

[excerpts from]
THE SOCIAL FUNCTION OF SCIENCE

By

JOHN DESMOND BERNAL, F.R.S.

Birkbeck College

Universtty of London

First published 1939

CHAPTER V: THE EFFICIENCY OF SCIENTIFIC RESEARCH

Once we admit any function for science in society, it is possible to ask whether that function is being carried out efficiently or inefficiently. Whether the results obtained are the best achievable with the human and material resources available. However, our judgment of the inefficiency of science will largely depend on our ideas regarding the function of science. Nonetheless, without prejudging that central issue of this book, we can still discuss the efficiency of scientific research in relation to various hypothetical functions of science.

Three Aims for Science: Psychological, Rational, and Social

Science as an occupation can be considered to have three aims, which are not mutually exclusive:

1. The entertainment of the scientist and the satisfaction of his innate curiosity.
2. The discovery and integrated understanding of the external world.
3. The application of such understanding to human welfare issues.

We can term these as the psychological, rational, and social aims of science. The social effectiveness of science will be discussed in a later chapter. Our current concern is the other two aims.

Estimating the efficiency of science concerning its psychological aim in a strict sense is challenging. Still, given that psychological satisfaction plays a vital role in conducting scientific research, it must be factored into any discussion about the general efficiency of science.

That scientific research is profoundly satisfying to all who choose to engage in it is undeniable. Typically, individuals choose the path of a scientist mainly due to the anticipated satisfaction. However, this satisfaction is not unique to science. Almost every profession offers opportunities for exercising disciplined curiosity, no different from what's seen in scientific research. The growth of the science profession isn't due to a spontaneous surge in naturally curious individuals. Instead, it's the realization of the value science offers to its backers. Here, the pre-existing natural curiosity is harnessed. Science leverages curiosity and requires it, but curiosity didn't create science.

Interestingly, it's only in relatively recent times that scientists have defended science based on the psychological gratification it provides. Historically, science was justified because it glorified God or benefitted humanity. These claims can be viewed as a subtle nod to the psychological justification, but overtly, they tied science to divinity or utility, perceived then as mankind's overarching goals. Seventeenth-century scientists had compelling reasons to emphasize science's utility. They uniquely grasped its potential and sought external support, which could be gained by highlighting its tangible benefits. They had to champion this practicality against critics like Dean Swift, who mocked the scientists of his era for indulging in pointless and fruitless fantasies. However, there's no evidence to suggest that these scientists didn't genuinely believe their work was beneficial to society. Nor did they consider that science's success could be harnessed differently.

The Ideal of Pure Science

Confidence in science began to wobble in the nineteenth century when it was evident that science could be, and was being, exploited for nefarious purposes. This void was filled by the idealism of "pure science" — science conducted without any thoughts of application or rewards. Thomas

Henry Huxley [1893: *Method & Results*] eloquently captures the sentiments of the Victorian scientist in his compelling prose.

"In fact, the history of physical science teaches (and we cannot too carefully take this lesson to heart) that the practical advantages attainable through its agency have never been, and never will be, sufficiently attractive to men inspired by the inborn genius of interpreting Nature. Such advantages do not provide the motivation required for the toils and sacrifices demanded of its followers. What truly excites these individuals is the love of knowledge and the joy of discovery, as described by ancient poets — the unmatched pleasure of extending the boundaries of law and order towards the unreachable extents of the infinitely vast and the infinitely minute, amidst which our brief existence occurs. In this endeavor, the physical philosopher, occasionally on purpose but more often by accident, stumbles upon a finding of practical worth. Such discoveries are met with great celebration by those who stand to benefit. For that moment, science becomes the admiration of all. However, while these triumphs are being celebrated and the incidental benefits of scientific inquiry are converted into wages and wealth, the true wave of scientific exploration continues its journey across the vast sea of the unknown."

"Thus, without underestimating the practical outcomes of enhanced natural knowledge and its positive impact on our material world, I believe we must acknowledge that the pivotal concepts, some of which I've touched upon, along with the ethical spirit I've tried to depict in the limited time available, signify the enduring importance of natural knowledge. If, as the world matures, these concepts are confirmed and this spirit extends to all realms of human thought, equating to the entire spectrum of knowledge, and if humanity, as it reaches its zenith, discerns that there's only one form of knowledge and a singular method to obtain it, then we, as current torchbearers, must recognize the wisdom in advancing natural knowledge, assisting ourselves and our successors towards the magnificent destiny that awaits humanity." — *Method and Results* [Huxley, 1893], pp. 54 and 41.

In a different context, the ideal of pure science became a mark of elitism, reflecting scientists attempting to emulate scholars and gentlemen. An applied scientist was at risk of being perceived as somewhat commercial, potentially forfeiting their status of genuine interest. By championing science for its intrinsic value, the pure scientist rejected the basic material foundation that underpinned their work.

Science as Escape

The broad disillusionment that followed the War began to dim even the luminance of pure science. Advances in psychology implied that the quest for knowledge was merely an extension of childhood curiosities into adulthood. A grandson of Huxley, in his writings about scientists, makes a character remark:

"I perceive now that the real charm of the intellectual life — the life devoted to erudition, to scientific research, to philosophy, to aesthetics, to criticism — is its easiness. It's the substitution of simple intellectual schemata for the complexities of reality; of still and formal death for the bewildering movements of life. It's incomparably easier to know a lot, say, about the history of art, and to have profound ideas about metaphysics and sociology than to know personally and intuitively a lot about one's fellows and to have satisfactory relations with one's friends and lovers, one's wife and children. Living's much more difficult than Sanskrit or chemistry or economics. The intellectual life is child's play; which is why intellectuals tend to become children — and then imbeciles and finally, as the political and industrial history of the last few centuries clearly demonstrates, homicidal lunatics and wild beasts. The repressed functions don't die; they deteriorate, they fester, they revert to primitiveness. But meanwhile, it's much easier to be an

intellectual child or lunatic or beast than a harmonious adult man. That's why (among other reasons) there's such a demand for higher education. The rush to books and universities is like the rush to the public-house. People want to drown their realization of the difficulties of living properly in this grotesque contemporary world, they want to forget their own deplorable inefficiency as artists in life. Some drown their sorrows in alcohol, but still more drown them in books and artistic dilettantism; some try to forget themselves in fornication, dancing, movies, listening-in, others in lectures and scientific hobbies. The books and lectures are better sorrow-drowners than drink and fornication; they leave no headache, none of that despairing post coitum triste feeling. Till quite recently, I must confess, I too took learning and philosophy and science — all the activities that are magniloquently lumped under the title of 'The Search for Truth' — very seriously. I regarded the Search for Truth as the highest of human tasks and the Searchers as the noblest of men. But in the last year or so I have begun to see that this famous Search for Truth is just an amusement, a distraction like any other, a rather refined and elaborate substitute for genuine living; and that Truth-Searchers become just as silly, infantile, and corrupt in their way as the boozers, the pure aesthetes, the businessmen, the Good-Timers in theirs. I also perceived that the pursuit of Truth is just a polite name for the intellectual's favourite pastime of substituting simple and therefore false abstractions for the living complexities of reality. But seeking Truth is much easier than learning the art of integral living (in which, of course, Truth-Seeking will take its due and proportionate place along with other amusements, like skittles and mountain climbing). Which explains, though it doesn't justify, my continued and excessive indulgence in the vices of informative reading and abstract generalization. Shall I ever have the strength of mind to break myself of these indolent habits of intellectualism and devote my energies to the more serious and difficult task of living integrally? And even if I did try to break these habits, shouldn't I find that heredity was at the bottom of them and that I was congenitally incapable of living wholly and harmoniously?" — From *Point Counter Point* by Aldous Huxley [1928], pp. 442-4.

Here it is recognized that science is being used mainly for the enrichment of the few and the destruction of the many. Consequently, its ultimate justification is that it is quite an amusing pastime. This attitude, though rarely admitted, is actually extremely widespread among scientists, particularly those in the safer and more comfortable positions. Science is one of the most absorbing and satisfying pastimes, and as such it appeals in different ways to different types of personality. To some, it is a game against the unknown where one wins and no one loses, to others, more humanly minded, it is a race between different investigators as to who should first wrest the prize from nature. It has all the qualities which make millions of people addicts of the crossword puzzle or the detective story, the only difference being that the problem has been set by nature or chance and not by man, that the answers cannot be got with certainty, and when they are found often raise far more questions than the original problem.

If we examine the present state of science from this point of view, it must be admitted that on the whole it is fairly satisfactory. The only complaints of the scientists are on purely material grounds.

Given an adequate salary and fair security of tenure, together with no obligation to perform any specified tasks, the scientist would be happy enough. From what has already been said, even these conditions are not available for the majority of scientists, but they are available for quite a number and they represent a perfectly attainable ideal. If the game were the only thing that mattered, the major inefficiencies from other points of view — the lack of apparatus or information, the lack of any general plan or direction, and the failure to co-ordinate science with other human activities — are all immaterial. Actual material deficiencies can be considered extra hazards added to the game; overcoming them is itself the education of the scientist. The conditions of his work make it particularly convenient for him to take this point of view. But the danger of treating science purely as a game is that playing games as a life work does not often bring lasting or full satisfaction. Men require to feel that what they do has a social importance as well. Even a supreme performer such

as Morphy could get no satisfaction out of his success because he could not bear to be regarded as only a chess player.

Science and Cynicism

Nevertheless, sufficiently narrow specialization and the inclination to make the best of whatever means are available still assure many scientists a relatively happy time. Some, not so limited in their views, may yet accept this attitude deliberately. "Whenever I look out at the world," a professor once remarked, "I see such misery and mess that I prefer to bury myself in my own work and to forget about things that in any case I could do nothing about." To others, the psychological attitude towards scientific research leads to a cynical admission of the complete futility of science itself, an attitude which expresses itself in theories attempting to prove the impossibility of exact knowledge and the failure of determinism or even of simple causality.

Ultimately this view reduces science to a more or less ornamental, but in any case, quite useless outgrowth of civilized society, yet it is clear that whatever the scientists themselves may think, there is no economic system which is willing to pay scientists just to amuse themselves. Science must pay its way just as much as any other human activity, though the payment need not always take a purely material form. The prestige of science and its moral and political influence also have to be taken into account.

...

Scientific Publications

As science grows, the facts on which it is founded and the way of building laws and theories from them depend less and less on the direct observation of nature by the scientific worker and more and more on the previous observations of other workers and on their methods of interpretation. The very instruments of science are, as it were, material embodiments of previously achieved theories. It is consequently of critical importance that the scientist at every stage in his work should be able to reach, rapidly and in a convenient form, the results up to date of all relevant scientific knowledge. This is the function of the system of scientific publication which has grown up with the development of science itself. It is at present an enormous and chaotic structure. There are in the world today no less than 33,000 different scientific periodicals, probably more, for this number was given in the last (1934 edition) of the World List of Scientific Periodicals. Besides these, there are an uncounted number of books, pamphlets, and theses. Each of these periodicals fulfills, or attempts to fulfill, the needs of scientific information in a particular field in a particular country. Some, such as the journals of the academies, cover all subjects and have a worldwide circulation; others are the product of some single highly specialized institute and are only with great difficulty available outside their country of origin.

The production of scientific publications has long ago become so large that it is recognized that a scientific worker can only read a small fraction of the papers in what is itself a very small part of science. But how can he ensure that the papers he does read are those that are to be of the most value in his work or how can he be certain that he is not in fact reduplicating work already done? For this purpose, there has grown up in recent years a vast system of abstracting, in which the contents of each scientific paper are reduced to a few lines. In spite of attempts at rationalization there is still an enormous amount of overlapping and gaps in abstracting work, and abstracts

themselves have reached an unwieldy size. Thus American Chemical Abstracts consist every year of three volumes of 2000 pages each, with an index in addition of 1000 pages. This situation is growing rapidly worse; the number of entries in Biological Abstracts has grown from 14,506 in 1927 to 21,531 in 1934.

The burying of Published Work

The result is that it has become impossible for the average scientific worker, who does not wish to devote the major part of his time to reading, to keep up with the progress in his own field, and almost impossible for anyone to follow the progress of science as a whole even in the most general way. At the same time, a large quantity of good scientific work may be permanently lost because it was not appreciated when it was published, and subsequently, everybody has been so busy in keeping up with recent publications that there has been no time to sift through the records of the past. In part, these difficulties are an inevitable result of the enormous growth of science, but in far larger part, they are due to the lack of consideration which scientists are giving to the problem of communicating their results. The very bulk of scientific publications is itself delusive. It is of very unequal value; a large proportion of it, possibly as much as three-quarters, does not deserve to be published at all, and is only published for economic considerations which have nothing to do with the real interests of science. The position of every scientific worker has been made to depend far too much on the bulk rather than the quality of his scientific publications. Publication is often premature and dictated by the need of establishing priorities, itself an indication of the unnecessary struggle for existence that goes on inside the scientific world.

The number of scientific journals is altogether excessive. Each one had at its inception a certain *raison d'être*. It was founded to express the results of some new science from a point of view other than the orthodox, but in the course of time these distinctions disappear and the journal remains. A great deal in science has been sacrificed to local patriotism or personal distinction. Owing to this, the circulations of the journals are all small and, as a large number of them never reach the libraries of any but the most important universities and learned societies, their purpose is for the most part lost.

The Cost of Publication

The burden of this vast mass of publication is in itself a great handicap to scientific research. Apart from certain Government subsidies, the cost of scientific publication is paid for by the scientists themselves. Very few journals, and those mostly technical, are run at a profit. The majority are supported by learned societies, and indeed put such a drain on their resources that they are rarely able to spend anything for research purposes. The cost of journals, books, and subscriptions to learned societies are not usually reckoned as laboratory expenses, and the real salary of the scientist is, for this reason, always between 5 and 10 percent less than what he nominally receives. Besides this, owing to the knowledge that, under present conditions, it is unlikely that all those who should be interested will see any particular piece of work, the practice has grown up by which each scientist sends anything up to 200 reprints of his work to selected people, which of course imposes on him an additional and often considerable expense. This sending of reprints is in itself a hopeful sign and may, as is suggested in a later chapter, point the way to an altogether better system of communication, but at present, it is inefficient and costly, as there is no relation of demand to supply for any particular paper. In particular, reprints of papers which are recognized to be important are generally quite unobtainable after a lapse of as little as a year.

It should be clear from what has already been said that the present system of scientific publication wastes both time and money and is a constant source of irritation to the scientists themselves. Efforts, it is true, are continually being made to improve it. A system of reports on progress in

different fields of science is gradually spreading. The number of abstracting journals has been reduced and abstracts better classified, but these improvements hardly keep pace with the cropping up of new journals and the accumulation of unread papers. What is wanted is a far more drastic revision of the whole system of scientific communication. Some suggestions for this are contained in a subsequent chapter.