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# 'Newton's Health and Confusion to Mathematics'

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An initial remark touches on limitations of the deductive-postulational view of mathematics; but the main aim of the Address is to offer a diagnosis of present difficulties in the relations between science and society. A look at early attitudes of nonscientists to science leads to Karl Marx's dictum that 'philosophers have only *interpreted* the world in various ways, but the real task is to *alter* it'. It is argued that the Marxist view that the quest for *power* is the supreme purpose of science lies at the heart of our difficulties. Scientific Marxism is attractive to people dominated by the love of power. Politicians, administrators, and laymen all tend to subscribe to it. The moral authority of science stems from its uncompromising intellectual standards and goals and, inevitably, it falters when power replaces truth as the desideratum. Unsurprisingly, the moral authority of science is at present in decline: scientists overstate the immediate utility of their work; all and sundry claim too much for the 'scientific method' and overestimate the scientific content of social problems; and the Lord Snow and James Watson are scribes of the new mores. Finally the general public begins to have doubts. An unhappy aspect is that scientists cease to be exemplars to the inquiring young. The revolution of the young is understandable, but no less grave for that.

We all know that mathematicians are querulous and demanding people, and I was naturally apprehensive at the task confronting me today. Some months ago, on the phone to the Secretary of Section 8, I happened to voice my misgivings. The Secretary is obviously very kind —

and she put me out of my misery at once: 'There's nothing to worry about' she said. All the mathematicians will have gone to Adelaide for the AMS meeting. So, ladies and gentlemen, welcome to a non-event: the Presidential Address for Mathematics is to consist of a non-mathematician talking to non-mathematicians.

In deference to the occasion, I shall begin by offering a few remarks on mathematics and its consequences for science in general;

but I want to devote most of my time to the wider theme of the interactions between science and society.

## Mathematics and science

Firstly, then, a message to our absent mathematicians. At Port Moresby last year, I pointed out to the physicists (Philip, 1970) that 'intuition is sometimes no more than inherited prejudice', and that 'the intuitive urge for a physical picture may become an ultimate obstacle to progress in a field of physics, in classical physics as much as in modern physics'. And this led to a discussion of the axiomatic approach in physics, whereby we recognize the program of axiomatization put forward by David Hilbert (1900) and 'face up to the . . . inescapable fact that at least some of the physical entities with which we work are *primitives* or *undefined objects*'. It is acceptance of the inevitability of such primitives which serves to liberate us, where necessary, from the intuitive insistence on a physical picture.

In my experience, this is a helpful message to many physicists; but, insofar as I can appreciate the fashions and current modes of thought of the pure mathematicians, I feel impelled today to offer comment of a *precisely opposite nature*. I shall develop my message in a rather diffident way through the words of three great mathematicians of the first half of this century.

Firstly, let us hear from Henri Poincaré. A decade after Hilbert announced his program of axiomatization, Poincaré, in an essay entitled *The Future of Mathematics* (1913), damned it with the following faint praise: 'It seemed at first that this domain would be very restricted and there would be nothing more to do when the inventory should be ended, which could not take long. But when we shall have enumerated all, there will be many ways of classifying all; a good librarian always finds something to do, and each new classification will be instructive for the philosopher.'

Twenty years later, Hermann Weyl (1931) felt impelled to remark: 'I should not pass over in silence the fact that today the feeling among mathematicians is beginning to spread that the fertility of [the axiomatic method] is approaching exhaustion. The case is this: that all these nice general notions do not fall into our laps by themselves. But definite concrete problems were conquered in their undivided complexity, single-handed by

brute force, so to speak. Only afterwards the axiomaticians came along and stated: Instead of breaking in the door with all your might and bruising your hands, you should have constructed such and such a key of skill, and by it you would have been able to open the door quite smoothly. But they can construct the key only because they are able, after the breaking in was successful, to study the lock from within and without. Before you can generalize, formalize and axiomatize, there must be a mathematical substance. I think that the mathematical substance in the formalizing of which we have trained ourselves during the last decades, becomes gradually exhausted. And so I foresee that the generation now rising will have a hard time in mathematics.'

And a decade after that Richard Courant (Courant and Robbins, 1941) wrote: 'There seems to be a great danger in the prevailing overemphasis on the deductive-postulational character of mathematics. . . . A serious threat to the very life of science is implied in the assertion that mathematics is nothing but a system of conclusions drawn from definitions and postulates that must be consistent but otherwise may be created by the free will of the mathematician. If this

assertion were accurate, mathematics could not attract any intelligent person. It would be a game with definitions, rules, and syllogisms, without motive or goal. The notion that the intellect can create meaningful postulational systems at its whim is a deceptive half-truth. Only under the discipline of responsibility to the organic whole, only guided by intrinsic necessity, can the free mind achieve results of scientific value. . . . To establish once again an organic union between pure and applied science and a sound balance between abstract generality and colourful individuality may well be the paramount task of mathematics in the immediate future.'

It is unnecessary to labour the common point of these quotations. Courant's 'paramount task' remains to be attempted. One has the uncomfortable feeling that, all too often, pure mathematics reduces to the art of inventing games which mathematicians can win.<sup>1</sup> The scientist, on the other hand, must struggle to win the games which nature thrusts upon him. I hardly need remark that it is the (largely twentieth-century) schism between physics and mathematics which lies behind my conflicting pleas. Last year I urged the physicists to use insights they

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may glean from mathematics; this year I urge the mathematicians to remember the challenges of the physical world.

### Science and society

I turn now to the theme of Science and Society. Let me say at the outset that I shall attempt no more than a diagnosis of the present problems between science and society: I certainly don't pretend to offer a cure. Perhaps it will come through implicitly that I regard as tragically facile at least some of the remedies we are offered so persuasively; but I am well aware that it is easier to be critical than to offer constructive alternatives. I hardly need say that I have no expertise which entitles me to put forward this gappy diagnosis with such apparent arrogance and confidence. My only qualification, I suppose, is what I imagine to be a genuinely held love of science over 30 years and a deep personal concern lest the loved one be falling apart.

Let us begin with a look at the attitudes of non-scientists to science over the centuries. Samuel Johnson, in his *Life of Milton* (1779), made the classic case against science with an eloquence lacking in most later opponents of science. As a young man, Milton ran a private school, and Johnson complains, in a typically pungent and moralizing passage, about Milton's choice of Greek and Latin texts:

'The purpose of Milton, as it seems, was to teach something more solid than the common literature of Schools, by reading those authors that treat of physical subjects; such as the Georgick, and the astronomical treatises of the ancients . . .

'But the truth is, that the knowledge of external nature, and the sciences which that knowledge requires or includes, are not the great or the frequent business of the human mind. Whether we provide for action or conversation, whether we wish to be useful or pleasing, the first requisite is the religious and moral knowledge of right and wrong. . . . Prudence and Justice are virtues, and excellences, of all times and of all places; we are perpetually moralists, but we are geométricians only by chance. Our intercourse with intellectual nature is necessary; our speculations upon matter are voluntary, and at leisure . . .

'Let me not be censured for this digression as pedantick or paradoxical; for if I have Milton against me, I have Socrates on my side. It was his labour to turn philosophy

from the study of nature to speculations upon life; but the innovators whom I oppose are turning off attention from life to nature. They seem to think, that we are placed here to watch the growth of plants, or the motions of the stars. Socrates was rather of opinion, that what we had to learn was, how to do good, and avoid evil.'

At first glance Samuel Johnson and William Blake seem strange bedfellows: but it is no real surprise to find them at one on the subject of science. Blake's prayer

'May God us keep  
From Single vision & Newton's sleep!  
distills Johnson's sermon down to three-quarters of a couplet.

Not all literati were hostile to science, however. One hundred and ten years before Johnson's *Lives*, the youthful Royal Society had set up a committee to encourage the use of simple and lucid prose: one member of the committee (which, it is recorded, met in a coffee house once a fortnight) was John Dryden, FRS. This was the poet whom the wrong-headed Johnson admired and revered above all others in his *Lives*.

The low esteem in which science was held by the Romantic poets and their friends is surprising: Benjamin Robert Haydon,<sup>2</sup> the artistic gadfly and diarist of that time, tells of a dinner held in his studio with his newly-completed painting, *Jerusalem*, upon the wall. He records (Taylor, 1853) that Charles Lamb 'abused me for putting Newton's head into my picture; "a fellow" said he, "who believed nothing unless it was as clear as the three sides of a triangle". And then he and Keats agreed he had destroyed all the poetry of the rainbow by reducing it to the prismatic colours. It was impossible to resist him and we all drank "Newton's health and confusion to mathematics". It was delightful to see the good humour of Wordsworth in giving in to all our frolics without affectation and laughing as heartily as the best of us.'

Coleridge was not there; but the sympathetic concern for science revealed in his writings<sup>3</sup> indicates that he would never have drunk the infamous toast without protest.

Thirty years after Haydon's dinner party, another humanist was concerning himself with science. Not that this one thought of himself as an opponent of science. On the contrary. The only trouble was that, in the enthusiasm of his blind embrace, he did

his lady Science damage from which she has not yet recovered; and, indeed, her injuries may yet prove mortal.

The year was 1845. The humanist was Karl Marx. As Bertrand Russell (1951) puts it: 'Science used to be valued as a means of getting to *know* the world; now . . . it is conceived as showing how to *change* the world'. Marx's pronouncement was: 'Philosophers<sup>4</sup> have only *interpreted* the world in various ways, but the real task is to *alter* it' (Marx, 1845).<sup>5</sup>

It would be quite false, of course, to pretend that Marx was the first to value the technological uses of science. Indeed the founders of the Royal Society were concerned with the implications of their science in the practical arts as much as with knowledge for its own sake. But it was Marx who was the first, in his dogmatic way, to deny a place to the quest for knowledge for its own sake — and to set up the quest for *power* as the supreme purpose of science. (Even Bacon, with his experiments of light and his experiments of fruit, had been in two minds.)

Unsurprisingly, this Marxist view of science (which I call henceforth 'scientific Marxism') has proved immensely attractive to people dominated by the love of *power*: and this holds good regardless of their nominal political convictions. My own observations suggest, for example, that it is better established in politically conservative parts of the US than it is in the Soviet Union. Although the matter is perhaps too grave to joke about, I confess that I have enjoyed expressing to certain conservative American colleagues my horror at discovering their Marxist view of science.

Scientific Marxism is more readily accepted and, I think, more prevalent outside the ranks of practising scientists than within them. But, in a world where politicians, administrators, and the literate layman are hooked on scientific Marxism, scientists who are *not* are under constant pressure.

### The moral authority of science

I think that the thing which disturbs me most about this all-pervading Marxism is that it erodes the *moral authority of science*. To speak of the 'moral authority of science' may well seem both nebulous and pretentious, but I believe many of you will know what I mean. We should never forget that it is through its passionate scepticism, and the rigour of the intellectual standards which stem from this

scepticism, that science has become the greatest achievement of the human race. It has profoundly influenced, and influenced for the better, the sensibilities and tacit assumptions of Western man, whether he knows it or not.<sup>6</sup>

As Jacob Bronowski (1951) has written, science 'takes for ultimate judgement one criterion alone, that it shall be truthful. If there is one system which can claim a more fanatical regard for truth than Lao-tse and the Pilgrim Fathers, it is certainly science . . . . T.H. Huxley was an agnostic, Clifford was an atheist, and I know at least one great mathematician who is a scoundrel. Yet all of them rest their scientific faith on an uncompromising adherence to the truth, and the irresistible urge to discover it. All of them spurn that grey appeal to expediency which is the withering thumb-print of the administrator in committee.' Bronowski is not here writing of scientific Marxism. He is writing of science with its primary motivations in the love of ideas and in the desire to comprehend ourselves and the world in which we live. Bronowski's words seem singularly old-fashioned, do they not? And I suspect that many of our present-day troubles in science arise because his words do seem old-fashioned.<sup>7</sup>

### Erosion of the moral authority of science

Let us try to be more specific about this erosion of the moral authority of science, and the ways in which this leads very naturally to the prevalent disenchantment with science. Let's not waste time documenting the disenchantment. You know and I know that the general public grows more disillusioned with science every day: and, even more gravely, you know and I know that the young become increasingly fed up with science. I say 'even more gravely' because science grows very sick indeed when it can no longer attract to its ranks the right kind of young minds.

One of the obvious ways in which science has decreased in stature is through the dishonesty of our claims for it.<sup>8</sup> It seems that all too often we are impelled to overstate the immediate practical consequences of our own work and of science in general. Perhaps we have only ourselves to blame if, after a quarter-century of increasing scientific affluence, some of our chickens are starting to come home to roost. You can't fool all of the people all of the time.

Another facet of this dishonesty relates to the bland and quite child-like insistence of all and sundry spokesmen for science, and of various species of public figure, that all we need to do to solve the problems of society is to apply 'the scientific method' — whatever that really means. The complicity of scientists is that they do nothing to suppress this furrpy and to expose it for the nonsense which it is. Let me read you what Sir Peter Medawar (1969) has to say on this matter.

'Perhaps then we should no longer think of scientific methodology as a discipline of which the chief purpose is to teach scientists how to conduct their business, but rather as an attempt to get non-scientists to pull themselves together and smarten up and generally speaking be much more scientific than they are . . . . While I respect this evangelistic mission, I am not in sympathy with it. The "backwardness" of sociology (as in the nineteenth century of biology) has little now to do with a failure to use authenticated methods of scientific research in trying to solve its manifold problems. It is due above all else to the sheer complexity of those problems. I very much doubt whether a methodology based on the intellectual practices of physicists and biologists (supposing that methodology to be sound) would be of any great use to sociologists . . . . The elevated prose and studied postures of a flourishing school of social anthropology in France today are best explained away as a reaction against the crude scientism of those who have urged upon sociologists the adoption of a style of investigation which they do not use themselves and cannot authenticate from their own experience.'<sup>9</sup>

Let me mention one topic of great political and emotional concern these days, the environment. Now it is, of course, true that the geophysical and biological processes of the environment present many important research challenges; it is also true that many of the technologically produced problems of the environment have technological solutions; and it would be folly to turn our backs on these facts. Politicians, administrators, and scientists alike claim, however, that all we need to fix the environmental mess is environmental science, environmental science, and more environmental science. There is, unfortunately, a dearth of clear-sighted and honest assessments of the possibilities. One is that of Bob May,

which appeared in a recent issue of *Search*, (May, 1971). May concludes that the vast bulk of the problems of the environment are, in fact, *not* amenable to scientific solution. He goes on to provide a penetrating discussion of the political problems of the environment.

Another expression of this loss of moral sensitivity in science was the reaction to the revelations of James Watson's *Double Helix* (1968). At first the occasional murmur was to be heard,<sup>10</sup> but all too soon everyone seems to have accepted the fact that self-seeking ambition and the lust for honours is an acceptable driving force in science today. The scientific community adjusted its public morals to *The Double Helix* with even more alacrity than the people of America (and, I suppose, Australia) have adjusted theirs to the My Lai massacre. And the layman saw that scientists really did behave like the immature and unpleasant cardboard figures of Snow's novels.

### Lord Snow and Jacob Bronowski

Now that I have mentioned Snow, I cannot forbear to say more about him. One of the most interesting examples of the acceptability of scientific Marxism to establishments is the Lord Snow. Although his famous Radio Lecture *The Two Cultures and the Scientific Revolution* (Snow, 1959) is often supposed to be a humane and culturally valuable exposition of science to modern society it is, at heart, simply a manifesto of what I am calling scientific Marxism. It is true that it does make its remark about the two cultures, but we should remember that, eight years before Snow's *Two Cultures*, Jacob Bronowski had published *The Common-sense of Science* (1951). This is a sensitive exposition of science as the search for truth and for understanding of the world and ourselves. Not that Bronowski turns his back on the utility and the social consequences of science, but he recognizes that the moral authority of science stems from its intellectual goals, and so keeps his priorities straight. In the course of his book, Bronowski beautifully develops the common ground of science and the arts and shows that they do not stand in mutual antipathy, but are closely related expressions of man's urge to be creative and to comprehend his fate. Bronowski was a Polish Jew and not quite an Establishment.

Snow was more fortunate. He was Establishment material, he was a happy exponent of scientific Marxism, and he

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had the great good luck to irritate F. R. Leavis (1962). And with Leavis for an enemy, Snow didn't need his friends.

Leavis' attack on Snow was so shot through with personal animosity and cheap spite that nobody noticed the elements of irrefutable truth in some of his criticisms. Other, more temperate, critics have offered a reasoned assessment of Snow. Kathleen Nott (1969), for example, makes some interesting comments. Referring to Snow both as Science Policy Man and as novelist, she writes: 'Snow views his boffins, in the world and in fiction, suffering as they do from [a] terrible and petty moral paralysis, with an almost avuncular affection, with no sense of humour at all, and with a resentful eye on criticism'. Somewhere in his writings, Snow approves the dictum that 'satire is cheek' and goes on to explain that it is the 'revenge of those who cannot really comprehend the world or cope with it'. Miss Nott comments: 'I have no doubt that satire appears to be cheek to those who have good reason to be oversensitive to criticism. Satire has always been recognized as a good way of dealing with tyrants and the pompous who would like to tyrannize'.

I hardly need remind you that the heavy seriousness and moral insensitivity which Miss Nott deplors in Snow are all too common amongst the disciples of Marx.

### The young and science

That the young are today estranged from their elders is not news to any of us. This estrangement may or may not in itself be good. But the really sad aspect for all scientists is that, whereas science might reasonably be expected to be that ingredient of the older generation which is closest to the minds and the aspirations of the young, the opposite is the case. In fact, science and the scientist symbolize the things which the young expressly seek to reject.

Five weeks ago I was in Amsterdam and saw for myself the mindless lemming huddle of the young around the Dam monument. Three weeks ago I was in the basement of Sterling Hall at the University of Wisconsin being shown the damage from last year's fatal bombing, and that inspection was interrupted by my first experience of tear gas — sucked into the airconditioning as police and students battled outside above our heads. One week ago I was in Berkeley observing the smashed traffic signals and shop windows

from the previous day's riots, and attempting to gain some insight into the minds of the young from a startled perusal of the *Berkeley Barb*. And, just for good measure, lest I might have imagined that the alienation of the young just didn't happen here, I arrived back in Canberra last Friday to find the streets choked with bus loads of riot police — with running battles reminiscent of those between the *flics* and Algerians in Paris during the troubles.

Thirty years ago the moral authority of science had not been sapped. My image of science as a boy came close to that which Bronowski describes. I really wonder whether I should have been much interested in science had I been offered a Snow-Marxist picture of it. Can one, in fact, wonder at the reservations of the young about science presented to them in this way. And, let us not forget it, that is the public image of science, whether it be true or false.

If it is true — if we are in fact nothing but the technically marvellous serfs of a bread-and-circus society — then we merit both Samuel Johnson's strictures and the contempt of the young. It may well be that it is for the lack of worthy scientific exemplars that the counter-culture of youth turns away from the intellectual bite of the natural sciences and loses itself in handicrafts, in astrology, in drugs, and in its own vulgarized versions of the Eastern mysticisms.

It is reported that Konrad Lorenz, the naturalist and animal behaviourist, has been going about warning hostile student audiences that, if they tear down man's knowledge to start afresh, they will backslide not a few centuries but two hundred thousand years (Lessing, 1971). Perhaps this is an overreaction, but we should not forget that it was disappointed anti-intellectualism which led to Fascism in the twenties and thirties (cf. Hamilton, 1971).<sup>11</sup> And, as Karl Popper argues in *The Open Society and Its Enemies* (1945), the irrational antiscientific urge in man is a constant pressure for return to tribalism and the unremitting foe of civilization.

### Notes

1. But Professor L. Bass has offered in discussion a picture of pure mathematics as an exploration of introverted consciousness and as therefore important source material for neurophysiology. Professor Bass stresses that neurophysiology includes at least an element of meta-science, since it concerns itself with the processes whereby we receive all sensory signals from 'the external world' (Bass, 1968).

2. Haydon has a curious connexion with Australia. He shot himself in 1846 after the failure of his exhibition of two large paintings, *Nero and Aristides*. He had been perpetually in debt and the crowd of creditors with claims on his estate included a Cheapside merchant, R. Twentyman. The fatal paintings passed to Twentyman, who emigrated to Australia shortly after. In 1948 *Nero and Aristides* were reported locked in a small dark room of the Melbourne Aquarium. On January 28, 1953, the Aquarium burnt down: the recorded survivors were two seals, some birds and Ned Kelly's armour. George (1970) states that *Aristides* was used as a target by the RAAF trainees camped in the Aquarium during World War II, but that both paintings survive as property of Sir Gengoult Smith stored in the Exhibition Building. [Barrett Reid reports that a crate of paintings owned by Sir Gengoult was seen near the carpenters' shop at the Exhibition on June 16, 1971.]
3. See his *Essay on Method* (Coleridge, 1818). This was at the printer's at the time of Haydon's dinner. Coleridge was essentially confined to his sickroom in Highgate from 1830. He made only two excursions from it: the first to York, in September 1831, for the historic First Meeting of the British Association; the second to Cambridge, in June 1833, for the Third Meeting. On this last excursion he stayed at Trinity, paid his respects to the bust of Newton there, and was delighted to meet Faraday. Thirteen months later he was dead.
4. With respect to Marx's use of 'philosopher', we recall that the word 'scientist' was scarcely yet in circulation. The Reverend Mr Whewell of Trinity had invented it just five years before (Whewell, 1840).
5. We should recognize that, from the viewpoint of science as 'economy of thought', which was stressed by Mach, Clifford, and Kirchhoff (e.g. Mach, 1942), the dichotomy between 'truth', 'knowledge' or 'understanding', on the one hand, and 'power' or 'utility', on the other, is an imperfect one: but it is convenient here.
6. Cf. Bronowski (1961).
7. Cf. Sol Ensel (1968): 'Science has lost its critical function; no longer are natural scientists burned at the stake for their views about the nature of the world'.
8. Cf. Greenberg (1967).
9. Cf. Ashby (1971): 'The scientific method can speak authoritatively about means in society but it cannot be authoritative about ends. There is no straight path from fact to value. If we rely on science alone, questions of purpose will not be answered; and politics are about purpose'.
10. The reviews in *Science* (Chargaff, 1968) and *Nature* (Hollander, 1968) did express reservations: but the *Nature* editorial (217, 1087, 1968) was friendly; and the, fortunately anonymous, review in the *Australian Journal of Science* (31, 234, 1968) was abjectly enthusiastic.
11. Sir Eric Ashby (1971) also remarks on the threat of fascism implicit in the antiscience of the counter-culture: but, from the viewpoint of the present thesis, there is irony in his citation in this connexion of Bernal (1939).

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note also F. Schwartz "The Peruvian Influence of Mathematics on Science" in LOGIC, METHODOLOGY & PHILOSOPHY OF SCIENCE AN ENGEL'S P. Supper and A. Tarski.

reason and the counter-culture  
 reason ← neurophysiology