

"I highly recommend this as a 'must-read' for anyone considering starting a new venture."

—David Courtney,  
Executive Vice President and Board Member of TiVo, Inc.

# FINDING FERTILE

Identifying Extraordinary Opportunities for New Ventures

# GROUND



DR. SCOTT A. SHANE

# **Finding Fertile Ground**

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**Identifying Extraordinary  
Opportunities for  
New Ventures**

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**To Lynne, for supporting my writing  
and everything else that I do**

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# CONTENTS

	Acknowledgments	ix
	Introduction	xiii
<b>Chapter 1:</b>	Selecting the Right Industry	1
<b>Chapter 2:</b>	Identifying Valuable Opportunities	19
<b>Chapter 3:</b>	Managing Technological Evolution	39
<b>Chapter 4:</b>	Identifying and Satisfying Real Market Needs	63
<b>Chapter 5:</b>	Understanding Customer Adoption	81
<b>Chapter 6:</b>	Exploiting Established Company Weaknesses	101
<b>Chapter 7:</b>	Managing Intellectual Property	125
<b>Chapter 8:</b>	Appropriating the Returns to Innovation	147



<b>Chapter 9:</b>	Choosing the Right Organizational Form	163
<b>Chapter 10:</b>	Managing Risk and Uncertainty	177
	Conclusions	199
	Index	215

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I decided to write this book after teaching a course in technology entrepreneurship to MBA students at Massachusetts Institute of Technology and at the University of Maryland. The class was very popular because it demonstrated how to start a new business that had a high probability of going public or becoming a high growth private enterprise. However, finding something for the classes to read on the topic was a challenge. There was no book that discussed high-technology entrepreneurship in a way that showed people how to identify a business opportunity to exploit a new technology successfully. As a result, I had to search a wide range of academic articles to find the materials that I needed to explain the key issues identifying an opportunity to start a successful technology company. My interactions with the students, and, in particular, the questions that they asked me about the articles that they read and the lectures that they heard provided the basis for the material in this book. Therefore, I would like to thank all of those students for their intellectual

curiosity, which helped me figure out what aspiring technology entrepreneurs really need to know about how to develop an effective business concept for a new technology business.

I would also like to thank all of the scholars and practitioners on whose work I have drawn to provide the framework for this book. While the ideas presented in this book were influenced by many people, several are particularly important: David Audretsch, Amar Bhidé, Clay Christiansen, Richard Foster, Alvin Klevorick, Richard Levin, Geoffrey Moore, Richard Nelson, Everett Rogers, David Teece, and Jim Utterback. The books and articles that these people wrote were extremely valuable in helping me to develop the ideas presented in this book.

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# INTRODUCTION

We live in an entrepreneurial society in an entrepreneurial age. Surveys consistently rank the United States as one of the most entrepreneurial countries in the world. Moreover, the rate of new firm creation in the United States has grown dramatically since the mid-1970s. The number of organizations created each year has reached levels that have not been seen since records have been kept (the past 150 years). As a result of this entrepreneurial orientation, approximately 4 percent of the U.S. labor force is involved in starting a new company every year—more than the number of people getting married or having children each year!<sup>1</sup>—bringing the total of business owners to about 13 percent of the nonagricultural labor force.<sup>2</sup>

In addition, our economy operates through a process of creative destruction. Every year large, established corporations are toppled from their positions of dominance by start-up companies whose new ways of doing business render the competitive advantages of established firms obsolete. A glance at the pages of the Fortune 500 over the past several decades indicates incredible fluidity among the listed

companies. Very few Fortune 500 companies remain Fortune 500 companies for more than a decade or two. Every year new companies go public and use the capital that they raise to challenge established industry leaders. The tendency for our economy to create new firms that topple giants in their industries has made successful entrepreneurs such as Jeff Bezos, Bill Gates, Michael Dell, Steve Jobs, Sam Walton, and Meg Whitman, who have founded these giant-killers, heroes and household names.

Despite the entrepreneurial orientation of our economy, and the iconlike status of successful entrepreneurs, most of the entrepreneurial activity that takes place in our economy is actually a dismal failure. Much like the typical lottery ticket buyer who dreams of being the jackpot winner, but ends up holding a handful of losing tickets, the typical entrepreneurial effort ends in a business closure that was not financially beneficial to its founder. Forty percent of all new businesses started in the United States do not live one year, more than two-thirds of new business created in this country die before their fifth birthday, and only 25 percent of new businesses survive eight years. Moreover, most entrepreneurs make very little money. On average, an entrepreneur who continues a business for 10 years—the elite few who manage to survive that long—make only 65 percent of the value of the real earnings that they made in their previous employment, including their return on stock ownership in their new company.<sup>3</sup>

## **The Purpose of This Book**

Obviously, something separates successful entrepreneurs from the masses who try their hand at this activity every year. This book identifies the key difference between the successes and the masses—the selection of the right business concept to exploit a valuable opportunity. The central goal of this book is to provide you, as a potential or

actual technology entrepreneur, with the tools necessary to identify the right business concept to exploit a valuable opportunity when you establish your business.

Of course, the information provided in this book will not guarantee you success in a high-technology entrepreneurship. Much in the same way as having the right form for a jump shot will not guarantee that a basketball player will earn \$20 million per year in the NBA, understanding what makes a business a good one for an entrepreneur to start will not guarantee that you, as an entrepreneur, will take a start-up public, replace the leading companies in an industry, or even be profitable. However, understanding the information in this book, and following the rules that it outlines, will dramatically increase the probability of a successful outcome.

You probably noticed that the title of this book implies that it focuses on technology entrepreneurship, and I have not said anything about technology businesses yet. The title of the book is not wrong—the book is indeed about technology entrepreneurship—and this is the first lesson of being a successful entrepreneur. On average, entrepreneurs are more successful if they create high-technology start-ups than if they initiate low-technology start-ups. This is not to say that you cannot be successful if you start a low technology business. You only have to look to Sam Walton and Walmart to know that is not true.

However, being a successful entrepreneur involves playing the odds, not looking at extreme examples. Much like most professional gamblers know that they cannot guarantee they will win any given game they play at a casino in Las Vegas or Atlantic City, but play the games that have the best odds, most professional entrepreneurs play the opportunities that have the highest probability of generating profitable private companies or create new public companies. Professional entrepreneurs—serial entrepreneurs such as Jim Clark, who founded Netscape and Healtheon—and their professional investors, the venture capitalists who finance many of these firms, almost always focus on high technology businesses because they know



that the odds of success are best with these kinds of companies. These professionals know, for example, that, over the past 25 years, the number one factor predicting the proportion of start-up firms in an industry that become one of the *Inc* 500 fastest growing companies or have gone public is the proportion of technical employees in the industry. They also know that the number one predictor of new business failure is the industry in which the firm is founded, with retail businesses and restaurants having extremely high failure rates.

Despite the clear effect of industry on the probability of new venture success, the typical entrepreneur starts a business in low-technology industry such as retail or restaurants, where the failure rate of new businesses is highest and the average profits are lowest. Unlike the successful entrepreneurs, typical entrepreneurs choose to start businesses in the wrong industries, making them very unlikely to be successful.

While this observation is disheartening because it illustrates how the majority of entrepreneurs set themselves up for failure, it is also instructive. It demonstrates that you can maximize your chances of success by following the example of professional entrepreneurs and their investors by choosing the right industries to enter, and ignoring the example of the mass of uninformed and unsuccessful entrepreneurs who select the wrong ones.

## **What I Mean by Technology**

One thing that is important to clarify right at the outset of this book is what I mean by technology. In recent years, there has been a tendency for the media to use the word technology to mean information technology (IT). These days, when you turn on CNBC or read the *Wall Street Journal*, and you hear or see the word “technology” to describe something, it is usually in reference to IT companies. This book uses the word technology in a broader, more traditional sense.

Technology is the embodiment of knowledge in ways that make it possible to create new products, exploit new markets, use new ways of organizing, incorporate new raw materials, or use new processes to meet customer needs. Certainly, information technology—the use of zeros and ones in digital form on computers—is an important technology, but there are many other important technologies as well. Biologically based technologies, such as those used to create new drugs or to clean up pollution, are also important. Similarly, mechanically based technologies, such as those that make pumps or valves, matter. New materials, such as those in new ceramic composites, are valuable.

When I refer to technology in this book, I do not just mean simply information technology, though that is certainly one form of technology; I also mean new microorganisms, new mechanical devices, new materials, and a host of other things. So when you see the phrase technology start-up in this book, do not just think of the Internet and computer software companies, think of new businesses producing fuel cells, ceramic composites, new drugs, heart valves, and a variety of other things that are the embodiment of knowledge as a way to meet customer needs. Therefore, this is not just a book about how to create successful Internet or software companies; it is also a book about how to create successful companies in biotechnology, medical devices, materials, manufacturing components, and other industries that are reliant on new technology.

## **How This Book is Different from Other Books**

This book is different from most books on entrepreneurship in three important ways. First, the book focuses on what matters the most for successful entrepreneurship—picking a good opportunity for starting a new business—rather than what most people write about—the

attributes of successful entrepreneurs. Why is this latter approach a problem? Because of what academic research has shown about entrepreneurship. Despite decades of effort to identify the special features of successful entrepreneurs, there really are none. Anyone can become a successful entrepreneur. You do not need special psychological characteristics or attitudes. Take the example of Bill Gates. He is not a billion times more successful than the average entrepreneur who founds a restaurant because he has a billion times larger endowment of special psychological traits and attitudes than the average entrepreneur. Instead, Bill Gates is more successful because the creation of the DOS operating system—the technology on which he built Microsoft—created a superb opportunity for the creation of a new business. It was much more valuable than the opportunity for any of the retail or restaurant businesses that the average entrepreneur starts.

I do not mean to imply that entrepreneurial attitudes and talent do not help entrepreneurs. Certainly having better entrepreneurial talent and attitudes than other people helps entrepreneurs to perform better, all other things being equal. However, we live in a world where all other things are not equal, and what accounts for the vast majority of entrepreneurial success is the business opportunity that a person chooses to pursue. Academic research on entrepreneurship has shown that the effect of business opportunities on the performance of new ventures is so large that it swamps the effect of entrepreneurs' characteristics. While it wouldn't hurt to be a good entrepreneur no matter what business you start, what really matters is picking the right business for a start-up.

To put this in plain English, even at the risk of putting too fine a point on it, if you start a biotechnology firm, your chances of success are much greater than if you start a restaurant. The difference between a biotechnology firm and a restaurant is so great that the differences between individual entrepreneurs exert little more than a rounding error on the performance of the ventures.

If what separates successful entrepreneurs from everyone else is an understanding of how to pick the right opportunities for starting new companies, then what a good book on entrepreneurship should do is tell readers how to pick the right opportunities. Unfortunately, that isn't what most books do. This book differs from almost all other entrepreneurship books because it sets aside the discussion of the things that make some people better entrepreneurs than others and focuses attention on the characteristics of great opportunities for new businesses.

This book also is also different from most books on entrepreneurship, which focus on *how* to get a new company started rather than on what kind of business is a good one to start. While books on “how to start a business” are fine for answering questions like “how to incorporate a company” or “how to fill out tax form,” they do nothing to help entrepreneurs to start successful companies. Unfortunately for entrepreneurs, there is no answer to the “how-to” question that is a secret to success. So there is no way to follow the recommendations of any of these how-to books to increase the chances of being a successful technology entrepreneur.

The “how-to-get-started books” miss the point of what would-be entrepreneurs need. As I said when I began this introduction, most people do not have a problem getting started in business; they have a harder time figuring out the right business to start. So what you need is a book that tells you how to pick a business opportunity that will make you successful, not how to get started in business. This book will help you to identify an opportunity for your new business and define your business concept.

Moreover, the book takes the idea of explaining how to pick the right business opportunity seriously by developing a framework of rules for success that are based on academic research which shows the things that make new companies successful. The book uses this framework to identify specific tools for identifying your business opportunity and developing your business concept that you can use to enhance

the performance of your new company—such things as tools for the evaluation of customer needs for new products, tools for measuring adoption and diffusion patterns, tools for financing new companies, and tools for protecting a new venture’s intellectual property. By bringing these tools together in one place and translating them from academic-speak into plain English, this book provides you with an understanding of how to create a successful new technology company.

This book additionally focuses on explaining how to identify a business concept that can support the development of a successful technology-based business. This is important because the performance of technology-based businesses—businesses such as the Internet, pollution abatement chemicals, high-temperature ceramics, fuel cells, and so on—depend on a variety of factors that are not present or are of relatively little importance in businesses not based on technology. The important factors in technology-based businesses, which are discussed in later chapters, include such things as intellectual property, increasing returns, dominant designs, diffusion, and S-curves. By explaining how to harness the factors that influence the performance of businesses in high-technology industries, this book provides you with the tools to create successful companies in these industries. Understanding and applying these tools helps you, as a high-technology entrepreneur, because the application of many concepts from low-technology business settings to high technology industries fails to help most entrepreneurs to be successful and, in some cases, even hinders their performance.

Why is this book’s focus on the factors that matter to high-technology entrepreneurship unique? Given the fact that technology-based businesses are, on average, the most successful new businesses, you would think that many authors would focus their attention on these kinds of businesses. However, almost all existing books in the market discuss entrepreneurship in general, without considering the special nature of high technology. As a result, there really are no good guides available to explain to people the keys to success with high-technology enterprises. This book fills this void. It explains how the

special characteristics of high technology influence what needs to be done to be successful with new technology-based businesses.

## **What This Book Does Not Do**

Having said what this book does, it is only fair to tell you what it doesn't do. This book doesn't deal with the process of starting a company once you have identified your valuable opportunity. It doesn't deal with things like how to write a business plan or how to raise money or how to create a venture team or how to hire employees. There are many books out there that can explain these things to you. While it certainly wouldn't hurt to read these other books, the information contained in them is not a substitute for what is contained here. No matter what you do after you have identified a business opportunity, it is good to have selected a valuable one. And the lessons contained here will help you to do just that.

## **Who Should Read this Book and When Should They Read It?**

You should read this book if you are thinking of starting a business. Ideally, you should read this book when you are first deciding what type of business you are going to start. Because this book focuses on identifying the fertile ground for your new business—what opportunity you should pursue and how you should pursue it—it is designed to help you conduct a feasibility analysis of your business opportunity. The frameworks described in the following pages, along with the recommendations for “dos” and “don'ts” and the questions to ask yourself are designed to help you to think about the business ideas that you come up with. Are they good for starting a new business? Will your venture be planted in fertile ground? Or will it be planted in arid soil that will make it very hard for you to succeed even if you are a great entrepreneur?

Moreover, you have probably thought of three or four ideas for a new business and you don't know which one to pursue. The discussion in the pages that follow will help you to figure out which of these opportunities is the best. After all, you are only going to be able to pursue one of your business ideas at a time. So you might as well pursue the best one first.

Even if you do not want to be the next Bill Gates, building the next big thing, taking your company public and becoming fabulously wealthy, this book will still be valuable to you. It is still easier to have a nice, comfortable business if you find fertile ground and pursue an opportunity that tends to favor start-up companies.

## **The Sources of Knowledge Underlying the Book**

Because I have said that this book uses academic research to create a framework for understanding how to create successful technology-based new companies, it is only fair for me to tell you the source of information underlying this book. The book has two specific sources of information. Some parts of the framework and evidence presented here are based on my own primary research. Other parts are based on the research of other academics. Regardless of the source, this book compiles, combines, and translates into plain English, material that is otherwise available only in a variety of different academic articles and books. As a result, you will find all of the key concepts that you need to understand to be a successful technology entrepreneur summarized and explained in one place, presented in a clear and straightforward manner.

## **The Key Lessons**

Successful technology entrepreneurs approach entrepreneurship differently from other entrepreneurs, not because they are smarter than or different from other people, but because they have learned how to

identify valuable opportunities for new technology companies. This book presents ten rules for entrepreneurs to follow to develop a business concept that will provide the basis for a successful high-technology company. Each of these rules is explained in a different chapter of the book. The rules are

1. Select the right industry
2. Identify valuable opportunities
3. Manage technological transitions
4. Identify and satisfy real market needs
5. Understand customer adoption
6. Exploit established company weaknesses
7. Manage intellectual property
8. Create barriers to imitation
9. Choose the right organizational form
10. Manage risk and uncertainty

## **An Overview of the Chapters**

The first rule of technology entrepreneurship explained in this book is to select the right industry in which to found a new firm. Some industries are simply better than other industries for the creation of new companies. For instance, fully one-fourth of all the companies listed on Inc magazine's list of the 500 fastest growing private companies since 1982 have been software firms. Moreover, the proportion of start-ups in an industry that experience an initial public offering or are listed in the *Inc* 500 varies by a factor of over 800 times between some of the more favorable industries and some of the less favorable ones. Chapter 1 identifies the industries that are favorable for founding new firms and explains why those industries are more



favorable to new firms than other industries. Specifically, the chapter examines five different dimensions of industry differences that influence the performance of new firms: knowledge conditions, demand conditions, industry life cycles, the presence or absence of a dominant design, and industry structure.

The second rule of technology entrepreneurship is to identify valuable opportunities. One of the ironies of entrepreneurship is that, despite the motivation of the world's entrepreneurs, we do not really need many new businesses. Established businesses are already meeting most market needs quite effectively because, in the absence of some sort of external change, someone will have figured out already how to satisfy the needs of potential customers. Therefore, to be a successful technology entrepreneur, you have to find an external change that creates an opportunity for a new business. Chapter 2 explains why opportunities for new technology companies exist and what the sources of those opportunities are. In general, three sources of change—new technology, political and regulatory shifts, and social and demographic movements—open up opportunities. The chapter also discusses the types of innovations that generate entrepreneurial opportunities, as well as the place within and outside the value chain where those innovations tend to occur. Furthermore, the chapter explains why and how some people and not others identify those opportunities.

The third rule of technology entrepreneurship is to manage technological transitions. Entrepreneurial success is enhanced by starting a firm to transition from one technological paradigm to another because change in a technological paradigm undermines the advantage of established firms. For example, few entrepreneurs have ever been able to start new firms that challenge Kodak's position in traditional film, but the shift to digital camera technology made it possible for many entrepreneurs to enter and compete with Kodak. Chapter 3 explains how you can manage technological transitions to become successful. The chapter explains

- Why technologies follow evolutionary patterns of change that open up discrete points of transition between technological paradigms that are valuable to entrepreneurs.
- How you can forecast the S-shaped pattern of technological development and use this pattern to manage when and how to enter industries.
- How dominant designs influence competition by entrepreneurial ventures.
- How you can exploit technical standards to enhance the success of your new business.
- What you should do differently to be successful in increasing returns businesses, which are common in high technology.

The fourth rule of technology entrepreneurship is to identify and satisfy a real market need. To be successful, you must introduce a new product or service that offers an economical solution to an unsatisfied customer need or that satisfies a customer need better than existing alternatives. Chapter 4 explains how successful entrepreneurs go about identifying customer needs for high technology products and services in ways that go beyond the traditional market research methods of surveys and focus groups. The chapter provides insight into why and how the advantages of successful new firms lie in product development rather than in manufacturing or marketing. Finally, the chapter explains how successful technology entrepreneurs identify the key decision makers in purchasing decisions, as well as how these entrepreneurs price their new products and services to make them attractive to these decision makers.

The fifth rule of technology entrepreneurship is to understand customer adoption and market dynamics. Contrary to the popular conception that evaluating markets is as simple as looking for large markets, evaluating markets for new technology products and services is relatively complicated. In particular, it requires successful

entrepreneurs to take a dynamic approach that forecasts the adoption patterns for new technology products and services and explains how markets for these products and services evolve. Chapter 5 explains why new companies have to focus their new product or service development efforts on particular market segments, but why choosing where to focus effort is hard to do. The chapter also explains how successful entrepreneurs evaluate the customer and their reasons to buy as a way to determine where to focus their efforts. Furthermore, the chapter discusses the evolution of markets for new technology products and services, particularly the dynamics of technology diffusion and substitution.

The sixth rule of technology entrepreneurship is to exploit established company weaknesses. Most of the time, established companies succeed when they compete with new firms because of the wealth of advantages in marketing and manufacturing that they have. However, established firms have several weaknesses that hinder their efforts to exploit technological opportunities that new firms can exploit. Chapter 6 identifies what you should do to compete successfully with established firms in high-technology settings. For instance, the chapter explains why you should pursue uncertain, disruptive technologies that demand new architectures, first focusing on niche customers in small market segments, and then expanding up market. The chapter also explains why you should focus on technologies that cannibalize established firms' investments, make established firm capabilities obsolete, and impose large exit costs on firms using the old technology.

The seventh rule of technology entrepreneurship is to manage intellectual property effectively. Introducing a product or service that meets a market need is a necessary, but not sufficient condition to profit from innovation. You must also protect your innovation against imitation. Chapter 7 discusses basic ideas behind appropriating the returns to innovation, focusing on the choice between secrecy and patenting.

The eighth rule of technology entrepreneurship is to create barriers to imitation. Chapter 8 examines how you can create barriers to

imitation by controlling resources, establishing a reputation, creating a first mover advantage, exploiting the learning curve, and making use of complementary assets in manufacturing, marketing and distribution.

The ninth rule of technology entrepreneurship is to choose the right organizational form. Chapter 9 explains when you are best off owning the various parts of the value chain, such as product development, manufacturing, and distribution, and when you are best off using market-based mechanisms, such as licensing, franchising, and strategic alliances, to control them.

The tenth rule of technology entrepreneurship is to manage risk and uncertainty effectively. Chapter 10 describes the tools and techniques that successful entrepreneurs use to reduce, reallocate, and manage risk. The chapter also discusses the use of real options and scenario analysis, as well as behavioral techniques for convincing others to bear risk, such as escalation of commitment, bringing together different parties at the same time, and closing skills.

The conclusion of the book returns to the theme introduced in the first chapter about the importance of understanding how to identify valuable opportunities for the creation of new technology companies. Specifically, it summarizes the key actions that you should take to come up with an opportunity that will support, and even foster, the creation of a new high-technology company.

The next chapter explores the first key lesson in starting a successful new high-technology company: picking the right industry.

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# 3

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## MANAGING TECHNOLOGICAL EVOLUTION

While the previous chapter indicated that technological change is a source of entrepreneurial opportunity, the discussion was incomplete. Responding to the right type of technological change is as important, if not more important for successful technology entrepreneurship, than is responding to technological change in general. Successful technological entrepreneurship requires a focus on technological transitions.

This focus on technological transitions is important because, most of the time, entrepreneurs target the wrong type of technological change to establish their new businesses. They start their businesses to exploit incremental change. By focusing on incremental change, entrepreneurs often find that they cannot compete with established firms and fail. What successful technology entrepreneurs have come to realize is that, to be successful, new ventures need to target technological transitions, points when an industry is shifting from one basic technology to another, such as when the printing industry

shifted from hot lead linotype machines to cold off-set printing generated by computers.

Your new venture will be greatly advantaged by focusing on technological transitions because they undermine the advantages of established firms. The reluctance of established firms to embrace these transitions will allow you to enter an industry and use the new technology to develop a business that is based on what may ultimately become a better technology than that belonging to the established firm. However, these transitions are difficult to manage because they involve improving the new technology from its initial state and timing entry appropriately. Therefore, successful technology entrepreneurs have developed specific strategies for managing technological evolution.

This chapter focuses on explaining several key characteristics of managing the process of technological evolution. The chapter:

- Explains why technologies follow evolutionary patterns that open up discrete points of transition that are valuable for entrepreneurs to exploit
- Describes the S-shaped pattern of technological development and the implications of this pattern for technology entrepreneurs
- Discusses the role of dominant designs and explains how these designs influence competition by entrepreneurial ventures
- Describes technical standards and how entrepreneurs can use strategic action to focus them around their products and services
- Explores increasing returns businesses, explaining both why increasing returns businesses exist, and how entrepreneurs should approach those industries to be successful

## Evolutionary Patterns of Development

New technology tends to develop in an evolutionary manner. For example, technological advance in the computer industry has followed a pattern in which microprocessors have become smaller and more powerful because engineers have developed better and better ways of packing more and more onto each microchip.

While scientific, economic, and institutional factors shape the direction in which technology evolves, the evolution depends primarily on the incremental process by which research occurs. Scientists and engineers work within particular frameworks that limit their approaches to problem solving. In particular, these frameworks influence how innovation occurs by affecting the identification of the problems that need to be solved from those that do not. These frameworks have the advantage of keeping researchers focused on the key questions that they need to answer. However, they also limit possibilities. By leading to the creation of a particular outlook on problems, these frameworks create a strong tendency for researchers to ignore certain types of approaches.<sup>1</sup> For example, current technological frameworks view making microchips faster as an electrical problem, not a biological one. As a result, researchers do not work on biological solutions to semiconductor speed.

At discrete points in time, opportunities appear to fundamentally change the technological frameworks that scientists and engineers in

### Stop! Don't Do It!

1. Don't focus all of your efforts on an existing technological paradigm. If you do, you will not be able to exploit the new paradigm when it comes along.
2. Don't ignore the changes in technological frameworks that scientists and engineers are using; they often signal new opportunities.



an industry tend to use. For example, the photographic film industry faced a fundamental shift to digital technology from traditional film in the 1990s. Similarly, in the late 1980s, offset printers faced a fundamental shift to desktop publishing from cold type printing. These discrete shifts are important to entrepreneurs because new firms founded to exploit these shifts tend to be the most successful new firms started.

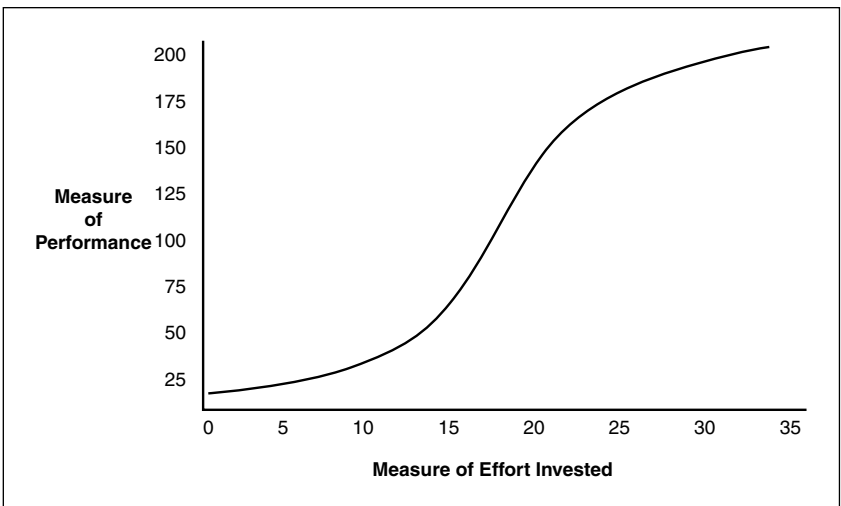
## Projecting Foster's S-Curves

The incremental advances that occur within a technological framework and the radical shifts between technology frameworks can be presented graphically using a concept called the S-curve. Developed by Richard Foster, a McKinsey consultant, the S-curve shows the performance of a technology as a function of the amount of effort expended to develop it. That is, an S-curve allows you to show graphically the development of a particular technology.<sup>2</sup>

New technology products and services begin with a very low level of performance on the dimensions that are important to potential customers.<sup>3</sup> The performance of new technology products and services increase as the developers of those technologies invest time and effort in their development, improving them on the dimensions that customers care about. However, initially, the developers of a new technology achieve very little return on the investment of time and money in a new technology. When people first work on advancing a technology, they often spend time on developmental dead ends. Moreover, even when they do not head down dead ends, their progress is slow. As soon as researchers solve one problem, they are confronted with others, leading each problem-solving exercise to yield little in the way of tangible performance improvements. Ultimately, the developers of a new technology achieve breakthroughs that allow for dramatic improvement in performance. This

improvement continues until the technology reaches diminishing returns, which then slows the rate of technology improvement. The result is an S-shaped curve of technology development (see Figure 3.1).<sup>4</sup>

The fact that technology development takes on an S-shaped pattern is important to you, as a technology entrepreneur, in several ways. The initial performance improvement of the new technology is so low that the performance of your new products and services is likely to be inferior to that of existing alternatives when it is first introduced. As a result, at first you cannot compete successfully with existing firms on the basis of the new technology. To compete successfully, you have to obtain capital and invest in the further development of the new technology to get it to the point at which your new products and services are competitive with existing alternatives. Take, for example, Internet telephone service. Voice-over Internet Protocol was launched in the 1990s, but companies that exploited it could not compete successfully with traditional telephone companies because the technology required further development before it offered performance that was comparable to traditional telephone service.



**FIGURE 3.1** The S-Shaped Curve of Technology Development

Because of the efforts of a large number of start-ups that invested in the development of this technology, it is now a competitive alternative to conventional telephone technology.

The S-curve signals when an opportunity is likely to open up and allow new firms to enter and compete with established firms. Established firms generally focus on making incremental improvements to an existing technology, a process that leads them to move up the S-curve on which they are already operating.<sup>5</sup> Ultimately, all technologies reach diminishing returns, making it difficult for managers to achieve very marked performance improvement in their technologies. At these points when technologies are facing these diminishing returns, new firms can often successfully enter industries with new technologies.

The S-curve helps you, as a technology entrepreneur, to understand why you, and not established firms, will introduce products and services based on new technologies. Because products and services based on new technology begin with inferior performance to products and services based on existing technology, established firms have little economic incentive to switch from the existing technology to the new technology. The managers of existing companies simply compare the new technology to the technology that they are already using and decide against the change. Moreover, the established firms have investments in existing technology that they do not want to cannibalize by changing technologies, further adding to their reluctance to introduce new technologies. Furthermore, the crudeness of new technology when it is first introduced often leads the managers of the established firms to believe that a new technology will have limited application. The failure to project the potential of new technology leads the managers of established companies to stick with the status quo when doing so does not make long-term sense. Finally, even if the new technology proves to be of value, established firms always have the option of improving their existing technology as a way to compete with new firms. As a result, they resist the adoption of new

technology. In short, you and other technology entrepreneurs like you are much more likely than established firms to be the ones to introduce new technology products and services.

The S-curve highlights the importance of timing the entry of your new business into an industry. Because the improvement in the performance of the new technology takes an S-shaped pattern, not a linear form, it is important for you to figure out when the performance of a new technology will accelerate. This tells you the right moment to enter. Entering too early will saddle your new venture with costs before it has a technology that is better than that offered by established firm competitors, allowing established firm competitors to drive you out of business. Entering too late will allow other new firms to enter before you do and gain the advantages of being a first mover.

E-books provide a good example of S-curves and the problem of timing market entry. For several years, people have been saying that electronic books will replace paper books. However, to date, the performance of E-books—ease of use, availability of titles, and so on—has not exceeded that of paper books, and the rate of performance improvement in them has been rather slow. As a result, most E-book publishing companies that have been founded have run into financial trouble. Why? The entrepreneurs who founded these companies have mistimed the S-curve. They have entered the market too early

### Stop! Don't Do It!

1. Don't expect your new products to be as good initially as those of established companies if you start a company to exploit a new technology.
2. Don't enter an industry too soon after its core technology changes.
3. Don't wait too long to enter an industry after its core technology changes.

in its growth. By entering before the acceleration point of the S-curve, the entrepreneurs have been saddled with technology that is not superior to that of competitors, leading them to run out of cash before they can come up with a product that is competitive with paper book technology.

## The Role of Dominant Designs

Another important issue for you to consider in managing the process of technology evolution is that many new technologies converge on dominant designs, or common way that all companies producing a product will design their version, and that convergence dramatically changes the nature of competition in an industry.<sup>6</sup> The internal combustion engine in automobiles is a good example of a dominant design. All automakers produce vehicles with internal combustion engines. The alternatives of steam-powered engines that once existed are long gone.

Dominant designs matter to you, as a technology entrepreneur, because the way in which firms compete depends largely on whether a dominant design exists. Technology evolves through periods of incremental change, interrupted by radical developments. During periods of incremental change, one design is dominant in an industry. A radical development ushers in an era of change in which many designs compete. Ultimately, a convergence on a dominant product design occurs.<sup>7</sup>

In general, the conditions that exist before a dominant design emerges are more favorable to new firms than conditions that exist after a dominant design emerges. Before a dominant design emerges, barriers to entry are low, facilitating firm formation at a lower cost, and therefore a lower risk. Markets are also fragmented, with many small competitors. Because of this fragmentation, it is hard for firms to grow large, and few competitors have scale economies, or try to

compete on the basis of the efficiency of producing standardized products. As a result, new firms, which will lack scale economies and high levels of manufacturing efficiency, at least initially, are less disadvantaged than they would be if production were not fragmented. Moreover, because firms in the predominant design phase are not hindered by having to adopt a product design that is the same as that belonging to more experienced firms, competition occurs on the basis of varied product design. This, too, favors new firms, which have the nonhierarchical organization structures that facilitate product design and development.

However, once a dominant design emerges, firms can no longer compete on the basis of variation in design and, instead, have to compete on cost. The existence of a dominant design allows firms to exploit economies of scale and become efficient in manufacturing, making it hard for new firms to match the advantages of existing firms.<sup>8</sup> As a result, once a dominant design is in place, industries consolidate around a small number of larger firms. The number of competing firms in an industry drops dramatically, with estimates of the drop in the number of firms in an industry from the peak level to a stable level averaging 52 percent and ranging as high as 87 percent.<sup>9</sup>

The story of electric vehicles is one that illustrates the concept of convergence on a dominant design. David Kirsch, a business historian, explains that, in 1900, gasoline powered vehicles were actually less common than steam and electric powered vehicles.<sup>10</sup> Although electric and steam vehicles had many technical advantages over gasoline powered vehicles, they were not as effective for touring. As a result, people began to favor gasoline-powered cars. Over time, as gasoline-powered cars became the most popular, manufacturers designed fewer and fewer steam and electric powered vehicles and those who did tended to fail. As a result, the automobile industry converged on a dominant design in gasoline powered engines in the early part of the twentieth century, and this design has remained dominant ever since.

Because dominant designs are important to entrepreneurial performance, successful entrepreneurs understand why dominant designs emerge. In some cases, chance occurrences can lead to their formation. That is, we end up with a dominant design because that design was in the right place at the right time. This cause, of course, is the hardest cause for you to manage because you cannot influence chance. However, it is important for you to understand, nonetheless.

Social, political, and organizational factors can lead to the creation of a dominant design. For example, as was mentioned earlier, one reason we ended up with the internal combustion engine being the dominant design in automobiles was that, at the beginning of the twentieth century, people used their automobiles largely for touring. This social factor made gasoline-powered engines better than electric-powered ones because the latter needed recharging, which was hard to do in the countryside.<sup>11</sup> Because social, political, and organizational factors influence the convergence of a technology on a dominant design, you can benefit from understanding the way in which these factors influence the development of a dominant design in an industry.

The nature of the technology can lend itself to the formation of a dominant design. For example, the chemical makeup of synthetic fibers means that only a few of them—nylon and polyester, for instance—can produce long fibers. As a result, nylon and polyesters are the dominant designs of synthetic fibers.<sup>12</sup> You can therefore evaluate the nature of the technologies on which you are working to determine whether it is likely to converge on a dominant design.

Dominant designs also have two important characteristics in common that you need to remember. Dominant designs are not technologies at the frontier of knowledge. State-of-the-art designs achieve superior performance through experimental advances that are too unreliable for the majority of customers. As a result, dominant designs are rarely cutting edge technologies, fitting the needs of the majority of adopters, rather than the lead users. The radical develop-

### Stop! Don't Do It!

1. Don't expect technology alone to determine the dominant design; remember social and political factors matter.
2. Don't expect a new technology that led to a radical shift in an industry to become the dominant design.

ments that led to the formation of an era of change also rarely become dominant designs. Why? Because the technologies that become dominant designs are generally shaped by technological variation during the era of change, and it is very hard for a radical technological change to pass through the era of change without undergoing modification.

## Understanding Technical Standards

Many new technology products and services must adhere to a technical standard, or an agreed-upon basis on which a product or service operates. A good example of a technical standard is the electrical outlet. All electronic devices have plugs that fit exactly the same technical standard. This ensures that all electronic devices fit into all outlets.

Technical standards are important to you, as a technology entrepreneur, for several reasons. Companies that produce products that become a technical standard are often incredibly successful. Why? Because all other companies have to design complementary products to fit the technical standard. As a result, the company that controls the standard can earn high margins on its product. Take the Windows operating system as an example. Because 80 percent of the world's computers use the Windows operating system, Microsoft can earn high margins on that system.



Technical standards often mean that you can sell products and services that are technically inferior to alternative products or services even if a superior technology comes along. The standard typewriter keyboard is a good example of what I mean. The standard QWERTY keyboard was designed initially to *slow* typing, which was important with typewriters of the 1880s that were prone to jamming. However, by the 1930s, several superior keyboard designs had been patented. In fact, one of these keyboards, patented by Dvorak and Dealey in 1932, was so good that the costs of retraining typists to use it could be amortized in ten days. However, the new keyboards have never been adopted—even today when all one has to do is flick a switch on one's computer to change keyboards—because the QWERTY keyboard is a technical standard. People stay with it, despite its technical inferiority, because that keyboard is complementary to hardware manufacturers and touch-typing trainers who can assume that everyone is following the same technical standard if the world remains set on the QWERTY keyboard.<sup>13</sup>

Failure to adhere to a technical standard can create great problems for entrepreneurs because customers naturally move toward suppliers that adhere to the technical standard. Take, for example, the experience of Scott McNealy at Sun Microsystems. For years, Sun has developed custom microchips that are more powerful and more expensive than competitors' chips. Initially, Sun found a performance niche in the powerful computers that run network servers. However, eventually these computers, like others, have converged on the Intel chip standard. As a result, Sun has suffered recently from very large declines in sales, and was forced to adopt the technical standard to survive.<sup>14</sup>

Given that technical standards are important to entrepreneurs; you need to know how they get established. Research has shown that four ways predominate. Initially, a group of firms agree to adopt a standard. Oftentimes this means that the leading firms in an industry get together and decide on the standard for the technology that they

are all using. For example, in the case of electrical engineering, the IEEE has many standards committees formed with this function in mind. Other times, the government imposes a standard, as would be the case if a government mandated that all firms use a particular telecommunications protocol to ensure that all consumers can communicate with each other. Sometimes, the technology itself motivates the creation of standard. This tends to occur when the technology has network externalities or faces increasing returns. Finally, the strategic actions of an entrepreneur drive an industry to a standard.

The use of strategic actions to make a firm's product or service a technical standard begs the question: What actions should you take when you found your company to make your new product or service the technical standard? After all, as I said earlier, firms that control the technical standard often earn very high margins. The best actions for you to take all revolve around getting more customers faster than competitors. One way to do this is to offer a low price to generate a high volume of customers. A high volume of customers attracts suppliers of complementary products and services, which makes the entrepreneur's product or service more attractive. Take Microsoft as an example. Because Microsoft attracted more customers to its operating system than its competitors did to theirs, more suppliers were willing to provide Microsoft with software applications, which made it a more attractive operating system to consumers than the Apple operating system. As a result, Windows became the technical standard for software makers.<sup>15</sup>

You can work with the producers of complementary technologies in other ways to make your products or services more attractive to customers, as was the case with the makers of VHS videocassette recorders. Videocassette recorders are complementary technologies to movies and other material recorded on the tapes. The VHS videocassette format became the technical standard, rather than the alternative of Betamax, because the companies producing the VHS format worked much harder than Sony to get producers of movies to record

### Stop! Don't Do It!

1. Don't fail to adhere to technical standards when creating your product or service.
2. Don't ignore the role of strategic action in creating a technical standard.

their movies in VHS format. As a result, more movies were available for VHS than for Betamax, encouraging the adoption of VHS as the technical standard.<sup>16</sup>

Another way that you can increase the likelihood that your product becomes the technical standard is to build sales quickly. Because it is easier to converge on a high-volume product as a technical standard than on a low-volume product, sales volume is important to making a product a technical standard. To do this, you will need to begin by introducing a simple version of their product with limited features to allow high-volume mass production to occur more quickly.<sup>17</sup>

## Evolution in Increasing Returns Businesses

Academics used to believe that all business was based on a concept of decreasing returns. Decreasing returns means that the more of something that you produce, the lower the returns that you will achieve on that production. A good example of decreasing returns is mining. At first, when you mine a vein of coal or gold, you get a high return because you tap the least costly veins. Over time, however, as you produce more and more coal or gold, you use up the easy-to-access material and are forced to incur higher and higher costs to get the remaining deposits. As a result, costs increase, causing decreasing

returns. While many industries—mining, heavy chemicals, agriculture, construction—display decreasing returns, researchers have recently discovered that many high-technology businesses display increasing returns.<sup>18</sup>

Increasing returns businesses are those in which the benefits of something increase as the volume of production increases. Software is a good example of a business based on increasing returns. The more software you produce, the higher your returns on sales will be because virtually all of the costs of producing software lie in the production of the first unit. Once initial costs of writing code have been paid for, it costs only pennies to stamp an additional compact disk with software. Researchers have found that many knowledge-based technology businesses—pharmaceuticals, computers, and telecommunication to name a few—display increasing returns.

Okay, so why do some industries, and not others, display increasing returns? The first reason was suggested earlier. When up-front costs are high, and marginal costs are small, unit costs drop dramatically as volume increases. As a result, increasing returns are present. Take, for example, drug production. It costs hundreds of millions of dollars to research and test a new drug. However, once that drug has achieved FDA approval, most of the costs have been incurred. The cost of producing each capsule of a drug is very small. The more of a drug that is produced, the higher is the profit margin on drug sales.

Another reason is network externalities. Network externalities describe a situation in which the value of a product or service increase with the number of people using it. Take e-mail as an example. When only a handful of people had e-mail, it was a much less valuable communication tool than it is now that large numbers of people have it. Why? When only a handful of people had e-mail, people could not assume that e-mail could be used as a way to communicate, reducing the value of the tool.

Increasing returns exist in some industries because complementary technologies are important in those industries. When comple-

mentary technologies exist—things like computer hardware and computer software that together help people achieve their goals—the value of both technologies increase with volume. A good example of this is the relationship between broadband Internet connections and voice-over Internet protocol. As broadband access becomes more pervasive, the ability to use the Internet for telephone conversations increases, facilitating the development of that product.

Increasing returns exist in some industries and not others because producer learning is high. When firms can learn a great deal by operating their businesses, efficiency increases significantly with production levels. So, the more a firm produces, the lower its costs become, and the higher its profit margins.

Increasing returns also exist in some industries and not others because switching costs are high. If it is expensive to switch from one product or service to another, customers become “locked in” to the product or service they are using. If switching costs are high, the customer is always better off remaining with the product or service that they have rather than incurring the cost of switching. If people do not switch, this benefits the firm producing the product or service.

Increasing returns are important for you to understand if you want to become a successful technology entrepreneur because starting companies in industries based on increasing returns is a very different from starting companies in industries based on decreasing returns. In industries based on increasing returns, “first mover” advantages—the benefits of providing the first product or service in a market—are very important. Early success often generates later success because the firms that have more customers initially face lower costs than those who have fewer customers initially. eBay, the Internet auction house, provides a good example. Because eBay was one of the first Internet auction houses, it garnered the first customers. By virtue of having those customers, other people were attracted to sell their things on eBay (the most customers were already going there), which allowed eBay to earn higher margins than

other Internet auction houses and kept them ahead of the competition.

Because first mover advantages are so important in industries based on increasing returns, waiting until one has the best technology is not a very effective strategy in these industries. If you delay the launch of your new product or service until you have perfected your technology and made it superior to that offered by competitors, you will have a lot of problems in an increasing returns business. In these businesses, the best technologies may not win out. If customers do not find it worthwhile to switch from another product to yours, they will often remain with the inferior technology after your superior technology has been introduced. As a result, a better strategy for you to follow in these industries is to get to market quickly with whatever products you have, and then try to improve your products in the process of operating your business.

This, of course, is standard operating procedure in the software industry. Knowing that software is an industry based on increasing returns, most successful entrepreneurs in that industry start out by launching beta versions that need significant technical improvement. They then improve their software over time while operating their businesses. These entrepreneurs have the comfort of knowing that it is very costly for customers to switch from their products to those of competitors, allowing the strategy to work.

The strategy of entrepreneurs in increasing returns businesses differs from that of entrepreneurs in decreasing returns businesses because of the importance of generating customer lock in. Because returns increase with the volume sold, locking in customers is important to enhancing financial returns.

One way to get customers locked into a product or service is to use a “razor blade model.” Named after the early safety razor companies who used to sell their razors at close to cost and then make all of their profit on the sales of blades that were uniquely designed for their razors, this approach leads customers to become locked into the

replacement components that belong to the company that supplied them with the initial system. Once customers have purchased the initial system, they are usually better off buying the components to that system rather than changing systems, even if the components cost more than those offered by competitors.

If your new product has one component that is purchased up front and another component that is purchased repeatedly over time, the best strategy for you to follow is to offer the up-front component at a low cost to lure the customer in. If the customer gets locked in, then the component purchased repeatedly over time can be sold at a high margin. A good example of this strategy is that used by video game manufacturers. Most of the devices to play video games are sold at very close to cost, but the software that plays the games is sold at high margins. Once people have purchased a particular video game device, they have high costs to switching to another one, allowing the video game manufacturers to sell the game cartridges at a high price.

Offering the up-front component at a low cost is central to this strategy for two reasons. Most new technology products are uncertain. Customers do not know if they will have value until they use them. Therefore, a low price is necessary to get them to try the system and see if it has value. Most customers are myopic. They will generally underestimate how many units of a product they will purchase over time, particularly if there is uncertainty initially about the value of the product. As a result, they will almost always select a product with a low-cost initial component and a high-cost recurring purchase component over a high-cost initial component and a low-cost recurring purchase component because they will believe that the first one is less expensive than the second.

Another important aspect of strategy for you to follow in increasing returns businesses is to take actions to ensure that complementary technology is developed. As a result, open systems strategies work very well in increasing returns businesses. By making your technology open for others to see, you can make it possible for the pro-

ducers of complementary technologies to understand how to provide complementary technologies. This, of course, will increase the likelihood that complementary technologies are available; and the availability of complementary technologies, in turn, will generate increasing returns.

The benefits of producing a product or service in an increasing returns business are also enhanced by strategic partnering. A firm can get its products or services to market more quickly by contracting with other firms to produce those products or services for it than it can by producing those products or services on its own. This approach is very effective in increasing returns businesses because volume production and first mover advantages provide such high benefits in these types of businesses. This, of course, is why so many new companies in industries, such as software, are virtual companies, in which new firms do not establish production, but license to, or form strategic alliances with, other firms to produce their software for them.

Another aspect of strategy for you to follow in increasing returns businesses is to make large bets.<sup>19</sup> There are a few reasons why. To be successful in these types of industries, you need to attract customers first, and make profits second, so these businesses experience high levels of negative cash flow. As a result, these businesses need deep-pocketed investors who will bet significant amounts of money on the businesses.

There is no reason for you to start small in an increasing returns business. If a technology offers increasing returns, there is significant value to having a high volume of production. As a result, starting a small business and bootstrapping it is not a very effective strategy in these industries. Starting on a small scale would lead you to miss out on the first mover advantages and the lock in of many customers that are central to success in increasing returns businesses. Therefore, you need to make large magnitude investments in increasing returns businesses.



### Stop! Don't Do It!

1. Don't adopt a decreasing returns business strategy in an increasing returns business.
2. Don't try to exploit an increasing returns business on a small scale.

Increasing returns businesses are winner-take-all businesses. Because the most successful firms in increasing returns businesses have much lower cost structures than competitors, these businesses tend toward natural monopolies in which the products of the most successful firms become de facto technical standards. As a result, the new ventures either control the market and earn high margins, or they tend to fail.

Of course, these businesses are not for the faint of heart. Businesses in which people make larger investments to try to dominate a market are riskier than other businesses because the ventures can fail and the downside loss from failure is higher if more has been

### Questions to Ask Yourself

1. Is the industry I am thinking of entering facing a technological transition?
2. What is the pace of technological progress in my industry?
3. Has a dominant design or technical standard emerged?
4. If not, what can I do to make my product the dominant design or technical standard?
5. Is the business I am entering an increasing or decreasing returns business?
6. If it is an increasing returns business, what should I do to capitalize on that?

invested. Therefore, the large bets in increasing returns businesses are important to success, but risky nonetheless. In fact, the Internet grocery delivery start-up, Webvan, provides an example of the magnitude of the risk that entrepreneurs and their investors face when starting a new company in an increasing returns business. The investors in this company lost several hundred million dollars of investors' money when this venture failed.

## Summary

Technological development follows an evolutionary pattern in which scientists and engineers work within frameworks that limit problem-solving approaches to a prevailing paradigm. At certain points in time, new technologies appear that radically shift the underlying technological paradigm. These radical shifts provide an excellent opportunity for entrepreneurs to enter industries, as long as they can successfully manage the technological transition.

Managing a technological transition first requires you to understand Foster's technological development S-curve. The S-curve shows that technologies initially experience slow performance improvement because of the process of learning. Then breakthroughs are made and technologies improve dramatically. In the final phase, improvement slows as laws of diminishing returns kick in. At this point a new technology often appears, leading to a transition to a new S-curve.

As a technology entrepreneur, Foster's S-curve has several implications for you. The transition to a new S-curve is almost always undertaken by new firms rather than established firms, which have little incentive to make the transition. The new technology generally begins with worse performance than the old technology, making it very difficult for the new firm to compete initially with established

firms. The timing of new firm entry is important. Too early entry means too slow technology improvement for new firms to be competitive with established firms using the old technology, and too late entry means a missed opportunity to other entrepreneurs entering with the new technology.

Managing technological evolution also involves understanding dominant designs and how they influence competition by new and established firms in an industry. New firms tend to perform better before a dominant design has been established than after a dominant design is in place because prior to convergence on dominant designs, barriers to entry are low, product competition is strong, learning curves are limited, efficiency is relatively unimportant, and organizational hierarchies are not effective in the predominant design phase. All of these things favor new firms over established ones.

Managing technological evolution requires you to consider the role of technical standards. Technical standards are created by firm agreement, government action, the characteristics of technology itself, and the strategic actions of entrepreneurs. Because establishing a firm's product as the technical standard generates large financial returns to entrepreneurial activity, successful entrepreneurs often take specific strategic actions to make their product a technical standard: adopting a low price, making their new products and services work effectively with complementary technologies, and launching simple products.

A final aspect of managing technological evolution that is important for you to consider is managing the differences in the pattern of development of increasing and decreasing returns businesses. Businesses have increasing returns when up-front costs are high relative to marginal costs, when network externalities are present, when complementary technologies are important to the effective use of a product or service, when producer learning is strong, and when switching costs are high. Under conditions of increasing returns, an effective entrepreneurial strategy involves achieving a first mover

advantage, partnering early with the producers of complementary technologies, and betting aggressively.

Now that you understand rule number three of technology entrepreneurship, manage technological evolution, we now turn to rule number four, identify and satisfy real market needs, which is the subject of the next chapter.

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# INDEX

## A

- Accelerating the pace to market, 165–166
- Adoption
  - customer, 81–99
  - of a dominant design, 12–13
  - of new products, 11
- Advertising
  - brand-name, 150–151
  - intensity, 14–15
- Amazon.com, 25, 110
- ARPANET, 31
- Assets, complementary, 105–106
- Average firm size, importance of, 16

## B

- Barnes & Noble, 109–110
- Brand-name, 14
- Brand-name reputation, 150–151
  - costs relative to, 151
- Broadband Internet, 54
- Business plan, developing, 180

## C

- Capital intensity, 14
- Capturing the returns from introducing new products, 147–162

- complementary assets, 156–161
- establishing a reputation, 150–152
- first mover advantage, 154–156
- learning curve advantage in, 152
- obtaining control over resources, 148–149
- Cash flow, 104
  - discounted, 190
- Change
  - in industry structure, 24–25
  - political and regulatory, 22–23
  - technological, 20–22
- Choosing the right organizational form, 163–175
  - accelerating the pace to market, 165–166
  - contractual modes of opportunity exploitation, 165–167, 168, 173
  - cost of exploitation, 164
  - hierarchical modes of opportunity exploitation, 163, 167–168
  - making use of the best capabilities, 166–167
  - managing information problems in organizing, 170–174

- Choosing the right organizational form
    - (*cont.*)
    - market-based modes of opportunity
      - exploitation, 164–165, 168, 169
      - nature of the technology, 167–170
  - Closing a sale, 76
  - Coca-Cola, 130, 133
  - Codification of knowledge, 6
  - Complementary assets, 105–106, 156–161
    - importance of, 158
    - mechanism for capturing returns to
      - new product introduction, 156–161
  - Complex production process, 4–5
  - Concentration, 15
  - Contracts, 168
  - Contractual modes of opportunity
    - exploitation, 165–167, 168, 173
  - Convincing stakeholders to bear risk, 193–196
  - Copyrights, 135
  - Cost
    - advertising, 15
    - of brand-name reputation, 151
    - drug production, 53
    - fixed, 183
    - of opportunity exploitation, 164–165
    - patenting, 139–140
    - of producing software, 53
    - of switching products, 54, 55
    - of technological change, 21
    - variable, 183
  - Customer
    - demand, 8–10
    - lock in, 55–56
    - needs, identifying and satisfying, 64–66
    - preferences, gathering information
      - about, 66–69
    - requirements, in the selling process, 76
  - Customer adoption, 11, 81–99
    - capturing the majority of the market, 85–87
    - market dynamics and, 89–97
    - pattern of, understanding, 82–85
    - selecting the right customers, 87–89
  - Demand conditions, 8–10
    - aspects of, 8–9
  - Demographic trend, 24
  - Deregulation, opportunities for new
    - business, 22
  - Development, evolutionary patterns of, 41–42
  - Diffusion patterns, 91–97
  - Disclosure paradox, 170
  - Disclosure problems, 171
  - Discounted cash flow, 190
  - Discreteness, 117–118
  - DISH Network, patent claim, 141
  - Dominant designs
    - adoption of, 12–13
    - characteristics, 48–49
    - factors that lead to, 48
    - role of, 46–49
- E**
- eBay, 54, 155
  - E-books, 45
  - Economical solution to real customer
    - needs, 71–73
  - Endorsement, 187
  - Established companies' advantages, 102–106
    - cash flow, 104
    - complementary assets, 105–106
    - learning curve, 102–103
    - reputation, 103–104
    - scale economies, 104–105
  - Established companies' weaknesses,
    - exploiting, 106–116
    - constraints of organizational
      - structure, 113–114
    - exploiting existing capabilities, 108–111
    - focus on efficiency, 107
    - need to reward employees, 114–115
    - need to satisfy existing customers, 111–113
    - product development in a
      - bureaucracy, difficulty of, 115–116
  - Estimating market size. *see* Market dynamics
  - Ethernet, 30
  - Evolutionary patterns of development, 41–42

**F**

- First mover advantage, 54–55, 154–156
- Fixed costs, 183
- Flexibility, maintaining, 184–185
- Forms of opportunities: beyond new products or services, 25–27
- Franchising, 171–172
- Free riding, 172

**G**

- Gathering information about customer preferences, 66–69
  - market research, 69–70
- General Motors, 156
- General purpose, 118–119

**H**

- Hidden costs, 77–78
- Hierarchical modes of opportunity exploitation, 163, 167–168
- High fixed costs, 77
- Human capital intensity, 118
- Hyundai, 156

**I**

- Identifying and satisfying real market needs, 63–80
  - gathering information about customer preferences, 66–69
  - necessities, nice to haves, and the unnecessary, distinguishing, 70–71
  - offering better alternatives than competition, 73–74
  - understanding the marketing and selling process, 75–79
- Identifying valuable opportunities, 19–38
  - access to information, 32–33
  - forms of opportunities: beyond new products or services, 25–27
  - information processing, effective, 34–36
  - matching innovation to types of opportunity, 27–29
  - recognizing that an opportunity exists, 31–32
  - sources of opportunities, 20–25
  - understanding the innovation chain, 29–31

**Imitation**

- of a documented process, 132
- legal barriers to, 135
- of new products or services, 126–129

**Inc 500, 2**

- Increasing returns businesses, 52–59
  - and customer lock in, 55
  - large bets in, 57–59
  - open systems strategies in, 56–57
  - software industry as example of, 53, 55
  - strategic partnering in, 57
  - switching costs and, 54

**Industry**

- dimensions that affect performance of new firms, 4–16
- dynamics, effect of technological change on, 21–22
- life cycles, 11–13
- structure, 14–16, 24–25
- changes in, 24–25

**Information**

- access to, 32–33
- problems, managing, 170–174
- processing, effective, 34–36
- searching for, 179–181

**Innovation, 6–7**

- chain, importance of understanding, 29–31
- relationship between opportunity and, 27–29

**Innovators, 83****Intel, 7****Intellectual property, 125–145****K**

- Knowledge conditions, 4–8
  - codification of knowledge, 6
  - complexity of production process, 4–5
  - innovation, 6–7
  - new knowledge creation, 5–6
- Kodak, 110

**L**

- Laggards, 84
- Learning curve, 12, 102–103
  - advantage of established companies, 102–103



Learning curve (*cont.*)  
 mechanism for capturing returns to  
 new product introduction,  
 152–153  
 Licensing, 166–167  
 Life cycles, industry, 11–13

**M**

Maintaining flexibility, 184–185  
 Majority, 83  
 of the market, capturing, 85–87  
 Making use of the best capabilities,  
 166–167  
 Managing information problems in  
 organizing, 170–174  
 disclosure problems, 170–171  
 Managing intellectual property,  
 125–145  
 Managing risk and uncertainty,  
 177–197  
 convincing stakeholders to bear risk,  
 193–196  
 risk perception strategies, 186–188  
 risk reallocation strategies,  
 185–186  
 risk reduction strategies, 179–185  
 tools for, 188–193  
 Managing technological evolution,  
 39–61  
 evolutionary patterns of  
 development, 41–42  
 increasing returns businesses,  
 52–59  
 projecting Foster's S-curves, 42–46  
 role of dominant designs, 46–49  
 technical standards, role of, 49–52  
 Market-based modes of opportunity  
 exploitation, 164–165, 168,  
 169  
 Market dynamics, 89–97  
 diffusion and substitution patterns,  
 91–97  
 static estimates, trap of, 89–91  
 Marketing process, 75–79  
 pricing new products, 77–79  
 Microsoft, 49, 51  
 Minimizing investment, 182–184

**N**

Netscape, 31  
 Network externalities, 53

New firms  
 industry dimensions that affect  
 performance of, 4–16  
 that become *Inc* 500 firms by  
 industry, 3  
 Noncompete agreements, 7

**O**

Obtaining control over resources,  
 148–149  
 Offering better alternatives than  
 competition, 73–74  
 Open systems strategies, 56–57  
 Opportunities, sources of, 20–25  
 changes in industry structure, 24–25  
 political and regulatory change,  
 22–23  
 social and demographic change,  
 23–24  
 technological change, 20–22  
 Opportunities that favor new firms,  
 117–121  
 discreteness, 117–118  
 general purpose, 118–119  
 human capital intensity, 118  
 uncertainty, 119–121  
 Opportunity  
 exploitation, cost of, 164–165  
 and innovation, relationship  
 between, 27–29  
 recognizing a valuable, 31–32  
 Opportunity exploitation  
 contractual modes of, 165–167, 168,  
 173  
 hierarchical modes of, 163, 167–168  
 market-based modes, 164–165, 168,  
 169  
 Organizational form, 163–175

**P**

Patents, 134–144  
 costs associated with, 139–140  
 defined, 135  
 disadvantage of, 142  
 effectiveness by industry, 143  
 importance of, 135–136  
 limitation of, 136, 138  
 Perception, shift in, 24  
 Personal selling, importance of, 75–77  
 Pharmaceutical industry, 15  
 Political and regulatory change, 22–23

Pricing new products, 77–79  
 affect of the environment on, 78  
 factoring in production costs,  
 77–78  
 Production process, complexity of, 4–5  
 Projecting customer adoption, 82–85

**Q**

QWERTY keyboard, 50

**R**

“Razor blade model,” 55  
 Real customer needs  
 developing an economical solution  
 for, 71–73  
 identifying, 64–65  
 satisfying, 66  
 Real options, tool for managing  
 uncertainty, 188–193  
 Recognizing a valuable opportunity,  
 31–32  
 Reputation, 103–104  
 brand-name, 150–151  
 establishing a, 150–152  
 Resources, obtaining control over,  
 148–149  
 Risk perception strategies, 186–188  
 Risk reallocation strategies, 185–186  
 Risk reduction strategies, 179–185  
 maintaining flexibility, 184–185  
 minimizing investment, 182–184  
 searching for information, 179–181

**S**

Satisfying real customer needs, 66  
 Scale economies, 104–105  
 Scenario analysis, tool for managing  
 uncertainty, 188–193  
 Searching for information, 179–181  
 Secrecy, 129–134  
 effective use of, 130–131  
 trade, 132–134  
 Segmented markets, 9–10  
 Selecting the right industry, 1–18  
 Selling process, 75–79  
 closing the sale, 76  
 customer requirements, 76  
 generating customer interest, 75  
 personal selling, importance of,  
 75–77  
 Shift in perception, 24

Social and demographic change,  
 23–24  
 demographic trend, 24  
 shift in perception, 24  
 social trend, 23–24  
 Social trend, 23  
 Sony, 152  
 Sources of opportunities, 20–25  
 Specialized complementary assets, 159  
 S-shaped curve, 42–46  
 defining, 42  
 of diffusion, 92  
 of technology development, 43  
 Stakeholders, convincing to bear risk,  
 193–196  
 Static estimates, trap of, 89–91  
 Strategic alliances, 165, 187  
 Strategic partnering, 57  
 Structure, industry, 14–16  
 Substitution patterns, 91–97  
 Sun Microsystems, 50  
 Switching costs, 54, 155

**T**

Technical standards, role of, 49–52  
 Technological change, 20–22  
 commercial viability of, 21  
 cost of, 21  
 effect on industry dynamics, 21–22  
 TiVo, patent claim, 141  
 Tools for managing risk and  
 uncertainty, 188–193  
 Trademarks, 135  
 Trade secrets, 132–134

**U**

Uncertainty, 119–121  
 tools for managing, 188–193

**V**

Variable costs, 183  
 Venture capitalists, 185  
 Voice-over Internet protocol, 22, 43,  
 54, 110

**W**

Windows operating system, 49

**X**

Xerox Corporation, 30