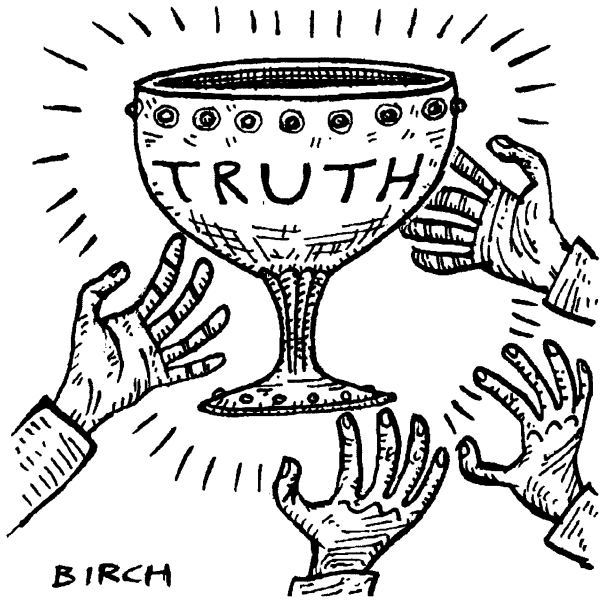
Is science losing its objectivity?

John Ziman

The philosophy of science is not independent of the way research is organized. Can scientists produce objective knowledge in a world where their research is increasingly directed towards making money or meeting social needs?

SCIENTISTS know philosophy and sociology as fish know water. They understand instinctively how to live in it without being aware that they are doing so. That is, until the fish bowl is stirred or (horror!) overturned. We seem to be living in just such a time. Science is being shaken up and forced to abandon many of its cherished customs. We need to think hard about what is happening and what we should do, not merely to survive but to serve and delight humanity.

The initial impulse is to defend 'science' against its proclaimed enemies. But much of the pressure comes from equally demanding friends. And what is being defended? Science has already changed a great deal in just a few years. What is the essence that must at all costs be preserved? The bowl is not a black box, but it is filled with an invisible compound of philosophy and sociology. To understand its life-giving properties, this medium needs to be broken down into its component parts, perhaps to be resynthesized in new and more up-to-date forms.



Defining science

The fundamental question is simple: what is the framework that holds scientists together and keeps their personal rivalries within bounds? The conventional answer is that scientists are united in 'the pursuit of truth'. But some philosophers say that 'truth' is an illusion, whereas others say that it takes many forms, of which only a few are pursued scientifically. Even philosophers of science disagree on just what distinguishes science from other forms of organized knowledge.

What is clear, though, is that the type of knowledge produced by science seems to satisfy certain general principles, such as reliance on observation, explanatory power, universality and objectivity. These principles are abstract and impersonal. They do not tell us what this knowledge is good for, what motivates scientists to seek it or how they should work together in the process. Yet scientists doing basic research have a strong sense of belonging to a community and of being guided in their scientific work by just such principles. How is this achieved?

The answer lies in the fact that what we mean by basic or 'pure' science can be defined only sociologically. The social institution that has customarily fostered undirected research, without regard for its practical use, is academia. In effect, what we call basic research is almost synonymous with the type of research traditionally carried out in universities[1].

Every PhD student soon learns by experience that academic science is a distinct human culture, with its own peculiar practices, rules, traditions and conventions. In 1942, Robert Merton[2] suggested that these practices were governed by a set of unwritten social norms. This type of sociological analysis is now considered to be very questionable, but Merton's norms sum up many familiar social characteristics of academic science in a way that helps to relate them to the philosophical characteristics of scientific knowledge.

The norm of 'communalism', for example, requires that the fruits of research should be regarded as 'public knowledge'. It covers all the practices involved in the communication of research results to other scientists, to students and to society at large. But this has philosophical implications. By insisting on the pooling of personal knowledge gained from individual experience, it stresses the role of observation and experiment in science and underpins scientific realism and empiricism.

'Universality' requires that contributions to science should not be excluded because of nationality, religion, social status or other irrelevant criteria. In practice, this multicultural meritocratic ideal is achieved very imperfectly. But it does imply that scientific propositions should be general enough to apply in any cultural setting. It encourages scientists to construct abstract theories that claim to explain and unify a wide variety of phenomena.

The idea that academic scientists have to be 'disinterested' means that in presenting their work publicly they must discount any material interests that might prejudice their findings and adopt a humble, neutral, impersonal stance that hides their natural enthusiasm for their own ideas.

'Originality' energizes the scientific enterprise. Academic scientists are expected to be 'self-winding' in their choice of research problems and techniques. Their most cherished traditions celebrate and sustain this important aspect of academic freedom. This norm keeps science progressive and always open to intellectual novelty.

'Scepticism', on the other hand, is the basis for many academic practices, such as critical controversy and peer review. It is not a licence for systematic philosophical doubt, nor for total sociological relativism. But it does stress the systematic testing of research claims in terms of rational qualities such as logical consistency and practical reliability.

The scientific ethos

The close link between social norms and philosophical principles is no accident. It is not even clear which set comes first. It could be argued that the philosophical principles are primary and that the norms sum up the social practices that have naturally developed as scientists have tried to apply these principles in their research. But a sociologist might say that the institutional setting of academic science generates certain practices and that these practices determine the principles regulating the type of knowledge that is produced. The norms and principles are clearly complementary aspects of an ethos whose social and psychological parts are inseparable.

It does not follow, however, that all truth is 'relative' or that scientific knowl-

edge is 'constructed' entirely to suit certain social 'interests'. All it means is that the progressive unveiling of nature is not a very systematic process. How far we have got in that process — that is, what counts as scientific knowledge at any given moment — is obviously influenced by the way in which research is organized.

This comes out clearly when we consider how academic science is organized. Whatever the formal management structure, academic science is divided into disciplines. That disciplines are usually loosely organized does not make them ineffective. An academic discipline is a global 'invisible college' whose members share a particular research tradition. This is where scientists acquire the theoretical frameworks, codes of practice and technical methods considered to be 'good science'.

Specialization does not stop there. The subdivision of disciplines into narrow research specialities seems to be an unavoidable feature of academic science[3]. In practice, most academic scientists can satisfy the norms of originality and scepticism only by concentrating for years on what is known, what is hypothesized and what might be feasible in a limited 'problem area'. As a result, basic scientific knowledge is typically fragmented into little islands of near conformity surrounded by interdisciplinary oceans of ignorance. In other words, the philosophical ideal of a unified science is thwarted by institutional and psychological realities.

Motivating factors

The academic ethos says nothing directly about individual motivation or about how academic scientists make a living. Merton himself pointed out that the initial letters of the norms spell out the acronym CUDOS — that is, acclaim or prestige. The assumption is that academic scientists do research and make public their findings in exchange for 'recognition' by their colleagues. Recognition consists of citations in the literature, prizes, medals, titles — and especially employment.

The peculiar feature of academic science is that it developed as an activity engaged in principally by 'academics', whose official employment is to teach rather than to do research. Everybody knows, of course, that university teachers usually owe their posts to their proven research competence and earn further promotion by their research achievements. Still, the convention is that this research is 'their own work', which they are free to carry out and benefit from as individuals.

Paradoxically, academic research developed as the professional occupation of people not specifically paid for doing it. It has always relied on the willingness of universities and other bodies to provide resources for an activity that they do not directly profit from or control.

The key point is that academic science relies on public and private patronage[4], in the broadest sense of that old-fashioned word. Society gains directly from the applicable results and from the trained scientists who come out of universities. It also benefits indirectly from the objectivity of basic science. A scientist holding a permanent post as a university teacher is in a position to do 'pure' research, uninfluenced by commercial, political or other external interests.

Forces of change

Academic science is now changing rapidly. Some changes simply reflect scientific and technological progress. As always, the dedication of science to originality is drawing it into novel modes of activity[5]. Individual achievement is being merged into the collective action of multidisciplinary teams. Communication is being speeded up electronically until it becomes instantly global. Instrumental sophistication is making it easier, but more expensive, to do good science.

Academic science is undergoing a cultural revolution. It is giving way to 'post-academic' science, which may be so different sociologically and philosophically that it will produce a different type of knowledge

More and more forces are pressing on academic science from society at large[6]. In effect, the whole enterprise has now become too large and expensive to be allowed to go its own way. The governments that mainly fund academic research are putting strict financial ceilings on their patronage. The US decision to stop work on the Superconducting Super Collider was the clearest possible signal that this is a worldwide phenomenon. In every country, governments are trying to get better value for their money.

Whatever the cause, there are widespread signs of a decisive break with the academic tradition. This applies to many of the practices associated with Merton's norms, such as conditions of employment, problem choice, criteria of success and other important features. Transition to a 'steady state' regime is imposing on academic science several requirements incompatible with its traditional ethos. Academic science is undergoing a cultural revolution. It is giving way to 'post-academic' science, which may be so different sociologically and philosophically that it will produce a different type of knowledge.

This metamorphosis is still going on. A group of experts on science policy has recently suggested[5] that the academic mode of knowledge production — what they call 'mode 1' — is being systematically replaced by 'mode 2', a very different activity. If they are right, what would post-academic science be like?

Privatizing knowledge

The operating philosophy of research will surely stay unchanged. Scientists will go on theorizing and testing their theories by observation and experiment. Indeed, the norm of communalism underlying this attitude will be reinforced by the increasing speed, size and complexity of electronic communication. Novel observations and theories can be discussed in detail with distant colleagues — or even sceptical rivals. National frontiers become irrelevant. Researchers in industrial companies, government laboratories, charitable foundations and universities can work together in the same team. Even the tribal boundaries between disciplines can be disregarded.

But the pressure to open up the interface between academic institutions and industry has an important philosophical effect. Research results that an academic scientist would have published immediately are being identified as 'intellectual property', which may be kept secret for commercial reasons. In other words, post-academic science may no longer be so committed to the principle of 'public knowledge' — traditionally the linchpin of academic science[7].

Global networks of communication and collaboration would seem to favour social universalism — but not necessarily its philosophical counterpart. Indeed, according to its proponents, the 'new mode of knowledge production' is not directed towards producing knowledge as such: it is directed towards solving specific problems. This undoctrinaire striving for local understanding is not necessarily deplorable. Post-academic science may no longer be activated by the vision of a unified, universal scientific world picture. But in the end it may prove as effective in closing the gaps in the knowledge map as a single-minded pursuit of general intellectual unity.

Roots in reality

Post-academic science may also line up with many 'postmodern' philosophers in abandoning the age-old attempt to put human understanding on absolutely firm 'foundations'. Some scientists may find it difficult to accept that science should no longer claim that it can provide a universally applicable answer to every problem. I believe this position was always untenable, and that a retreat from it is one of the ways to defuse some of the current public hostility towards 'science'.

This does not mean that post-academic scientists will reject operational realism: they will still construct their accounts of nature on the basis of a firm belief in the existence of an external world whose behaviour is intelligibly regular and not disjoint. On the contrary, although post-academic science will surely still harbour a

considerable amount of research that is not immediately 'useful', this research will be more firmly rooted in the real world. It will draw on, and generate, its problems, techniques and results from all parts of the conventional 'research-and-development spectrum'. Basic research and technological development already inter-penetrate one another: in the long run, they will become inseparable.

Who sets the problems?

Academic science assumes researchers are free, within reasonable limits, to set their own problems. They regard this as the highest form of scientific creativity. By contrast, post-academic scientists will be expected to work together on problems they have not posed personally and to be rewarded principally for their skilful contributions to the success of their team. Competence as a researcher may then count for less than a good record as a team player or as an expert at dealing with certain technical problems.

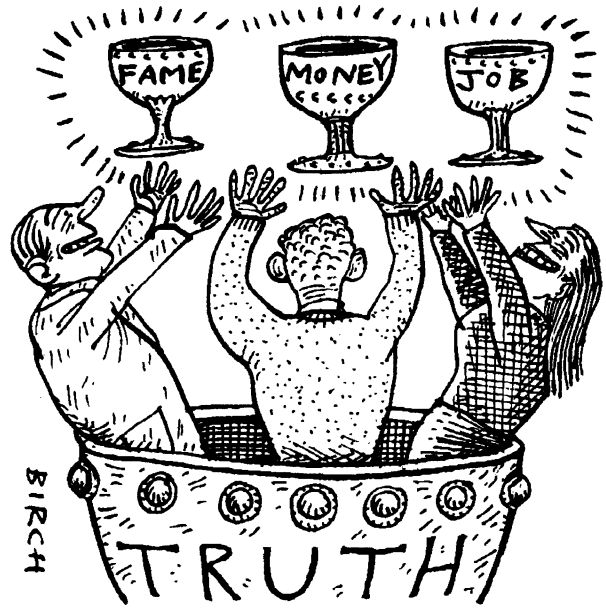
When resources are limited, even the most basic research does not take place in a power vacuum. It has to be supported financially and administratively by bodies whose interests go beyond the mere production of knowledge. They exercise these interests at the point of maximum leverage — when research problems are being set. All policy talk about foresight, priorities and accountability is really focused on 'problem choice'.

In effect, post-academic science will transform problem choice from an individual to a collective activity[3]. How well can this be done when the research is not directed towards a practical goal? Academic science has always worked on 'Darwinian' principles[8]. Scientists do research and offer results on many different problems; knowledge advances in unforeseen directions by the retention of the small proportion of results that survive rigorous testing.

Post-academic science will strive to improve on this apparently wasteful process. It will insist that all research projects are well-designed, non-redundant and directed towards well-posed problems. The unintended effect must be that outlandish projects and wild ideas never get a chance to show their hidden capabilities — which just occasionally open the doors to revolutionary progress.

Celebrating diversity

The world of practice does not carve itself up neatly along the joints between the academic disciplines. In the context of application, all problems require a multidisciplinary approach. Every important technological development — the transistor, antibiotics, nuclear weapons — combines ideas and techniques from all over the academic map. If we have enough imagination, we can see that this is equally true for research into fundamentals, such as the origin of life or the workings of the brain. The most radical feature of post-academic science could be its unselfconscious pluralism. It will welcome conceptual diversity and not be fearful of possible inconsistencies. If an untidy mixture of theory and practice, computer simulations and numerical data turns out to be the best available solution to a particular problem — so what?



This pragmatism will no longer bar academic science from hybridizing with knowledge and belief systems that do not share the same intellectual values or standards of 'good science'. Specialists from different disciplines, working together as a team, may assemble a mosaic of paradigms, techniques, expertise and practical applications that provides a launch-pad for further advances. But such a mosaic may not be very stable and may not have been built on sound intellectual principles and firm institutional soil. There may not be anybody waiting to welcome the astronauts when they parachute back to Earth.

In harsh reality, moreover, practical problems seldom appear out of nowhere, without antecedents. The world where research is to be applied is already highly structured: problems to be tackled are normally set and funded by their existing organizational 'owners', such as industrial companies, government departments or health services. In the effort to overcome the academic vice of narrow specialization, post-academic science may find that it has put itself into the hands of bodies even more parochial, fragmented and restrictive than the disciplines from which it has escaped. It may become even more difficult to begin research on a problem not already on the agenda of a wealthy funding body — a serious issue in a world where not all socially important problems are of recognized commercial, technological or political concern.

The price of excellence

Again, post-academic science will distrust the élitism of peer review and replace or bolster it with quality control of people, projects and performance. But this usually entails a much broader notion of 'excellence' than the traditional academic criteria for 'good science'. So greater importance may be attached to entrepreneurial and managerial skills, such as the ability to oversee the larger cycles of action in the research system.

The trouble is that the test of practical utility does not operate in basic research, where organized scepticism[2] is the only real protection against persistent error. The gravest threat to the reliability of scientific knowledge could be obsessive monitoring of the accountability and performance of researchers at the expense of systematic intellectual criticism of their claims. In any case, considerable intellectual uncertainty is inevitable in areas where post-academic science becomes entangled with 'trans-epistemic' issues, such as questions over bovine spongiform encephalopathy where 'nonscientific' social, environmental and humanistic values are involved.

Who pays the pipers?

Mode 2 researchers, we are told, work in shifting teams, like small companies producing goods for a competitive market. Jobs are never secure. As teams reorganize to tackle new problems, some researchers have to move elsewhere to make room for new people with new skills. As a result, few individuals have stable opportunities to establish or exercise their expertise. The contrast with tenured posts in academic institutions could not be greater.

But it is unrealistic to suppose that today's system of multifunctional universities will give way to a genuine market system sustaining many small, commercially independent research enterprises. Researchers will mostly remain full-time employees of universities, government laboratories, charitable foundations or industrial companies. If not, they simply won't be able to invest in the facilities they need.

Although post-academic science may look attractively unbureaucratic, it will really be heavily capital-intensive. It will continue to be funded and managed by a complex of governmental bodies, large public institutions and private corporations. The same questions will still be

asked: who will pay the pipers and what tunes should they be called on to play?

Industrial concerns

It seems to me, in fact, that many of the suggested differences between mode 1 and 2 are not changes from an old to a new mode of knowledge production. They typify the long-established distinction between 'pure' and 'applied' research, a distinction institutionalized nearly a century ago. There has always been a cultural gap between 'academic' science in universities and 'industrial' science in industrial laboratories[9]. In reality, the former was never totally pure, nor the latter entirely utilitarian, but they were organized differently.

Mode 2 actually reads like a 'post-industrial' version of applied science. Industrial laboratories, like industrial companies, used to be large, monolithic organizations run from the top by a hierarchy of managers. In the post-industrial era (so many economists and business experts tell us) market competition will replace command management. Even in large multinational corporations, global networks, profit centres and independent contractors will replace management charts, directorates and service departments. Naturally enough, technological research and development in the private sector is being reorganized along similar lines. Yet it is still directed towards the same objectives — primarily, financial profit — and is subject to the same socioeconomic imperatives.

What might really be happening is that the evolution of industrial science into post-industrial science is closing the gap between pure and applied research. Several factors are working towards a single post-academic culture. Scientific developments are blurring the distinction between fundamental and exploitable discoveries. Technological developments are generating heterogeneous hybrid teams that override institutional loyalties. Economic conditions are forcing the two cultures into the same organizational mould.

Indeed, a deliberate effort at a high level of political and managerial authority would probably now be required to keep the two systems from coalescing in style and function. But such a merger not only raises many practical issues of funding, disciplinary identity, criteria of excellence, career aspirations, intellectual property rights, institutional management and so on. It also brings face to face two very different sets of structural principles. In this confrontation, mode 2 seems already to be ousting mode 1. The academic ethos may well survive as an attractive but somewhat dated ideology; but the effective culture of post-academic science may well be predominantly post-industrial.

Who's afraid of postmodernism?

The philosophical background to science is often simply taken for granted. I have tried to show that it is closely connected with the way in which research is organized and carried out. Changes in the social framework of science eventually lead to changes in its philosophical principles. Indeed, a cultural theorist might argue that the transition to post-academic science, organized along post-industrial lines, is necessarily reflected in a transition from a 'modern' to a more 'postmodern' philosophical stance[10].

I do not accept this necessity. I am not suggesting that science is abandoning all its norms and principles and 'going postmodern' in some fashionable pseudo-intellectual sense. It is nonsense, for example, to say that today 'anything goes'. Most of the likely changes are mild, even benign. Some are much-needed corrections to the excesses of 'scientism'. Others are welcome antidotes to the extreme rationalism that has long plagued the philosophy of science. It must be a good thing to help rescue the scientific imagination from entrenched specialization. And localized pragmatism will largely compensate for the fragmentation of theoretical standards of scientific validity. Some of these changes may be philosophical dynamite, but they scarcely affect work at the coalface of research, and I doubt whether scientists or their leaders will even notice them.

Incorporating interests

But there is a serious threat to one fundamental feature of academic science — its objectivity. Objectivity can never be absolute. Philosophers and sociologists agree that the notion of a truly objective disinterested 'seeker after truth' is incompatible with the realities of social existence. We all have personal interests and institutional values that we are bound to promote in our scientific work, however hard we try to suppress them. The virtue of academic science was that it took a strong line in support of the norm of 'disinterestedness' and often managed in practice almost to live up to its ideals.

The transition to post-academic science is eroding the practices that underpin this norm. 'Public knowledge' is being transformed into 'intellectual property'. Basic research networks include many research groups with direct industrial interests. Researchers will not be protected from commercial influences by academic tenure. Their work will often deal with matters where social values — safety, profitability, efficacy — must have the highest priority.

In general, then, post-academic science is bound to be shot through with social interests. It will surely defend objectivity as an ideal, impossible to realize completely in practice but always to be respected and desired. But if all research arises in close connection with its potential for application, there may never be any occasions where this ideal is paramount — where conscience insists we must publicly voice Galileo's whisper: "It really does move!".

Scientific objectivity is not an abstract philosophical virtue. It is a cultural norm embodied in a web of social practices. Academic scientists incorporate the norm of 'disinterestedness' into their system of personal values as a result of their own experience in research situations where these practices are systematically observed. They never forget the moment when they were reproved by their professor for failing to present fairly the arguments of their opponents or for conveniently 'forgetting' an awkward fact that invalidates their exciting discovery. From then on, they know in their hearts that this is how real scientists ought to behave. It is hard to see how this norm will be sustained when there are few situations yielding the relevant experience.

Objectivity is what makes science so valuable in society. It is the public guarantee of reliable disinterested knowledge. Science plays a unique role in settling factual disputes. This is not because it is particularly rational or because it necessarily embodies the truth: it is because it has a well-deserved reputation for impartiality on material issues. The complex fabric of democratic society is held together by trust in this objectivity, exercised openly by scientific experts. Without science as an independent arbiter, many social conflicts could be resolved only by reference to political authority or by a direct appeal to force[11].

Science and technology have always been growth enterprises. Scientists look forward to ever-more exciting achievements. But when we reflect on the prospects for change, we should not fall into a reckless, purely celebratory mood. My fears may be exaggerated. Other factors may be at work, completely altering the situation. Is there anything that should be done about it — and if so, what? □

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