

# Preface

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Industrial innovation profoundly affects us all. It provides the basis for national wealth, corporate profitability and a focus for human creativity and endeavour. It enhances the quality of our lives through improved health, communications and living environment, and can liberate us from monotonous and dangerous work. At the same time, industrial innovation has given us machines of mass destruction, numerous ecological disasters, and the means for accentuating already broad international differences in economic development. Understanding the nature, determinants and consequences of industrial innovation is therefore crucial for our understanding of the world.

We are assisted in the task of studying industrial innovation by the rapidly growing body of research into it. Scholars from a number of disciplines have increasingly taken industrial innovation, in its many guises, as the focus of their studies. This book brings together a very wide range of theoretical and empirical insights from these studies. The approach we took was to select what we saw as the major issues of industrial innovation and to invite leading academics in the field to write about what they believed to be the most important theoretical considerations, and empirical and practical findings.

The range of analyses presented reflects the huge variety in the circumstances in which innovation occurs, the processes that make it manifest, and its economic and social outcomes. The studies reveal how understanding the complexity of industrial innovation requires insights from a variety of perspectives, and consideration at the level of the economy, the sector, the region, the technology and the firm. By pulling together in one volume diverse and interdisciplinary bodies of research, the aim is to provide a source-book for all students of industrial innovation.

Rather than including a limited number of long chapters we chose to cover more ground by asking for many short pieces encompassing more issues. This put a lot of pressure on our contributors who were asked to discuss large bodies of literature, much of which they had authored, in 3000 to 4000 words. They responded admirably. In addition to the concise syntheses provided, we also present chapters which introduce valuable new empirical information and conceptual thinking. Authors were encouraged to submit select bibliographies on what they consider to be the key texts on the subject. This will provide an invaluable guide to further reading.

It is obviously impossible to cover the entire huge range of industrial

innovation in one volume. We have been selective, and others might have made different choices. Based on our experiences of researching and teaching industrial innovation, we believe that the issues we have chosen are all centrally relevant to students of this increasingly important subject.

The book is structured as follows:

### **Part 1: The Nature, Sources and Outcomes of Industrial Innovation**

The aims of this section are to introduce a number of ways of conceptualizing industrial innovation, to outline some of the key factors affecting its realization, and to analyze its outcomes for economic growth. The first three chapters provide a number of different levels of analysis of the form and process of innovation, all of which emphasize the interrelated or systemic nature of innovation. Marceau describes, from a broad conceptual perspective, a number of 'analytical lenses' on innovation at a macro level, including 'chains', 'clusters' and 'complexes'. Carlsson analyzes what he calls 'technology systems', delineating the major characteristics of the interrelated system of innovation in a number of different technologies. Cooke and Morgan provide a regional perspective on innovation and argue the spatial significance of 'the creative milieu'. Rothwell's chapter focuses on innovation at the level of the firm, describing strategies and success and failure factors in innovation and the movement towards what he calls the 'Fifth Generation Innovation Process'.

The following two chapters introduce some issues around the multiplicity of sources of innovation, something which is examined in greater detail in later sections. Steinmueller analyzes the important role that science plays in industrial innovation. Fransman then describes the Japanese system of innovation, one denoted not only by its success, but also by its past comparative lack of scientific efforts. He emphasizes the importance of processes, institutions and forms of organization in Japan.

The outcomes of industrial innovation are analyzed by Freeman in his historical theoretical review and analysis of the relationship between innovation and growth at the level of the firm and the economy. The way in which industrial policies supporting innovation can actively encourage economic development is described by Hobday in his chapter on the 'East Asian Tigers', the area of the world presently enjoying the most vigorous economic growth. This section concludes with a review from an economist's perspective, by Lissoni and Metcalfe, of the centrally important question of the diffusion of technology.

### **Part 2: Sectoral and Industrial Studies of Innovation**

This section of the book analyzes innovation in a variety of industries and technologies, and highlights the considerable differences between them.

Cawson analyzes innovation in consumer electronics and examines the importance of standards and the integration of different technologies and firms through strategic alliances. Hobday critically examines the popular 'Silicon Valley' model of innovation in semiconductors. Sharp describes innovation in the much more heterogeneous and more mature chemical and pharmaceutical industry. MacKerron examines innovation in the energy sector with a particular focus on electricity generation. Walker discusses military technology, its impact, proliferation and regulation. Gann analyzes innovation in construction, a traditional but important and innovative industry. Graves discusses the major issues of innovation confronting the automobile industry. Mansell looks at innovation facilitated by new telecommunications technologies, and Miles examines the broad issues of innovation in services.

The chapters presented in this section highlight diversity in the sources of innovation: differences in, for example, the role of basic science, government procurement, the inputs of suppliers and users, the importance of technological collaboration and the significance of small firms. They also clearly reveal the integrated nature of innovation, showing the interdependence of numerous actors in the innovation process.

### **Part 3: Key Issues Affecting Innovation**

In this section some of the major issues influencing innovation are examined. Tylecote analyzes the impact of different financial systems on industrial innovation, separating what he calls 'bank-based' and 'stock exchange-based' systems. The following three chapters develop a key aspect of innovation – inter-firm relationships – discussed in sectoral studies. Sako discusses the importance of the nature of supplier relationships, and the question of 'trust' between them in encouraging innovation. Shaw describes the significance of close links between the suppliers and users of innovation, and Dodgson examines the role of collaboration between firms in the development of technology. Littler then considers the role of marketing in shaping innovation. Lamberton analyzes the relationship between innovation and intellectual property rights. Rothwell and Dodgson consider the role of small and medium-sized firms in industrial innovation. The last three chapters in this section consider the major organizational and personnel issues affecting innovation within the firm. Fairtlough analyzes the crucial question of organization for innovation. Martin discusses the relationship between industrial relations and innovation, and Warner describes the importance of training.

### **Part 4: The Strategic Management of Innovation**

One of the major constraints to successful product and process innovation is its strategic management. This section examines the issues in a variety of

ways. Pavitt considers the key characteristics of the innovative firm. Granstrand and Sjölander look at some of the major issues of technology transfer within firms, and corporate integration. Coombs examines the changing strategies that firms have adopted to their R&D functions. Bessant examines manufacturing strategies, and Voss examines the implementation of manufacturing innovations. These contributions combine to provide a broad review of the major strategic challenges facing companies in industrial innovation, and valuable insights into how successful companies have overcome them.

### **Part 5: Future Challenges of Innovation in a Global Perspective**

The problems and challenges of the processes and management of innovation are discussed throughout the book. The adverse consequences of innovation are also discussed, particularly in the chapters on military technology and energy. This section concludes the book with two chapters highlighting the problems and responsibilities of industrial innovation. Skea examines the relationship between innovation and the environment, and Whiston considers innovation into the 21st century. Both of these provide a sobering view of the extensive challenges remaining for industrial innovation.

We would like to record our thanks to all the contributors to the book, and to Chris Freeman and Edward Elgar for the idea of producing it. The book was written when both editors were at SPRU and particular thanks are extended to Lorraine Fowlie and Melna Charin in SPRU for their hard work, excellent production skills and much-tried patience. We are also very grateful to Lynn Frances whose freelance skills saw the book through to completion.

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