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# A CONSUMER'S GUIDE TO SCIENCE PUNDITRY

*Henry Bauer*

> Unfortunately, the 'metascientists' – the historians, philosophers, sociologists, psychologists, economists and political scientists who describe and analyse science and technology from a variety of different points of view – have not yet come up with a coherent account of just how the research process actually works. Indeed, much of their contemporary discourse seems aimed at proving that there is no such process, that anyway it doesn't work, and moreover that it works all too well on behalf of certain sinister power groups.
>
> (Ziman 1994)

Science – a term I use here to refer to the natural sciences – explains a great deal about the world. But what explains science's success at finding good explanations? A resolution of this conundrum is far from a purely academic matter. Among the concrete issues that call for concrete answers are the following:

1 What should every educated citizen know of or about science?
2 What should science teachers know of and about science? What about science writers? Or journalists in general?
3 How much of society's resources should be devoted to science? To what sort of science – exploratory or applied? In which fields? Physics? Biology? Chemistry? On attempts to find a cure for cancer? For AIDS? For heart disease?
4 What place should science have in the curricula of elementary (primary) schools? Of secondary or high schools? Of colleges?

Those questions are of the widest concern. And there is no consensus over answers. On each and every such issue, politicians, media and public find ample room to disagree. So do the experts even as they each claim authority for their own viewpoint. Those disagreements reflect the lack of unison over the very fundamentals of how science actually works: how reliable its knowledge is, how any given bit of science can best be appraised, how we can judge when science is able to supply a specific recipe for something we want done.

The central puzzle, how science has been able to produce such reliable and potent knowledge, has elicited a variety of responses. Some say that science's secret lies in its special method of inquiry, usually said to be reliable and self-correcting (but why should, how can, an inherently reliable approach need perpetual correction?). Others suggest that the secret is empiricism and pragmatism – which fails, however, to capture the role that theories and beliefs play in science. Certain contemporary pundits take the effectiveness of science to be illusion rather than reality. And there are all sorts of other views on the matter as well.

Absent a consensus, it is useful to know what the most prominent camps have to say and why they disagree with one another. I shall describe here the viewpoints about science that are native to various disciplines, as well as an ideological divide that cuts across the disciplines.

## DISCIPLINES ARE CULTURES

It is a common presumption that all fields of science – or even all intellectual disciplines – are essentially the same sort of thing: the pursuit of truth, albeit about different topics. In point of fact, this is quite wrong. Each intellectual discipline carries with it idiosyncratic beliefs about what 'truth' even means, about what is valuable and what trivial, about how much or little objectivity is possible, about how certain is the knowledge that can be obtained, and much more. There is good reason to think of the academic disciplines as cultures, whose members have not only a common intellectual task but also many values and many characteristics of behaviour in common (see e.g. Bauer 1990a). Each discipline develops a distinct culture specifically suited to its particular intellectual task – for example differences between pure mathematics and mathematical physics (Quinn 1996). One consequence is that disparate answers may be offered by various disciplines on any given question, say as to how science works: each discipline looks in its own manner for the answer, and each seeks its own sort of answer.

Were disciplinary differences only a matter of different bits of 'true knowledge' available to the respective experts, then disagreements could be settled by recourse to evidence and logic. That unanimity has not ensued despite the adducing of much evidence, and the deployment of much logic by many experts over many decades, illustrates the degree to which cultural differences are at issue. It is just very difficult for physicists, say, even to understand how sociologists can take the sort of stance that they typically do, let alone to engage in fruitful intellectual discourse with them. As with national cultures, each disciplinary culture has its own language or dialect, practices and traditions – each has its own set of things that are taken for granted and customary patterns of behaviour that set members of one culture off visibly from those of another. Among the easily noticed consequences (see Bauer 1990a, 1990b) that have no obvious connection with disciplinary contents are the following:

First, scientists strive to speak (or to appear to speak) off the cuff, using the barest minimum of notes, to demonstrate their mastery of the material. Historians or philosophers, by contrast, read from prepared scripts: should they venture to speak off the cuff, their audience would infer not mastery of the material but that the speaker had not taken the time to prepare a proper paper.

Second, when the professional work of academics is judged by their peers, the manner in which appraisers describe the work is idiosyncratic to each field: in mathematics, for example, individual pieces of work are analysed and rated for creativity and elegance of execution, and direct comparisons with other individuals are typically made; whereas in sociology, the analysis tends to stress such things as the numbers of publications, the prestige of the journals and the roles of co-authors (see Bauer 1988).

Third, practitioners of different disciplines typically differ also in political and religious associations: scientists and engineers are characteristically more conservative and more likely to be religiously affiliated than are sociologists or political scientists or psychologists; but physicists differ markedly from other scientists in these respects (see e.g. Ladd and Lipset 1972).

It is hardly surprising then, though it has remained largely unremarked, that different disciplines have quite different things to say about what science is, how it works, and why (or whether) it has been successful. One point of at least implicit agreement, however, is that science has an impressive record, most especially over the last three centuries or so, of providing definite answers to a host of substantive questions about how the world works. Yet there is disagreement as to whether, or in what sense, the changes in scientific knowledge over these last centuries can legitimately be called progress, and if so, in what sense.

On many points the opposing views correlate strongly with the disciplines within which they have evolved. Other dissensions, however, are found within individual disciplines between experts adhering to disparate schools of thought. Thus within philosophy of science there are various opinions as to how scientific concepts or objects correspond to things in the actual world; within sociology of science too there are many varieties of 'realist' as contrasted with 'relativist' persuasion. There are ideological as well as disciplinary correlates of beliefs about science.

## DIFFERENT EXPLANATIONS OF SCIENCE

Broad-brush comparisons as in this chapter must deal largely in stereotypes and pass over nuances and overlaps. I hope that no one will accuse me of pretending, for example, that all scientists think of science in the manner I describe below or that all sociologists hold the views I ascribe to their discipline. But I do claim that these are, as tendencies and by-and-large descriptions, matters of empirical fact familiar to people who have read or heard something of the pertinent disciplinary discourses.

One source of distorted views of science stems not from disciplinary bias but from the historical fact that astronomy and mechanics were the first bits of science to captivate the modern human imagination. Thus physics became the paradigm of 'modern science' on which historians long concentrated to the virtual exclusion of other sciences. Philosophers sharpened their wits on what history of science had most explored; and sociology of science followed. Only in relatively recent times have other sciences come under as detailed scrutiny as physics has received for well over a century.

### Explanations by scientists

Another caveat is at once called for. There are substantial differences among the various sciences on several relevant points, for example between geologists and physicists (see Bauer 1992), yet on the issues emphasized here, scientists as contrasted to others do tend to hold something like the following views.

Working scientists accept, through experience if for no other reason, that most scientific knowledge is enormously reliable, 'factual' – corresponding in some valid manner to the realities of Nature. They are already inclined to that view, of course, through learning science in the first place. In school and to college undergraduates, science is taught as indisputably correct knowledge arrived at by the scientific method which guarantees reliability. In graduate work, doing genuine research, science students get the opportunity to recognize what degrees of uncertainty may attach even to some long-accredited facts; yet this remains a gloss of occasional doubt over a large body of established knowledge.

Scientists implicitly believe that through experiments they discover facts; that doing this is what the scientific method amounts to; that scientists more-or-less automatically use the scientific method without needing explicit training in it.

Scientific knowledge is what works, scientists understand. Facts lead to and determine theories. The theories themselves are only heuristic: they get dropped when found seriously wanting (that is, no longer useful) – though up to the very moment of that decision they command unstinted credence. This uncritical, albeit temporary, allegiance gets easily misunderstood by outsiders, who do not appreciate – even though the history of science is replete with examples of it – just how fickle scientists' devotion to any particular theory is. (Individual scientists, of course, just like any other stubborn human beings, may often stick with their own pet theory even when the rest of the discipline has long discarded it; and of course experimentalists are usually more ready to discard any given theory than are the theoreticians.)

To most scientists, it is not theories but techniques that are the biggest deal, for every new instrument or method makes possible studies that were not possible before and leads to ideas that were literally inconceivable beforehand. For example the polymerase chain reaction has allowed genetic engineers now to contemplate doing things that earlier seemed science fiction. War-spurred advances in microwave technology led to revolutionary advances in radio-astronomy; later developments in electronics have made the search for extraterrestrial intelligence scientifically respectable. Several decades ago a question on our Chemistry Honours exam reflected this understanding of the significance of experimentation: 'Every advance in science is an advance in technique. Discuss.' It is a telling comment on the state of science punditry and the matter of disciplinary biases, that only rather recently has the significance of experimental innovation in the progress of science become a 'hot' topic in meta-science; owing in no small part, moreover, to the influence of the physicist Allan Franklin (see Franklin 1986).

Just as non-scientists are naive and ignorant about some aspects of science that practising scientists take for granted, so scientists are naive and ignorant (and disbelieving) of some things that seem elementary to those who study the humanities and social sciences. Thus scientists presume that controversies get settled because logic rules and evidence piles up; whereas political scientists, historians and others are clear that arguments often do not get settled just because the facts have become intellectually plain. Psychologists, too, know of the many ways that human beings have of ignoring unwanted evidence and seeing only what they want to see. So while scientists often have a good intuitive grasp of matters internal to doing science, they can often be naive and ineffective on questions of public policy and public relations pertaining to science.

Scientists do not realize that other disciplines do not deal in or even aim for reliable factual answers: that philosophers may agree over the rules of logic but not over how or whether truth can be established; that historians, philosophers or sociologists do not expect ever to find final answers to which everyone else in their discipline would be willing to assent; that in those fields it is useful, interesting and worth while to remain in disagreement even as individuals press their own views vigorously, just as though they believed themselves right and potentially able to convince others of it. In science, when consensus is lacking, that is thought to be owing only to some needed facts still being missing.

Scientists believe that humankind has no finer pursuit than science. So nothing is more important than carrying it on. Thus high-energy physicists have no doubt that a Superconducting Super-Collider (SSC) needs to be built and that whatever it costs must be worth it; and other scientists would not have disputed that, were it not that their own sciences now compete for the same limited funds.

Because scientists take knowledge in science to be openly demonstrable and unequivocally provable, they willingly defer to their fellow experts in the sundry scientific specialities and sub-sub-specialities: all scientists accept what chemists say about molecular interactions, what physicists say about elementary particles and forces, what biologists say about evolution. Naturally, then, they adopt the same attitude on matters outside science. Thus on questions of meta-science, scientists naturally defer (without looking into it very much) to people who carry such labels as historian, philosopher or sociologist of science – unless or until, that is, they become aware that science is being attacked or nonsense about it spoken. (Scientists' incredulity and anger over distortions of science are well illustrated in Paul Gross and Norman Levitt's (1995) *Higher Superstition*. Scientists find it difficult to comprehend that intelligent people could hold the opinions that relativists voice, and are aghast when they come across what is said about science by radical feminists, Afrocentrists or Marxist purists.) Perhaps most commonly adopted by scientists is the realist philosophers' postulate of a methodical, logical science whose theories encapsulate scientific knowledge: it is after all congenial to scientists that science be regarded as an essentially rational pursuit whose method makes their results automatically right.

But most scientists feel no need for an explanation of how or why science works: they just do it, solving problems and making discoveries. Scientists who actually look into meta-science tend to find Thomas Kuhn's (1963) classic *The Structure of Scientific Revolutions* full of authentic insight into scientific activity; in particular, they recognise the verity of Kuhn's insight that scientific revolutions can alter scientific theories without much changing the essence of scientific knowledge, namely how to observe and how to do specific things. For philosophers of science, Kuhn's book was (and remains) controversial. Many sociologists, however, have embraced a relativist interpretation of the book that Kuhn himself strenuously disavows.

## Explanations by philosophers

Philosophers of science have concentrated on what philosophy has traditionally covered: analysis of meaning, intricacies of logic, and epistemology. So philosophy of science has focused on scientific theorizing and scientific method. What can make scientific method reliable? What are the criteria for good, better, or best theories? When and why do theories change? Thus, as already mentioned, it has only recently come to the attention of philosophers that progress in science hinges in large part on experimental capabilities.

Philosophy's preoccupation with theory and method has been influenced by the common perception that modern science stems from the Copernican, Galilean, Newtonian episode whose significance lends itself well to discussion in terms of theories: earth-centred versus sun-centred and the religious and therefore social consequences of that. Galileo's role has often been described as illustrating the proper role of method – testing theories by observation – rather than what was really crucial, invention of the telescope and, before that, of the manufacture of lenses. Moreover the view that the essence of science is theorizing and testing theories by crucial experiment happens to be more compatible with physics – elementary-particle physics – than with most other sub-specialities in science.

So philosophers equate science and scientific knowledge primarily with scientific theories. The abhorrence some of them have for Kuhn stems from seeing his work as denying that science exemplifies rationality at work (see e.g. Stove 1982).

## Explanations by historians

There used to be two schools, the internalists who looked at the substance of the science and the externalists who looked at the environment in which the science is done; but this distinction no longer (it is often said) applies since it is evident that the two approaches are both indispensable parts of the same story. Yet in practice one still sees work that amounts to internalist because it neglects social circumstances, and also work that is externalist in its neglect of the content of the underlying science.

The historian's trade is to tell authentic stories about the past. Historians are clear that any particular interpretative framework is unlikely to enjoy universal validity, so grand theorizing is eschewed; such maverick theorizers as Toynbee and such amateur synthesizers as H. G. Wells are given little professional shrift. Historians of science have rarely sought to join the disembodied theorizing engaged in by other meta-scientists (though they do like to present stories that show how one or another meta-theory is excluded or not excluded by the evidence).

Not only does unwillingness to venture grand schemes prevent history of science from speaking with unequivocal authority, but also historians concentrate on disparate factors: on ideas, or on social interactions, or on political frameworks – usually within discrete periods of time and specific cultures. Historians habitually and consciously take the modest stance that they are telling only part of a whole story.

## The Romantic divide

In the history of human thought one can discern an ancient, now ever-present tension between the belief on the one hand that human intuition and concrete human experience are the royal road to comprehension and the conviction on the other hand that reason, logic and intellectual abstraction are the valid path to understanding. Probably no individual or group has held precisely to either of these extremes, yet history does show periods and places of dominance of the one view over the other. The Scientific Revolution of seventeenth-century western Europe is often taken as harbinger of the eighteenth-century Enlightenment in which rationality in all matters became a guiding principle; used, abused or misused in the service of social revolution, for example, in France. The intellectual 'excess of abstraction that marked the end of the Age of Reason' stimulated the reaction of early-nineteenth-century Romanticism with its emphasis on 'concreteness and the love of common facts' (Barzun 1994). The middle and late nineteenth century then saw a resurgence of 'realism' in response to an excess of Romanticism. At the end of the nineteenth century another predominantly negative response to realism came in neo-romanticism, to be followed in turn by a period of neo-realism (see e.g. Brush 1978).

These sweeping characterizations, of course, express only an apparent predominance of the one attitude over the other. Few if any individuals exemplify the extreme of scientism or the opposite extreme of unmitigated Romanticism. (A dictionary definition of scientism is quite serviceable: the theory that investigational methods used in the natural sciences should be applied to all fields of inquiry, the application of quasi-scientific techniques or justifications to unsuitable subjects or objects.) Both attitudes are simultaneously ubiquitous in people and in societies. Periods of rapid scientific advance are often accompanied by romanticized notions of an anti- or pseudo-scientific sort (see Bauer 1986a, 1986b). Nineteenth-century discoveries in electromagnetism were accompanied by a plethora of electric health-cures and quackery. The realism of natural selection and the tracing of human origins to the animal kingdom came simultaneously with Spiritualism and the enthusiastic investigation of psychic phenomena. The end of the nineteenth century and the beginning of the twentieth saw not only the genuine discoveries of radioactivity and X-rays but also the illusory ones of N-rays and mitogenetic radiation. The Second World War was followed not only by an avalanche of new science and new technology but also by the advent of flying saucers and renewed interest in cryptozoology and parapsychology. Our most modern scientific age also harbours New Age beliefs that counter the cold, hard facts of established science with intuitive, mystical and pantheist concepts.

Among the intellectual disciplines one sees the same cycles as in society at large, though mathematicians, scientists and perhaps philosophers and historians are less likely to partake deeply of Romanticism than are behavioural and social scientists.

### Explanations by sociologists

The classical (Mertonian) kind of sociology of science takes a realist view and examines the detailed interactions in the scientific community that have made it pre-eminent as a means of generating reliable knowledge (peer review, criteria for attaining prestige, and so forth). In recent times this approach has been largely pushed aside by the 'sociology of scientific knowledge' which emphasizes that human knowledge is not directly of any real world but only of some consensus reached by specific communities about their world. 'Discovery' is replaced by '(social) construction' (as in Pickering 1984). Scientific practice is thought to be explicable through ethnomethodological studies – observing scientists at work in the lab – rather than by looking at the capabilities of the instruments being used.

At the same time, paradoxical though it may seem, sociologists are utterly devoted to the notion that being scientific means using the scientific method (see Bauer 1992: 128–40). Thus contemporary constructivists and relativists delight in illustrating that scientists do not really practise the scientific method and that, therefore, the natural sciences are no more a matter of hard knowledge and objectivity than are the social sciences.

That belief comes to them naturally, of course. The social sciences do not have the experience that pervades the natural sciences, of dealing with facts that cannot be gainsaid, with operationally unambiguous knowledge and the sort of intellectual consensus that follows therefrom. In the social sciences, schools of disparate viewpoint flourish and coexist as they do not in the natural sciences. Thomas Kuhn's (1963) notion of 'paradigms' is sometimes misappropriated by social scientists to imply that in a science there may fail to be consensus on fundamental matters; one even hears sociology self-described as a 'multi-paradigmatic discipline'. Theory-building is highly regarded (though the testing and discarding of theories is not much in evidence), and sociology of science often harps as much as does philosophy of science on the theorizing part of scientific activity.

## INTER- OR MULTI-DISCIPLINARY APPROACHES: 'SCIENCE STUDIES' OR 'STS'

A number of more-or-less organized efforts to blend some of these differences of viewpoint has been made during the last several decades. By the late 1960s, a significant number of college courses (in the USA) addressed social implications of science and technology, often through co-operative ventures among scientists, engineers, humanists and social scientists. Joint ventures by philosophers and historians and sociologists sometimes went so far as the establishment of such departments as History and Philosophy of Science, or Philosophy and Sociology of Science. Full-blooded attempts at inter- or multi-disciplinary scholarship and teaching have led to the founding of units or departments or centres of what is now typically called 'Science Studies' (in Britain) or 'STS' (in the USA). Professional associations too reflect these attempts at synthesis, as for example the Society for Social Studies of Science (founded in the 1970s) or the Society for History, Philosophy, and Social Studies of Biology (established in the 1980s).

However, as the epigraph quoted at the outset indicates, no consensus has yet emerged from these attempts. There is no comprehensive, coherent account of the actualities of scientific activity to which most practitioners and all the parent disciplines, including the sciences themselves, are willing to assent. Indeed, the current scene shows not only some disciplinary merging but also a deep bifurcation. On the one hand – the traditional or right hand – are those who take a realist stance toward science and the world; they include many, perhaps even most philosophers of science and historians of science as well as most scientists and engineers and political scientists engaged in policy studies. On the left stand relativists, constructivists, and debunkers of scientific hubris: social scientists of a theorist rather than an empirical or practical bent together with people in various disciplines with strong ideological commitments to Marxism, radical feminism, and the like.

Once again I pause to note that no such dichotomy should be taken more literally than intended or warranted. Between those left and right hands stretches a well-populated continuum. There are indeed few who would explicitly and seriously propound either extreme view (though there are some). Nevertheless there is quite a clear distinction between the two camps in the *tone* with which science is talked and written about. Those of the right hand are squarely in the Enlightenment tradition, stand somewhat in awe of the success that science has brought to humankind's understanding of how the universe works, and see science as one of the strongest resources for betterment of the human condition. Those on the left harp more in the Luddite tradition on the evils of modern technological society and the science which they Romantically hold (or claim to hold) largely responsible for those evils.

Most of us, of course, harbour some sentiments and attitudes and beliefs from both hands, just as society itself carries concurrent streams of Romanticism and scientism. And just as with society and with individuals, so too with the academic institutions – centres, journals, societies: though incorporating both streams, most of them reflect a predominating set of swimmers of the left or of the right persuasion. By and large, where membership comes chiefly from sociologists, rhetoricians, non-realist philosophers, Marxists, feminists, and the like, then the programme or publication features chiefly a tone that is rather suspicious of science, rather deprecating of it, insisting on its overweening pretentiousness; for example, the early and influential Science Studies Unit at Edinburgh and the journal *Social Studies of Science*. But in those programmes and publications where practising or former engineers and scientists congregate, and practice-oriented political scientists and sociologists, one finds more of a pragmatic concern with putting to good use the unquestioned sound knowledge that science offers, for example, *Bulletin of the Atomic Scientists* or *Bulletin of Science, Technology & Society*.

## CAVEAT EMPTOR: ABOUT EXPLANATIONS OF SCIENCE

I began with examples of questions about science for which answers are needed. The most direct way to judge different explanations of science is to test them against such concrete questions: are these met by sensible, realistic answers or by evasion and obscurity?

Using that criterion, common sense can decide among even sophisticated arguments. Here are some questions, more explicit than the earlier ones, that ought to be answerable by people who understand science and might therefore have informed opinions about science policy:

1 What accounts for the success of science over the last few centuries? Why did that begin in seventeenth-century western Europe rather than at some other time or elsewhere? How can we ensure that similar progress will continue?

2 How much of national resources should be devoted to science? How divided between basic and applied? Concentrated in what specialities?

3 What should we teach our children of and about science? Why?

4 What makes for greatness in science? What makes for competence in science? Can we train any or every child to become a good scientist?

5 How come science commands such reliable knowledge and yet seems unable to give us some knowledge that we really want, like cures for cancer and AIDS and cheap sources of non-polluting energy? What determines these limits on scientific knowledge?

6 Why does science enjoy such high prestige at the same time as many are suspicious of or antagonistic to it? Does it really benefit society to harbour a thriving scientific community? In what ways?

7 What exactly is 'pseudo-science'? Why does science pooh-pooh so many subjects that people are greatly interested in, like UFOs and Loch Ness Monsters?

8 Why do we hear so much nowadays about misconduct by scientists? Are they less ethical than other professional people? Are scientists less ethical than they should be? If so, what should be done about it?

Here now are examples of typically unhelpful, biased answers that are offered, and some critical comments on those answers.

Imagine that the first question is met with an answer along the following lines:

> What do you mean by 'success'? Scientific theories are always subject to change. Science has no privileged path to knowledge. Modern science dates to seventeenth-century Europe because it was cultivated there while Europe's military and economic power made the rest of the world subservient. Current scientific knowledge embodies the biases of European, elitist males and serves their interests. If society were differently organized, scientific knowledge too would be different. How to ensure satisfactory progress depends on what you regard as satisfactory, a Eurocentric science or a Third-World-oriented one, an elitist or a democratic one.

That is the sort of answer that relativists have to offer, though they may at times disguise it for tactical reasons. I suggest that common experience and common sense enable us to discard it and to pay no attention to policy suggestions from people who insist on it. Being excessively polite, one might respond: 'How very interesting! But, you know, I've heard quite other things from some historian and philosopher and scientist friends of mine. Let me get you all together, and when you've arrived at a consensus, do let me know and we'll be sure to act on it.'

Imagine that the second question is answered thus:

> Tell us what exactly you want, and give us enough resources, and we'll deliver the goods. Of course, you must also give us continually increasing resources to furbish our infrastructure, because we need to expand our fundamental understanding all the time to make possible the useful applications you ask for. If we're slow delivering what you want, it will only be because you don't give us enough of the needed wherewithal.

That is the sort of answer likely to come from the scientific community. A reasonable response might be:

> How very tempting! But do you have any references as to your qualifications to do all that? I happen to have some historian and sociologist friends who harbour doubts that you can always deliver. They tell me that $20 billion spent in the last couple of decades in a war on cancer haven't made notable inroads into that disease. They remind me that you promised us cheap atomic energy forty years ago and that we haven't got it yet. You told us that *very* cheap, non-polluting energy would come from nuclear fusion, and we've spent billions on that, and now you suggest that we might have a

> demonstration power-plant around 2020 or so. Can you convince us that your promises of today are better founded than those of yesteryear?

Imagine that the third question brings the answer,

> We shouldn't overburden our children's minds with masses of stuff to memorize. They need only to know that the scientific method has been responsible for science's success, and if they learn it they too can become competent or even great scientists themselves.

Respond to that with quite a diatribe: How does 'the scientific method' help us answer questions 4, 5, 6 or 7? Does it not suggest an answer to question 2 that we have just found wanting? Does it not suggest as answer to question 1, the absurd inference that it took Europeans of the seventeenth century to realize that you need to test the validity of ideas by observation or experiment? Since different disciplines offer disparate insights, in other words, and since there are also marked ideological biases in play, canny consumers will not accept any single answer before they have confronted the relativist with a realist, a practising scientist with a historian, and so on. Such conversations can be enlightening – so are a number of accessible publications that afford useful insights into the history and contemporary workings of science relatively free of the ideological and disciplinary blinders described in the foregoing; for example, see Marks (1983), Knight (1986), Burnham (1987) and Brush (1988). The works of Bauer (1992), Ziman (1978, 1994), De Solla Price (1986) and Stephan and Levin (1992) look at contemporary working in science and are especially recommended.

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# SCIENCE TODAY

## Problem or crisis?

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