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Strategic Management of Technological Innovation

Melissa A. Schilling

McGraw Hill

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Seventh Edition

Melissa A. Schilling
New York University

Mc
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Hill

STRATEGIC MANAGEMENT OF TECHNOLOGICAL INNOVATION

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About the Author

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Melissa Schilling is the John Herzog family professor of management and organizations at New York University's Stern School of Business. Professor Schilling teaches courses in strategic management, corporate strategy and technology, and innovation management. Before joining NYU, she was an Assistant Professor at Boston University (1997–2001), and has also served as a Visiting Professor at INSEAD and the Bren School of Environmental Science & Management at the University of California at Santa Barbara. She has also taught strategy and innovation courses at Siemens Corporation, IBM, the Kauffman Foundation Entrepreneurship Fellows program, Sogang University in Korea, and the Alta Scuola Polytecnica, a joint institution of Politecnico di Milano and Politecnico di Torino.

Professor Schilling's research focuses on technological innovation and knowledge creation. She has studied how technology shocks influence collaboration activity and innovation outcomes, how firms fight technology standards battles, manage platform ecosystems, and utilize collaboration, protection, and timing of entry strategies. She also studies how product designs and organizational structures migrate toward or away from modularity. Her most recent work focuses on knowledge creation, including how breadth of knowledge and search influences insight and learning, and how the structure of knowledge networks influences their overall capacity for knowledge creation. Her research in innovation and strategy has appeared in the leading academic journals such as *Academy of Management Journal, Academy of Management Review, Management Science, Organization Science, Strategic Management Journal,* and *Journal of Economics and Management Strategy* and *Research Policy.* She also sits on the editorial review boards of *Academy of Management Journal, Academy of Management Discoveries, Organization Science, Strategy Science,* and *Strategic Organization.* She is the author of *Quirky: The Remarkable Story of the Traits, Foibles, and Genius of Breakthrough Innovators Who Changed the World,* and she is coauthor of *Strategic Management: An Integrated Approach.* Professor Schilling won the Organization Science and Management Science Best Paper prize in 2007, an NSF CAREER award in 2003, and Boston University's Broderick Prize for research in 2000.

Preface

Innovation is a beautiful thing. It is a force with both aesthetic and pragmatic appeal: It unleashes our creative spirit, opening our minds to hitherto undreamed of possibilities, while accelerating economic growth and providing advances in such crucial human endeavors as medicine, agriculture, and education. For industrial organizations, the primary engines of innovation in the Western world, innovation provides both exceptional opportunities and steep challenges. While innovation is a powerful means of competitive differentiation, enabling firms to penetrate new markets and achieve higher margins, it is also a competitive race that must be run with speed, skill, and precision. It is not enough for a firm to be innovative—to be successful it must innovate better than its competitors.

As scholars and managers have raced to better understand innovation, a wide range of work on the topic has emerged and flourished in disciplines such as strategic management, organization theory, economics, marketing, engineering, and sociology. This work has generated many insights about how innovation affects the competitive dynamics of markets, how firms can strategically manage innovation, and how firms can implement their innovation strategies to maximize their likelihood of success. A great benefit of the dispersion of this literature across such diverse domains of study is that many innovation topics have been examined from different angles. However, this diversity also can pose integration challenges to both instructors and students. This book seeks to integrate this wide body of work into a single coherent strategic framework, attempting to provide coverage that is rigorous, inclusive, and accessible.

Organization of the Book

The subject of innovation management is approached here as a strategic process. The outline of the book is designed to mirror the strategic management process used in most strategy textbooks, progressing from assessing the competitive dynamics of the situation, to strategy formulation, and then to strategy implementation. The first part of the book covers the foundations and implications of the dynamics of innovation, helping managers and future managers better interpret their technological environments and identify meaningful trends. The second part of the book begins the process of crafting the firm's strategic direction and formulating its innovation strategy, including project selection, collaboration strategies, and strategies for protecting the firm's property rights. The third part of the book covers the process of implementing innovation, including the implications of organization structure on innovation, the management of new product development processes, the construction and management of new product development teams, and crafting the firm's deployment strategy. While the book emphasizes practical applications and examples, it also provides systematic coverage of the existing research and footnotes to guide further reading.

Complete Coverage for Both Business and Engineering Students

This book is designed to be a primary text for courses in the strategic management of innovation and new product development. Such courses are frequently taught in both business and engineering programs; thus, this book has been written with the needs of business and engineering students in mind. For example, Chapter Six (Defining the Organization's Strategic Direction) provides basic strategic analysis tools with which business students may already be familiar, but which may be unfamiliar to engineering students. Similarly, some of the material in Chapter Eleven (Managing the New Product Development Process) on computer-aided design or quality function deployment may be review material for information system students or engineering students, while being new to management students. Though the chapters are designed to have an intuitive order to them, they are also designed to be self-standing so instructors can pick and choose from them "buffet style" if they prefer.

New for the Seventh Edition

This seventh edition of the text has been comprehensively revised to ensure that the frameworks and tools are rigorous and comprehensive, the examples are fresh and exciting, and the figures and cases represent the most current information available. Some changes of particular note include:

Six New Short Cases

Netflix and the Battle of the Streaming Services. The new opening case for Chapter Four is about a battle unfolding for dominance in movie and television streaming. Though the case focuses on Netflix, it also details the moves made by competitors such as Amazon Prime Video, Disney, Hulu, and HBO. The case reveals the very interesting synergies Netflix has reaped in being both a content developer and a distributor, and it highlights the tradeoffs content developers make in choosing to have their content exclusive to a particular streaming service.

Failure to Launch at Uber Elevate. The opening case for Chapter Five in the sixth edition was about UberAIR, Uber's plan for launching an air taxi service; the opening case for Chapter Five for the seventh edition is about Uber's withdrawal of plans to launch its own air taxi service and the other companies that are still moving forward. This case highlights the range of challenges in launching something as new as air taxi service. While battery life and flight time are still considered areas that need improvement, the primary challenges to this market are now regulatory and infrastructure oriented: Where will the eVTOLs land? Who will regulate air traffic and how? Will the eVTOLs be too noisy? Will the eVTOLs be manned by pilots or autonomous? It is pretty easy to conclude from the case that Uber probably tried to enter this market too early, but it remains unclear whether the remaining players (who are almost all manufacturing startups dedicated wholly to producing eVTOLs) will fare better.

Zeta Energy and The "Holy Grail" of Batteries. Chapter Eight now opens with a case about Zeta Energy, a young battery technology startup that is in the process of developing a lithium metal sulfur battery. The technology is impressive and the potential markets are huge and diverse (e.g., electric vehicles, grid storage, consumer devices, and drones), but Zeta faces a dilemma of how to reach the stage of commercialization. Battery development is expensive and risky; Zeta has had problems raising enough funding to build the kind of facility it needs to produce the batteries at scale. The case highlights the various partnering strategies Zeta is considering, setting up a nice opportunity for students to analyze the pros and cons of types of collaboration agreements and types of partners.

The Patent Battle Over CRISPR Cas-9 Gene Editing. The new opening case for Chapter Nine is on what has been described as one of the most important patent battles in the last 50 years. CRISPR Cas-9 is a breakthrough technology that enables live animals (including humans) to be gene edited—potentially enabling us to eliminate and/or treat a wide range of diseases. Even more exciting is the fact that the technology itself is relatively inexpensive and simple, prompting a flood of students, researchers, and manufacturers to enthusiastically begin using it. The ownership of the intellectual property rights, however, are contested between a group at Berkeley and a group at MIT. The way each group's patents were filed, concomitant with the change of patent law, collectively created one of the most interesting—and high-stakes—battles patent lawyers have seen in decades.

How Apple Organizes for Innovation. Chapter Ten now opens with a case that describes how Apple is organized. The case tells the story of when Steve Jobs returned to Apple and dramatically reorganized the firm, yielding a big firm that has a structure that is much more commonly seen in small firms. The case provides detail on why Jobs felt the structure was appropriate, what its tradeoffs are, notably highlighting how much power the structure gives to its top leader. While this was probably a very desirable feature for Jobs, the case raises the question of whether or not the same structure makes sense for Apple under Tim Cook and whether it would make sense for different kinds of firms.

Magna International's Carbon Fiber "Lightweighting" Project. The opening case for Chapter Twelve describes in detail how Magna International, a Tier 1 automotive supplier, developed a scalable manufacturing method for carbon fiber auto parts in response to BMW's announcement of its intentions to build cars with the new material. With details and quotes from Tom Pilette, the VP of Product and Process Development of Magna who led the project, we learn about how the team was assembled and managed, how the team culture evolved, how team members were compensated, and more. BMW ends up deciding to make carbon fiber composites in house rather than buying from a supplier, but Magna's efforts transform it into an award-winning world leader in carbon fiber composite manufacturing.

Cases, Data, and Examples from around the World

Careful attention has been paid to ensure that the text is global in its scope. The opening cases and examples feature companies from China, India, Israel, Japan, The Netherlands, Kenya, the United States, and more. Wherever possible, statistics used in the text are based on worldwide data.

More Comprehensive Coverage and Focus on Current Innovation Trends

In response to reviewer suggestions, the new edition now provides an extensive discussion of the use of "Big Data" in guiding innovation, the strengths and weaknesses of grand prizes (like the XPRIZE) in generating innovation, characteristics of breakthrough innovators, the role of organization culture in innovation, a detailed example of Failure Modes and Effects Analysis that helps students set up their own FMEA spreadsheet, and more. The suggested readings for each chapter have also been updated to identify some of the more recent publications that have gained widespread attention in the topic area of each chapter. Despite these additions, great effort has also been put into ensuring the book remains concise—a feature that has proven popular with both instructors and students.

Supplements

The teaching package for *Strategic Management of Technological Innovation* is available online from Connect at connect.mheducation.com and includes:

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- Jordan Cunningham, Eastern Washington University

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Melissa A. Schilling

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Chapter One

Introduction

THE IMPORTANCE OF TECHNOLOGICAL INNOVATION

technological innovation
The act of introducing a new device, method, or material for application to commercial or practical objectives.

In many industries, **technological innovation** is now the most important driver of competitive success. Firms in a wide range of industries rely on products developed within the past five years for almost one-third (or more) of their sales and profits. For example, at Johnson & Johnson, products developed within the last five years account for over 30 percent of sales, and sales from products developed within the past five years at 3M have hit as high as 45 percent in recent years.

The increasing importance of innovation is due in part to the globalization of markets. Foreign competition has put pressure on firms to continuously innovate in order to produce differentiated products and services. Introducing new products helps firms protect their margins, while investing in process innovation helps firms lower their costs. Advances in information technology also have played a role in speeding the pace of innovation. Computer-aided design and computer-aided manufacturing have made it easier and faster for firms to design and produce new products, while flexible manufacturing technologies have made shorter production runs economical and have reduced the importance of production economies of scale.[1] These technologies help firms develop and produce more product variants that closely meet the needs of narrowly defined customer groups, thus achieving differentiation from competitors. For example, in 2021, Toyota offered dozens of different passenger vehicle lines under the Toyota brand (e.g., Camry, Prius, Highlander, Yaris, Land Cruiser, and Tundra). Within each of the vehicle lines, Toyota also offered several different models (e.g., Camry L, Camry LE, Camry SE, and Camry Hybrid SE) with different features and at different price points. In total, Toyota offered over 200 car models ranging in price from $16,605 (for the Yaris sedan) to $85,665 (for the Land Cruiser), and seating anywhere from three passengers (e.g., Tacoma Regular Cab truck) to eight passengers (Sienna Minivan). On top of this, Toyota also produced a range of luxury vehicles under its Lexus brand. Similarly, in 2021, Samsung produced more than 43 unique smartphones, from the Galaxy A01 priced at roughly $100 to the Galaxy Fold priced at roughly $2000. Companies can use broad portfolios of product models to help ensure they can penetrate almost every conceivable market niche. While producing multiple product variations used to be expensive and time-consuming, flexible manufacturing technologies now enable firms to seamlessly transition from producing one product model to the next, adjusting production schedules with real-time information on demand. Firms further reduce production costs by using common components in many of the models.

As firms such as Toyota, Samsung, and others adopt these new technologies and increase their pace of innovation, they raise the bar for competitors, triggering an industry-wide shift to shortened development cycles and more rapid new product introductions. The net results are greater market segmentation and rapid product obsolescence.[2] Product life cycles (the time between a product's introduction and its withdrawal from the market or replacement by a next-generation product) have become as short as 4 to 12 months for software, 12 to 24 months for computer hardware and consumer electronics, and 18 to 36 months for large home appliances.[3] This spurs firms to focus increasingly on innovation as a strategic imperative—a firm that does not innovate quickly finds its margins diminishing as its products become obsolete.

THE IMPACT OF TECHNOLOGICAL INNOVATION ON SOCIETY

If the push for innovation has raised the competitive bar for industries, arguably making success just that much more complicated for organizations, its net effect on society is more clearly positive. Innovation enables a wider range of goods and services to be delivered to people worldwide. It has made the production of food and other necessities more efficient, yielded medical treatments that improve health conditions, and enabled people to travel to and communicate with almost every part of the world. To get a real sense of the magnitude of the effect of technological innovation on society, look at Figure 1.1, which shows a timeline of some of the most important technological innovations developed over the last 200 years. Imagine how different life would be without these innovations!

gross domestic product (GDP)
The total annual output of an economy as measured by its final purchase price.

The aggregate impact of technological innovation can be observed by looking at **gross domestic product (GDP)**. The gross domestic product of an economy is its total annual output, measured by final purchase price. Figure 1.2 shows the average GDP per capita (i.e., GDP divided by the population) for the world from 1980 to 2019. The figures have been converted into U.S. dollars and adjusted for inflation. As shown in the figure, the average world GDP per capita has risen pretty steadily since 1980. In a series of studies of economic growth conducted at the National Bureau of Economic Research, economists showed that the historic rate of economic growth in GDP could not be accounted for entirely by growth in labor and capital inputs. Economist Robert Merton Solow argued that this unaccounted-for residual growth represented technological change: Technological innovation increased the amount of output achievable from a given quantity of labor and capital. This explanation was not immediately accepted; many researchers attempted to explain the residual away in terms of measurement error, inaccurate price deflation, or labor improvement.

FIGURE 1.1
Timeline of Some of the Most Important Technological Innovations in the Last 200 Years

1800	-	1800—Electric battery
	-	1804—Steam locomotive
	-	1807—Internal combustion engine
	-	1809—Telegraph
	-	1817—Bicycle
1820	-	1821—Dynamo
	-	1824—Braille writing system
	-	1828—Hot blast furnace
	-	1831—Electric generator
	-	1836—Five-shot revolver
1840	-	1841—Bunsen battery (voltaic cell)
	-	1842—Sulfuric ether-based anesthesia
	-	1846—Hydraulic crane
	-	1850—Petroleum refining
	-	1856—Aniline dyes
1860	-	1862—Gatling gun
	-	1867—Typewriter
	-	1876—Telephone
	-	1877—Phonograph
	-	1878—Incandescent lightbulb
1880	-	1885—Light steel skyscrapers
	-	1886—Internal combustion automobile
	-	1887—Pneumatic tire
	-	1892—Electric stove
	-	1895—X-ray machine
1900	-	1902—Air conditioner (electric)
	-	1903—Wright biplane
	-	1906—Electric vacuum cleaner
	-	1910—Electric washing machine
	-	1914—Rocket
1920	-	1921—Insulin (extracted)
	-	1927—Television
	-	1928—Penicillin
	-	1936—First programmable computer
	-	1939—Atom fission
1940	-	1942—Aqua lung
	-	1943—Nuclear reactor
	-	1947—Transistor
	-	1957—Satellite
	-	1958—Integrated circuit
1960	-	1967—Portable handheld calculator
	-	1969—ARPANET (precursor to Internet)
	-	1971—Microprocessor
	-	1973—Mobile (portable cellular) phone
	-	1976—Supercomputer
1980	-	1981—Space shuttle (reusable)
	-	1987—Disposable contact lenses
	-	1989—High-definition television
	-	1990—World Wide Web protocol
	-	1996—Wireless Internet
2000	-	2002—CRISPR Cas9 gene editing
	-	2003—Map of human genome
	-	2008—Blockchain
	-	2010—Synthetic life form
	-	2017—SpaceX reusable rocket

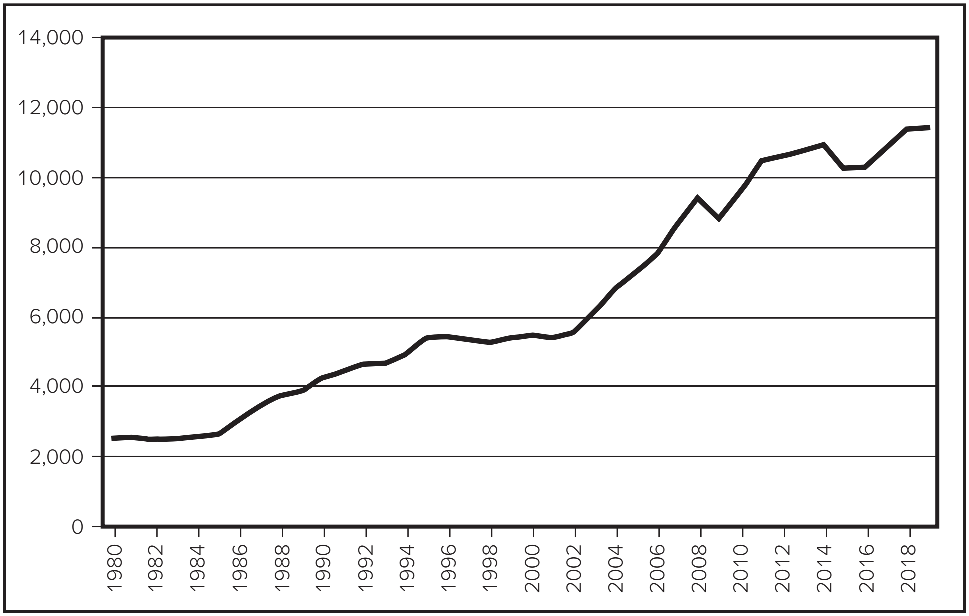
But in each case the additional variables were unable to eliminate this residual growth component. A consensus gradually emerged that the residual did in fact capture technological change. Solow received a Nobel Prize for his work in 1981, and the residual became known as the Solow Residual.[4] While GDP has its shortcomings as a measure of standard of living, it does relate very directly to the amount of goods consumers can purchase. Thus, to the extent that goods improve quality of life, we can ascribe some beneficial impact of technological innovation.

Sometimes technological innovation results in negative **externalities**. Production technologies may create pollution that is harmful to the surrounding communities; agricultural and fishing technologies can result in erosion, elimination of natural habitats, and depletion of ocean stocks; medical technologies can result in unanticipated consequences such as antibiotic-resistant strains of bacteria or moral dilemmas regarding the use of genetic modification. However, technology is, in its purest essence, knowledge—knowledge to solve our problems and pursue our goals.[5] Technological innovation is thus the creation of new knowledge that is applied to practical problems. Sometimes this knowledge is applied to problems hastily, without full consideration of the consequences and alternatives, but overall it will probably serve us better to have more knowledge than less.

externalities
Costs (or benefits) that are borne (or reaped) by individuals other than those responsible for creating them. Thus, if a business emits pollutants in a community, it imposes a negative externality on the community members; if a business builds a park in a community, it creates a positive externality for community members.

FIGURE 1.2
World Gross Domestic Product per Capita, 1980–2019 (in real 2019 U.S. dollars)

Source: "World GDP Per Capita 1960–2021," Macrotrends, https://www.macrotrends.net/countries/WLD/world/gdp-per-capita.



INNOVATION BY INDUSTRY: THE IMPORTANCE OF STRATEGY

As will be shown in Chapter Two, the majority of effort and money invested in technological innovation comes from industrial firms. However, in the frenetic race to innovate, many firms charge headlong into new product development without clear strategies or well-developed processes for choosing and managing projects. Such firms often initiate more projects than they can effectively support, choose projects that are a poor fit with the firm's resources and objectives, and suffer long development cycles and high project failure rates as a consequence (see the accompanying Research Brief for a recent study of the length of new product development cycles). While innovation is popularly depicted as a freewheeling process that is unconstrained by rules and plans, study after study has revealed that successful innovators have clearly defined innovation strategies and management processes.[6]

The Innovation Funnel

Most innovative ideas do not become successful new products. Many studies suggest that only one out of several thousand ideas results in a successful new product: Many projects do not result in technically feasible products and, of those that do, many fail to earn a commercial return. According to a 2012 study by the Product Development and Management Association, only about one in nine projects that are initiated is successful, and of those that make it to the point of being launched to the market, only about half earn a profit.[7] Furthermore, many ideas are sifted through and abandoned before a project is even formally initiated. According to one study that combined data from

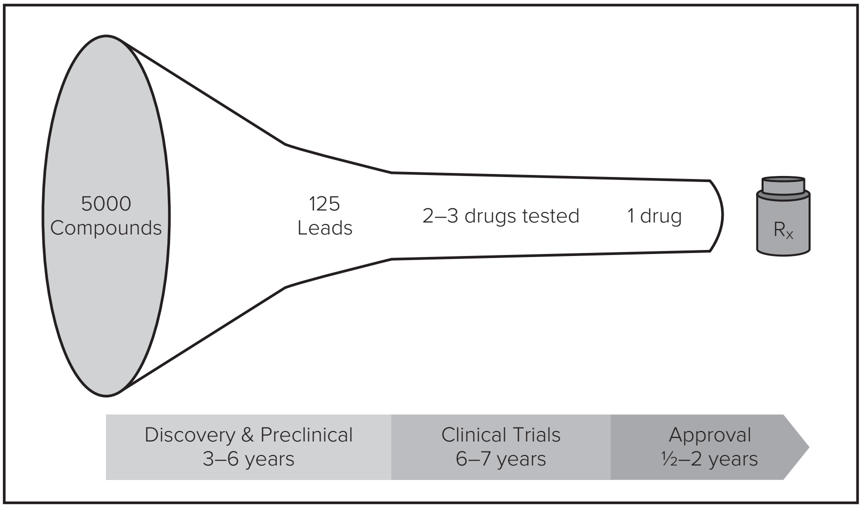
Research Brief How Long Does New Product Development Take?[a]

In a large-scale survey administered by the Product Development and Management Association (PDMA), in 2012, researchers examined the length of time it took firms to develop a new product from initial concept to market introduction. The study divided new product development projects into categories representing their degree of innovativeness: "radical" projects, "more innovative" projects, and "incremental" projects. On average, *incremental* projects took only 33 weeks from concept to market introduction. *More innovative* projects took significantly longer, clocking in at 57 weeks. The development of *radical* products or technologies took the longest, averaging 82 weeks. The study also found that on average, for *more innovative* and *radical* projects, firms reported significantly shorter cycle times than those reported in the previous PDMA surveys conducted in 1995 and 2004.

[a] Adapted from Stephen K. Markham and Hyunjung Lee, "Product Development and Management Association's 2012 Comparative Performance Assessment Study," *Journal of Product Innovation Management* 30, no. 3 (2013): 408–29.

prior studies of innovation success rates with data on patents, venture capital funding, and surveys, it takes about 3000 raw ideas to produce one significantly new and successful commercial product.[8] The pharmaceutical industry demonstrates this well—only one out of every 5000 compounds makes it to the pharmacist's shelf, and only one-third of those will be successful enough to recoup their R&D costs.[9] Furthermore, most studies indicate that it costs at least $1.4 billion and a decade of research to bring a new Food and Drug Administration (FDA)–approved pharmaceutical product to market![10] The innovation process is thus often conceived of as a funnel, with many potential new product ideas going in the wide end, but very few making it through the development process (see Figure 1.3).

FIGURE 1.3
The New Product Development Funnel in Pharmaceuticals



The Strategic Management of Technological Innovation

Improving a firm's innovation success rate requires a well-crafted strategy. A firm's innovation projects should align with its resources and objectives, leveraging its core competencies and helping it achieve its strategic intent. A firm's organizational structure and control systems should encourage the generation of innovative ideas while also ensuring efficient implementation. A firm's new product development process should maximize the likelihood of projects being both technically and commercially successful. To achieve these things, a firm needs (*a*) an in-depth understanding of the dynamics of innovation, (*b*) a well-crafted innovation strategy, and (*c*) well-designed processes for implementing the innovation strategy. We will cover each of these in turn (see Figure 1.4).

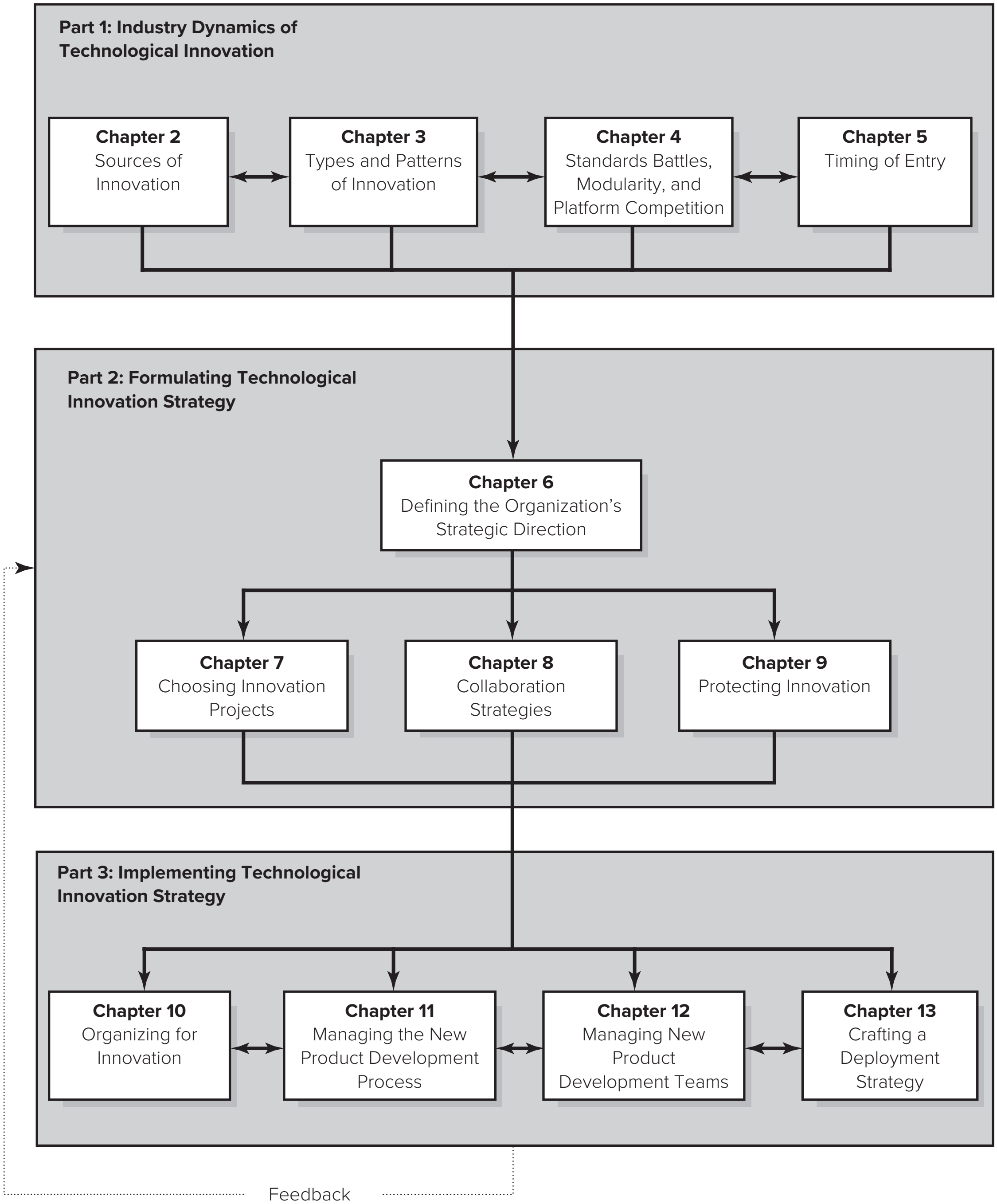
In Part One, we will cover the foundations of technological innovation, gaining an in-depth understanding of how and why innovation occurs in an industry, and why some innovations rise to dominate others. First, we will look at the sources of innovation in Chapter Two. We will address questions such as: Where do great ideas come from? How can firms harness the power of individual creativity? What role do customers, government organizations, universities, and alliance networks play in creating innovation? In this chapter, we will first explore the role of creativity in the generation of novel and useful ideas. We then look at various sources of innovation, including the role of individual inventors, firms, publicly sponsored research, and collaborative networks.

In Chapter Three, we will review models of types of innovation (such as radical versus incremental and architectural versus modular) and patterns of innovation (including s-curves of technology performance and diffusion, and technology cycles). We will address questions such as: Why are some innovations much harder to create and implement than others? Why do innovations often diffuse slowly even when they appear to offer a great advantage? What factors influence the rate at which a technology tends to improve over time? Familiarity with these types and patterns of innovation will help us distinguish how one project is different from another and the underlying factors that shape the project's likelihood of technical or commercial success.

In Chapter Four, we will turn to the particularly interesting dynamics that emerge in industries characterized by network externalities and other sources of increasing returns that can lead to standards battles and winner-take-all markets. We will address questions such as: Why do some industries choose a single dominant standard rather than enabling multiple standards to coexist? What makes one technological innovation rise to dominate all others, even when other seemingly superior technologies are offered? How can a firm avoid being locked out? Is there anything a firm can do to influence the likelihood of its technology becoming the dominant design? When are platform ecosystems likely to displace other forms of competition in an industry?

In Chapter Five, we will discuss the impact of entry timing, including first-mover advantages, first-mover *dis*advantages, and the factors that will determine the firm's optimal entry strategy. This chapter will address such questions as: What are the advantages and disadvantages of being first to market, early but not first, and late? What determines the optimal timing of entry for a new innovation? This chapter reveals a number of consistent patterns in how timing of entry impacts innovation success, and it

FIGURE 1.4
The Strategic Management of Technological Innovation



outlines what factors will influence a firm's optimal timing of entry, thus beginning the transition from understanding the dynamics of technological innovation to formulating technology strategy.

In Part Two, we will turn to formulating technological innovation strategy. Chapter Six reviews the basic strategic analysis tools managers can use to assess the firm's current position and define its strategic direction for the future. This chapter will address such questions as: What are the firm's sources of sustainable competitive advantage? Where in the firm's value chain do its strengths and weaknesses lie? What are the firm's core competencies, and how should it leverage and build upon them? What is the firm's strategic intent—that is, where does the firm want to be 10 years from now? Only after the firm has thoroughly appraised where it is currently can it formulate a coherent technological innovation strategy for the future.

In Chapter Seven, we will examine a variety of methods of choosing innovation projects. These include quantitative methods such as discounted cash flow and options valuation techniques, qualitative methods such as screening questions and balancing the research and development portfolio, as well as methods that combine qualitative and quantitative approaches such as conjoint analysis and data envelopment analysis. Each of these methods has its advantages and disadvantages, leading many firms to use a multiple-method approach to choosing innovation projects. This chapter also includes some of the sources of funding an innovative startup might use to finance their projects.

In Chapter Eight, we will examine collaboration strategies for innovation. This chapter addresses questions such as: Should the firm partner on a particular project or go solo? How does the firm decide which activities to do in-house and which to access through collaborative arrangements? If the firm chooses to work with a partner, how should the partnership be structured? How does the firm choose and monitor partners? We will begin by looking at the reasons a firm might choose to go solo versus working with a partner. We then will look at the pros and cons of various partnering methods, including joint ventures, alliances, licensing, outsourcing, and participating in collaborative research organizations. The chapter also reviews the factors that should influence partner selection and monitoring.

In Chapter Nine, we will address the options the firm has for appropriating the returns to its innovation efforts. We will look at the mechanics of patents, copyright, trademarks, and trade secrets. We will also address such questions as: Are there ever times when it would benefit the firm to not protect its technological innovation so vigorously? How does a firm decide between a wholly proprietary, wholly open, or partially open strategy for protecting its innovation? When will open strategies have advantages over wholly proprietary strategies? This chapter examines the range of protection options available to the firm, and the complex series of trade-offs a firm must consider in its protection strategy.

In Part Three, we will turn to implementing the technological innovation strategy. This begins in Chapter Ten with an examination of how the organization's size and structure influence its overall rate of innovativeness. The chapter addresses such questions as: Do bigger firms outperform smaller firms at innovation? How do formalization, standardization, and centralization impact the likelihood of generating innovative ideas and the organization's ability to implement those ideas quickly and efficiently? Is it possible to achieve creativity and flexibility at the same time as efficiency and reliability? How does the firm's culture influence its innovation? How do multinational firms decide where to perform their development activities? How do multinational firms coordinate their development activities toward a common goal when the activities occur in multiple countries? This chapter examines how organizations can balance the benefits and trade-offs of flexibility, economies of scale, standardization, centralization, and tapping local market knowledge.

In Chapter Eleven, we will review a series of "best practices" that have been identified in managing the new product development process. This includes such questions as: Should new product development processes be performed sequentially or in parallel? What are the advantages and disadvantages of using project champions? What are the benefits and risks of involving customers and/or suppliers in the development process? What tools can the firm use to improve the effectiveness and efficiency of its new product development processes? How does the firm assess whether its new product development process is successful? This chapter provides an extensive review of methods that have been developed to improve the management of new product development projects and to measure their performance.

Chapter Twelve builds on the previous chapter by illuminating how team composition and structure will influence project outcomes. This chapter addresses questions such as: How big should teams be? What are the advantages and disadvantages of choosing highly diverse team members? Do teams need to be colocated? When should teams be full time and/or permanent? What type of team leader and management practices should be used for the team? This chapter provides detailed guidelines for constructing new product development teams that are matched to the type of new product development project under way.

Finally, in Chapter Thirteen, we will look at innovation deployment strategies. This chapter will address such questions as: How do we accelerate the adoption of the technological innovation? How do we decide whether to use licensing or OEM agreements? Does it make more sense to use penetration pricing or a market-skimming price? When should we sell direct versus using intermediaries? What strategies can the firm use to encourage distributors and complementary goods providers to support the innovation? What are the advantages and disadvantages of major marketing methods? This chapter complements traditional marketing, distribution, and pricing courses by looking at how a deployment strategy can be crafted that especially targets the needs of a new technological innovation.

Summary of Chapter

1. Technological innovation is now often the single most important competitive driver in many industries. Many firms receive more than one-third of their sales and profits from products developed within the past five years.
2. The increasing importance of innovation has been driven largely by the globalization of markets and the advent of advanced technologies that enable more rapid product design and allow shorter production runs to be economically feasible.
3. Technological innovation has a number of important effects on society, including fostering increased GDP, enabling greater communication and mobility, and improving medical treatments.