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EXPLAINING TECHNICAL CHANGE

STUDIES IN RATIONALITY AND SOCIAL CHANGE

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Preface and acknowledgements

The occasion for writing this book was provided by Bernt Schiller of the University of Linköping (Sweden), who asked me to write a textbook in the philosophy of science that could be suitable for their doctoral programme 'Technology and social change'. I am grateful for the suggestions and comments offered by him and his colleagues along the way. I should also like to thank the following for their comments on an earlier draft: G. A. Cohen, Aanund Hylland, Michael MacPherson, Nathan Rosenberg, and an anonymous referee of Cambridge University Press. Acknowledgements for comments on the Appendices are given at the appropriate places. Appendix 1 was originally published in *Social Science Information* 18 (1979).

Part I of the work can be read as an introduction to the philosophy of scientific explanation. The Achilles heel of this part, clearly, is the chapter on causal explanation. My competence in these intricate matters is not high, but since the chapter was required by the overall architectonics of the book I felt I should state my views even when they are not strongly grounded. I hope I have avoided saying too much that is obviously wrong, but the reader may justifiably feel that some of what I say is not very interesting or not as tightly argued as he might wish.

Part II is *not* to be read as an introduction to the theory of technical change. It is subordinated to the epistemological purpose of showing how the distinctions and propositions of Part I can be applied to a specific set of empirical problems. Here the danger is that my exposition of the theories may be too compact for the non-specialist and too sloppy for the specialist. To the first, I can only offer the advice to look up the original works. To the second I make a plea that ambiguous statements be taken in their most plausible sense. Even so, there will probably remain some statements that are plainly wrong, of which the reader can justly complain.

J.E.

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General introduction

The study of technical change is uniquely well suited to epistemological analysis. It is located at the interface of social science and the natural sciences, and so might be expected to be relevant to the discussion of 'the unity of science'. It bridges the gap between pure science and everyday affairs, and might therefore be expected to throw light on how theoretical knowledge relates to the observable world. Technical change – the manufacture and modification of tools – may have played an important role in the evolution of intelligent life on earth, comparable to that of language. During the course of human history, social institutions have emerged and disappeared largely in response to changes in productive and destructive technology. Moreover, technical change offers a challenge to analysis in that it is fundamentally unpredictable. 'If I knew where jazz was going, I'd be there already', Humphrey Lyttelton is reported to have said. Similarly, any attempt to explain technical change sooner or later comes up against the paradox of turning creativity into a dependent variable.

In this book I first set out the main varieties of scientific explanation, and then look at some central theories of technical change from the vantage point provided by that discussion. This enables me to deal with what are, I think, the two main approaches to technical change. First, technical change may be conceived of as a rational goal-directed activity, as the choice of the best innovation among a set of feasible changes. Secondly, technical change may be seen as a process of trial and error, as the cumulative addition of small and largely random modifications of the production process. Any serious student of technology will agree that technical change exhibits both these aspects, but there are strong differences in emphasis between the contending explanations.

This main dichotomy cuts across many of the other relevant distinctions that can be made in this domain. I believe, for instance, that neoclassical and Marxist theories of technical change at the level of the firm

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share an emphasis on the rational-actor approach. True, Marxists have not engaged in much detailed modelling of technical change at the micro-level, but there are a number of historical studies by Marxists who argue that the entrepreneur uses innovation as a weapon in the class struggle. The neoclassical economists explain technical change in the light of profit maximization, whereas Marxists tend to argue that power rather than short-term profits is at stake. Within both traditions technical change is explained in the light of the goal to be achieved, although they impute different goals to the entrepreneur.

On the other side of the main dichotomy we find the 'evolutionary' theories of technical change, which emphasize past history rather than future goals in the explanation of why firms currently use the techniques they do. Typically the proponents of these theories look at technical change as more or less closely analogous to evolution by natural selection. It is instructive, therefore, to consider the socio-biological studies of animal tool behaviour which explain technical progress as a literal rather than a metaphorical instance of biological evolution. These theories set out to explain not only specific inventions, but also the emergence of genes for inventiveness. Interestingly, tool behaviour turns out to be closely related to play behaviour – a reminder that creativity is of the essence in technical change.

Technical change may be studied at various levels of aggregation, and for various time spans. Neoclassical and evolutionary theories tend to study change at the levels of the firm and the industry, in contradistinction to the large-scale historical syntheses offered by Schumpeter and Marx. Schumpeter probably is the most influential single writer on technical change, its causes and consequences. Again, this may be because he emphasized creativity and disequilibrium, rather than trying to fit technical change into the pattern of routine profit maximization. He praised capitalism not because of its efficiency and rationality, but because of its dynamic character – to be explained in terms of irrational expectations and dreams of founding private dynasties. Marx also insisted on the uniqueness of capitalism in that, in contrast to all earlier modes of production, it does not oppose technical change, but rather depends on it. Yet in his materialist conception of history he also, somewhat inconsistently, argued that the development of the productive forces is the major determinant of social change in all modes of production.

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It ought to go without saying that I am not offering an introduction to theories of technical change. In most cases, the reader will have to go elsewhere for detailed expositions of the various theories discussed in Part II. The discussions of Marxism in Ch. 7 and in Appendix 2 are somewhat more detailed, because I happen to know more about this tradition than about the others. But even in this case my attention is directed by epistemological concerns rather than by an informed interest in the substantive issues. This is a case study in the philosophy of science, not a bird's eye view of science. Again, it ought to go without saying that I am not out to tell economists or historians how to do their work. I believe, however, that philosophers of science can be of help in distinguishing true from spurious foci of disagreement within the empirical disciplines. Empirical work conducted in isolation from the philosophy of science may be no worse for that, whereas the philosophy of science atrophies if it is not in close and constant touch with the development of current thinking on empirical matters. Yet the asymmetry is not so radical as to make philosophy of science totally parasitic.

This will be admitted by many scientists with respect to problems of verification and falsification. Few will contest the statement that Popper's methodology of science – basically an injunction to scientists to stick their necks out – has had a valuable influence. At the more technical level, the issue of statistical inference has been discussed by philosophers of science and scientists working in parallel and sometimes in tandem. My concern here, however, is with the structure of scientific explanations. Whereas I believe that the problems of verification are basically the same in all disciplines, I shall argue that the differences in their subject matters impose different strategies of explanation. I shall distinguish between causal, functional and intentional explanations, corresponding – broadly speaking – to the physical, biological and social sciences respectively. While recognizing that causal explanation in some sense or senses is more basic than the other modes, I shall argue that there nevertheless is room and need for the latter.

The dichotomy between rational-choice theories of technical change and evolutionary theories corresponds – and once again I have to speak very broadly – to the distinction between intentional and functional explanation. It will turn out, however, that in many respects the exceptions to this statement are the more interesting cases. In fact, not only science, but philosophy of science as well, has most to offer at the level of

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detailed analysis where such glib generalities break down. Technical evolution differs from biological evolution in that the changes are far from totally random, but to some extent directed; they are also screened by a mechanism in which human intentionality plays a crucial role. Similarly, not all intentional models of technical change qualify as rational models – for there may be cases when the underlying expectations are not rationally formed. The lack of rationality in the expectations may be due to complex strategic interactions, or to a fundamental uncertainty about the future, or to both. It is perhaps the interaction between these two sources of ignorance that lends a unique flavour and depth to the issue of explaining technical change. Taken separately, both games without a solution and decisions under radical uncertainty create havoc with rational-choice models. When they both operate in a given choice situation, the result is close to chaos. Out of this chaos the evolutionary theories emerge as the more likely to explain actual technical progress. But here I go beyond my self-imposed limitations, so instead let me turn to matters more within my competence.

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