted by an impartial *judge* who may take an active part in the proceedings and is expected to 'sum up' the arguments on either side before putting the question to the vote.
- The debate almost always concludes with a *decision*—i.e. a 'yes' or 'no' answer to the question—determined typically by a simple majority of those who have (supposedly!) attended to the debate and are qualified to vote on such matters. Sometimes this includes the whole audience, who may be treated quasi-legally as a previously uninformed *jury*, although they are not expected to produce a unanimous *verdict*.

These are, I think, the main formal features of a traditional political or legal debate. In practice, of course, these features are varied and combined in many different ways, according to local custom. All I am saying at this point is that the social methodology of the Science Policy Forum clearly derives from this tradition and is, therefore, adapted to the rhetorical style shaped by it. Let us now look at the disputation rituals of science, and at the rhetorical style that they have shaped.

3. *Scientific argumentation*

A scientific dispute resembles a 'debate' in one extremely important respect: it is conducted in *public*. This is not a trivial similarity. The norms of 'communalism' and 'universalism' require that a serious contribution to scientific knowledge, including provisional research claims or counter-claims, should be openly accessible, and should be attributed to a named *author* or *authors*. The notion that a scientist might be persuaded to accept an idea for secret reasons, or from an anonymous source, is as unacceptable as that a member of parliament or a juror might be swayed by a bribe!

Indeed, this requirement is so strict that scientists are not obliged to take formal cognisance of any discourse, whether creative or critical, unless it has been *published* in an archival journal or book. Scientific disputation thus typically involves sequences of *written* arguments and counter-arguments in the official scientific 'literature', rather than *oral* exchanges in a public forum. It is significant that even supposedly verbatim reports of 'discussions' at scientific meetings are usually edited by the various speakers before publication. Scientific rhetoric is thus principally designed for written argumentation with distant opponents over substantial periods of time, rather than for short-term verbal confrontation.

Of course the practice of science customarily involves a great amount of oral discourse, at conferences, seminars, lectures, etc. Although public eloquence can be a distinct professional advantage on such occasions, a remarkably low level of verbal

fluency is acceptable. This is because the standard component in all such proceedings is the ritualised presentation of a 'paper'—not necessarily the verbatim reading of a written text, but essentially as if summarizing, or indicating in preliminary draft form, the substance of a publishable scientific communication. Occasional questions may be permitted during this presentation, but only to clarify specific points of detail. However badly this part of the ritual is performed, the audience is expected to listen, or watch any visual aids, in silence, endeavouring as best they can to grasp what the speaker is trying to tell them. The conventional presumption, emphasized by stock courtesies from the chair, is that the theme of the paper is worthy of serious attention, even if, at first hearing, it seems incomprehensible, wildly speculative, inconsistent, totally boring or otherwise unconvincing or uninteresting!

This ritual is deemed to be incomplete—in fact, discourteous to the presenter—until rounded off by 'questions to the speaker'. Indeed, in the social and human sciences it is customary to follow the presentation of a paper with a prepared comment by a 'respondent'. But this fellow scholar is not cast in the role of an 'adversary' and usually takes this as an opportunity to produce another paper on much the same theme, obliquely critical in spirit perhaps, but not overtly hostile.

The discussion phase of the ritual of 'presenting a paper' may occasion many rhetorical tropes. There is a story of Paul Dirac remaining silent when a member of the audience said: 'I didn't quite understand what Professor Dirac meant by...' The chairman finally asked him to answer the question. Dirac replied: 'That wasn't a question: it was a statement!'. Although such 'questions' are often disingenuously critical, and recognized as such by the speaker and by knowing members of the audience, they are normally phrased very politely. But there is no attempt to arrive at a conclusion, and the speaker always has the last say. However seriously challenged, an experienced academic performer can usually escape with a perfunctory counter-argument. I recall with delight the response of the late Sir Karl Popper to a tough question from Max Perutz: 'I thought I had explained that clearly. But if you think about it for a whole afternoon you will see that I am right!'

It is true that scientific meetings are frequently arranged to deal with notoriously controversial topics, but these are advertised as 'discussions' rather than 'debates' and are programmed to permit each of the principal contestants the opportunity to present their particular point of view positively, without necessarily attacking the alternatives. In practise, of course, the formal papers are followed by informal, unscripted exchanges which may become quite heated. At the end, however, the ranking independent authority on the subject, rather like a judge in a court of law, sums up the proceedings in terms that carefully avoid any definitive conclusions on the main bones of contention. In effect, this summing-up operates as a social device for cooling the rhetorical atmosphere, rather than a way of further building up the tension until it is released in the final drama of a 'verdict'.

Indeed, apart from book reviews—which are ignored, or cited as 'informal communications' in the official scientific archives—disputatious discourse seldom appears as such in the published scientific literature. It is normally reported only at second hand, ostensibly as if by an impartial observer, in conference summaries, review articles, surveys of the field, key-note addresses, introductory remarks from the chair, etc. Such 'secondary' texts play a major part in the production of scientific knowledge, but only as a medium through which a research community can achieve some sort of clarity and order in a controversial domain. Their official function is not to adjudicate between rival views, or even to state definitively what is currently accepted as

scientifically valid. Nevertheless, they are rhetorically sensitive because they are often extremely influential in dismissing completely implausible ideas or framing what will henceforth be taken to be the key issues.

4. *Scientific discourse*

Science is unlike law and politics in that it does not provide formal occasions for direct public argumentation. This is not to say, of course, that scientific papers, written or spoken, avoid controversial statements. On the contrary, one of the norms of science is that a would-be contribution to knowledge must always be 'original'. By arguing positively for novel facts or interpretations it inevitably pits itself against the supposed alternatives. This is usually so obvious that a major part of a scientific paper is customarily devoted to locating it in this pre-existing framework in order to demonstrate its novel features. In effect, the author rehearses—from their own point of view—the controversy to which it contributes or might be expected to arouse.

Indeed, one of the curses of present-day academic science is that every paper starts with a very conventional 'survey of the field', including a lengthy bibliography that cites all the usual suspects. This ritual might seem quite unnecessary, since the audience will consist almost exclusively of research specialists who are already thoroughly familiar with the relevant literature and would be quite satisfied with a reference to the latest review article. Perhaps this tiresome practice is just a custom transferred from the standard statutory requirements for a doctoral dissertation. But it can be interpreted functionally as a rhetorical device designed to show that the author is so completely at home in the field that their novel ideas are worthy of attention.

There is a deeper, more functional explanation. Science is like a mystery religion, where the public rituals are only outward forms of the real action. Before a scientific paper can be published, it is subject to critical appraisal in the form of peer review. One of the responsibilities of reviewers is to check that the paper is sufficiently convincing, in the light of current expert knowledge, to merit publication. This critique necessarily includes an analysis of its status within any relevant on-going controversy. Every author is well aware that one of the reviewers may support another side in such a controversy and is likely to turn down a paper that does not present fairly the case for that side. Such a presentation is therefore almost obligatory, as a matter of elementary prudence.

Indeed, peer review, although private and nominally confidential, is very much in the minds of all the parties to a scientific dispute. It is a hidden social mechanism that strongly shapes all public scientific discourse, formal and informal, written or spoken. Scientists learn by imitation and experience that their serious contributions to knowledge must always be presented as if to a fully-informed, professionally sceptical audience, whether as confidential referees or public auditors.

That is clearly why formal scientific knowledge is communicated quasi-logically, in technical terms, as if based entirely on accepted technical premises. It also explains the prejudice against instructive analogies and metaphors that could weaken an argument with dangerous ambiguities. Indeed, the prospect of facing peer scepticism, in private or public, affects the whole rhetorical structure of scientific discourse. Obvious objections or alternative interpretations have to be anticipated and disarmed, implicitly or explicitly, before they can be raised by referees or public critics. The innovative ideas in a good scientific paper are not just novel theoretical inferences that arguably fit the observed facts: they are pre-adapted to survive in the critical environment in which they

are to be presented. Ideally, they are presented as if they were already part of the (thus newly-achieved) consensus, in a form that is so unquestionable that it can be treated as camera-ready copy for a new chapter in the next generation of textbooks!

5. *Who is the protagonist?*

In scientific disputation, the author of a paper plays the part of the protagonist of its argument. He or she is clearly identified as a named individual, and is deemed to bear full personal responsibility for its contents. Whether or not these contents are novel or conventional, contested or indisputable, critical or confirmatory, they are associated at that point with the person who states them. They are taken to constitute genuine information, honestly arrived at and sincerely analysed with the intention of persuading the audience that they are worthy of scientific consideration. A scientific paper, written or verbal, does not just report certain findings and abstractly debate their interpretation: it puts forward the *personal* conclusions of its author (or authors) on the matter under investigation. This is a major point of principle, with a significant practical function in attributing discoveries, regulating citations, and even in assigning blame in cases of deception.

Yet, paradoxically, scientific papers are always written in an entirely *impersonal* style. Apprentice researchers have to learn to put all their verbs into the passive voice, to exclude all personal pronouns, to code all references to their colleagues and generally to present their work as if it had been performed by nameless, soulless robots somewhere in Outer Space. The norm of disinterestedness requires that the research should be reported out in a spirit of perfect modesty, completely detached from any supposed human interest that the nearly invisible author might have in its just possible success.

Thus, in the formal presentation of a scientific argument, the protagonist plays a peculiarly paradoxical role. On the one hand, he or she is a real person putting forward findings and interpretations in which they have a large professional stake. On the other hand, they write and talk as if they were a mere channel for the communication of facts and theories generated absolutely elsewhere by anonymous androids. They bring, as it were, 'news from nowhere'. Their virtuosity as proponents lies not in arousing more-than-rational sentiments favouring the views that they advocate but in concealing all possible causes for suspicion that they might actually be partial to these particular views. They pretend that all that they are doing is presenting the realities of the situation, as now revealed to all good scientists interested in unveiling them.

This paradox is so familiar to experienced researchers that they completely discount it. It may even be inverted rhetorically, so that the most credence is given to those who apparently strive least for it. In principle, the spirit in which a research claim is made should have no effect on how it is assessed: in practise, too much zeal can win negative marks in the contest for credibility. I remember Edward Bullard remarking that the enthusiasm with which the excitable 'outsider', Alfred Wegener, presented his idiosyncratic hypothesis of Continental Drift was a distinct handicap in opposing the shy, dry mathematical formality of Harold Jeffreys, a remote Cambridge don who 'obviously' had nothing to gain personally from the outcome of the controversy!

Needless to say, the conventions of scientific disputation exclude personal attacks on the competence or motives of one's opponents. This is not just a formally regulated courtesy, as in a parliamentary assembly: it is a tactical imperative. Nobody is under any illusion about the fierce personal antagonisms aroused in scientific controversies,

but public abuse of one's opponents is immediately taken as an indication of a case that cannot stand up on its own merits. One of the standard items of professional humour amongst scientists is a thesaurus of the euphemisms used by public reviewers to denote disbelief, rejection and intellectual scorn, such as: 'it is not quite clear that ...', 'certain questions remain unanswered ...', 'doubts remain ...', or, (most dismissive of all) 'this point has also been discussed by X'.

As I have already remarked, scientific argumentation does not usually proceed by the direct contraposition of individuals advocating opposing views. In practise, of course, the various participants in a 'discussion' identify themselves as strongly for or against particular propositions, and aim their remarks against easily identifiable opponents. Such divisions of opinion are not formalized and many participants may make comments that cut across the divide. The disputation rituals of science have no role for an official 'antagonist', analogous to a 'prosecuting attorney' or 'Leader of the Opposition'. Where, sometimes, this role is assumed by some establishment figure—for example, in the famous Oxford debate over Darwinism in 1860 and in the public debates over Continental Drift in the 1920s (Hallam 1973)—the result is usually deplorable. Indeed, as in the case of certain episodes in the Soviet Union during the reign of T. D. Lysenko, such an event is seen sometimes simply as a display of dogmatic authority. Where, as in a review article or survey, the presenter of a paper is personally licenced to comment directly on the work of others, this is not as a partisan in the controversy but as an impartial assessor summing up the case for each party (of which there may be more than two) for the benefit of the research community and only dismissing those that the audience most surely would not want to consider further. One of the merits of the reports of the ICRC on global warming has been their remarkable professional skill in adopting this stance consistently as the balance of the evidence has slowly changed with time.

6. *What is the proposition?*

A debate, in the formal sense, is normally about the acceptability of a specific proposition. but scientific controversies are seldom that simple. Only rarely can the issue be summed up succinctly in a short sentence such as 'the earth's atmosphere is warming', 'the continents drift across the globe' or 'AIDS is caused by HIV'. They arise typically around nodal points in networks or bundles of theoretical and empirical knowledge, or in relation to competing interpretations of complexes of evidence. The contestants may be well aware that this evidence would seem to confirm or refute a particular answer to some very radical general question, but they do not usually try to bring the whole of this larger issue into dispute. Thus, for example, scientific disputation about Continental Drift was focused on the difficulty of imagining a powerful enough mechanism, as if various empirical facts that seemed to favour it could be ignored.

In reality, scientific progress does not follow Popper's (1968 [1963]) recipe of successive theoretical conjectures being winnowed away by empirical refutations . As other philosophers have pointed out, there are always just too many other untested assumptions that might be the cause of the apparent disconfirmation. At any given moment, a research community has usually accumulated a variety of competing hypotheses designed to get around supposed contradictions and anomalies in order to explain what is thought to be known. There is seldom a novel item of information or analysis that can cut through a snarled-up controversy like a Damoclean sword.

Thus, a polarized debate on a carefully framed proposition may be too contrived, too coarse, as an epistemic instrument. More scientific progress in an active scientific controversy can be made by following the practise of some learned societies and journals—for example, *Brain and Behavioural Sciences*—in staging open 'discussions' where various interpretations of a contentious situation can be publicly advocated, critically scrutinized and privately assessed for their relevance and validity. The real question has to be, not 'is this or that proposal the right answer?' but 'what is it all about?'.

It is unusual, therefore, for an explicit scientific proposition to be put up for public scientific debate. When such a debate is sought, it is often about a 'heresy' that consciously challenges the established wisdom in a whole field of knowledge. 'It is the duty of the scientific community to decide once for all', insists the would-be protagonist, 'whether there is any scientific merit in my unorthodox interpretation of (special relativity), (thermodynamics), (stellar redshifts), (homeopathy), (the cause of AIDS) (etc.)'. One might have thought that this would be a good way of closing off a controversy. In practise, however, such challenges are seldom accepted, for if they are defeated they never prove definitive in the sense of silencing a convinced dissident. One of the characteristic episodes in academic life is the tennis volley of published 'comments' and 'replies' that is only ended by editorial decree. In most cases, indeed, the heretical view has already become fairly familiar through the research community, and—rightly or wrongly—rejected by almost everyone. In effect, the demand for a public debate is seen as an attempt to publicize the heresy and keep it alive scientifically rather than as a serious procedure for arriving collectively at the truth.

7. *What is decided?*

The fact is, nothing is ever finally decided in science. Scientific controversies are never formally closed. There is no procedure for putting an end to a dispute. People just take the views of the 'winning' side to be valid and rely upon them in their own research. After a time, the 'losers' are no longer cited, except as historical curiosities. Discredited ideas are simply ploughed in; the frontier of knowledge moves on.

This infuriates diehard 'heretics', who insist that it is the duty of an authoritative body, such as the Royal Society, to proclaim officially the scientific truth. The scientific community recognizes no such duty. In science, there is no ultimate Court of Appeal, no Supreme Court issuing definitive judgements on contentious issues. If such a judgement were handed down by some very prestigious body, it would immediately be subject to further intellectual challenge by the intrepid losers.

Thus, although scientific practise is designed to generate knowledge that commands a voluntary consensus, this consensus is never finally attained. Even when there is no active dissent, it turns out that people define quite diversely what it is they say they all accept. For example, all physicists nowadays accept quantum mechanics and use it without hesitation in their research. But you would come up with a wonderful variety of theoretical and factual complexes if you asked them, individually, what it was they actually believed about it. You might even find some thoughtful physicists who would say that quantum mechanics works well enough in practise but is so paradoxical in principle that it will surely be superseded by a better paradigm in due course.

In effect, then, what is normally being disputed is not the absolute validity or ultimate truth of certain propositions, but their relative *credibility*. In an active scientific

controversy, there are few perfect believers or disbelievers: the bulk of the participants are people with various degrees of provisional belief, suspended disbelief or qualified scepticism, who would have to vote 'don't know' if asked to state honestly what they think. This does not mean that scientific ideas are all equally uncertain—that it is ruled by the complete scepticism propounded by some ancient philosophers and modern sociologists. But scientific practise is based upon the premise that scientific knowledge is a system of beliefs, which are only relatively more or less tenable, never totally unquestionable.

Thus, the logic of scientific discourse is essentially Bayesian (Ziman 2000). Its rhetoric is directed at changing the 'subjective probability' of various propositions in the minds of members of a research community. At any given moment, an experienced research scientist is aware of various competing theories, backed by apparently inconsistent items of empirical information, to which she mentally attaches more or less significance in her ongoing research. Although she would not normally try to give a numerical estimate of the likelihood that any particular element is 'true', she is well aware of the way in which a change in the credibility of such an item will influence her belief in other items to which it is logically connected. Thus, for example, an experiment that fails to confirm a theoretical prediction may drastically reduce (but not totally 'falsify') the credibility of that theory.

The function of the argumentation rituals of science is to formulate and refine public statements about the networks of more or less credible interdependent propositions that span the current state of knowledge about a particular aspect of nature. Thus, questioning may elicit contradictions and uncertainties in particular items of empirical or theoretical evidence that will significantly alter its weight in the relative belief that people have in other more general ideas. At the end of the 'discussion', the balance of opinion may have changed markedly amongst the participants, to the extent that some of the competing ideas are no longer considered worthy of serious attention, whilst others are taken to be much better founded than was previously thought. This is genuine scientific progress, but it will only show in the use that scientists actually make of these ideas in their own research or technological practise.

8. *Conclusions*

The agonistic context for scientific rhetoric is thus very different from other modes of ritualized public argumentation. Unlike a conventional 'debate':

- A scientific dispute is normally conducted as much in writing as orally;
- The audience is assumed to be already very well-informed on the topic;
- There is no precisely defined proposition, to be answered yes or no;
- The proceedings are not adversarial, as between officially identified protagonists and antagonists;
- Attacks on the personal motivation or credibility of the disputants are unacceptable;
- The discussion does not close with a formal decision or verdict.

These peculiar features of scientific disputation are integral to its epistemic culture. Conventional 'debating' practises just do not fit into the evolution of scientific knowledge in its traditional academic mode. In effect, 'debatable' scientific issues are

never actually 'debated'. One must therefore seriously ask whether much of value can be achieved by a formal procedure designed to bring scientists together for just such an activity.

Transcientific issues emerge in socio-political contexts and give rise to disputes with scientific aspects that cannot be settled scientifically. Scientists are inevitably drawn into the sphere of politics, if only as experts enlisted by government officials, citizens, corporations and social movements to testify on their behalf. The ensuing argumentation tends to rupture the barrier that has separated the relatively stable traditional forms of scientific controversy from other—equally stable—forms of disputation. As a consequence, scientists who are only accustomed to the scientific mode of disputation are not well prepared for the debating rituals of transcientific controversies. They bring into the proceedings the scientific expertise and presentational skills which have stood them well professionally and find that these do not work as usual. That is to say, their accustomed rhetorical style, shaped and refined in purely scientific arenas, just does not succeed against the very different rhetorical styles of politics or law.

Thus, for scientists to contribute effectively to such debates, they must learn new ways of making their particular type of knowledge convincing in unfamiliar intellectual and social contexts. Much of this rhetorical re-education is just tactical, but it includes some important strategic considerations.

8.1. *Paradigm re-orientation*

It is not sufficient for scientists just to restate their research findings as simply as possible, in ordinary language, with a minimum of technical terms. Their discourse has to be adapted to the whole epistemic framework of the audience—the beliefs and opinions that most people have about the larger realities of the world. The way in which scientists carve up the world for research—for example, into 'disciplines', 'fields', 'specialties', etc.—does not conform to the way in which people categorize the entities of everyday life—e.g. as 'objects', 'organisms', 'persons', 'institutions', etc. A substantial re-orientation of normally unstated paradigms may thus be required to make even the most elementary scientific propositions intelligible.

8.2. *Doubt suppression*

Scientists learn by experience to hold simultaneously in mind a number of uncertain, perhaps inconsistent, ideas, without being paralysed by logical gridlock or complete scepticism. In professional disputation they are always careful to cover themselves by showing that they appreciate the innate corrigibility of even their most convincing arguments. For an audience that does not share this cognitive style they must suppress the expression of the hypothetical doubts that affect all their research, and speak only of realistic uncertainties. This may require very careful phrasing—admirably illustrated by the successive reports of the Intergovernmental Panel on Climate Change (IPCC)—so as not to fall over into the opposite trap of excessive positivism.

8.3. *Value candour*

By definition, transcientific issues involve personal, institutional and cultural interests and values that are systematically excluded from scientific argumentation. These interests are integral to the debate and have to be given public expression, even to the level of the imputation of self-interested motives to individual participants. For that

reason, scientists entering such debates must be prepared to encounter rhetorical practises that would be quite out of place and out of order in their scientific experience. Perhaps the best policy is to be entirely open and candid about one's personal interests and values, rather than trying to maintain a stance of pure scientific objectivity on matters where it is implausible to pretend to be impartial (Ziman 1996).

8.4. *Verdict focus*

A transcientific issue can never really be closed, but a transcientific debate is usually designed to arrive at a 'verdict' on a specific proposition. The argumentation, therefore, needs to be focused on obtaining a definite outcome, rather than on exploring and determining the relative credibility of all the lines of relevant evidence. This is not easily learned by a scientist who has become so engrossed with 'getting right' the minutiae of specialized research as to lose sight of the larger issues to which these relate.

9. *Conclusion*

I put forward these remarks very tentatively, for I am sure that a detailed study of the actual performance of scientists in transcientific debates would reveal many other factors that make their interventions less effective than one would suppose from the perspective of scientific rationality. Here, surely, is a fertile field for research on 'the rhetoric of science'.

It is also interesting to think about the contrary process: the introduction of transcientific considerations into ritualised scientific disputation. Indeed, as a matter of philosophical principle, such considerations are always present, although seldom acknowledged. Practical, common sense, socio-political influences cannot really be kept out of the research process (Ziman 2000). They play an important part in what problems are investigated, how they are formulated, what resources are available and even how the results are interpreted. One does not have to buy the whole 'social constructivism' doctrine to appreciate this and to note the extent that social interests and values actually sustain the explicit rituals of scientific argumentation.

The more interesting question is how to accommodate these considerations when they are quite obviously part of the argument. This is a major issue in the social sciences and humanities, where interests and values are integral to human behaviour, and where the distinction between lay and 'scientific' categories and concepts is usually quite artificial. Sometimes the difficulty is side-stepped by trying to model all the arguments on those of the natural sciences - for example, by excluding all references to intentional mental processes, or by presenting all human activity as if it were governed by quasi-economic rationality. But those who rely rhetorically on such devices in academic contexts should remember that they will not stand long against cross-examination in courts or assemblies where the realities of human existence are much better understood.

It may be, indeed, that novel procedures, such as variations on the 'Science Policy Forum' format, will be devised that can open up these hidden layers, and bring them into the arena of normal scientific argumentation, without transforming this into a typically political forum. Equally, these procedures may also evolve to reveal and take into account the concealed scientific elements in socio-cultural debates, without 'scientizing' them and thus jettisoning the more agonistic and participatory norms of deliberative rhetoric as a tradition of public argument. Experience with these formats

will surely produce people well adapted to operate rhetorically in them, and new institutionalized forms of disputation, blending scientific and socio-political knowledge, will surely emerge to suit new societal needs, just as previous types of argumentative ritual evolved into our present-day law courts, parliaments and scientific institutions.

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