# Introduction

A decision on the scope of the philosophy of science is a precondition for writing about its history. Unfortunately, philosophers and scientists are not in agreement on the nature of the philosophy of science. Even practising philosophers of science often disagree about the proper subject-matter of their discipline. An example of this lack of agreement is the exchange between Stephen Toulmin and Ernest Nagel on whether philosophy of science should be a study of scientific achievement *in vivo*, or a study of problems of explanation and confirmation as reformulated in the terms of deductive logic.[1] To establish a basis for the subsequent historical survey, it will be helpful to sketch four viewpoints on the philosophy of science.

One view is that the philosophy of science is the formulation of world-views that are consistent with, and in some sense based on, important scientific theories. On this view, it is the task of the philosopher of science to elaborate the broader implications of science. This may take the form of speculation about ontological categories to be used in speaking about "being-as-such". Thus Alfred North Whitehead urged that recent developments in physics require that the categories 'substance' and 'attribute' be replaced by the categories 'process' and 'influence'.[2] Or it may take the form of pronouncements about the implications of scientific theories for the evaluation of human behaviour, as in Social Darwinism and the theory of ethical relativity. The present study is not concerned with "philosophy of science" in this sense.

A second view is that the philosophy of science is an exposition of the presuppositions and predispositions of scientists. The philosopher of science may point out that scientists presuppose that nature is not capricious, and that there exist in nature regularities of sufficiently low complexity to be accessible to the investigator. In addition, he may uncover the preferences of scientists for deterministic rather than statistical laws, or for mechanistic rather than teleological explanations. This view tends to assimilate philosophy of science to sociology.

A third view is that the philosophy of science is a discipline in which the concepts and theories of the sciences are analysed and clarified. This is not a matter of giving a semi-popular exposition of the latest theories. It is, rather, a

matter of becoming clear about the meaning of such terms as 'particle', 'wave', 'potential', and 'complex' in their scientific usage.

But as Gilbert Ryle has pointed out, there is something pretentious about this view of the philosophy of science—as if the scientist needed the philosopher of science to explain to him the meanings of scientific concepts.[3] There would seem to be two possibilities. Either the scientist does understand a concept that he uses, in which case no clarification is required. Or he does not, in which case he must inquire into the relations of that concept to other concepts and to operations of measurement. Such an inquiry is a typical scientific activity. No one would claim that each time a scientist conducts such an inquiry he is practising philosophy of science. At the very least, we must conclude that not every analysis of scientific concepts qualifies as philosophy of science. And yet it may be that certain types of conceptual analysis should be classified as part of the philosophy of science. This question will be left open, pending consideration of a fourth view of the philosophy of science.

A fourth view, which is the view adopted in this work, is that philosophy of science is a second-order criteriology. The philosopher of science seeks answers to such questions as:

1. What characteristics distinguish scientific inquiry from other types of investigation?
2. What procedures should scientists follow in investigating nature?
3. What conditions must be satisfied for a scientific explanation to be correct?
4. What is the cognitive status of scientific laws and principles?

To ask these questions is to assume a vantage-point one step removed from the practice of science itself. There is a distinction to be made between doing science and thinking about how science ought to be done. The analysis of scientific method is a second-order discipline, the subject-matter of which is the procedures and structures of the various sciences, viz.:

| LEVEL | DISCIPLINE | SUBJECT-MATTER |
|---|---|---|
| 2 | Philosophy of Science | Analysis of the Procedures and Logic of Scientific Explanation |
| 1 | Science | Explanation of Facts |
| 0 | | Facts |

The fourth view of the philosophy of science incorporates certain aspects of the second and third views. For instance, inquiry into the predispositions of scientists may be relevant to the problem of evaluating scientific theories. This is particularly true for judgements about the completeness of explanations. Einstein, for example, insisted that statistical accounts of radioactive decay were incomplete. He maintained that a complete interpretation would enable predictions to be made of the behaviour of individual atoms.

In addition, analyses of the meanings of concepts may be relevant to the demarcation of scientific inquiry from other types of investigation. For instance, if it can be shown that a term is used in such a way that no means are provided to distinguish its correct application from incorrect application, then interpretations in which the concept is embedded may be excluded from the domain of science. Something like this took place in the case of the concept 'absolute simultaneity'.

The distinction which has been indicated between science and philosophy of science is not a sharp one. It is based on a difference of intent rather than a difference in subject-matter. Consider the question of the relative adequacy of Young's wave theory of light and Maxwell's electromagnetic theory. It is the scientist *qua* scientist who judges Maxwell's theory to be superior. And it is the philosopher of science (or the scientist *qua* philosopher of science) who investigates the general criteria of acceptability that are implied in judgements of this type. Clearly these activities interpenetrate. The scientist who is ignorant of precedents in the evaluation of theories is not likely to do an adequate job of evaluation himself. And the philosopher of science who is ignorant of scientific practice is not likely to make perceptive pronouncements on scientific method.

Recognition that the boundary-line between science and philosophy of science is not sharp is reflected in the choice of subject-matter for this historical survey. The primary source is what scientists and philosophers have said about scientific method. In some cases this is sufficient. It is possible to discuss the philosophies of science of Whewell and Mill, for example, exclusively in terms of what they have written about scientific method. In other cases, however, this is not sufficient. To present the philosophies of science of Galileo and Newton, it is necessary to strike a balance between what they have written about scientific method and their actual scientific practice.

Moreover, developments in science proper, especially the introduction of new types of interpretation, subsequently may provide grist for the mill of philosophers of science. It is for this reason that brief accounts have been included of the work of Euclid, Archimedes, and the classical atomists, among others.

## Notes

1 Stephen Toulmin, *Sci. Am.* 214, no. 2 (Feb. 1966), 129–33; 214, no. 4 (Apr. 1966), 9–11; Ernest Nagel, *Sci. Am.* 214, no. 4 (Apr. 1966), 8–9.

2 Whitehead himself did not use the term 'influence'. For his position on the relation of science and philosophy see, for example, his *Modes of Thought* (Cambridge: Cambridge University Press, 1938), 173–232.

3 Gilbert Ryle, 'Systematically Misleading Expressions', in A. Flew, ed., *Essays on Logic and Language—First Series* (Oxford: Blackwell, 1951), 11–13.