whatever perspective). It is a model for research methodology within the social sciences, and it is a source of valuable teaching material for those delivering courses on the social studies of science and technology. However, I do have some reservations about the book's appeal to a wider audience. Its origins appear to be in de Wit's PhD dissertation (submitted at Erasmus University, Rotterdam), and as in nearly all such texts the language is used to construct an academically credible argument—one that is credible to a community of scholars from which the external examiners are drawn—and not to engage an interested reader. This leads to a dense and somewhat stilted formal style, lacking in the rhetorical flourishes which leaven the prose. The sprinkling of well-reproduced archival photographs helps, but is not enough. So, while the book has considerable academic interest, I did not find it to be much fun to read.

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Paul K. Couchman
University of Wollongong
Wollongong, Australia

Managers and Innovation: Strategies for a Biotechnology

John Howells

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The aim of this book is to examine the management of technical innovation. The issue is tackled through a case study of a specific biotechnology, single cell protein (SCP) innovation, within companies in Western Europe: a process that Howells believes is probably the first manifestation of biotechnology. The data were collected from interviews with managers of 18 Western European companies, all of which were investigating the technology and developing products for market from the 1960s.

Case studies of this type provide a qualitative view of innovation, detailing the underlying processes in a way that is not possible with aggregated, quantitative data.[1] In the past this approach has been used, for example, to analyse the relative strengths of 'science push' and 'market pull' in innovative companies. Howells, however, concentrates on the impact of individuals in this process: intra-firm technological choices, company politics and interpersonal relationships, versus the external firm environment of consumer acceptance and the economics of competing products. This allows him to extend the discussion beyond the one-dimensional push-pull framework to develop a more

complex economic and organisational picture. This is possible because of the 30-year time span of the dataset plus the range of people interviewed within each company.

The book is organised into eight chapters, the first two of which set the scene. Chapter 1 outlines the role of technical innovation in the economy. It begins by discussing development of theory in innovation by Schumpeter and Kondratiev long wave cycles. The discussion of Kondratiev cycles is important as it sets the scene for the focus on the synthetic chemicals industry, associated by Freeman with the fourth Kondratiev ending in the 1980s.[2] Discussion of innovation itself requires a jump to the end of Chapter 1, where Gold's innovation diffusion studies of the 1980s provide the framework.

Attention then moves to the role of firms and individuals within firms, in particular the role of managers. Managers, it is explained, operate within a constantly changing environment. Individuals react to 'changes in the flow of an experience and activity' (p. 8) and, within the firm, negotiation over single events moves the individual towards a common view—a firm culture. This develops the framework for the empirical chapters, Howells proposing that the 'firm–environment boundary' is not a real separation—it is essential to examine how people operate within their organisation, in order to understand innovation.

Chapter 2 introduces SCP, which was industrial fermentation of micro-organisms to provide food and feed, i.e. a potential radical innovation which could replace agricultural production with manufacture. The chapter includes a short overview of the science base, production methods and an introduction to the 18 companies which attempted to use the technique. The economics of the process are a key issue and are also explained here. At the end of the chapter, chronologies for four companies—BP, ICI, Liquichimica and RHM—are provided. It is not clear, however, why only these companies are highlighted, given that the chapters which follow use examples from other companies such as Sugarco and Shell.

The next two chapters concentrate on the environment external to the case study companies. Chapter 3 deals with the markets and perceptions of these during development of SCP technology. Three potential markets for SCP are described—animal feed, human food, and what is called the political market, where 'third world' governments would licence SCP technology to improve the nutrition of their own population. The chapter discusses each of these submarkets in some detail, including their interrelationships, and the extent to which market perceptions within the companies influence the evolution of SCP research and development projects. This material is supplemented by an Appendix which provides additional calculations for economic decisions on, for example, the development of SCP as a viable alternative to fish meal, soya meal or milk powder at different times over the 30-year period in question; and whether changes to some of the key variables would make the process economically viable today.

Chapter 4 examines the interrelationships between the key firms. The first discussion concentrates on the relationship between BP and ICI, and the reaction of other oil companies to their entry into the SCP arena. The key conclusion is that firms cooperated where it helped introduce SCP into the market as a replacement for agricultural products, but competed on issues which would govern firms' places within the SCP market. A third company, RHM, is used later in the chapter to illustrate collaboration between smaller companies who could not finance SCP development alone.

Chapters 5 to 7 concentrate on intra-firm issues. Chapter 5, the longest in the book, highlights differences in culture between the chemical engineers of the parent companies and the biologists brought in to develop SCP products, and the differences in attitude to strategic markets wrought by company size. The chapter uses ICI to illustrate the former:

Sugarco and Shell for a discussion of the role of the R&D department and its link to company strategy. The examples are drawn together in a conclusion which discusses company culture, organisational subgroups and the value of R&D in different companies. Unfortunately, the discussion goes no further—the validity of 'market pull' assumptions are not questioned, and reasons for differences between the firms are not discussed in detail.

Chapter 6 deals with technical choices made by companies in development of fermentation research projects at all stages of selection of substrate and organism, scale-up and harvesting. Howells concludes that the process is both social and cognitive—the former influenced by the environment of the firm and the latter by patterns of understanding developed by managers. It is at this point that the concept of firm–individual boundary is again introduced, described as a 'socio-cognitive construction of technology' (p. 162) which determines choices in the context of other issues such as safety, economic objectives and the circumstances of the company. The chapter concludes with an attempt to define technology in terms of knowledge and ownership, the latter residing both in the firm and in the external market.

Patrons and project champions within these companies are examined specifically in Chapter 7. This chapter analyses the social context of individual actions and the informal networks that operate between individuals within the company, and between the company and external bodies such as government research agencies.

Project champions are at first distinguished from Schumpeter's company-founding 'heroic entrepreneurs'. In Howells' view, Schumpeter missed the fact that entrepreneurs may be driven by more than profits, and he also ignored the broader role of champions within corporations, including their existence within the social context of the firm. Even though existence of a champion may not necessarily lead to commercial success, Howells eventually concludes there are parallels between these champions and Schumpeter's entrepreneur because they appropriate company resources through their understanding of the company political structure and their common (cultural) understanding with those in authority.

The final chapter explores the connection between the previous issues and integrates the conclusions of previous chapters. These conclusions are used to build what is called a socio-cognitive view of the firm, a concept which is then expanded into a theory covering macro-level features of technical innovation. This chapter is short, and could have been extended further to help convince the reader of the argument. A diagram which provided a visual explanation of the concepts in the text would also have helped considerably.

In addition to the appendix material mentioned above, the last 30-odd pages of the book include additional appendices on development of SCP in countries outside Western Europe, and an extensive index.

How could the book be improved? The main fault is the lack of diagrams to support the text, particularly when the chapters themselves lack overview statements that could help the reader understand the structure of each section. In addition, it is not clear why each chapter reports only a selection of interviews from the 18 companies—is this because the other companies did not exhibit the behaviours highlighted? Finally, these companies all targeted different markets, recorded different successes, were of different sizes and shapes. An appendix which gave the reader a one-stop overview of the big picture would have made the key messages easier to place in a context, without as much close reading of the text.

Overall, however, this book provides fascinating insights into the subtleties of development of a radical new technology by a range of companies, and is an important contribution to the case study literature on innovation.

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Lyndal Thorburn
Macquarie University
Sydney, Australia

Women in Science, Engineering and Technology

Women in Science, Engineering and Technology Advisory Group, Office of the Chief Scientist, Department of the Prime Minister and Cabinet

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At the time of writing of this review, it is almost two years since the publication of the Advisory Group's report and some of the analysis, discussion and recommendations may well be a little out of date. For example, the changes wrought among scientists, engineers and technologists, their disciplines and their activities over the past few years by the so-called 'information revolution' continue unabated and include the rapid development of this revolution's own source—a branch of knowledge and application that combines the sciences of physics and mathematics with electronic engineering and technology. Having said that, the underlying issues still remain for women wishing to enter and to make their careers in science, engineering and technology (SET), and equity and justice are still in question. So, for its insights into them, and the ways proposed by the Group to deal with them, this publication has a good deal to say.

The main issues are that women continue to be underrepresented in some disciplines of SET, are seriously underrepresented at the most senior levels in all disciplines, have relatively poor retention rates on a career-long basis, and suffer degrees of gender bias and harassment from the male members of society. On the one hand, the report views the issues themselves as still being incompletely understood but, on the other, recent statistics indicate improvement in the participation of women in SET-based education, training and employment over the decade since the mid-1980s.

There is, the Group says, a 'need for a paradigm shift away from asking what is wrong with women to questioning what it is about the environment of SET (and society's perception of it) that it does not attract and retain the interest of girls and women'. The corollary, of course, is that this situation does not allow Australia to make the best use of its human resource potential.

Regarding the paradigm shift, the Group adopts two underlying principles: the need to question what it is about the environment of SET (and society's perception of it) that does not attract the interest of girls and women; and the need to adopt a holistic policy approach to the issues associated with their participation in SET. The Group recognizes that such requirements affect the education and careers of *all* women. In developing recommendations, it recognizes the wisdom of making use of the existing mandates of