# HANDBOOK OF TECHNOLOGY AND INNOVATION MANAGEMENT

Edited by

SCOTT SHANE
Case Western Reserve University



# HANDBOOK OF TECHNOLOGY AND INNOVATION MANAGEMENT

# HANDBOOK OF TECHNOLOGY AND INNOVATION MANAGEMENT

Edited by

SCOTT SHANE
Case Western Reserve University



Copyright © 2008

John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ. England

Telephone (+44) 1243 779777

Email (for orders and customer service enquiries): cs-books@wiley.co.uk Visit our Home Page on www.wiley.com

All Rights Reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, scanning or otherwise, except under the terms of the Copyright, Designs and Patents Act 1988 or under the terms of a licence issued by the Copyright Licensing Agency Ltd, 90 Tottenham Court Road, London W1T 4LP, UK, without the permission in writing of the Publisher. Requests to the Publisher should be addressed to the Permissions Department, John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England, or emailed to permreq@wiley.co.uk, or faxed to (+44) 1243 770620.

Designations used by companies to distinguish their products are often claimed as trademarks. All brand names and product names used in this book are trade names, service marks, trademarks or registered trademarks of their respective owners. The Publisher is not associated with any product or vendor mentioned in this book.

This publication is designed to provide accurate and authoritative information in regard to the subject matter covered. It is sold on the understanding that the Publisher is not engaged in rendering professional services. If professional advice or other expert assistance is required, the services of a competent professional should be sought.

#### Other Wiley Editorial Offices

John Wiley & Sons Inc., 111 River Street, Hoboken, NJ 07030, USA

Jossey-Bass, 989 Market Street, San Francisco, CA 94103-1741, USA

Wiley-VCH Verlag GmbH, Boschstr. 12, D-69469 Weinheim, Germany

John Wiley & Sons Australia Ltd, 42 McDougall Street, Milton, Queensland 4064, Australia

John Wiley & Sons (Asia) Pte Ltd, 2 Clementi Loop #02-01, Jin Xing Distripark, Singapore 129809

John Wiley & Sons Canada Ltd, 6045 Freemont Blvd, Mississauga, Ontario, L5R 4J3, Canada

Wiley also publishes its books in a variety of electronic formats. Some content that appears in print may not be available in electronic books.

#### Library of Congress Cataloging-in-Publication Data

 $Handbook\ of\ technology\ and\ innovation\ management\ /\ edited\ by\ Scott\ Shane.$ 

p. cm.

Includes bibliographical references and index.

ISBN 978-1-4051-2791-2 (cloth : alk. paper)

1. Technological innovations - Management. 2. Knowledge management. I.

Shane, Scott Andrew, 1964-

HD45.H295 2008

658.4'062-dc22

2008022824

#### British Library Cataloguing in Publication Data

A catalogue record for this book is available from the British Library

ISBN 978-1-4051-2791-2

Typeset in 10/12 Baskerville by Laserwords Private Limited, Chennai, India Printed and bound in Great Britain by Antony Rowe Ltd, Chippenham, Wiltshire

This book is printed on acid-free paper responsibly manufactured from sustainable forestry in which at least two trees are planted for each one used for paper production.

# Contents

Preface	ix
List of Contributors	xi
Editor's Introduction	XV
PART I THE EVOLUTION OF TECHNOLOGY, MARKETS, AND INDUSTRY	1
1 Technology and Industry Evolution	3
RAJSHREE AGARWAL AND MARY TRIPSAS	
2 The Evolution of Markets: Innovation Adoption, Diffusion, Market Growth, New Product Entry, and Competitor Responses	57
Venkatesh Shankar	
PART II THE DEVELOPMENT AND INTRODUCTION OF NEW PRODUCTS	113
3 Understanding Customer Needs	115
Barry L. Bayus	
4 Product Development as a Problem-solving Process	143
Christian Terwiesch	
5 Managing the 'Unmanageables' of Sustained Product Innovation	173
Deborah Dougherty	

vi Contents

PA	RT III THE MANAGEMENT AND ORGANIZATION OF INNOVATION	195
6	Rival Interpretations of Balancing Exploration and Exploitation: Simultaneous or Sequential?	197
	ERIC L. CHEN AND RIITTA KATILA	
7	R&D Project Selection and Portfolio Management: A Review of the Past, a Description of the Present, and a Sketch of the Future	215
	D. Brunner, L. Fleming, A. MacCormack, and D. Zinner	
8	Managing the Innovative Performance of Technical Professionals	239
	Ralph Katz	
PA	RT IV TECHNOLOGY STRATEGY	265
9	The Economics and Strategy of Standards and Standardization	267
	Shane Greenstein and Victor Stango	
10	Intellectual Property and Innovation	295
	Rosemarie H. Ziedonis	
11	Orchestrating Appropriability: Towards an Endogenous View of Capturing Value from Innovation Investments	335
	Henry Chesbrough	
12	Individual Collaborations, Strategic Alliances and Innovation: Insights from the Biotechnology Industry	353
	Paul Almeida, Jan Hohberger, and Pedro Parada	
PA	RT V WHO INNOVATES?	365
13	Technology-Based Entrepreneurship	367
	DAVID H. HSU	
14	Knowledge Spillover Entrepreneurship and Innovation in Large and Small Firms	389
	David B. Audretsch	

	CONTENTS	vii
15 The Financing of Innovation		409
Bronwyn H. Hall		

16	The Contribution	of Public	Entities t	o Innovation	and Technological	
	Change				J	431

MARYANN P. FELDMAN AND DIETER F. KOGLER

Index 461

# **Preface**

When Rosemary Nixon, an editor for Blackwell Publishing, now part of John Wiley & Sons, approached me in 2003 to edit a *Handbook on the Management of Technological Innovation*, I quickly agreed. The field of management of technology had undergone major changes in the previous two decades, with an increased focus on technology strategy, entrepreneurship, and product development, and I thought that the time was right for a handbook that provided some order to the plethora of new arguments and findings. Moreover, many of the names associated with cutting edge research in this area were not leading scholars two decades earlier – frankly, many of them were not even scholars 20, or even 10, years before. And I thought that a book that collected their views and summaries of the field would be extremely useful to current scholars and Ph.D. students. Finally, I thought that it would be easy to put together this handbook and that it would be published within a year.

Maybe I should have thought a little more about this undertaking before agreeing to do it. Instead of taking one year, it has taken closer to five years. Unfortunately, we lost several authors due to personal issues and had to replace them with others, which upturned all plans to get the handbook out quickly. However, with the manuscript now complete, I can reflect upon the effort and conclude that I was right about the idea behind the book. The changes in the field demand this handbook, and bringing together the work of the giants in the field will prove to be of value to both current and future scholars – even if agreeing to edit this handbook was probably a bad idea personally.

I need to offer my thanks to the authors of the chapters of this handbook and to my editor, Rosemary Nixon, and the staff at Blackwell Publishing and John Wiley & Sons for their extraordinary patience and flexibility. You are all better people than me. I probably would not have tolerated the delays in the development of this book with the grace that all of you showed.

I would also like to offer my thanks to A. Malachi Mixon III and the AT&T Foundation (formerly the SBC Foundation) for their financial support of my

X PREFACE

scholarly efforts since arriving at Case Western Reserve University. Without their generosity this book would not have occurred.

Lastly, I would like to thank my wife Lynne, daughter Hannah, and son Ryan. Each of them helped me in their own ways. Hannah and Ryan helped by being excellent playmates when I needed breaks from this project, and Lynne helped me by encouraging and supporting my efforts to create this book.

Scott Shane

# List of Contributors

# Rajshree Agarwal

College of Business University of Illinois at Urbana-Champaign Champaign, IL 61820 agarwalr@uiuc.edu

## Paul Almeida

McDonough School of Business Georgetown University Washington, DC 20057 almeidap@msb.edu

# **David Audretsch**

Institute for Development Strategies Indiana University Bloomington, IN 47405 daudrets@indiana.edu

## Barry L. Bayus

Kenan-Flagler Business School University of North Carolina Chapel Hill, NC 27599 Barry\_Bayus@UNC.edu

## **David Brunner**

Harvard Business School Harvard University Boston, MA 02163 dbrunner@hbs.edu

#### Eric L. Chen

Department of Management Science and Engineering Stanford University Stanford, CA 94305 elchen@stanford.edu

#### **Henry Chesbrough**

Haas School of Business University of California at Berkeley Berkeley, CA 94720 chesbrou@haas.berkeley.edu

# **Deborah Dougherty**

Rutgers Business School Rutgers University Newark, NJ 07102 doughert@rbsmail.rutgers.edu

## Maryann P. Feldman

Department of Public Policy UNC Chapel Hill Chapel Hill, NC 27599 maryann.feldman@unc.edu

#### Lee Fleming

Harvard Business School Harvard University Boston, MA 02163 lfleming@hbs.edu

#### **Shane Greenstein**

Kellogg School of Management Northwestern University Evanston, IL 60208 Greenstein@kellogg.northwestern.edu

#### **Bronwyn Hall**

Department of Economics University of California at Berkeley Berkeley, CA 94720-3880 bhhall@econ.berkeley.edu

# Jan Hohberger

Department of Business Policy ESADE Business School 08034 Barcelona, Spain Jan.hohberger@esade.edu

#### David Hsu

Wharton School of Business University of Pennsylvania Philadelphia, PA 19104 dhsu@wharton.upenn.edu

#### Riitta Katila

Department of Management Science and Engineering Stanford University Stanford, CA 94305-4026 rkatila@stanford.edu

## Ralph Katz

College of Business Administration Northeastern University Boston, MA 02115 r.katz@neu.edu

## **Dieter Kogler**

Department of Geography University of Toronto Toronto, ON M5S 3G3 dieter.kogler@utoronto.ca

#### Alan MacCormack

Harvard Business School Harvard University Boston, MA 02163 amaccormack@hbs.edu

#### Pedro Parada

Department of Business Policy ESADE Business School 08034 Barcelona, Spain Pedro.parada@esade.edu