GLOBAL INNOVATION MANAGEMENT

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GLOBAL INNOVATION MANAGEMENT

2nd edition

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PREFACE

This second edition of *Global Innovation Management* updates materials I have been using in classes taught at Hong Kong University of Science and Technology, University of Illinois – Chicago, the Vietnam EMBA and the University of Science and Technology in China. It addresses a question that I have encountered for at least a decade now: 'If you think you have invented a winning innovation, how can you bring your innovation out of the laboratory and turn it into a commercially successful product?' It is a question that comes up often today, in all areas of industry. The question crosses many disciplines, and is one that I wish were pursued more actively in business schools.

Nearly three decades ago Michael Porter suggested that innovation should be seen as a combination of invention and commercialization, reflecting received wisdom in both industry and academe. There are many books on the market that address innovation, the largest number being devoted to the first half of this combination – how to be inventive. Topics range from systems for helping people to be more creative to better managing laboratories and generating ideas. Clearly these activities must predicate any commercial successes in the market. They are necessary but not sufficient. The second half of the combination has received less attention; though there are several good books on commercialization of innovations, the study it has received has been incomplete.

Existing books in the market that address innovation tend to fall into three categories: (1) behavioural texts on how to be more creative; (2) industrial design and research and development (R&D) management books; and (3) industrial organization books that study the sources and influence of innovation. This book is intended to fill a slightly different niche – at once pragmatic, yet supported by field research and theory. It concerns the process of being a successful innovator. It is part history, part theory and part practical guide to the myriad tasks involved in innovating for a living. I hope it will find an audience with inventors, not just in labs but in market channels and in service industries, who want to turn their ideas into profitable and sustainable businesses.

It was my goal, in writing this text, to address the management of each major task on the path from idea creation to successful commercialization of an innovation. Creativity is addressed, in Chapter 11, mainly as a primer on identifying creative people and helping them to achieve their potential. I am biased in believing that, even though everyone can learn to be more creative, only a small percentage of the population is good enough to generate commercially useful innovations. These 'creative types' can be temperamentally idiosyncratic and require special handling.

Many of the other tasks in innovation parallel the concerns of entrepreneurs, but with substantially less historical information about how to structure your business models, and substantially more uncertainty about products and customers. Variations in traditional management required of innovations constitute the main body of this text.

Finally, I spend time answering the question 'Why bother?' It is not uncommon to encounter objections to the myriad difficulties entailed in high-tech and high-innovation businesses with suggestions that the firm would be better served by 'sticking to its knitting', so to speak, and only engaging in traditional, well-understood business activities. Unfortunately, globalization and the rise of internet business have moved many such 'traditional' industries to places where labour costs are low, environmental standards lax and factory scales huge. It has commoditized them, making it difficult for new entrants or small operations to compete even if they wanted to. The greatest profits today are to be made in areas with high technological and business risk.

I have avoided the overuse of the term 'technology' throughout this book, though many of our most successful innovations – automobiles, televisions, music players, airplanes, refrigerators and so forth – have succeeded only long after all of the detailed technological components were well understood and developed. The technology is too often out there in the lab, waiting for the right 'formula' to make it attractive to a wider consumer base. This book assumes that the raw technological components are already with us, just waiting to be plucked from the laboratory, or to be searched on Google Patent Search or called up over lunch with our engineering staff. Or it assumes that you've already identified your technology (maybe you've been hovering over it in your lab for the past two years) and you now want to figure out what next. Or that you are a salesperson, or product designer or hold any one of a number of other jobs in the firm that need to keep seeking the next big thing. The question arises as to how to manage all of the parts of a successful – with the emphasis on successful – design, development, introduction, sale and promotion of an innovation. In my system, technology is just one of the many components that have to be grafted into the overall innovation for success.

In my classes, I make use of a substantial amount of material that is not included in the text, but rather is available from the companion website to this book. The website allows me to continually update material, as well as provide supplemental presentation slides and exercises for in-class usage. It also provides a server platform for software programs which support the text. Server-based software provides me with greater latitude in my offerings than would a CD of software. First, it is much easier to programme a user interface as a web page than as a stand alone shell (and also gives me the fallback, in case of programming errors, of quickly correcting the interface). Second, I can compute user input with powerful software on the server (e.g. MatLab) that would be infeasible and expensive to implement in standalone support programmes. Finally, there are fewer copyright problems in placing material on a web page because they can be linked to a broad range of sources that can be tapped to help solve a problem, complete a plan or update your current knowledge. Where intellectual property issues do crop up, they can be resolved quickly. I believe the combination of a printed textbook – which is portable, easy to read, annotatable and easy to search – in combination with a supplementary web page – which can include updates, classroom materials and software – offers the best of both worlds. Visit https://he.palgrave.com/westland2 for online resources.

This book is designed to be used as a textbook in a one- or two-semester class on innovation, in an engineering programme, business programme or other science programme. There are 13 chapters, which fit with a 14-week semester. I teach my courses in two 7-week sessions. The second semester tends to overwhelmingly focus on financial analysis, as both investment bankers and corporate managers are quite interested in this aspect of innovation.

This text is divided into three sections covering specific topical clusters:

Internal components needed for successful innovation: this cluster of chapters presents the 'building blocks' of innovation. Here an innovation is not a product or service – rather it is a market niche defined by the customer's own needs, problems and willingness to trade money for solutions, recognizing that every innovation must ultimately be sold in a competitive market.

External factors in commercializing an innovation: intellectual property laws, disruptive innovation, technology acceleration and the competition for venture capital and finance are all important for successful innovation, but are only partly under the control of the innovator.

Social and technological ecosystems in which innovation thrives: emerging platforms such as robotics, autonomous vehicles, smart devices and artificial intelligence expand the innovator's palette while introducing risk. These in turn will evolve in a context of the individual, community and society which is rapidly moving us towards a creativity-based economy.

Because of the breadth of topics covered in this text, each chapter is intended to present the main ideas and components and their use and relevance to the innovation process. At the end of each chapter, I provide references and further reading that fills in the details that are needed for a practical implementation. You need to get the 'big picture' first, and then go back and start filling in details, especially since the details are likely to be different for every invention, every market and every project.

J. Christopher Westland

HOW TO USE THIS BOOK

Teaching a multifaceted and evolving discipline such as innovation is a humbling task fraught with pitfalls. I have grown painfully aware of this in trying to satisfy various constituencies in this 2nd edition. No two instructors agree precisely on what is important, nor how best to approach structure and pedagogy in an 'innovation' class. Innovation is a rich and interesting topic. I was fascinated by the many suggestions made for revising both structure and content of this new edition. In the end, I have needed to make choices and settle on a specific pedagogical path. This necessarily required the emphasis of some aspects of study, while making trade-offs in other potentially rewarding aspects.

The final product reflects my own vision of innovation, as well as a structure that has worked for me in the classroom. I emphasize the importance of innovating to generate a profitable business model – where product research and development (R&D), marketing and distribution channels, customer relationship management and competitive strategy are all central components of the model. These business models operate in the larger context of continual technological advancement, pervasive social networks and legal and regulatory constraints.

Where I have had choices I have tried to keep the approach as simple as possible without sacrificing comprehensiveness. This is one complaint that I have with some other widely used approaches. In particular, there are elaborately illustrated 'coffee table' books that I have found popular among Chicago area start-ups that offer up cluttered sets of tasks without fully defining what they are, how to implement them or why each is important. Faculty are in general under constraints to deliver their message clearly in a semester or shorter time period and require a clearly defined set of roles and functions that can be addressed within the semester. Many of the topics in these coffee table books conceivably demand their own course, when in fact the student is pressed to make sense of the larger task of innovating.

Theory is another contentious matter. Popular business 'theories' come and go, where they can provide useful perspectives on individual components of innovation. Many business theories have both detractors and profiteers, and may or may not offer a basis for longer-term practical management. The best theories can be tested empirically, whereas the weaker of them are passing fads.

I have generally tried to avoid faddism, concentrating instead on a set of flexible methods, each with clearly defined objectives that play specific roles in delivering profitable, successful innovations to market. Where I have been able to cite existing literature, I have provided references at the end of each chapter.

Innovation should not be thought of as solely the domain of 'technology' companies. Globalization, commoditization and greater access to the fruits of technology – digital electronics, global networks and databases – affect everyone. This forces most businesses to come to grips with the single most important problem facing technology companies – the need to continually innovate to differentiate themselves in the marketplace. The difference between technology companies and traditional businesses like real estate is that technology companies have always known that they needed to be innovative. The importance of innovation is only beginning to dawn on professionals in other fields.

The methods presented in this book are directed towards managing innovation's inherent risk through two proven techniques. The first is the idea of 'staging' the development of an innovation, and seeking scale economies at each stage. The second is the idea of 'adaptive execution' which minimizes a firm's own investment in resources at each stage of development. I embed both ideas in a larger framework where innovation is executed in a continuous process that keeps creating, evolving and redifferentiating the firm's portfolio of products and ideas. In successful companies, a continuous cycle of innovation starts with a constant search for product and service opportunities. This is followed by a matching of the most promising opportunities with the company's own competencies – the assets they own and the tasks that they do well. Finally, innovations that are deemed worthy of investment are vetted through a step-by-step market entry that gauges customer reaction at each step, and resolves design and technical problems before they have a chance to damage a product's reputation.

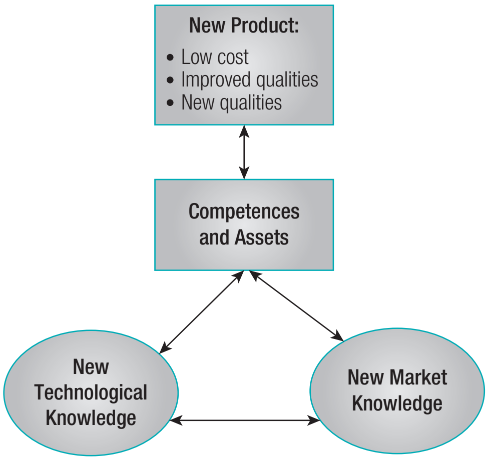

Figure I.1 Major Factors in Innovation

I have organized my chapters into specific clusters of tasks and issues which can be considered complete in their own right. This introduction lays out my – to some extent, unique – perspective of innovation.

Chapters conclude with a summary of chapter *key points* to help put chapter principles into practice. Through this inherently dynamic framework, inventions are identified; those that are consistent with firm competences and strategy are commercialized. Commercialization always attempts to control competition and minimize risk through adaptive execution, with emergent strategy which responds to competitor offerings and tactics. The text includes a single extensive case study at the end of each chapter which applies chapter concepts, and introduces concepts for later chapters. Supporting each section in the chapter are mini-case examples that provide a comprehensive picture of how firms successfully innovate.

Global Innovation Management Clusters

Materials in this text are organized into 13 chapters in three parts: the internal components of an innovation, the external factors influencing innovation, and the social and technological context of innovation.

Chapter 1 provides a comprehensive overview of the role and significance of innovation today. It emphasizes the impact of globalization and the consequent commoditization in eliminating advantages of location, size, brand or other previously important factors.

Chapters 2 through 6 cover all of the internal tasks that management needs to accomplish for a successful innovation. Chapter 2 presents the 'building blocks' of an innovation. Here an innovation is not a product or service – rather it is a market niche defined by the customer's own needs, problems and willingness to trade money for solutions. Chapter 3 considers how the constraints of current technology, the firm's assets, human resources and scale provide or proscribe particular implementations of this market niche in a saleable product or service. Chapter 4 looks specifically at how human resource-intensive services may be interpreted in the frameworks presented in the previous two chapters. Chapter 5 considers how a product or service can be delivered from the firm to the customer through marketing and logistic channels. Often these define an innovation; consider Amazon, which is retailing the same stuff as the US's Walmart and Best Buy but has innovated extensively on the marketing and logistics. Chapter 6 recognizes that no firm is truly a monopoly (although even monopolies need to worry about substitute products). Any innovation will be delivered in a competitive market which must be negotiated successfully.

Chapters 7, 8 and 9 address external factors influencing the business of innovation. Chapter 7 summarizes intellectual property laws. The focus is on the US, but the World Intellectual Property Organization (WIPO) helps to assure a convergence of laws around the world, so knowing US law is useful in most places in the world. The chapter ends with a workout on writing a patent – an important task that is seldom covered in business or law schools. Chapter 8 summarizes what we know about disruptive innovation and technology acceleration, and how these necessarily dictate strategic planning and finance in technology companies. Chapter 9 assembles all of the prior topics into a financial framework that is useful for presenting the innovation and business model to potential investors.

The final four chapters address the social and technological context in which innovations become reality. Chapter 10 is entirely new for the 2nd edition, and presents platforms like robotics, autonomous vehicles, the Internet of Things and artificial intelligence that are only now emerging. Most readers will see this as incomplete, and indeed I intend only for it to be a sampling of things to come. But the most important innovations in the coming decades will derive from these platforms, and this chapter should get you thinking about them. Chapters 11, 12 and 13 address important features of the individual, community and society that are moving us towards an economy based on creativity.

The complete set of topics in this book provides innovators with the tools to manage an invention from its creative origins to its successful marketing. The book's content and perspective are unique in that they focus on the *business of innovation*, providing action-oriented tools for commercializing great ideas. It is my hope as an author that I will see these tools successfully applied in the promotion of new generations of ideas which can empower consumers and inventors alike. At the end of each chapter, I include an Innovation Workout, a comprehensive case study (in addition to the mini-cases included in boxed text throughout the chapter) and lists of key points and action items. The Innovation Workout provides one exercise to help you become more innovative. These are not just 'creativity' exercises. Rather they emphasize necessary skills needed for the commercialization of an innovation. Each case study emphasizes concepts discussed in the chapter, and additionally introduces ideas and real-world problems that will be addressed in the subsequent chapters.

All of the material in this text is aimed at helping you to build a profitable innovation company – one that continually explores new and uncharted market spaces where innovation can gain it a competitive advantage. This is not a book about creativity. Nor does it promise to bring you in touch with your inner Picasso, though I do make an effort to tease out the characteristics of creative individuals who are able to harness their creativity to competitive advantage. This is a book about the business of innovation. For creative individuals and firms, I show you how to move through the creative process and to identify inventions with commercial potential, and how and when to bring an innovation to market.

In order to maintain focus, present the most useful knowledge in a one- or two-semester time period and to be an effective instructional tool, the text carefully prioritizes innovation topics into 'necessary', 'foundation' and 'optional' topics, with 90% of the material concentrated on knowledge you need to know or the foundations underlying that knowledge. To that end, the text sets the following five educational goals:

1. to provide a set of tools, metrics and concepts – a language of innovation – that will allow managers, scientists, salespeople and investors to communicate relevant information with each other;
2. to describe those tasks that must be systematically and continuously performed for a firm to sustain or boost its rate of innovation;
3. to survey the activities that can create an innovative firm either from an existing firm or as an entrepreneurial venture;
4. to describe who exactly are the innovative people that a firm needs in order to stay competitive; and
5. to describe where and how to employ and manage these innovators.

Innovation is a risky business largely because it is difficult to winnow successful from failed innovations in advance of investment. It is difficult, but it is also clear that most firms and individuals can do better. Successful innovators may benefit from substantially higher returns than traditional businesses, but they suffer from substantially higher rates of failure. In most technology industries, for example, failure rate exceeds 95%; of high-tech businesses that live by their innovations, pharmaceuticals are the most successful, with a 7.5% success rate on new products, largely because marketing is usually included in product development at an early stage.

Innovation is too often confused with creativity (which, indeed, plays an important role in being innovative), but innovation includes such extra-creative topics as management, strategy, technology valuation, competences and business alliances. Successful innovation firms such as

Apple are experts at implementing their ideas, and they do so by getting the business basics right.

My overarching goal for this book is for it to act as a one-semester course providing a framework for innovation including the survey of relevant issues to be considered in predicting the markets in which innovations must compete. This text is uniquely my vision, one that I hope, but do not expect, that you will share completely. As a consequence, you, the reader, are invited and encouraged to customize these chapters using your own unique vision and pedagogy. The greatest innovations are a personal statement of the inventor. I would be less satisfied if my exposition were in any way to shackle your unique vision. Successful innovations depend on the independence, perseverance and uniqueness of an inventor's ideas, and if they differ from mine I will see it as the sincerest flattery.

The Role of the Innovation Workout

Management is as much a matter of style as substance: creativity generates style from substance; innovation (invention + commercialization) is all about substance; and style is not necessary for success. Innovators are likely to lack the pragmatism, political sense and style of a good manager because they are more interested in their product systems than in corporate and market politics. Great innovators, e.g. Thomas Edison, Henry Ford and John Warnock, have made their companies successful by surrounding themselves with good administrators to complement their strengths.

How *do* people in corporations generate ideas? In countless ways. The consulting market in innovation tools and expertise has expanded rapidly over the past few years, and at least some of this growth is demand driven. Much of this meshes with the well-integrated sense of work-fun of Silicon Valley entrepreneurs; in contrast, they might be considered too frivolous for the button-down corporate crowd. And that is the point. Much of the value added by business is now being generated by companies like Electronic Arts, Pixar, Apple, Google and so forth that are comfortable with out-of-the-box innovation, with businesses predicated on idea generation. More conservative companies rightly see their survival as tied to their ability to generate and compete on ideas. There is a lot of pressure to be creative in more conservative industries, and this is forming the market for innovation workouts which are provided by consultancies.

The way to come up with good ideas is to generate lots of them. The way to generate lots of ideas is to use tools-heuristics such as our *Assumption Reversal* workout to force you to look at a particular business challenge from all sides. Our innate bias is to see any business challenge in terms of the successful businesses we have encountered. There's even a name for this: the *'X is Good' syndrome* – i.e. solution 'X' is considered good because it is the *only* thing we have ever seen. The Innovation Workouts are tools for getting those who haven't tried it before to think 'out of the box'.

Are managers actually drawing pictures and cutting up slides as we have instructed in some of our Innovation Workouts? Not always. As with most things today, many of the innovation workout techniques have been computerized. You can find write-ups by searching the world wide web (WWW). The intent and concepts of these computer tools are basically the same as our Innovation Workouts: they are tools-heuristics that: (1) force you to look at a particular business challenge from all sides, (2) make sure that you have considered all processes and attributes that are relevant to the product system, and (3) free your mind from existing biases, prejudices and incorrigibility. No matter what business you are in, staying competitive these days means getting innovative. With the Innovation Workouts presented in this text, you will make innovative thinking a habit, making mistakes publicly and analysing them in front of peers and showing patience as an innovation evolves and improves. And you will have a head start on your competitors.

1

INTERNAL COMPONENTS OF INNOVATION

An Introduction to Part 1

Successful innovations are born from an idea, a passion, an observation or any other of the muses that may inspire creativity. Creativity is only the beginning, though – many factors influence the maturation of a nascent vision into a fully fledged commercial venture. Some inventions are stillborn; others perish in infancy starved of capital, property rights or management. The few that evolution favours in the marketplace will possess the foundation 'building blocks' needed to realize the innovator's vision. *Global Innovation Management*'s initial cluster of chapters lays out this internal scaffolding underlying any successful innovation. It recognizes that an innovation is not solely a product or service – it is also a market niche defined by the customer's own needs, problems and willingness to trade money for solutions – and that every innovation must ultimately be sold in the competitive market.

Part 1 of *Global Innovation Management* lays out a comprehensive set of internal tasks necessary for successful innovation. It provides an overview of the role and significance of innovation, emphasizing the globalization and commoditization which have steadily eroded monopolies on location, size, brand and other previously important factors. Chapter 2 presents the 'building blocks' of the innovation which define its market niche, customer needs and problems, and argues why customers will be willing to trade their hard-earned money for solutions. Chapter 3 considers how the constraints of current technology, the firm's assets and human resources, and scale can provide or proscribe particular implementations for this market niche using a particular product or service. Chapter 4 looks specifically at how human resource-intensive services may be interpreted in the frameworks presented in the previous two chapters. Chapter 5 considers how a product or service can be delivered from the firm to the customer through marketing and logistic channels, which increasingly may themselves define the innovation. Chapter 6 recognizes that no firm is truly a monopoly – but that even monopolies need to worry about substitute products and emerging technologies.

Together the chapters of Part 1 offer a complete set of topics that provide would-be innovators with the tools to define and polish their invention from its creative origins to its successful marketing.

CHAPTER 1

Innovation, Globalization and Commoditization

Learning Objectives

After finishing this chapter, you will

- Understand why innovation is no longer optional, but a necessary activity in every competitive business.
- Understand the difference between innovation, invention, creativity and commercialization.
- Understand the forces of globalization and commoditization, and identify their causes.
- Identify opportunities for innovation in industries undergoing consolidation and commoditization.
- Understand that only innovations that ultimately will be profitable are of interest to firms.
- Understand the components of innovation.

After doing the *Innovation Workout* you will be able to perform assumption reversals to gain a new and innovative perspective on a product, market or service.

After reading the Alibaba *case study* you will be able to identify the roles of profitability, innovation, imitation, pricing and commercialization in the success of Alibaba's unique business-to-business (B2B) business model.

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Innovation

There has never been a better time for innovators than the present. The word 'innovation' has grown pervasive in industry, with business press, news announcements and pages of prose praising the latest innovations destined to change our lives and enrich their inventors. CEOs, in speech after speech, invoke the mantra of innovation to justify their strategy. New courses in marketing, strategy, finance and other functional areas in business schools have emerged that are devoted to explaining the role of innovation.

Innovation is the industrial religion of the 21st century. Firms describe innovation as key to increasing sustainable profits and market share. Governments invest billions to spur innovations, or complain about the lack of it when trying to explain why their people aren't competing. Around the world, the vernacular of innovation drives the pace of economics, politics, culture and health. Politicians, managers and the public maintain that competitive advantage is now predicated on successful innovation.

You might well ask 'Why?'

Because industry around the globe is challenged by rapid globalization and commoditization in goods and services. These forces are the consequences of several decades of steady advances in logistics and information technology, and have advanced to a point now where it is difficult for firms to sustain competitive advantage without constantly innovating.

Innovations yield far better returns than traditional business ventures. Improved profits come with elevated risk – business and technological – that confront investors and managers with new challenges. Even when an innovation is successful, it may be difficult to figure out exactly why.

Innovation: It's Not Always New, But It's No Longer Optional

Many concepts for managing innovation today would have been familiar to Thomas Edison 150 years ago.

Alfred DuPont Chandler wrote extensively and insightfully on the role of innovation in sustaining competitive advantage in his 1962 book *Strategy and Structure* which examines the histories of industrial giants like General Motors, Sears and others. Innovation and its management have had central roles in many industries since the Industrial Revolution.

What makes the 21st century different is the pervasiveness and necessity of innovation. Neither nations nor businesses can expect to succeed – whether in software, shipping or steel – without continually innovating to stay ahead of competitors. As the Red Queen chastised Alice in *Through the Looking Glass*, any country in which you don't have to run as fast as you can to stay in one place is now 'a slow sort of country'.

In Thomas Edison's day, there were many paths to wealth and power, and innovation could safely be ignored in their pursuit. The CEO no longer has the luxury of being able to ignore innovation. In the 21st century, innovation is coded into the DNA of every successful firm and nation. Those who fail to innovate are the endangered species; the evolutionary dead-ends in a global industrial ecosystem.

This has piqued the curiosity of investors and the financial press like never before. Despite their high-risk/high-return profile, investments in innovation have expanded to a point that intellectual assets (patents, copyrights and the like) now constitute 40% of the US asset base; a bit more than 15% of US GDP consists of production tangible goods; the rest is generated by ideas and service. Innovation is no longer optional.

Some industries, for example banking and insurance, are built entirely around managing information, or (even less tangible) the risk surrounding that information. Global competition and rapid advances in information technology, which have impacted logistics, production, automation and substitution of intangible for tangible assets, have shoved information to businesses' centre stage. In turn, rapid growth, reduced cost and the improved efficiency that information technology has lent logistics has translated into an unprecedented degree of globalization in production and sales. If there are economies of scale to be had in the production of any given product, then all of the world's production can easily migrate to wherever production costs are lowest. These shifts have brought about the rapid rise of the Chinese and Indian economies (among others) over the past decade.

As the breadth of research areas available in science has expanded, so has the potential to spend money on research that will never yield tangible benefits. As a consequence, firms are increasingly blurring the distinction between 'R' (research) and 'D' (development) into a continuum which directs basic research towards product teams who work with the scientists to move those technologies out of the lab and into the marketplace. Not surprisingly, researchers who matured during the years that 'R' and 'D' were distinct activities find it hard to adjust to this new reality. It is one thing to come up with blockbuster products when you can over-engineer with an unlimited budget; it is another to innovate within the given budgets and timeframes of commercial product life cycles. The new 'R' and 'D' continuum requires smart, energetic and flexible minds that can innovate on the fly. It also requires flat organizations that communicate quickly and widely, and outsource as soon as it is clear that requisite expertise and resources reside outside their own laboratory. As a consequence, research policy at Apple, Google and IBM are directed towards avoiding the inefficiencies resulting from handoffs. Paul Horn, who once managed IBM's research, asserts that 'technology transfer' is a bad phrase at IBM, where researchers are expected to stay with their ideas all the way through manufacturing.

There are two problems with technology transfer – with the formal handoff of ideas from laboratory scientists to manufacturing engineers. First, this handover of responsibility provides many opportunities for delay and attribution of blame for any problems in the technology. And second, it reinforces a false and archaic hierarchy of 'pure science' over product engineering, to the detriment of the modern firms which tend to be flat and egalitarian. These problems bedevil university laboratories and science parks as well, a topic we will revisit later in this book.

Flat management structures and short product cycles are partly responsible for the blurring of 'R' and 'D' but a greater impetus comes from the trend towards innovating in software rather than hardware. For example, in the 1980s, a new model of SLR camera might innovate on the shutter, focus screen, film advance mechanism or numerous other tangible physical components. But a comparable camera today lacks a physical shutter, a focus screen, or any film at all. It is essentially a small standardized computer, image chip and lens, with components shared across competing manufacturers. Indeed, most people don't even think about buying a camera today, because they already have one embedded in their phone – one that is networked, and allows them to instantly post pictures to Facebook, or email them to their friends. Market-differentiating innovation occurs in the software and firmware where development times are fast and the internet is expected to deliver any updates to the existing base of consumers who have already purchased the product. Corporate innovation today demands that basic research be delivered before, during and even after sale of the product.

What is Innovation?

An innovation is a bundle of features that is – as a whole – new in the market, or is commercialized in some new way that opens up new uses and consumer groups for the bundle of features. Beyond this very general definition, you will find that different professions perceive innovation in vastly different ways. Like the three blind men describing an elephant, each group defines innovation in terms of the parts that they handle. This explains the wide array of definitions for innovation that have been vetted over the years. The focus of the current text is the business of innovation. It narrows the context in which to define and study innovation to that of creating a profitable service or product; one that customers will buy.

A cursory look at the companies that are perceived to be innovative reveals that it is not simply creativity that makes a company 'innovative'. Rather it is the ability to spot innovations and profitably commercialize them, in addition to a well-focused internal competence in design and creativity, that makes these companies innovation leaders.

An American in Beijing (Part 1)

China has developed rapidly in the past three decades to become one of the most innovative countries in the world. Many individuals are unaware of the dramatic rise of innovation and technology in China, partly due to intense secrecy surrounding activities in technology centres throughout the country. Thus we set out on our global tour of innovation with a number of cases from China, to be balanced later with European, African and North and South American innovations. Let's begin!

Unlike most of his classmates, Richard Robinson never coveted a so-called 'real job' after his 1989 graduation from the University of Southern California. Instead, he travelled the world, supporting himself with one peculiar job after another – a bartender in the Virgin Islands; a door-to-door cable TV salesman in Boston; a concierge/ski bum in a Swiss hotel; an English teacher in post-revolution Prague; a house painter in Norway; a grape picker in France; and a BMW factory worker in Munich. In Robinson's mind this was 'taking his dessert first before the main course. Having retirement first before working'.

Robinson's journey would be familiar to innovators like Steve Jobs, Philippe Kahn and Jack Dorsey who similarly eschewed 'real jobs' in their early days. Robinson's first trip to China was during one of his Europe–Asia tours. 'I hitched to Prague and then took a train two days to Moscow and stayed for a few days, then I hopped on the Trans-Siberian Express through Siberia via Mongolia to China. Overall I spent 11 days on the train from Prague to Hong Kong over a one-month period. I had an epiphany and instantly fell in love with China as soon as I rolled over the border. From China I traveled to Thailand, Cambodia, Vietnam, Laos, Indonesia, Hawaii, LA, then back to Boston.' (So & Westland, 2012)

Tired of itinerant life, Robinson enrolled in the MBA programme at Rotterdam School of Management where in 1994 he discovered the internet. 'I got a job working in the school library, spending too much time online right when Netscape's first browser came out and was hooked on the web. From then on I knew I wanted to be involved in the internet industry and somehow do it in China.'

Thus the seeds of an idea were sown that would eventually see Robinson emerge as an international tech entrepreneur.

Two things set apart organizations with a good record of innovation. One is that they foster individuals who are internally driven – whether they are motivated by money, power and fame, or simply curiosity and the need for personal achievement. The second is that they do not leave innovation to chance: they pursue it systematically. They actively search for change, the fount of innovation, and carefully evaluate its profit potential.

Michael Porter observed that innovation is 'a new way of doing things (termed invention by some authors) that is commercialized' (Porter, 1990: 780). Though the process of innovation cannot be separated from a firm's strategic and competitive context, Porter's definition can serve as a succinct formula that will prove useful in clarifying the roles of particular activities in innovation:

Innovation = Invention + Commercialization

Inventions can be new products or services, but they can also be new ways of improving a product sufficiently for market entry; creation of a better product or process to perform tasks; bundling services; or handling internal operations to provide a product cost advantage. Innovation is often domain specific, and because of this I will spend very little time discussing how inventions come about. This reflects the reality of innovation – many new ideas come not from the laboratory but from marketing, or from customers; most fail or languish in laboratory notebooks, never being commercialized; sometimes commercialization works only on the second, third or nth try.

How Innovation Impacts Consumer Prices

Even in a single country, a monetary value measure is a difficult thing to tie down. For example, since 1900 average consumer prices in the US have grown twentyfold, or an average of about 3% a year. Additionally, the variations are large between products. Goods or services that have benefited from large productivity gains, thanks to technological improvements and mass production, have seen large price falls in real terms. Prices of telephone use, electricity, bicycles and cars have all fallen. In 1900 a car, then handmade, cost over $1,000. Henry Ford's original Model T, introduced in 1908, cost $850, but by 1924 only $265: he was using an assembly line, and, in a virtuous cycle, was also selling far more cars. Over the century, the real price of a car fell by 50%.

The figures also overstate the true increase in unit price, because they do not take account of improvements in quality. Automobiles in 2000 were much more comfortable, reliable and faster than cars of 1900.

Substitutes have given consumers choices that they did not have in 1900. For example, a consumer might have been tempted to take his car to an orchestral concert in 1900; in 2000, he or she might be tempted to download the MP3 files of the same musical renditions at a fraction of the cost of the original concert.

Where such substitutes are not an option, as in labour-intensive services, prices have increased, in real terms – for example those of hotel rooms and orchestra seats.

But when scientists, strategists and salespeople get together they become a formidable engine of profitability. I look at how to cost-effectively keep a steady flow of inventions coming out of the firm; what to do with the inventions you have; how to assess the financial value of an invention; what steps are necessary to commercialize an invention; how to choose and influence the competitive terrain in which you introduce the invention; and how to efficiently manage risk through adaptive execution and a continually evolving 'emergent' strategy.

An American in Beijing (Part 2)

During his Rotterdam MBA programme, Robinson acquired an internship in internet-related consulting for the Hong Kong Trade Development Council. Hong Kong enchanted Robinson, but, still feeling the need for travel, he scheduled a trip to the Middle East and a solo bicycle trip through Africa before settling into frenetic Hong Kong business life.

Robinson's expanded his consulting in Hong Kong into a real business. Through the connections made during his internship, he was hired by New York-based Poppe Tyson, helping them to open an Asian office in Hong Kong. The company was acquired by Modem Media and Robinson's team was expanded to 45 people, concentrating on consulting, development and interactive marketing for major corporations such as IBM, Citibank, AT&T and Intel. Robinson was able to do what he liked best – travel. His work took him to China, Taiwan, Japan, Australia and New York. After two-and-a-half years, the company listed on NASDAQ at the peak of the dot.com bubble.

Flush with cash, Robinson decided to try his hand at a company that actually produced a service, rather than just dealing up consulting reports. 'During that time I met two former McKinsey consultants who were starting a Chinese version of GeoCities called RenRen.com or "everybody" in Chinese. I became the first vice president they hired and part of the founding team,' said Robinson. 'We had very little funding and only eight people, but from there we went on a crazy dot.com ride from eight people to 350 in eight months by closing a US$6 million A round, a US$31 million B round, and then listing on the Hong Kong Stock Exchange. Until the market crashed, we were briefly worth over a billion US dollars.'

Innovation for Marketability: Features, Constraints and Figures of Merit

This book asks you to take a leap of faith: that innovation is not really about stylish 'new' technology, design or marketing. It is instead all about new combinations and configurations of features constrained by the capabilities of existing technology. Jony Ive from Apple commented that 'only when the technology is invisible is it of any use'. The big advances in our standard of living have always come from 'better recipes, not just more cooking'. The overall desirability of these recipes is measured in 'figures of merit'. A figure of merit is a quantity used to characterize the performance of an innovation relative to other products or services of the same type. It is often used as a marketing tool to convince consumers to choose a particular brand, or a benchmarking tool to assess how well one's own products are performing.

Outsourcing Non-Core Tasks and Globalization

Europe, Japan, Korea and the US have experienced steadily rising labour costs over the past decades. This has made automation and overseas outsourcing of labour-intensive jobs more attractive. The largest destination for industrial outsourcing since 1990 has been the People's Republic of China. China has two attractions: (1) inexpensive labour, even though now labour costs are less than 10% of total value added in export merchandise from China; and (2) the massive scale of its production facilities, where individual factory capacity may constitute 20–50% of total world demand.

Currently, trade between China, India, the US and Europe accounts for 65% of the more than 250 million containers moved around the world each year. Utilization of China's industrial capacity is enormously complex and creates many new jobs for innovators. Foreign investment accounts for over half of China's exports and imports and 30% of Chinese industrial output. In essence what it does is create jobs for design, financing, shipping logistics and marketing and retail logistics for Europe, the US and Japan – these countries also keep the profit from products. It creates huge numbers of jobs for China which essentially produces goods to order on a cost-plus basis.

Both sides have benefited. China has gained from the employment of its vast populace, which helps to maintain social stability and boosts the emergence of an educated middle and professional class. Multinational firms have been able to control their labour costs and have gained scale by sharing factory costs – especially in electronics – with other manufacturers, creating or keeping markets for many new and innovative products.

Despite the West's simplistic views of China, it has more diversity than Europe. China has twice as many people as Europe and the income difference between the richest and poorest provinces is three times as great in China as between countries in the Euro zone. Since the 1990s China has created 300 million jobs – more than the entire population of the US.

There are two lessons to be learned from America's outsourcing of non-core production to China:

1. Outsourcing increases the wealth of the outsourcing country by making possible the production of goods – i.e. turning innovations into real products – that otherwise would never have been designed.
2. Outsourcing helps corporations restructure their business models for a time when automation

will ultimately be able to substitute for all human labour. This transition has already taken place in disk drives, surface mount electronics and quartz watch movements and in speciality metal products like rocket engines that can only be produced by 3D printing. It is only a matter of time before the physical production tasks can take place entirely without people.

Thinking about innovation in terms of figures of merit frees us from a host of inbred biases about what is 'new', or 'high tech', or 'cool and interesting'. It forces us to focus on what customers want; what technologies can produce; and how we are supposed to know when we've finally developed the best product or service possible. Almost every failure of a promising innovation can be attributed to the inventor's inability to honestly maintain this sort of focus on the innovation goal.

A product or service feature is a prominent or distinctive aspect, quality or characteristic; one that potential consumers would consider to be particularly attractive or as an inducement to purchase. The process of developing an innovation is fundamentally the process of deciding which combination of features to bundle into a product or service and what priority each feature has in the overall product design.

Innovation would be easy if all that were necessary was the selection of desirable features. Unfortunately, each feature carries with it both desirable and undesirable characteristics – the undesirable characteristics constrain what we can do with a feature. Of foremost concern is the cost constraint – there is often a direct correlation between desirability and cost. Cost-conscious consumers will of necessity limit their purchase of a costly product or service, no matter how otherwise desirable, if only because they are constrained by their own limited budgets. Constraints will also arise from technology – e.g. battery power is limited – or by prior legal claims – e.g. your innovation may infringe on copyrights and patents owned by others.

Apple's Chief Designer on Innovation

I think one of the things we are good at as a team is gently moving these fragile ideas along a bit so they become just a little more robust and you can actually start to see what they are. So we go from those sorts of discussions and then we just make lots and lots of prototypes. Then we spend a lot of time at the manufacturing sites. We'll be there right to the end when we're in production.

If you are going to design something that's going to be truly innovative, my experience has been that this will require the company that's going to make it to change – often to change fundamentally – in its approach to how it develops products, how it evaluates them, how it makes them, and how it markets them. We try very genuinely to design products that solve problems. They are not about self-expression. What we are trying to do is design something that when you see it you really wonder if it's been designed at all because it seems so obvious and so inevitable and so simple.

We don't make very much stuff. That's a very important part of our approach to what we do, which is to not do a lot of unnecessary stuff but just to focus and really try very sincerely to care so much about the few things that we do.

We love taking things to pieces and understanding how they are made. We will figure something out that seems relatively interesting and we'll spend some time in Northern Japan talking to the master about how we can form metal in a certain way. As you truly understand that, that obviously informs your design rather than it just being an arbitrary shape.

(Source: Interview with Jony Ive, Radical Craft Conference, Art Center College of Design, Pasadena, March 25, 2006)

When do you Have an 'Innovation'?

By its very definition, you are likely to know when you stumble across an innovation. The fact that what you have found is *new* – to you, your customer or your employer – makes it an 'innovation'. But because of its newness, you are just as unlikely to know its value.

Innovations are often conceived in terms of new product market opportunities. But to be successful, they must align with the competences and assets of the firm. The consequences of misalignment are poor production and channel efficiency, and the prospect of rivals outcompeting you. No innovation has value until it is 'completed' and 'complemented' in various ways through the various processes of innovation management.

A widely used definition of innovation is that it is an invention that has been commercialized. The '*innovation = invention + commercialization*' characterization that we set out earlier immediately offers several insights.

First, new ideas either arise in (1) the technology behind the invention; or (2) the marketing, logistics, networking and design strategy behind the profitable sale of that invention.

An American in Beijing (Part 3)

After the dot.com bubble burst, most of RenRen's staff were laid off. 'The good news was that we were fully acquired in May of 2001, so we all got to exit,' said Robinson. Undeterred, he started a new venture far from the much derided (at least in 2001) internet industry – a comedy production house. Up to that time, Hong Kong's comedy scene was dominated by the traditional Cantonese version of cross-talk called *xiangsheng*, rich in puns and allusions delivered in a rapid, bantering style.

'We invested some cash and started to bring over North American acts to perform in Hong Kong', said Robinson. He later expanded it to Japan, Bangkok, Beijing, Shanghai and Singapore. 'One of my favorites was when I brought out Colin Quinn for a tour of Beijing, Shanghai, and Hong Kong', he said.

One venture was not enough, and Robinson also started another venture – a wireless game company in Beijing called Mobile interactive Games (MiG) in partnership with a PricewaterhouseCoopers Consulting investment incubator called MINT. MiG grew along with the wireless market in China. It was fully acquired about a year later by the Sun Microsystems-backed Softgame, which was Sun's first investment in the wireless space outside of America. In 2007, MiG was ultimately acquired for US$40 million by NASDAQ-listed Glu Mobile.

At MiG, Robinson closed an exclusive deal with Yao Ming to create a suite of cellphone services for the Chinese market based around the NBA All-Stars, and also created a cellphone tie-in with the release of *Spiderman* – the first such tie-in for a major Hollywood movie in China.

Second, success requires a holistic perspective towards management of the innovation process. Innovations will not come about just by the R&D department inventing whatever it fancies, then throwing it over the transom for production to make, and marketing to sell. All specialities in the firm are needed at all phases of the innovation's life cycle if it is to be a success.

Finally, the factors that can make your innovation a success – either marketing or technological – are often neither under your control nor available at all times. Successful innovation demands that the firm be sensitive to 'windows of opportunity' where competitive dynamics provide the chance to promote a new product, and where technology is advanced enough to allow the design of an attractive product at an attractive price.

The Twin Challenges of Globalization and Commoditization

In 1950, America produced 53% of gross world product; by 2016 this was around 20%, though America's GDP in absolute terms increased. The rise of new industrial powers like India, China, Russia and Brazil has provided new venues for traditional industries. Europe and the US have responded by coming up with new ideas – through innovation. Rather than being hollowed out, developed economies have transformed, with varying success, into innovation societies. Now the emphasis is on developing the tools and management techniques needed to make the most of that. These developed economies enjoy traditions in software, electronics, cinema and TV, music and numerous other information industries that have given them a head start over the rest of the world in understanding what management of ideas – innovation with a profit motive – is all about.

At the start of the Industrial Revolution, factories were located next to power sources such as rivers that could turn water wheels, and employees were expected to come to the factory when the machines were operating. Computers have changed all that by opening up production of nearly everything to the entire world. Purely informational services like software programming, engineering design, data entry and call answering can be distributed around the globe by the internet and international telephone cables. Physical goods are transferred globally by a logistics network of ships, airplanes and warehouses, all managed by increasingly sophisticated computer systems. Taken together, physical and informational distribution systems consume close to 20% of gross world product; the value generated by *globalization* is substantially greater.

No matter what you produce, or what service you provide, there are likely to be individuals or firms somewhere in the world that can and will do the work for less. This is the pressure that globalization generates to commoditize products and services. Commodities are differentiated primarily on price, and commodity markets will migrate to the cheapest producers. When you are not the cheapest producer, your only option is to differentiate your products, and that usually requires innovation. Developed economies, by definition, are seldom the low-cost producer (though they can attain this status with innovative production and logistics), and, as a consequence, innovation is no longer optional – thinking like an innovator is prerequisite to business success.

Waves of Innovation

The economist Joseph Schumpeter observed that a healthy economy was not one in equilibrium, but one that was constantly being ‘disrupted’ by technological innovation. Others before him had noticed ‘long waves’ of economic activity, notably the Russian economist, Nikolai Kondratieff, who drew attention to them in 1925, using data on prices, wages and interest rates as well as industrial production and consumption drawn from France, Britain and the US. In Schumpeter’s view, each of these long business cycles was unique, driven by entirely different clusters of industries. A long upswing in a cycle started when a new set of innovations came into general use – as happened with water power, textiles and iron in the late 18th century; steam, rail and steel in the mid-19th century; and electricity, chemicals and the internal combustion engine at the turn of the 20th century. In turn, each upswing stimulated investment and an expansion of the economy. These long booms waned as the technologies matured and returns to investors declined.

By the time Schumpeter died in 1950, the third cycle of his ‘successive industrial revolutions’ had already run its course. The fourth, powered by oil, electronics, aviation and mass production, is now in decline. And a fifth industrial revolution, based on the knowledge-intensive industries of semiconductors, fibre optics, genomics and software, powered the expansion of the global economy at the end of the 20th century.

The sixth industrial revolution is the revolution of the innovation economy. The tangible drivers of previous industrial revolutions have become commoditized into platforms onto which can be installed innumerable permutations of ideas and innovations. It is the ideas – data, designs, news, processes, software, pictures and so forth – which will power the global innovation economy of the 21st century.

Thinking Like an Innovator

Innovators, whether firms or people, enjoy a strong tradition of entrepreneurship. Innovators view the competitive landscape differently from the rest of us. With increasingly competitive, commoditized and globalized markets, the entrepreneurial perspective is now as relevant to large bureaucracies as it is to high-tech start-ups. The entrepreneurial perspective diverges from tradition in three important ways – they are action oriented; they like to simplify problems into the core challenges that require action; and they are continually learning from their mistakes and from competition.

Innovators are action oriented; they need to be able to act quickly, and make decisions in a continually evolving competitive and technological landscape. Rather than top-down, bureaucratic, long-term strategies, they need adaptive execution of strategies that rapidly adapt to continually changing competitive landscapes, customer expectations and available technology. Simple heuristics are more valuable than involved, complex and sluggish strategizing. When you are moving fast – as fast as you can to stay in one place – complexity creates confusion and delay. Innovation and technology management requires you to simplify complexity.

Simplification focuses action, and avoids diversions that can consume time and undermine delegation. It is the secret to decisive leadership: co-workers, assistants and collaborators can act with self-confidence, and furthermore can feedback the information to keep the development of your innovation on track to be a success. The ideas presented here are standard items in the toolkits of successful innovators, as will be documented in the many mini-case studies that accompany this text.

Successful innovators are continually learning – learning about the competition, learning about their products and technology, learning about themselves. By its very nature, innovation defies the use of checklists and rote exercises. Innovators think out of the box; they break the mould, defy convention and look at the world in new, exciting and profitable ways. Learning to innovate demands personal and intellectual growth. As you move through the chapters of this text, you will encounter increasingly challenging tools to help you learn to be a successful innovator. The goal is to make innovation a habit. Habitual innovators see every product, service or operation as a challenge for improvement. They make careers out of commercializing their ideas – starting a business, selling ideas within their own firms, and stimulating their friends and co-workers to take action on their ideas. Habitual innovators make careers by forging opportunities out of uncertainty.

This text distils the ideas and action strategies of habitual innovators. It will show you how they think, how they behave and exactly what they do to achieve their goals. Innovators capitalize on the uncertainty of their competitors, create simplicity out of disorder and complexity, and know the difference between a risk and a calculated risk. They see windows of opportunity, recognizing that it is more expensive to be slow than to be wrong. They understand that making a mistake is not only unavoidable, but it is also the right thing to do. Mistakes offer an affordable opportunity to learn as long as you consciously minimize your exposure while taking action. Whether your aspiration is to be a manager, entrepreneur, artist or bureaucrat, you can learn a great deal from the stories and case studies of habitual innovators presented here. Throughout the text you will learn how to apply the insights of habitual innovators to your domain, whether it be your own firm or a major corporation.

The Shift from Research to Development

In the waning days of World War II, Vannevar Bush, the senior science advisor to President Franklin Roosevelt, laid out the blueprint that would dictate the organization or technological innovation for the next half century. This blueprint saw separate roles for academe and industry – universities researched 'basic science,' publishing it in journals that industry could access to develop products for the market. In

Bush's words 'basic research is performed without thought of practical ends'. Research and development (or R&D for short) was defined as two distinct activities. Organizations developed along the lines perceived by Bush, keeping research scientists safely apart from the more pragmatic engineers. The approach spawned numerous successful university research groups as well as commercial labs like Xerox PARC, AT&T Bell Labs and IBM's Zurich Research Laboratory. These were places where basic science was done to be handed off later to industry from production and marketing.

Modern technology firms are much less vertically integrated than the quasi-monopolies of AT&T, IBM and Xerox were in their heydays. Modern firms also face shorter product cycles than companies in the 1950s and 1960s, when new computers, telephone handsets or switches might appear every five years, rather than every five months. In contrast, Google, where CEO Eric Schmidt contends that you cannot isolate researchers, epitomizes the contemporary R&D doctrine. The 'smart people on the hill' method no longer works. 'Researchers have become intellectual mercenaries for product teams: they are there to solve immediate needs.' Failure is an essential part of the process, and employees are encouraged to 'please try to fail very quickly' so that they can try again.

Making Innovations Profitable

The first challenge that firms wanting to be innovative face is how to ensure that their innovations are profitable. If innovations are not profitable in a relatively short time, then the firm is likely to run out of funds to pay for more innovation.

Only after a firm has solved the puzzle of making innovation pay for itself does it have the luxury of unfettered creativity or playing at the 'casinos of technology'. There is no greater source of corporate angst today than that generated by uncertainties about the ultimate profitability of inventions coming out of R&D. Innovative industries confront a high failure rate. Successful innovators need to manage both assets and people to assure that profits from successful products outweigh the costs of failure. They do this by taking small steps with tightly controlled expenditures in the early stages of R&D, scanning the environment for innovations that already exist in university labs or other firms, constructing 'emergent' strategy on the fly as they learn more about their customers, markets, competitors and technology along the way, and taking calculated risks.

The objective of these activities is to encourage expenditures on inventions that will ultimately turn into profitable innovations. Internally, this means gaining access to people, labs and capital; externally, it means convincing venture capitalists to invest. Most innovators, though, discover that one of their greatest challenges is finding the money that they need to generate new ideas and turn them into products that customers will buy.

From the investors' standpoint, financing an innovation is no different than any other financial investment: it needs to be assessed on the basis of return, risk and maturity schedule. Where innovations differ is in their high-risk/high-return profiles. Investments in traditional industries with long time-series of performance histories, and widely understood business models, have over the past three decades averaged 10% to 15% return on investment. Successful innovations, in contrast, average, by one accounting, in excess of 40% return on investment. But this higher return comes at a cost; innovations (by definition) lack a history of operations and customer acceptance. That translates into significantly elevated risk to the investor, since financial analysis of the innovation is not straightforward using traditional tools.

Innovations that involve new technologies or untested markets make investors especially nervous. Such concern is understandable. Investors may lack an understanding of the technology they are investing in, as well as the industry and markets which might buy it.

If there is no history of business success in a particular product, or if business models are poorly articulated, the traditional tools for computing return will give them little insight into what to expect for an innovative product. This bodes poorly for the innovator. In attempt to offset higher risk, investors may demand usurious returns from their investments in a start-up, sometimes at short maturity. They may demand active participation in management and impose covenants that give them the power to completely take over management and operations should certain targets fail to be met by the entrepreneur. The only recourse for the innovator is to provide better information on risks, returns and the cash flows that will be required. I show you in later chapters exactly how to provide this information.

An American in Beijing (Part 4)

Robinson's heavy travel and volatile finances did not make for a comfortable family life. 'My wife wanted me to do something more stable so I took a position as vice president of the international department of China's first/leading mobile entertainment company–Linktone', he said. His role was to source and manage partnerships with international companies such as Cartoon Network, the big four music labels, Japanese cartoon companies, Indian tech companies, Disney, McDonald's, News Corp and so forth. 'We were the first wireless entertainment company globally to list on NASDAQ, and it was an interesting ride. We grew from 180 to about 1,000 people and I was the only foreigner, so that had its own challenges', said Robinson.

Robinson yearned for the entrepreneurial world, and felt constrained at Linktone, leaving after two-and-a-half years. During that time, he founded his third venture, DragonPorts (now Shouji Mobile Entertainment). 'While I was at Linktone, I met a lot of foreign companies with a similar problem. They needed to [adjust] their wireless applications to different models of cellphone, which is a tedious process. So I founded DragonPorts with a partner and we recruited a group of Chinese engineers to work on those projects.' DragonPorts/Shouji had about 70 staff in early 2009, with revenues of nearly US$2 million. Its clients include EA Mobile, Disney Mobile, THQ Mobile and Vivendi Games Mobile.

Robinson, by this time, had metamorphosed into a serial entrepreneur, founding a continual stream of companies, including Kooky Panda and Dada Asia. Kooky Panda provided casual mobile games developed by his Beijing staff. Robinson built up Dada's operation in 10 countries in the region covering India and Australia to Greater China. In addition, he was involved with a few companies as an investor/advisor on the side. He spread his passion for development through the Beijing Chapter for Entrepreneurs' Organization, which he co-founded in 2009.

The serial entrepreneur now lives comfortably with his wife and two sons in Beijing. 'We built a courtyard home here in Beijing, have four big dogs, an SUV, and a BBQ,' said Robinson, 'so I'm pretty much living the suburban nightmare that I've been able to avoid in America all these years and I'm digging it!'

Chapter 1 Innovation Workout: Reversing Assumptions

Sometimes the assumptions we make about a problem, business challenge or scenario seem so basic, so fundamental, that we never think to challenge them. This can have dire consequences. Suppose you built a house using a 'yard' stick that was actually an inch short. If you assumed that it was a full yard and used it to measure everything you built, then everything would be wrong, and your ceilings, doors and windows would be too low. If you had started by questioning the measuring stick, there would have been no problem. It is the same with all problems: if you start with incorrect assumptions, your solutions will be poorly constructed.

Sometimes we need to 'think outside the box'. Outside the box refers to a puzzle where you are asked to try to link nine dots with no more than three straight lines which will cross through all nine dots, and without lifting your pencil.

Many people make two mistaken assumptions: (1) you must not extend beyond the outside dots, and (2) the lines must pass through the centre of each dot. Neither of these 'rules' was mentioned above, and once you challenge those assumptions, the problem is easily solved.

In your *Assumption Reversals* Innovation Workout, choose a product or service that is already on the market and do the following:

1. State the major challenges involved in marketing this product or service to your customer base.
2. List your assumptions.
3. Challenge your fundamental assumptions.
4. Reverse each assumption. Write down the opposite of each one.

Whenever Thomas Edison was about to hire a new employee, he would invite the applicant over for a bowl of soup. If the person salted his soup before tasting it, Edison would not offer him the job. He did not hire people who had too many assumptions built into their everyday life. Edison wanted people who consistently challenged assumptions, figuring our initial perceptions were too often 'salted' with assumptions that hindered creativity.

Any assumption can be challenged. Obviously many, if not most, things must be taken for granted, as no one has the time or need to challenge every assumption. Nothing is sacrosanct, though, and you should be ready to challenge any assumption in pursuit of innovation, competitiveness and profit. Once you truly realize this, you are open to all sorts of opportunities that may not be apparent to your competitors.

For example, consider the case of the Citibank who assumed that its retail banking customers preferred to interact with human tellers. Its major challenge in marketing its services was to make sure that the short time that customers spent with tellers was pleasant and productive. This meant well-trained, educated and courteous tellers – a conjunction of traits that also meant that these tellers were expensive to employ. Older retired people often might want tellers to socialize as well; they liked tellers who would listen to personal issues, or just chat. As socializing dramatically lowered customer throughput, being a courteous teller might often mean being an inefficient one.

By the early 1980s, Citibank's costs began getting out of hand, and it concluded that installing automatic tellers could help it significantly cut costs. However, the Citibank executives were certain that customers would *not* prefer dealing with machines, so they reserved human tellers for people with more than $5,000 in their accounts and relegated modest depositors to the machines. The machines were unpopular, and Citibank stopped using them in 1983. Bank executives took this as proof of their assumption about people and machines.

Months later, one of Citibank's managers challenged this assumption by looking at the situation from the customer's perspective rather than from a cost accountant's perspective. He discovered that small depositors refused to use the machines because they resented being treated as second-class customers. He reinstituted the automatic tellers with no 'class distinctions,' and they were an instant success. Today, 70% of Citibank's transactions are handled by machine.

Reversing assumptions is about challenging prevailing beliefs and assumptions by looking at them from the customer's, or some other stakeholder's, perspective. To make reversing assumptions a formal exercise, try writing a paragraph about the challenges as you see them. Next, change your perspective. If you're male, write it from a female standpoint; if you are a salesperson, write it from a customer's perspective; if you are a subordinate, write it from a superior's point of view, and so forth. Reversing assumptions broadens your thinking. You may often find yourself looking at the same thing as everybody else, yet seeing something different. Many creative thinkers get their most original ideas when they challenge and reverse the obvious.

Many of the greatest breakthroughs in management have been the direct result of assumption reversals. Consider Henry Ford. Instead of answering the usual question, 'How can we get the workers to the material?', Ford asked, 'How can we get the work to the people?' With this reversal of a basic assumption, the assembly line was born.

Alfred Sloan took over General Motors when it was on the verge of bankruptcy and turned it around. His genius was to take an assumption and reverse it into a 'breakthrough idea'. For instance, it had always been assumed that you had to buy a car before you drove it. Sloan reversed this to mean you could buy it while driving it, pioneering the concept of instalment buying for car dealers.

Sloan also changed the American corporate structure by challenging the conventional assumptions about how organizations were run. He quickly realized that GM's haphazard growth was stifling its potential. So he reversed the basic assumption that major companies are run by an all-powerful individual, creating a new theory that allowed for entrepreneurial decision making while still maintaining ultimate control. Under Sloan, GM grew into one of the world's biggest companies, and his reversal became the blueprint for the modern American corporation.

Once an assumption is reversed and a breakthrough idea achieved, you may be startled by how obvious the idea seems. The reversal need not be a 180-degree turn – just a different angle on a problem. Years ago, shopkeepers assumed they had to serve customers. Someone changed that to shoppers serving themselves and the supermarket was born.

Let's try one more reversal. Suppose my challenge is: 'In what ways might I create a new business for airports and train stations?' My basic assumptions are:

1. Airports and train stations are for people who are travelling from one point to another.
2. Planes and trains are constantly arriving and departing.
3. People depart rapidly.

I reverse these assumptions to:

1. Airports and train stations are for people who are not travelling.
2. Planes and trains are not arriving and departing.
3. People are not departing rapidly.

I now have a new perspective on the challenge. Perhaps I could create a business to serve people caught by bad weather, strikes, missed trains or planes, or those who have long delays or layovers and want to rest – people who, for some reason, are not able to travel. They would need lodging, but would not want or be able to leave the terminal.

The idea: A capsule hotel that would provide basic amenities in modular, prefab, Pullman-style sleeping compartments that could be stacked two or three high. Each capsule would come with a TV, radio, alarm clock and reading light. A community shower would be available to all guests. The front desk would be staffed 24 hours a day and would carry razors, soap, toothpaste, toothbrushes and so on. The price for a 24-hour stay would be 50% cheaper than airport hotels and would also have low hourly rates, perhaps $10 an hour. Such hotels are already in use in Japan, and are quite popular. The capsules would be easy to clean and maintain. Because they are modular, they could be easily moved between locations. They could also be leased to cities as temporary lodging for the homeless or for people who are forced out of their homes by fires and floods.

Reversing your assumptions gives you a new tool that enables you to:

1. Escape from looking at a challenge in the traditional way.
2. Free up information so that it can come together in new ways.
3. Think provocatively. You can take a novel position and then work out its implications.
4. Look for a breakthrough.

Case Study: Alibaba

Ma Yun is a one-time English teacher born in rural China to traditional musician-story-tellers. Early on Ma adopted the English name 'Jack'. Jack ultimately moved on to become one of the richest men in China, and one of the most successful entrepreneurs in the world. He started with the simple idea of setting up an electronic message board for small business people in China and around the world to exchange trading information. To grab market share, Ma allowed users to access the service for free. Jack Ma called his business Alibaba, after the hero in one of the *One Thousand and One Nights* stories.

Alibaba.com grew fast, quickly dominating his largest competitors; but Jack Ma's 'free' strategy almost bankrupted him in the beginning. Ma was born in 1964 just before the start of the Cultural Revolution (1966–1976) in a centrally planned economy in which government officials decided what to produce, how much of it, who to sell it to and at what price. By the time Ma was a teenager, China had found a new leader, Deng Xiaoping. Deng in 1961 had famously quipped that it didn't matter whether a cat was white or black, as long as it caught mice (a quip which landed Deng in a prison camp for 're-education'). By the early 1980s, Deng had convinced China's leadership that it was time to 'switch cats' and open up the economy. Ma's hometown of Hangzhou provided him many insights into free markets and the chance to meet Westerners who influenced his ideas on commerce. In 1985, Ma was invited by a pen pal to spend his summer vacation in Australia, an experience that changed him completely. Before he left, he was told that China was the richest, happiest country in the world; Australia was a revelation.

As an outsider in a culture in which formal education paved the road to power and position, Ma's future was far from certain. He failed to gain admission to any of China's better universities, and twice failed his college entry examinations, eventually ending up in Hangzhou Teachers Institute, the least prestigious college in the city. He graduated, taking a position as lecturer in English and international trade at the college for the next five years.

Opportunities expanded for Ma in 1995 when he was hired as an interpreter for a Chinese trade delegation to America, reputedly organized by a local mobster. It was in the US that Ma first used the internet in his hotel room, and was intrigued by the ability to search for nearly anything on the Web. He also noticed how little data on China was contained on the Web when he searched on 'beer' and 'China' using Yahoo, a search that returned exactly zero responses. It was at that point Ma decided to launch his China Pages website to host websites for China's numerous small companies. Ma's little business was competing directly with government-owned China Telecom, the country's dominant fixed line phone company and internet service provider. China Telecom saw the value in Ma's business and formed a joint venture with him, paying Ma about US$185,000 – more money than he had ever had. China Telecom quickly pushed Ma out of the venture, and Ma spent the next few years running a government group to promote e-commerce and as head of the China International Electronic Commerce Centre's Infoshare division.

Anxious to get back into industry, Ma left government and founded another e-commerce company in 1999. Modelling his new business on Hong Kong entrepreneur Merle Hinrich's Global Sources, Ma gathered 18 friends and ex-colleagues in his Hangzhou apartment to found Alibaba. He told them about his idea – a global marketplace where buyers and sellers could find each other online, ultimately raising US$60,000 to form Alibaba. Alibaba was easy to spell, and people everywhere associated it with 'Open, Sesame', said Ma. (In the *One Thousand and One Nights*, the story of 'Ali Baba and the 40 Thieves' tells of a poor boy who unlocks a cave full of hidden treasures using the magic words 'Open, Sesame'.) Today, 17 of Ma's 18 original partners are still with him and the company.

China's Supplier Problem

Throughout the 1990s 'Made in China' steadily grew in familiarity to Western shoppers. Yet that simple attribution masked a complex, inefficient and unmanaged chain of processes: factories sold to trading companies, trading companies to importers, importers to distributors, retailers, etc. Products with a factory cost of $1 might end up selling for $100 by the end of this process.

Alibaba's solution was simple and inspired by bulletin boards in the US: let Chinese suppliers put their information online – the products they made, their prices and their contact information. Overseas buyers would read these messages and contact the factories directly, either by email, phone or fax. Similarly, buyers who needed certain products could put their requirements online and wait for interested suppliers to contact them. Alibaba would be China Pages on steroids, with sophisticated search, contracting, import-export and other services built in. By 1999 Alibaba had implemented most of these middle-man-busting services in Alibaba, though in a form that was primitive compared to that of the Silicon Valley services. Companies such as Ariba developed complex systems for managing supply chains down to the most minute details – which was necessary to support the information-intensive supply chains of Western companies. Alibaba in 1999 was not pretty, but it was functional, and there were no other alternatives as comprehensive in China.

Ma customized one particular feature for the 1990s China market, based on what he had learned from China Pages. 'You don't ask your child to go to work at the age of five. You raise him and give him a proper education so that he can land a good job and make lots of money.' Thus inspired, Ma refused to charge either sellers or buyers for Alibaba's services during their first three years of operation of subscription. His vision was to let Alibaba grow and become part of the life of its users. Once users formed an inseparable bond with the trading platform, he could start charging them and the money would find its way to Ma's pocket. By not charging, Alibaba was able to grow its user base rapidly to the disadvantage of his competitors. Alibaba was lucky to have investors with deep pockets: Goldman Sachs, Venture TDF and Fidelity. Softbank of Japan contributed nearly US$25 million. Ma opened offices in San Francisco and Hong Kong and hired American executives and engineers to build the technology platform and oversee global expansion. Commercials appeared on CNBC touting Alibaba.com for Chinese trade.

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Competition

There had been numerous attempts to create business-to-business (B2B) portals in the West, the most successful being captives of either buyer or seller groups. But there was nothing like Alibaba in the West. When the dot.com bubble burst in 2000, most US and European B2B companies failed. China, in contrast, had many players running on models similar to Alibaba's; in particular, Hong Kong-based Global Sources, run by CEO Merle Hinrichs since 1971. It began as a series of trade magazines called Asian Sources. These inches-thick catalogues were stuffed with advertisements from hundreds of factories and trading houses in Asia. They were distributed monthly to importers and traders in North America, the Middle East and Europe. The company had everything from clothing and shoes to electronics and auto parts covered. A website, Asia Sources Online, was launched in 1995. By 1999, renamed Global Sources, the site was already a bustling e-marketplace. Global Source positions itself at the high end of the market, dealing with the largest buyers and their suppliers. The company targeted the mid- to large-sized companies. Hinrichs believed in the 80/20 rule (an example: in America the top 3,000 buyers account for more than 67% of total imports). Alibaba, on the other hand, welcomed anyone, even the smallest traders and factories. Most of its users were small- to medium-sized companies.

The 2000 dot.com crash hurt Alibaba's business. By 2001, the company had only US$10 million in the bank and was spending US$2 million a month. There was no choice. It had to downsize, and the well-paid American executives were the first to go. The offices in San Francisco were closed and the rest of management took a 'voluntary' salary cut. The company retreated to Ma's hometown of Hangzhou. 'It was our B2C strategy – Back to China', an Alibaba employee recalled. An ex-General Electric executive, Savio Kwan, was hired to cut spending and do the layoffs. He tidied up Alibaba's operations, which had been running without much discipline. A corporate value system was introduced to give employees a sense of direction and guidance on what was and was not acceptable behaviour. Traffic and users were no longer the only objectives. The new goal was to generate revenue – sustainable, long-term cash flow.

That was when Alibaba started to notice the business model of its competitor, Global Sources, which in 2000 raked in US$54 million in online membership fees. Global Sources' experience showed that suppliers were willing to pay subscription fees of several thousand American dollars per year, as long as the site generated new sales. For suppliers, it was a part of their marketing, just like placing ads in trade magazines or setting up booths at trade shows.

Of course, in China, you would need an aggressive sales force to carry off the same trick. No one would be willing to turn over thousands of dollars, a considerable sum for most companies, without a sales rep egging them on. Kwan started to train a sales force, which remains a key asset for Alibaba to this day.

Alibaba successfully made the transition. As of June 2007, 71% of Alibaba's 4,400 staff were in sales and marketing. It had large teams in 30 cities across China and Hong Kong, over 1,900 full-time field sales employees, over 800 telephone sales employees, and more than 400 full-time customer service employees.

Restoration

Though buyers and suppliers could continue to enjoy free services, Alibaba introduced a premium membership called Gold Supplier for exporters in China. The subscription fee was about half what Global Sources charged its clients. Paying customers would be entitled to display a much bigger catalogue on the site, and their products would be guaranteed to pop up first in response to buyer searches. Plenty of extras were thrown in to add value to the membership, for example free photoshoots for their products, video factory tours, training courses on dealing with overseas clients and so on.

Later Alibaba introduced two other forms of paid membership at a much lower price point (less than a hundred dollars a year): International TrustPass and China TrustPass. These members would enjoy fewer privileges than Gold Supplier members, but more than the non-paying users. For example, their products would be shown after those of the Gold Supplier members, but before those of the non-paying users.

By 2002, Alibaba managed to get US$3.7 million in revenue from selling memberships, mainly to suppliers in China. Alibaba broke even, and Ma heaved a sigh of relief. It was a best-of-both-worlds strategy – the offer of free, basic services continued to increase user numbers, and as the B2B site grew in popularity more suppliers were willing to sign on as premium members in order to stand out from their competitors. Aggressive sales tactics helped to speed up the process.

More investment arrived in 2004 from Softbank, Fidelity Capital, Granite Global Ventures and Singapore's Venture TDF Pte Ltd (US$82 million). This money, however, was mainly intended to support Ma's new initiative – he started an auction site, Taobao, to compete head on with eBay in China. Another boost to Alibaba's confidence and bank balance came in 2005, when Yahoo bought 40% of the company for US$1 billion and turned over Yahoo's China operation for Ma to run. Of this sum, US$750 million was used to pay back earlier investors. Alibaba kept US$250 million for expanding its footprint in other internet businesses. Apart from the B2B site and the auction site, Alibaba branched into online payment with Alipay and internet-based business software with Alisoft.

Alibaba's B2B site, which thrived on trade and exports, recorded US$285.3 million in revenue in 2007, up about 59% from the previous year, while profit increased 4.4 times to US$127.7 million. It decided there was no point in further delaying its initial public offering (IPO). Alibaba listed its B2B site, Alibaba.com, on the Hong Kong Stock Exchange in November 2007. It raised US$1.5 billion, the largest internet-related stock sale since Google. Its share price nearly tripled on the first day of trading.

By 2008, the world economy had started to tumble. Factories in China were badly hurt by growing costs and a sudden decline in overseas demand. Under pressure from America, China modified its pro-export policies. Its currency, the yuan, which had been kept artificially low, appreciated 20% over four years (2004–2008). The government also reduced tax rebates to export companies. It amended its labour laws in 2008, increasing most factories' wage costs by 10%.

Oil prices reached a record high of nearly US$150 per barrel in 2008 and the price of materials such as iron, copper and plastic doubled or tripled. An electrical fan maker in South China said his costs increased by 40% over three years, wiping out his profit margin. At the same time, the global financial crisis started by subprime lending began to take a toll on consumer spending. Many retailers, such as the 100-year-old British department store chain Woolworths, went bankrupt. Others, such as the American electronic store Circuit City, were reducing the number of outlets and cutting their total floor space.

Demand for consumer goods dwindled worldwide, especially in America and Europe, where most Chinese exports go. Chinese exports, after shrinking for four consecutive months from November 2008, dropped by 25.7% from a year earlier in February 2009, the sharpest fall in at least 18 years. Imports fell 24.1%.

Twenty thousand factories in China's Guangdong province closed in the five-month period from October 2008 to February 2009. Two million factory workers were laid off. Those feeling the squeeze included suppliers to companies such as Mattel Inc., the world's biggest toymaker, and the American department store chain J. C. Penney Company.

Alibaba saw its growth rate for new subscriptions and renewal rate for existing subscriptions slow from the beginning of 2008. Especially hard hit was its pricey premium membership, Gold Supplier. At the same time, competitor Global Sources cut its prices significantly. Alibaba matched that by launching a baby version of Gold Supplier at about half the price. Although that encouraged more suppliers to sign up, Alibaba's profit margin was hurt.

Alibaba also started to focus more on domestic trade in China and opportunities for Chinese import trade. The Chinese domestic economy was holding up quite well. The top 1,000 retailers saw their sales rise by something like 24% for 2008. Because its subscriptions are prepaid, the downturn did not affect Alibaba's financial performance until late 2008, but worried investors dumped its shares anyway. From a peak in November 2007, Alibaba.com's stock market value fell 90% in the space of a year.

Overall, Alibaba still managed well under the financial crisis, although its growth in revenue was slower and profit margin lower. Net profit in 2008 grew 37% to US$174.8 million, although this was much less than the 362% growth it had had the year before.

Global Expansion

Ma remained undeterred by his earlier failures. Alibaba's foundations were firm, and its sales were still growing in 2008, up 53% to US$435.2 million, although slower than the 66% growth it had had a year earlier. Net profit margin decreased to 40% from 45% the year before – exemplary by global standards.

By 2009 Alibaba's management was feeling confident enough about its brand and operations to launch a US$30 million marketing campaign to build awareness of the brand in America and Britain. The potential to monetize Jack Ma's years of work and risk taking was no doubt a lure as well, as the possibility of a public stock offering in rich Western stock markets loomed large in Ma's mind. Ma had previously tried, and failed in 1999, to get a listing on NASDAQ. But the 2008 financial crash, and subsequent years of 'quantitative easing' saw the US dumping money into the asset markets. By 2014, Alibaba was ready for the richest IPO the world had seen. In September 2014, the company began selling shares and was immediately oversubscribed. Underwriters exercised their option to purchase additional shares at the $68 IPO price, boosting the total amount raised by Alibaba from $21.8 billion to $25 billion. Bankers bought an additional 48 million American depositary shares, taking the total amount of shares sold in the offering to 368 million, or about 14.9% of the company. Alibaba was able to sell more shares due to its over-allotment, or 'greenshoe', option, which allows underwriters to placate investor demand for the stock by obtaining more shares from the company at the IPO price. Existing shareholders Alibaba Chairman Jack Ma, Vice Chairman Joseph Tsai and Yahoo provided the extra shares sold in the over-allotment. Additionally Ma sold a total of about 15.5 million shares in the IPO, becoming the second richest person in China after property developer Wang Jianlin.

Culture Wars

Alibaba's original inspiration, the e-commerce giant Amazon, had always struggled to make inroads against Alibaba in Asia. It had purchased Alibaba's smaller Chinese rival Joyo, rebranding it as Amazon China, but gained little in market penetration. Ironically, Alibaba had similar troubles extending its brand into the US, where its 11 Main brand is decidedly niche. Overall, 11 Main seeks to differentiate itself from the cluttered Walmart feel of Amazon (and its own colourful and chaotic TaoBao and Tmall brands) by creating an online version of the main street shopping experience for American consumers. From its simple black-and-white logo to the site's overall presentation, 11 Main paid attention to design, making the site look clean and polished. Still, a stylish website isn't likely to make 11 Main stand out in the sophisticated universe of online shopping in the US where popular design-conscious shopping sites like Etsy and fab.com dominate.

The alternative presented by Amazon was more prosaic; it was comfortable with the Walmartesque jumble of products displayed in Alibaba's Tmall, and in March 2015 set up a store with Alibaba. Without fanfare, Amazon launched its store on Alibaba's Tmall platform, with limited offerings: women's shoes, American-style snacks and children's toys from brands like Crayola, Lego and Blue Diamond. In a turnabout Amazon must pay Alibaba a commission whenever a customer buys anything from its store. But at the moment Amazon still needs a lot of help to grab a piece of the enormous Chinese market. According to a November report from Beijing-based market consultancy outfit iResearch, Amazon's four-year-old Chinese site accounted for just 1.3% of China's business-to-consumer sales transactions in the third quarter of 2014, ranking it a dismal eighth. Tmall claimed the top spot with 57.6% of sales transactions.

Alibaba, meanwhile, stands to benefit from the deal by gaining a credible retailer on its platform. Alibaba has faced aggressive scrutiny from Chinese authorities over counterfeit goods on its platform. Having Amazon on board gives Alibaba another credible, mainstream brand to burnish its reputation. At the same time, Alibaba announced its own significant move across the ocean with the opening of a data centre in Silicon Valley to compete with Amazon in the cloud. So far, Alibaba hasn't signalled any major plans to challenge the online retail might of Amazon in the US. But in this Pacific Rim rivalry, it's hard to imagine that these two giants won't end up clashing on every front.

Chapter 1: Questions for Review

1. Explain why innovation is no longer optional, but a necessary activity in every competitive business.
2. How would you define the following terms?
   - innovation
   - invention
   - profitability
   - creativity
   - commercialization
3. Think of one product, service or industry. Explain the changes in the past decade that have accelerated the forces of globalization in industry. How has this changed the structure of the industry? How has this changed the activities and resources required to successfully compete?
4. For the same product, service or industry you chose in question 3, explain the changes in the past decade that have accelerated the forces of commoditization in industry. How has this changed the structure of the industry? How has this changed the activities and resources required to successfully compete?
5. For the same product, service or industry you chose in question 3, perform assumption reversals to gain a new, innovative perspective on a product, market or service.
6. For the same product, service or industry you chose in question 3, identify opportunities for innovation in industry. What new products or services do you expect to see in 10 years in that industry? How will the industry and market structure be different in 10 years?
7. If companies are *only* interested in innovations that ultimately will be profitable, who will be responsible for creativity? Who will be responsible for 'fundamental science'? Who will innovate where there is no apparent commercial value for the innovation?
8. Describe the difference between: (1) research; (2) development; (3) production; and (4) commercialization. How is each complementary or supplementary to the others?
9. Choose three items within your field of view at this moment, and provide for each the 'figure of merit' that best conveys what makes that item good or bad.
10. In what ways are science and technology complementary disciplines?
11. Choose two items within your field of view at this moment. Consider for each the impact of complementary products, imitability of the product, and the technical and market capabilities of the firm that makes these products. How much unit profit do you think is made on each unit? Would you describe either of these items as a luxury product? A commodity product?

Chapter 1: Key Points

1. Innovation = Invention + Commercialization.
2. Creating new businesses = Entrepreneurship (it can happen either inside or outside of a corporation).
3. Rates of return on successful innovations typically average over 40%, compared to those of traditional business that average in the range of 10% to 15%. Improved profits come with elevated risk – business and technological – which need to be managed.
4. US asset base today consists of around 40% intellectual assets (patents, copyrights and the like); a bit more than 15% of US GDP consists of production tangible goods; the other 85% represents ideas and services.
5. The rapid pace of globalization and technology development ensure that in the future most new businesses will be innovation businesses.

Further Reading

Abernathy, W. J. and Clark, K. B. (1985). Innovation: Mapping the winds of creative destruction. *Research Policy* 14, 3–22.

Bass, Frank (1969). A new product growth model for consumer durables. *Management Science* 15(5), 215–227. doi:10.1287/mnsc.15.5.215.

Baumol, William (2002). *The Free Market Innovation Machine*. Princeton, N.J.: Princeton University Press.

Bell, D. (1999). *The Coming of the Post-Industrial Society*. New York: Basic Books Reissue edition.

Bennett, Drake (2014, 20 June). Clayton Christensen responds to New Yorker takedown of 'Disruptive Innovation'. *BloombergBusiness*, www.bloomberg.com/bw/articles/2014-06-20/clayton-christensen-responds-to-new-yorker-takedown-of-disruptive-innovation, accessed 17 June 2016.

Chen, L., Mac, R. and Solomon, B. (2014, 22 September). Alibaba claims title for largest global IPO ever. *Forbes*.

Chesbrough, H. (2013). *Open Business Models: How to Thrive in the New Innovation Landscape*. Harvard Business Press.

Chesbrough, H. W. and Teece, D. (1996). When is virtual virtuous? Organizing for innovation. *Harvard Business Review* Jan–Feb, 11, 65–73.

Clark, P. and Staunton, N. (1993). *Innovation in Technology and Organization*. London: Routledge.

Davenport, T. H. (2013). *Process Innovation: Reengineering Work Through Information Technology*. Harvard Business Press.

Drucker, P. (2014). *Innovation and Entrepreneurship*. Routledge.

Fannin, R. (2008a). How I did it: Jack Ma, Alibaba.com, the unlikely rise of China's hottest internet tycoon. *Inc. Magazine*, January.

Fannin, R. (2008b). *Silicon Dragon*. McGraw-Hill.

Freeman, C. and Soete, L. (1997). *The Economics of Industrial Innovation*, 3rd edition. The MIT Press.

Goldberg, D. E. (2013). *The Design of Innovation: Lessons From and for Competent Genetic Algorithms* (Vol. 7). Springer Science & Business Media.

Gundling, E. (2000). *The 3M Way to Innovation: Balancing People and Profit*. New York: Kodansha International.

Howe, K., Saracevic, A. T., Kirby, C., Kopytoff, V., Lee, E. and Corder, S. (2006, 7 May). ALIBABA.COM: On the record: Jack Ma. *San Francisco Chronicle*.

Henry, J. & Walker, D. (eds) (1991). *Managing Innovation*. Sage/OU Press: London.

Jones, O. (1992). Postgraduate scientists and R&D: The role of reputation in organisational choice. *R&D Management* 22(4), 349–358.

Kanter, R. M. (2015). From spare change to real change: The social sector as beta site for business innovation. *Harvard Business Review* May–June, 122–132.

Katz, D. and Kahn, R. L. (1966). *The Social Psychology of Organizations*. New York: John Wiley.

King A. A. and Baatartogtokh, B. (2015, 15 September). How useful is the theory of disruptive innovation? *Sloan Management Review*, Fall 2015, http://sloanreview.mit.edu/article/how-useful-is-the-theory-of-disruptive-innovation/, accessed 17 June 2016.

Langrish, J., Gibbons, M., Evans, W. G. and Jevons, F. R. (1972). *Wealth from Knowledge*. London: Macmillan.

Lenore, J. (2014, 23 June). The disruption machine: What the gospel of innovation gets wrong. *The New Yorker*, www.newyorker.com/magazine/2014/06/23/the-disruption-machine, accessed 17 June 2016.

Madsen, A. (1999). *The Deal Maker*. New York: Wiley.

Mayer, N. Zald (1970). *Power in Organizations*. Nashville, TN: Vanderbilt University Press.

Mintzberg, H. (1978). Patterns in strategy formulation. *Management Science* 24, 934–948.

Osawa, J. (2014). A walk through Alibabas 11 Main. *Wall Street Journal*, http://blogs.wsj.com/digits/2014/06/20/a-walk-through-alibabas-11-main-shopping-site/#, accessed 17 June 2016.

Osterwalder, A. and Pigneur, Y. (2010). *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*. John Wiley & Sons.

Pavitt, K. (1994). Sectoral patterns of technological change: towards a taxonomy and theory. *Research Policy* 13, 343–373.

Pearson, A. (1991). Managing innovation: an uncertainty reduction process, in Henry, J. and Walker, D. (eds) *Managing Innovation*. London: Sage/OU Press.

Perrow, C. (1970). *Organisational Analysis: A Sociological View*. London: Tavistock Publications.

Porter, M. E. (1985). *Competitive Advantage*. New York: Free Press.

Porter, M. E. (1990). *Competitive Advantage of Nations*. New York: Free Press.

Roberts, E. B. and Fushfield, A. R. (1981). Staffing the innovative technology-based organisation. *Sloan Management Review*, Spring, 19–34.

Rogers, Everett M. (1962). *Diffusion of Innovations*. Glencoe: Free Press.

Rothwell, R. (1992). Successful industrial innovation: Critical factors for the 1990s. *R&D Management* 22(3) 221–239.

Sheene, M. R. (1991). The boundness of technical knowledge within a company: Barriers to external knowledge acquisition. Paper presented at R&D Management Conference on The Acquisition of External Knowledge, Kiel, Germany.

Slevin, D. P. and Covin, J. G. (1990). Juggling entrepreneurial style and organizational structure: How to get your act together. *Sloan Management Review* Winter, 43–53.

So, S. and Westland, J. C. (2010). *Red Wired: China's Internet Revolution*. Marshall Cavendish International Asia Pte Ltd.

Taylor, E (1947). *Scientific Management*. New York: Harper & Row.

Tushman, M. L. (1977). Communication across organisational boundaries: Special boundary roles in the innovation process. *Administrative Science Quarterly* 22, 587–605.

Tushman, M. L. and Nadler, D. (1978). An information processing approach to organizational design. *Academy of Management Review* 3, 613–624.

Utterback, J. M. (1975). The process of technological innovation within the firm. *Academy of Management Review* 12, 75–88.

van de Ven, A. H. (1986). Central problems: The management of innovation. *Management Science* 32(5) 590–607.

Westland, J. C. (2002). *Valuing Technology*. J. Wiley & Sons.

Westland, J. C. (2003). *Financial Dynamics*. J. Wiley & Sons.

Westney, D. E. (2013). *Imitation and Innovation*. Harvard University Press.

Wolfe, R. A. (1994). Organizational innovation: review and critique and suggested research directions. *Journal of Management Studies* 31(3) 405–431.

CHAPTER 2

Components of an Innovation

Learning Objectives

After finishing this chapter, you will

Be familiar with the **Innovation Analysis Toolkit** which focuses on three important components of any innovation (this Toolkit is the focus of the Innovation Audit):

Customers: Innovation satisfies a customer need ñ either real or contrived ñ to consume your product or service. If customers do not purchase your product or service, then you will not have a revenue stream that will allow for tomorrowís investments. We present techniques of *quizzing*, *mind maps*, statements of the problems to be solved, and social incentives to acquire and *learning curves* for use of the product, in order to define the motives that particular customer groups may have for purchasing your innovation.

Channels, both communication and distribution: Innovation requires a sequence of activities ñ advertising, marketing, logistic, financing, warranty and disposal activities must occur for a product to be consumed by customers. We call this the *consumption chain*.

Capabilities: Innovation is limited by capabilities, comprised of (1) assets (factories and other production) and (2) competences (staff with special skills and knowledge). The proliferation of third-party markets for manufacturing and services has made the ownership of production and hiring of specific competences easier to outsource. The emergence of 3D printing, for example, will further erode competitive advantages of a large staff and manufacturing capacity.

After doing the *Innovation Workout*, you will see some of the unanticipated problems that arise because of the dynamics of channel activities.

After reading the Viagra *case study*, you will be able to understand the importance of the way that components are conceptualized, and the impact that a particular conceptualization has on market acceptance of a product.

Innovation Ecosystem: Introducing the Innovation Analysis Toolkit

Chapter 2 introduces the various components required for innovation analysis in this book. Innovations themselves are either products or services or mixes of the two. But they survive and thrive in a much larger **ecosystem** which ultimately determines their success (proliferation) or failure (dying out). In devising, assessing and constructing a successful business around that innovation, it is imperative to understand your **customers**, **channels** and **capabilities**. This ecosystem ultimately determines both an innovation's **phenotype** – its observable characteristics – and its **genotype** – its DNA, dictating internal structure and organization.

Successful innovators always start by analysing the ecosystem in which their product or service competes. Failed product launches almost always start by defining the innovation – a solution – then naïvely searching for problems that the innovation might hopefully solve. Once an inventor falls in love with his or her invention, it is very difficult to see clearly the competitive forces allied against its success. Understanding an innovation's ecosystem always comes first. The competitive ecosystem determines the niche in which the innovation will be allowed to survive; conversely it quickly destroys random mutants that are insufficiently fit.

Customers are the primal authority ruling over the competitive system. If an innovation is attractive to customers, if it solves their problems or satisfies their needs, then that innovation should generate enough money for future innovations and extensions. If not, the company will run out of money and die. The Innovation Analysis Toolkit includes techniques of quizzing, mind maps, statements of the problems to be solved, and social incentives to acquire and learning curves for use of the product, in order to define the motives that particular customer groups may have for parting with money in exchange for that innovation.

Customers will neither be able to find, nor acquire, the innovation unless they are provided with **marketing channels** to learn about and search for the innovation; and **distribution channels** to address any physical and geographic transfer and support activities. The two sets of channels are linked and require a sequence of activities – advertising, marketing, logistic, financing, warranty and disposal activities – for each product to be consumed by customers. We call this the **consumption chain**.

It is not enough for an innovation to generate revenues; it needs to generate profits as well. The profitability of an innovation is the difference between the maximum customer willingness to pay for the innovation, i.e. its sales price, and the total cost of production and channel activities. These **capabilities** are comprised of **assets** (factories and other production) and **competences** (staff with special skills and knowledge). The proliferation of third-party markets for manufacturing and services has made the ownership of production, and hiring of specific competences, easier to outsource. It has made ever more difficult any decisions about particular competences to retain in-house.

This chapter introduces each of the components of the Innovation Analysis Toolkit. This Toolkit will help us refine our understanding of the competitive ecosystem into which we plan introduce our product. In doing so, it allows us to fine-tune the characteristics of our product to maximize the probability of success.

The Structure of an Innovation

More mythology surrounds creativity and innovation than perhaps any other human endeavour. Yet a closer inspection of the lives and work of great innovators like Miles Davis, Albert Einstein, Steve Jobs or Isaac Newton reveals a focus and structure in thinking that belies this mythology. In most cases a form and structure of their activities can be surmised. Innovation in different fields will differ in its components; in this chapter we want to lay down the common challenges and components in development of new products and services that are required for 'innovation'. We call these collected challenges and components the Innovation Analysis Toolkit (the Toolkit).

The Toolkit provides a framework in which innovators can think about three necessary components of a successful product or service: (1) customer demand; (2) communication and distribution channels linking customer demand with product supply; and (3) the firm's asset base and competencies, collectively called capabilities.

Innovation satisfies or creates a customer need – either real or contrived – which is satisfied by your product or service. Understanding the nature, social context and extent of your customers' demands is essential to your firm's survival. If customers do not purchase your product or service, then you will not have a revenue stream that will allow for tomorrow's innovations. Our Toolkit contains methods for: (1) defining the social, commercial and activity context of demand and potential customer groups (quizzing); (2) organizing demand features identified in quizzing in a product-specific manner (mind maps); and (3) mapping the roles of product features demanded in terms of market positioning of your product or service (feature maps).

A firm's production needs to be linked to consumer demand – these links are called channels. Distribution channels deliver the actual good or service to the customer; communication channels provide information on value and use of the product in the form of advertising, education and social media. Innovation requires a complex set of customer-facing activities that few firms are able to master well – advertising, marketing, logistic, financing, warranty and disposal activities must occur for success. We call this the consumption chain, and it outlines the necessary channel activities for a product or service.

The scope of a firm's innovation is ultimately limited by its capabilities, comprised of (1) assets (factories and other production) and (2) competences (staff with special skills and knowledge). The proliferation of third-party markets for manufacturing and services has made the ownership of production, and hiring of specific competences, easier to outsource. The emergence of 3D printing will further erode competitive advantages of a large staff and manufacturing capacity. The best innovations will seek that sweet spot where a firm's capabilities are fully used in creating a highly marketable product. This requires a continual adjustment of capabilities, market strategies and product design in a process of adaptive execution.

Further elaboration of the Toolkit will start with some musings on the driver of any successful innovation – consumer demand.

The Mystery of Demand

The great unknown in any innovation is consumer demand. Demand forecasts, when properly used, are tools that help decide between alternatives rather than prognostications of future wealth. That is not all bad – an understanding of the way in which decisions are made needs to predicate any informed assessment of a new innovation.

The ideal consumer in economic models is a rational economic being who carefully weighs the beneficial features of a product against its cost. In practice, of course, this is not what happens; consumer behaviour departs from 'rationality' because of individual quirks in our thinking processes – because we are human. Some of these atavistic consumer behaviours were very useful when we lived as hunter-gatherers; often they are less so in the modern world. Human decision makers suffer from limited processing capabilities; emotional swings which impact decisions; and tend to be motivated by appearances as well as outcomes.

Research on financial investors has identified three particular 'irrationalities' that are systematic and robust across traders: (1) overconfidence; (2) loss aversion; and (3) salience. Let's look at each of these individually and consider how they may be put to use in a new product innovation setting.

When financial traders are overconfident, they tend to overestimate the precision of their knowledge and their abilities. Overconfidence has several implications. Overconfident traders believe their own valuations and worry less about the beliefs of others, leading to speculation and high volume of trading. Overconfident traders overweight their personal signals, and when those signals are correlated (as might be expected), this increases volatility and makes prices less informative. Overconfident investors trade more than 'normal' investors and lose money. Men are in general known to be more overconfident than women, and do worse than women on their investments: on average men earn 6.9% less than the market while women earn only 4.1% less.

Loss aversion and regret avoidance occur because it usually hurts a consumer more to lose $1,000 than it gives pleasure to gain $1,000. Loss aversion tends to cause investors to sell winning stocks too soon and hold losing stocks too long; collect a gain now, but put off taking a loss until later. In product markets, regret avoidance motivates consumers who have already purchased a product to look for and read only material that confirms the 'wisdom' of their prior purchase. Disconfirming evidence is ignored. This can be a problem for new entrants in a product market.

Consumer avoidance of disconfirming evidence is related to a third 'irrationality' that concerns the evidence that investors choose to accept as true. People generally tend to anchor on salient evidence – they overweight evidence that is vivid and captures attention; they prefer stories to data. They tend to be less critical of the source of information if they like the message. And they tend to overweight evidence that supports their existing belief and do not collect disconfirming evidence.

Research by Thomas Griffiths and Joshua Tenenbaum provides evidence that decision making under uncertainty is decidedly Bayesian, with priors drawn from a small set of conjugate distributions (Griffiths & Tenenbaum, 2006). Anecdotal evidence abounds for a Bayesian basis for human decision making among computer scientists trying to design software with human-like intelligence. Bayesian reasoning lies at the heart of leading internet search engines and automated 'help wizards' and assumptions are often made that the brain copes with everyday judgements in the real world in a Bayesian manner. Griffiths and Tenenbaum found that Gaussian (normal), Poisson, Erlang and power law prior distributions lay at the root of much human decision making – including the decisions that eventually influence and constitute consumer demand. Contrary to assertions suggesting it is impossible to model irrational decision making, the 'irrationality' we see in consumption of goods and other human decision making follows specific distributions and methods, and Bayesian models of decision making are an effective tool for predicting both 'rational' and 'irrational' consumer behaviour. Though consumer 'irrationality' may prove difficult to understand, products can be optimized to take advantage of the peculiarities of consumer decision making. The subsequent sections present a methodological approach to designing products, complementary services and consumer experiences that – irrational as they may be – will maximize the profitability of the innovation.

The precise form of human 'irrationality' was been successfully studied by Daniel Kahneman and Amos Tversky starting from the 1970s (Kahneman & Tversky, 1979). Kahneman ultimately won the Nobel Prize for this work in 2002 (Tversky had passed away six years earlier). Kahneman and Tversky's Prospect Theory described human decision making under uncertainty as a two-step anchoring and adjustment heuristic. The anchoring heuristic sets a reference point and then considers lesser outcomes as losses and greater ones as gains. The adjustment heuristic optimizes expected gain under an S-shaped loss function where extreme gains or losses are attenuated in the mind of the decision maker. Daniel Kahneman has written several well-received business texts that explore the consequences of actually making decisions under anchoring and adjustment.

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Fender's Tube Amplifiers: Innovating by Redifferentiating and Remarketing a Winning Sound

Consumer demand is the driver behind commercial success, and once you have demand for a product, you should do everything possible to hold onto it. Old technology can sometimes have hidden attractions that are not noticed until consumers begin to deal with their technologically more sophisticated replacements. Leo Fender – famous for his eponymous guitars and amplifiers – developed products with just such attractions. In the 1950s, to complement his then 'radical' electronic instruments, he built portable amplifier-speaker consoles. He didn't design his amplifiers in the 1950s with any thought of the controlled and sustained overdrive, nor any of the other vacuum tube amp qualities that guitar players have come to crave. In fact, his first amp designs were straight out of the RCA vacuum tube handbook.

With the help of field tests with musicians like guitar-pick-melting American surf guitar guru Dick Dale, Leo Fender created a physically and electronically reliable design to withstand use and abuse by touring performers. It just happens that the combination of his robust design and the natural overdrive characteristics of tubes produces the trademark Fender sound we came to love.

Electronics subsequently evolved into more robust, compact and powerful transistor platforms. Unfortunately, early solid-state amplifiers became infamous for their harshness and limited dynamic range, caused almost entirely by the super clean sound and wide frequency response up to their maximum output, after which the onset of clipping occurred quite abruptly and harshly. The attack of notes (that bit immediately after the note is struck) pushes the amplifier briefly into the clipping region, producing a 'squashy, spitting' sound at the start of each note. If the amplifier is overdriven well into the clipping region, the type of overdrive was typically very dirty and unmusical.

Russell Hamm, in his seminal study 'Tubes Versus Transistors: Is There an Audible Difference?' found that bass and guitar amplifiers are often severely overloaded by signal transients. The transistor characteristics which guitarists and bassists dislike are buzzing, white-noise sound and the lack of 'punch'. The buzz is directly related to the 'edge' (like the edge of a square wave) produced by overloading on transients (like the high amplitude attacks on individual notes). This white noise contains edge harmonics like the seventh and ninth that are not musically related to the fundamental.

Vacuum tube amplifiers differ from transistor amplifiers because they can be operated in the overload region without adding objectionable distortion. The combination of the slow rising edge and the open harmonic structure of the overload characteristics form an almost ideal sound recording compressor. Within the 15 to 20 dB 'safe' overload range, the electrical output of the tube amplifier increases by only 2 to 4 dB, acting like a limiter. Tubes also sound louder and have a better signal-to-noise ratio because of this extra subjective headroom that transistor amplifiers do not have. Tubes get punch from their naturally brassy overload characteristics. Since the loud signals can be recorded at higher levels, the softer signals are also louder, so they are not lost in tape hiss and they effectively give the tube sound greater clarity. The feeling of more bass response is directly related to the strong second and third harmonic components which reinforce the 'natural' bass with 'synthetic' bass. In the context of a limited dynamic range system like the phonograph, recordings made with vacuum tube preamplifiers will have more apparent level and a greater signal-to-system noise ratio than recordings made with transistors or operational amplifiers.

So why is this important? The sound of a tube power amplifier moving into and out of its clipping region is the sound that many bassists and guitarists crave. Additionally, musicians perceive vacuum tube-based instrument amplifiers to be noticeably louder than a solid-state amplifier which has the same power. This occurs because of the logarithmic response of our hearing. For example, a 100-watt amp sounds only a little more distorted when trying to deliver 110 watts. This means that you can drive the amp quite hard with a 'musically pleasant' amount of overdrive that sustains a volume level at the amplifier's maximum power capability. As the note decays, the volume level changes little while the sound gradually cleans up (sometimes referred to as a 'warm bloom').

How ironic that in an era of blistering computational power in cheap boxes, we are still trying to capture the analogue sonic character of Leo Fender's classic early amps. Fender's designs gave a characteristic full and punchy sound, suitable for many styles of the day – and later. Steel and country players like the chime-like clean sounds, and blues players were quick to discover the classic way it breaks up when pushed hard. The Fender company to this day counts vacuum tube amplifiers among its most successful product lines, despite the availability of cleaner, cheaper, more powerful transistor designs.

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Exploring the Potential Demand of Customers for an Innovation

Innovation satisfies a customer need – either real or contrived – to consume your product or service. If customers do not purchase your product or service, then you will not have a revenue stream that will allow for tomorrow's investments. We present techniques of quizzing, mind maps, statements of the problems to be solved, and social incentives to acquire and learning curves for use of the product, to define the motives that particular customer groups may have for purchasing your innovation.

Crowdsourcing Ideas

Crowdsourcing of product design and manufacturing can take place through a number of different routes – online contests, interactive forums, community discussions, specialists and intermediaries. The added complexity of crowdsourcing does offer benefits that in many cases justify the added complexity. It offers quick access to specialized human resources and benefits from the innovative strength of idea generation outside an organization rather than drawing from internal ideas. More importantly, it potentially decreases production and inventory management costs through tight alignment of consumer needs with crowdsourced specifications, the reduction of the need for in-house research and development (R&D) and shorter marketing channels.

Customer incentives and involvement refer to methods and techniques applied by companies to engage customers in the development of new products. By leveraging the creativity, insight and wit of customers, brands are attempting to better target and segment their audience in order to predict market demand and design their marketing campaigns accordingly.

With over 10 million people contributing to crowdsourcing activities across the world, customer involvement activities are a new form of how businesses interact with customers breaking with the traditional seller–buyer relationship. Today, companies are empowering their customers to reap the benefits from their experience, expertise, motivation and time in order to come up with data-driven market decisions.

The internet has been pivotal in providing the customer–producer forums necessary for successful crowdsourcing. Several examples of companies that have flourished from applying this technology are:

1. Shapeways of the Netherlands, which offers printing services where users design and upload 3D printable files and Shapeways prints the objects for them or others. Users can have objects printed from a variety of materials, including food-safe ceramics, in a variety of locations. Shapeways employs about 100 people serving a community of 300,000 members and three million products in its online catalogue. It also has 10,000 shops selling designs and items. Each month, the company receives, prints and ships 60,000 orders to customers all over the world.
2. Hypios in France uses the internet to find experts for specific challenges using what they term 'intelligent crowdsourcing'. Hypios draws from a global network of a million experts solving R&D problems submitted by its clients.
3. eYeka in France has collected a bespoke creative community of 250,000 artists, designers, technology experts and professionals in 154 countries to design new products for its clients, including P&G, Kraft, Coca-Cola, Unilever, Nestlé, Danone, Hyundai, Citroen and Microsoft.
4. InnogetCloud of Spain helps clients to build open innovation marketplaces where their organization's members can interact and collaborate by posting technology offers and requests. The service is aimed at companies, universities, science parks, technology clusters, business associations and public institutions that promote innovation.

The first steps towards understanding whether an innovation has commercial potential – and thus whether it should be either pursued or left in the opportunity register until such commercial opportunities arise – require that we ask questions about customers' potential use and perception of this invention. We accomplish this through a process of successive refinement – by means of a series of tasks – of feature set, complements and market niches which hold commercial potential.

Task 1: Your first task should be to '**quiz**' to explore all possible influences on customer demand. Quizzing is a free-form brainstorming of potential customers and groups to identify where the company might find useful pools of demand. It involves asking questions, often in a team or group of product designers, to find out the who, what, when, where, how and why of the features that customers would want. Quizzing is the first step in feature mapping. Quizzing helps the innovator identify the drivers of consumer demand: consumer needs, social influences, influential friends or family, activities involving the product, time of day the product is used, and so forth.

Task 2: Use **mind maps** to organize the products of quizzing demographic groups and particular features, activities and innovations that would likely appeal to each using mind maps (presented in the Innovation Workout at the end of the chapter).

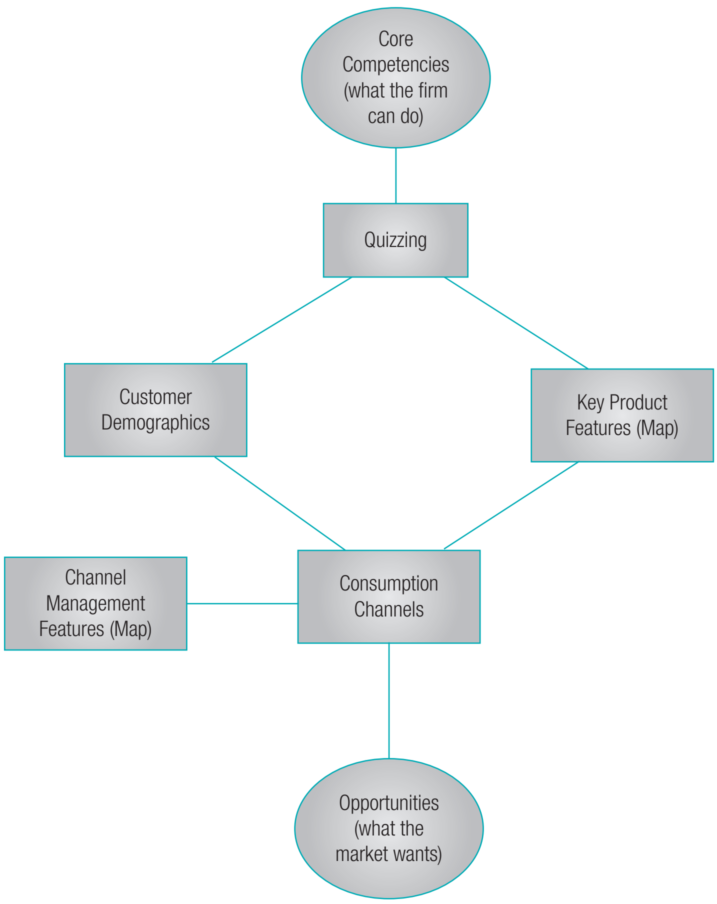

Figure 2.1 Tools for Assessment of Potential Customer Demand

Task 3: Map the target customer demographic groups and particular features, activities and innovations that would likely appeal to them onto **feature maps**. Try to organize these into detailed feature maps for each important feature, demographic group and activity to identify potential product features for the innovation. Indicate the channel activities that will be required to promote demand for your innovation in each of the selected customer groups and visualize these in terms of **consumption chains**.

Innovations may be conceived in terms of new product market opportunities, but to be successful they must align with the competences and assets of the firm (Figure 2.2). The consequences of misalignment are poor production and channel efficiency; and the prospect of rivals outcompeting you.

Until this point, we have focused on the character of innovation, as well as misconceptions and biases that may keep individuals and firms from achieving their greater creative potential. Thus, armed with a sound theoretical understanding of innovation, we can move on to studying some tools and techniques that can help us generate innovations that satisfy specific pairs of firm competences and market opportunities. In this section we introduce three tools: quizzing, consumption chain analysis and feature mapping, for testing new ideas and inventions against existing market and supply realities.

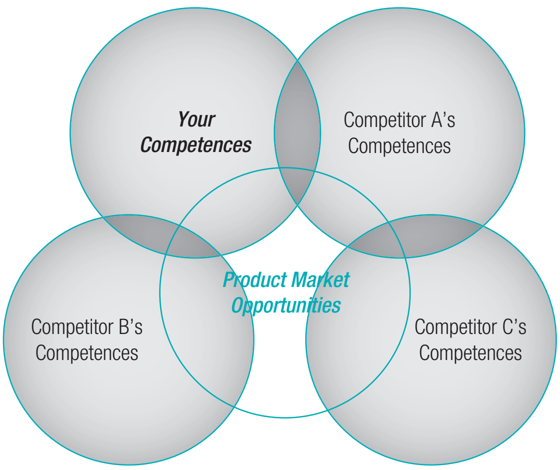

Figure 2.2 Mismatch of Markets and Competences

Quizzing

I keep six honest serving-men
(They taught me all I knew)
Their names are What and Why and When
And How and Where and Who.
I send them over land and sea,
I send them east and west;
But after they have worked for me,
I give them all a rest.

Rudyard Kipling

Quizzing offers the innovator an unstructured, open-ended approach for making a comprehensive analysis of customer usage and decision making regarding a product. The goal is not just to understand a customer group, but to identify new potential users. The approach takes a free form, 'stream of consciousness' contemplation of a potential customer's perspective via a series of questions. The stream of consciousness approach is closely identified with the Bloomsbury Group in English thought that championed investigation through the set of constantly changing inner thoughts and sensations which an individual has while conscious. The Bloomsbury Group sought to describe an individual's point of view by giving the written equivalent of the character's thought processes. May Sinclair transferred 'streaming's' context from psychology to the literary arena, where figures such as Virginia Woolf, E. M. Forster and Clive Bell in literature, Vanessa Bell, Duncan Grant, Dora Carrington, and Roger Fry in art, John Maynard Keynes and Leonard Woolf in economics and Saxon Sydney-Turner in music sought to apply it to the widest range of topics.

Quizzing brings these elitist concepts into our pragmatic world of products and customers. It is our first attempt to understand where we can innovate; our first attempt to understand potential customers and their experiences using our proposed products and services. Specifically it looks for ideas which hold the power to change your customers' experience. Because experience is dynamic, so must be the questions in quizzing. The basis for quizzing is a simple sequence of questions: what, who, when, where, how and why:

- What is the problem?
- Who (which individual in the case) is responsible for solving the problem and making a decision?
- Where is the money? (The value generated by the solution.)
- When does the problem need to be solved?
- How will you measure success?
- Why did you have this problem, and what will you do to prevent it in the future?
- Who is with customers while they use the product?
- How much influence do they have?
- If we could arrange it, who would we want the customers to be with?
- What do our customers experience?
- What else might customers have on their minds?
- When do our customers use this?
- Where are our customers when they use this?
- How do customers learn to use the product?

Quizzing, properly done, will generate an avalanche of insights, ideas and modifications to the invention, and the addition of features that had not been initially obvious. But this embarrassment of riches is also accompanied by a need to bring order to chaos; to prioritize and reduce the choices the innovator needs to make. The Innovation Workout for this chapter explains how to organize the output of quizzing through a method popular among Silicon Valley technology firms: the mind map, which has been promoted by top design consultancies such as IDEO.

It is at this point that the firm must make a fundamental calculation – will the product compete only on price (i.e. will it be a commodity product), or will it be differentiated in some other way from competitors that will allow the firm to charge a premium? Unless your firm is the sole holder of a new cost-reducing technology, or is very rich with world-class production or logistics, it is unlikely that competition on price will be attractive. The innovator's challenge is to differentiate the goods from the competitor's to gain a competitive advantage – even if only temporary, and even if only with a niche customer group.

Consumption Chains: Bridging the Gap from Producer to Customer

Consumption chains provide us with a map of the sequence of activities that comprise a *channel*. Marketing and distribution channels are sequences of necessary activities that allow the transfer of ownership of goods, from the point of production to the point of consumption. They provide a strategic path for goods and services to travel from the firm to the customer; this is a central part of effective marketing strategy. Any particular product may have multiple channels (and thus multiple consumption chains) that service the same customer group with different approaches (e.g. website sales vs. in-store sales); or multiple channels that are able to reach multiple customer groups.

Channels influence many strategic decisions in the firm. Most fundamentally they link producers to consumers. But they also influence pricing strategy. For example, many of the products on Whole Foods grocery shelves are the same ones sold by Trader Joe's, but the latter are priced on average at about 70% of the Whole Foods' price. Producers are able to affect this dual channel relationship, which extracts significantly more demand for products and allows longer production runs, by giving each channel its own brand and advertising. For large products such as cars and home appliances, financing provides an important boost to demand by allowing cash-strapped buyers to trade on future personal income.

Third parties – the intermediaries or middlemen – that extract a fee for providing services, manage many important channel activities. Intermediaries consolidate their activities around the products of many producers, achieving economies of scale. For example, physical retailers such as Tesco create assortments of products from many producers that are especially attractive to consumers; many products

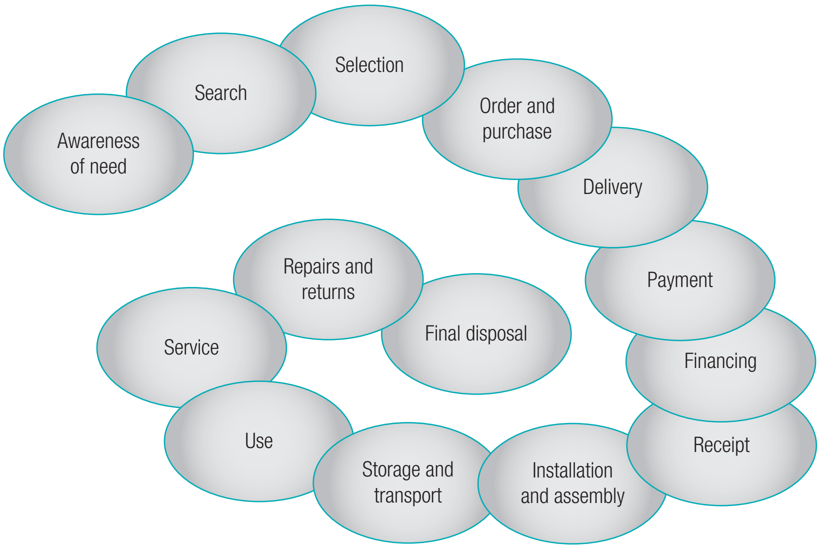

Figure 2.3 Customer Consumption Chain for an Automobile Purchase

would be impossible to sell in any other type of venue. Consumption chains mapping these activities can be very short, as in direct-to-consumer sales via a website, for example. Or they can be extremely long, with advertising, selection, financing and many supporting activities being required to stimulate demand. Figure 2.3, for example, defines the very long consumption chain of activities that might be required for automobile sales.

Each step of Figure 2.3's consumption chain represents an activity resulting in a choice: either the customer moves on to the next link or ceases to be interested in the product, in which case none of the subsequent links are visited. Moving the customer on to the next activity requires that your product meets minimum product standards; that it is differentiated enough from competitors' products that the customer gives it attention; and perhaps that its innovative features are exciting enough that it becomes a 'must own' product.

Quizzing and mind maps establish a context in which an invention is polished, fine-tuned, and made attractive to potential customers. Through them, you will decide:

1. For which customer demographic groups you will chose to design your product, services, marketing, production and logistics;
2. For those demographic groups, what features will differentiate your product from competitors; and
3. How to prioritize the importance of the features you have chosen.

Having honed in on the particular customers you are trying to engage, the next step is to walk through the customer's experience with each unique permutation of the features you feel are important in the product or innovation.

The activities that you walk through are typically called 'channels' and are often distinguished as distribution channels, which involve physical logistics, and marketing channels, which focus on advertising, education and community services such as forums, recommendations and shared experiences.

There will be a separate consumption chain for each potential customer group identified in the quizzing process. Walking through a consumption chain allows an evolutionary revision of the firm's business model and capabilities, through a continual tweaking and redesigning of products or services. This fine-tuning of channels is designed to target customers at every stage of the process so that they will be more compelled to buy from you. Management theorist Peter Drucker observed that the purpose of a business is to create a customer. Think of the purpose of the consumption chain as a way – once you have created a customer – to target, attract and keep that customer through every step of the business. This is ultimately what channel design and optimization is about. Channels must provide all of the advertising, education, support and distribution that are needed to satisfy customers, but must do so economically and efficiently. For the innovator who wants to focus on product design and manufacture, there exist many third-party channel services for hire – logistics, advertising, accounting and warrantor services are available under economical contracts.

Figure 2.4 provides a more specific implementation of a consumption chain, showing the potential for lost sales when a consumption activity is not effectively managed. It considers specifically the activities that have been set up for the DJI Phantom drone, which is the subject of our case study in Chapter 6.

'A chain is as strong as its weakest link' goes the adage. In the case of consumption chains, a well-managed activity will entice potential customers to proceed to the next activity on the consumption chain. A poorly managed activity will discourage or enrage customers to consider competitors' products, or not to buy at all. Consumption chains are notoriously difficult to manage well because everything has to be managed, not just a subset of activities. Fortunately there has been substantial innovation in third-party vendors who specialize in one or more particular activities on the consumption chain. Google, Facebook, Baidu, Bing and other search engines specialize in providing ad placements and user communities; Amazon, Alibaba and other e-tailors can provide logistics and cloud services; and firms like Salesforce provide analytics to fine-tune the operation of consumption chain activities. These allow innovators to focus on their core competencies, while building a complete business.

The Feature Map

There will be a distinctive set of features that define an innovation – either product or service – in the customer's eyes. Typically you should focus on a few key features – only one, two or three features will really matter to a customer. Customer attention is limited and most likely when asked, customers will choose the one feature that, to them, really defines the reason that they would buy your product. Successful innovators identify key features early in the development cycle and do everything they can to see that their products excel in the delivery of these features. Customers may perceive a feature to be attractive (making it more likely to buy) or unattractive (leading them to lose interest in your product). Intelligent choice of a feature set gives

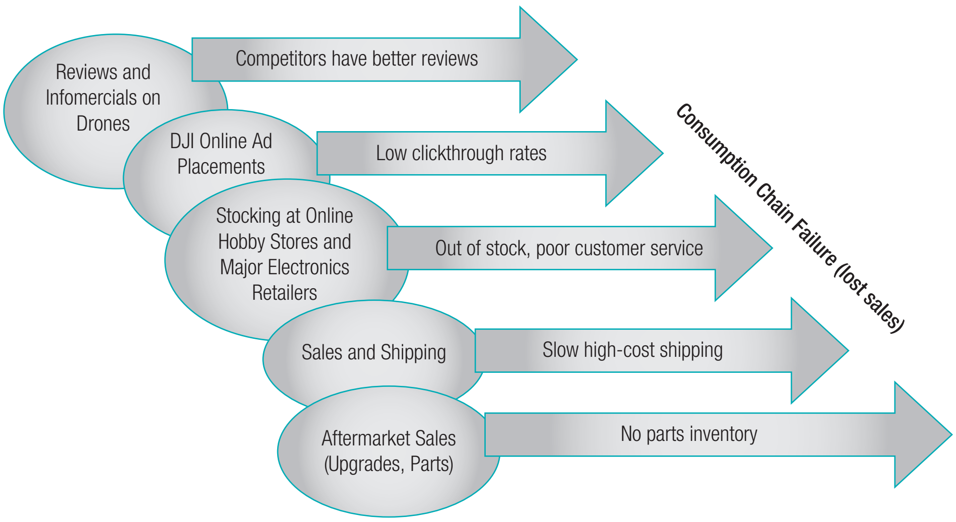

Figure 2.4 An Example of a Consumption Chain for DJI's Phantom Quadcopter Drones, Showing the Reasons That Sales Might Be Lost When a Customer Leaves the Consumption Chain

the innovator a chance to mould not only the product, but also consumer perceptions and the entire consumption experience.

The feature maps – one for the customer demand and one establishing the supply costs – are components of innovation that help you to identify winning features while avoiding costs of features that do not matter to the customer. Feature maps and consumption chains formalize the documentation of customer activity in a way that allows it to be explored, to see how altering the design of the product can ensure maximum profitability of sales.

> We've talked about technology as if it were a stand-alone product – something that either does or doesn't sell well. But it is really an enabler for an awful lot of the great products that have made life better for all of us, including cars, computers, PDAs, and phones. Because technology enables these things, any broad recovery will be felt immediately in the technology arena. Tech is the sweetener in the lemonade, you might say.
>
> *Hector de J. Ruiz, CEO, Advanced Nanotechnology Solutions, Inc.*

For each activity in the consumption chain, innovators need to consider both the demand impact and the supply impact of a given feature. A demand-side feature map (Figure 2.5) is a 3×3 table that locates the customer's perception of the feature in terms of whether it is expected in such a product (i.e. a basic feature); if it will somehow help to differentiate your product from competitors (be a discriminator); or will single-handedly galvanize a customer to make a decision about purchasing your product.

Perceptions of features can be positive, negative or neutral. Ideally, a feature worth pursuing will be a '*differentiator*' (i.e. a discriminator that influences a positive move to the next stage in consumption) or an '*exciter*' (i.e. an energizer that incites a positive move to the next stage in consumption). *Dissatisfiers* and *enragers* are features either to be avoided, or, if that is difficult, to be managed so that customers see them as tolerable. *Basic features* are features that will appear in most of your competitors' products or services. You need them – they are the ante to play in the game. But customers will only notice them if your product doesn't have them.

In the 'for-profit' world, innovative products are intended to ultimately make money for their inventors. Quizzing, feature maps and consumption chains provide information about demand – about the willingness of consumers to pay for

	Basic Features	Differentiators	Energizers
Positive Impact	Features that appear across all competitors' products. Customers expect these – they are the 'ante' to play in this market	Discriminators that make your product stand out from the competitors	Exciters that motivate customers to impulse buy your product. These are rare, and most products cannot expect to 'excite' customers
Negative Impact	Disliked features across all competitor's products. Generally these cannot be avoided in the design of the product or service	Discouragers that drive business to your competitors	Enragers that may destroy your business
Neutral Impact	Invisible features that no one notices. Most of the features in complex products fall into this category	Parallel features shared by some but not all competitors	N/A

Figure 2.5 The Demand-side Feature Map

	Core Features	Non-Core Features
Increases Costs	Incremental value must exceed incremental cost	Generally avoided
Decreases Costs	Optimal	Cost reduction must be substantial to offset cost of acquiring capabilities

Figure 2.6 The Supply-side Feature Map

the product or services. In contrast, the supply-side feature map (Figure 2.6) is a 2×2 table which 'reality checks' the incremental cost added by each feature in the product. If the feature is compatible with the firm's current core capabilities (i.e. its assets plus its competences) then any cost increases have to be justified by assurances that customers are willing to pay a premium for the feature. If adding the feature requires non-core capabilities, then the company will need to outsource these or acquire them itself. Both are expensive propositions involving infrastructure and organizational learning and may only be justified for radical innovations with a potentially high risk of failure. Furthermore, these supply-side cost considerations aren't restricted just to manufacturing the product or completing a service, but they need also to embrace each activity in the consumption chain.

Demand- and supply-side feature maps should be considered as 'maps' – tools to help the innovator assess how the customer will perceive their product, and whether that product can expect to be profitable. These feature maps definitely *should not* be perceived as checklists! You cannot build a successful service or product by ticking off boxes in the feature maps. Available technologies, human resources and access to capital and machines will dictate the exact character of a product. Feature maps encourage you to think of your product in terms of features that are important to your customer. They try to protect you from being obsessed or blinded by the technology and the labour put into the product. They encourage you to think of your innovation in the same way your potential customers would see it. Feature maps protect you from one of the greatest mistakes that new entrepreneurs make: assuming your customers will share your perception of the elegance of your innovation or appreciate the time and effort involved in creating it. Customers have their own agendas, and the feature map is designed to focus you as an innovator on the customers' agenda.

Let's consider the way these feature maps might be used in defining the features of the DJI Phantom quadcopter drone considered in the end-of-chapter case study in Chapter 6. The DJI Phantom was introduced in 2013 and has gone through several stages of improvement, but its defining features have stayed the same. Figure 2.7 shows these superimposed on the demand-side feature map.

Again it should be emphasized that feature maps are not checklists – you should not be filling in every box with a list of features that fit a description. This is a common mistake made by would-be innovators that are more comfortable filling out forms than actual problem solving. Innovators need to keep in mind that customers can only keep a few facts about your product in mind, and these will ultimately differentiate your product and create demand. Note that DJI's choice of a small battery straddles both the discriminator and discourager cells. Small batteries are lighter, which gives shorter flight times but more manoeuvrability. Most products face design trade-offs like this, and feature maps are a way of making the best product design decisions in the trade-offs.

Figure 2.8 shows how the particular key feature choices for battery and plastic shell would map onto the supply-side feature map.

Figure 2.8 emphasizes DJI's choice of a more expensive but more durable injection moulded shell rather than a thermoplastic one. Most innovations add value and cost incrementally to

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	Basic Features	Differentiators	Energizers
Positive Impact	Quadcopter is reliable with few moving parts versus RC airplane or helicopters	Discriminators that make your ... stand c... comp... / Small battery: Low weight (discriminator). Short flight times (discourager)	Durable crash-proof plastic shell
Negative Impact	Requires some training and experience to fly	Disc... drive... your...	Enragers th... destroy y... / Stable camera platform
Neutral Impact	STM32F427 controller chip, 800kv motors, numerous internals	Parallel features shared by some competitors	N/A

Figure 2.7 The DJI Phantom's Demand-side Feature Map

	Core Features	Non-Core Features
Increases Cost	Inc... exce... / Injection moulded plastic shell, ball-bearing motors	Generally Avoided
Decreases Cost	Optimal / Smaller battery = lower weight	Cost redu... substa... of acquri... / Fragile thermoplastic shell (used by competitors)

Figure 2.8 Supply-side Feature Map for the DJI Phantom's Plastic Shell and Battery

products and services around which firms have built their core capabilities. Despite the disproportionate press given to radical innovations, the majority of innovations are mundane (and consequently not of great interest to the media). That does not absolve the firm of its responsibility for either radical or incremental innovation – it merely puts in perspective the proportionate effort the firm needs to spend on each type of innovation. Radical innovations set up temporary barriers to the entry of competitors until they can figure out how to duplicate their success. Incremental innovations, in contrast, keep firm personnel thinking, and make sure they are continually attuned to the needs of their customers. Radical innovations are risky, because technologies may prove unreliable, and customers need education about their value; their pay-off is high. Incremental innovations exercise the creativity of the firm on a daily basis, with lower risk and easily managed failures.

Creative Tension

Even if you create marvellous inventions, your customers will not care unless those inventions are precisely what they think they will need. Business customers are especially impatient with any product that fails to help them gain competitive advantage. At the same time, your own firm cannot expect to maintain its competitive advantage unless its services and products, and all the complementary processes, lie mostly within the firm's core capabilities – their existing corporate inventory of assets and competences. Firms establish their core capabilities by investing in their people, investing in their assets and facilities, and firmly identifying and focusing on their mission. Core capabilities consume your resources; innovative services and products generate more resources. The creative tension within an innovation firm continually reviews and balances one against the other.

Innovation Workout: Brainstorming: A Framework for Quizzing

Alex Faickney Osborn was the 'O' in the name of advertising giant BBDO, and the developer of arguably BBDO's greatest product – brainstorming. It was used internally at BBDO for over a decade before Osborn outlined the method in his 1942 book *How To Think Up*. The method inspired Olaf Helmer's development of the Delphi Method in the early 1950s at the RAND Corporation, involving the repeated collection and distribution of the judgements and opinions of individual experts through the exchange of written documents or electronic mail. RAND's methods were the basis for the Group Decision Support Software which was popular in the 1980s and 1990s. Osborn's brainstorming was designed to encourage a group to express various ideas and to defer critical judgement until later. Everyone offers ideas that are listed, combined, improved and changed into various other ideas. In the end, the group agrees on a final resolution.

Successful brainstorming creates an environment that encourages imaginative ideas to flow. The usual method is to have a small group (six to 12 people) discuss a specific problem. One member records the remarks and suggestions. All withhold judgement on all suggestions. After the session, the various ideas and suggestions are reviewed and evaluated.

The two basic principles of brainstorming are:

1. **Quantity breeds quality:** You should never attempt to solve a challenge with only a single idea. The more ideas you come up with, the more likely you are to arrive at the best solution.
2. **Defer judgement:** Groups instinctively tend to anchor on the first idea thrown out (this is an inherent fault known as 'groupthink' studied extensively by Irving Janis in the 1950s). We naturally defer judgement when shopping for clothes; it is similarly the right way to shop for ideas.

Blueprint

A chain is only as strong as its weakest link, as we have seen, and a negative thinker can derail a proposal by focusing on only a fraction of it. Showing that one part of the whole is absurd, he or she implies that the whole is equally absurd. By destroying a part, a person can destroy the whole and feel a sense of achievement without taking the time or making the effort to create anything.

When we collaborate and align and attune ourselves to a common purpose our energies must be channelled in constructive directions. The success of any brainstorming session depends upon all members understanding the importance of creating a positive environment. To encourage this, avoid making negative judgemental statements about ideas such as:

- Let's shelve that for the time being.
- Who is going to do it?
- I have something better.
- We tried that before.
- It won't fit our operation.
- It's against all our combined logic.
- Not enough return on investment.
- It's great, but …
- Someone must have already tried it.
- I thought of that a long time ago.
- We can't afford that.
- You'll never get approval.
- You're on the wrong track.
- Don't rock the boat.
- The market is not ready yet.
- It's not a new concept.

Group brainstorming helps re-educate people to think positively about ideas. The procedures are:

1. Select your problem. Write the problem as a definite question, as specifically as possible.
2. Choose the participants. The ideal number of participants is between six and 12. Participants should have a positive mental attitude and be fluent and flexible thinkers. They should be strong, independent personalities who are excited about participating and feel a genuine need to improve goods and services. Someone who has the power to make and implement decisions should also be present (though it is extremely important for the group leader to control and put in perspective the decision implementer's comments, as nothing subdues a subordinate faster than the strong opinion of authority).
3. Choose the environment. The preferred location is a comfortable room off-site. The meeting leader should communicate a strong sense of urgency and a hunger for innovative ideas, but should allow for frequent breaks.
4. Select a group leader. The group leader should have strong interpersonal skills and be able to paraphrase and find analogies for suggestions. The group leader should:
   - Prepare in advance as much as possible. Ask each participant to become as familiar as they can with creativity exercises. Plan the meeting carefully.
   - Invite people from diverse areas: non-experts as well as experts on the situation, and people who can make decisions about ideas generated by the group. Discourage observers, onlookers and guests. Every attendee should be a participant.
   - Write an agenda and send it to all invitees.
   - Employ a variety of creativity techniques to get ideas flowing. Use humour and bizarre examples to loosen people up.
   - Focus on the challenge. Be specific about what decisions have to be made and continuously summarize the group's progress throughout the meeting.
   - Encourage any and all ideas, the more bizarre the better. Pay attention to the ideas, and avoid identifying specific ideas with the person who suggested them.
   - Be prepared to go back and manipulate ideas. Creativity always involves manipulation. Use questions that are designed to manipulate the subject in some way so as to change its position, rearrange its components, exaggerate some part or alter the attributes to produce a series of ideas in a short time.
   - Emphasize everyone's unique contribution to the meeting.
   - Select a recorder. Assign someone to record all ideas the group suggests. If the ideas are not recorded, they will vanish completely.
5. After brainstorming, the group leader or the group as a whole should arrange the ideas into related groups to prioritize and evaluate them. In the evaluation stage, some will be discarded, some will stand out as worthwhile, and others will lend themselves to further modification and manipulation.
6. Try using generative graphics such as large wall-mounted scrolls of paper to facilitate group problem solving. Record the ideas with a cartoon, diagram or written phrase using large coloured felt markers. The idea is to stimulate full and energetic participation, and to find colourful, stimulating and graphic ways to portray ideas and illustrate the group's thinking. For many of us, this method of sketching ideas is closer to how our thoughts naturally grow. Later, your generative graphics can be translated and recorded.
7. Follow up. Directly after the meeting, have a lunch, dinner, or cocktail party to celebrate the group's achievements. Write letters to the supervisors of participants acknowledging each individual's contribution to the session.
   - It's a good idea to send each person a categorized list of the ideas that the group generated so that they can continue working on those ideas and keep the momentum of the brainstorming session going.
   - Another good follow-up is to ask each participant to report back on at least one idea he or she thinks is worthy of action,

and four or five recommendations for implementing the idea.

8. Evaluate the ideas. If you try to get hot and cold water out of a faucet at the same time, all you get is lukewarm water. If you try to evaluate ideas as they are being generated, you will not get the ideas hot enough or the criticism cold enough. Do not evaluate ideas until the end of the session.
9. At the end of a brainstorming session, make three lists: ideas of immediate usefulness, areas for further exploration, and new approaches to the problem. The leader can categorize the ideas alone, or he or she can have the group evaluate the ideas by voting on the most useful.
10. Strive for quantity. List all ideas as they pop up no matter how similar they may seem.

Variations

Variations on the basic process of brainstorming have been designed to overcome resistance or dysfunction that may occur in cultures that encourage reticence, deference to hierarchy and power, or which may be instinctively critical. These variations may allow participants more anonymity, or a greater chance to ponder and record their thoughts before commitment.

Brainwriting

The term 'brainwriting' was coined by scientists at the Batelle Institute in Frankfurt, Germany. This is a brainstorming approach in which a group generates ideas silently in writing. Each person writes their ideas on a sheet of paper and then exchanges it for another member's sheet. The ideas on the new sheet will stimulate more ideas, which are added to the list. The process continues for a specified time period, usually 15 minutes. The rules for brainstorming also apply to brainwriting: strive for quantity, defer judgement, encourage freewheeling, and seek combinations and improvements.

Brainstorming Bulletin Board

Use a bulletin board to brainstorm creative ideas at your office. Place the bulletin board in a central location, write the problem to be solved on a piece of coloured paper and place it in the centre of the board for all interested parties to see. Anyone with an idea or suggestion about the problem writes it on a white piece of paper and places it under the problem on the board.

The advantages of this technique are:

1. The problem is visible, and thus will be on the minds of all interested people.
2. It spurs ideas by association. As one person reads the problem and ideas on the board, he or she is likely to think of a new idea.
3. You can leave the problem up as long as you like. This gives people sufficient time to consider it.
4. If few or no people offer ideas, then you might consider ways to encourage workers to become more creative.

Solo Brainstorming

If you are doing a solo brainstorm, write your ideas on index cards. Jot down one idea per card until you run dry. Write the ideas as they come to you – good ones, bad ones, absurd ones, without regard to logic or value. You end up with a pack of ideas that you can then sort, re-sort, and add to as you shuffle them around to decide the best ones to pursue for your purposes.

Assume your challenge is to come up with ways to differentiate your bank from other banks. The first idea that occurs to you is: 'Why not make the bank comfortable and homey?'

Rather than rejecting this idea as impractical, you could come up with a new way of handling banking transactions. For example, you could create a bank where customers hand their money and forms to a receptionist who passes them to a row of clerks for processing. Instead of waiting in line, you could sit in a 'homey' atmosphere in a comfortable chair, watch TV, read magazines and sip coffee. The clerk would call your name when your transaction was complete.

The key is to write down every thought, regardless of its appropriateness to the challenge. It doesn't matter what the thought is. If you think it, write it.

Visual Brainstorming

Brainstorming can also take other forms: a golfer can brainstorm different shots while playing, a composer can brainstorm with music, actors and actresses can brainstorm expressions while acting, and a visual thinker can brainstorm by sketching ideas as they occur.

Ideas usually appear in rapid succession, and spontaneous sketching can create a momentum in which expression keeps pace with thinking. In addition, drawing an idea helps prevent you from making judgements about it before it is fully developed and evaluated.

The basic principles of visual brainstorming are:

1. *Fluency and flexibility of thinking.* Fluent thinking means coming up with a large number of ideas; flexible thinking demonstrates diversity and variety.
2. *Deferred judgement.*
3. *Quick response.* If you fail to draw the idea at once, you may lose it.

However it may be conducted, brainstorming when well run can generate the insights and innovative power of quizzing and stream of consciousness idea generation, but fuelled by all of the experience and wisdom of the group. The secret is to avoid groupthink and encourage everyone to exercise their imagination through these short bursts of creative fecundity.

Workout: Organizing your Quizzing with Mind Maps

Methods for quizzing and reorganizing a stream of creative ideas have been vetted since at least the turn of the 20th century. Design firm IDEO tackled the process of organizing and consolidating creative ideas through its mind maps, which map the products of quizzing in a visual schematic.

Mind maps provide a graphic technique for organizing ideas. They create a picture of the way your mind blueprints a challenge, and allow you to record, store and manipulate information about a challenge in a variety of ways, as well as letting you see relationships between different parts of the problem.

All mind maps share five basic characteristics:

1. Organization. Mapping presents information organized in the way you think it. It displays the way your mind works, complete with patterns and interrelationships, and has an amazing capacity to convey precise information, no matter how crudely drawn.
2. Key words. Ignore all irrelevant words and phrases and concentrate only on expressing the essentials, and what associations these 'essences' excite in your mind.
3. Association. Make connections, links and relationships between seemingly isolated and unconnected pieces of information. These connections open the door to more possibilities. You can feel free to make any association you wish, without worrying whether or not others will understand you.
4. Clustering. The map's organization comes close to the way your mind clusters concepts, making the mapped information more accessible to the brain. Once your ideas are clustered, try to adopt the viewpoint of a critic seeing the ideas for the first time. This allows you to test your associations, spot missing information and pinpoint areas where you need more and better ideas.
5. Conscious involvement. Continuous conscious involvement allows you to group and regroup concepts, encouraging comparisons. Moving the components of your mind map around into new juxtapositions provokes new ideas.

Mapping a challenge or an idea allows you access to a certain mental spark: it flares up in the mind, is conducted to the hand, flows to the paper, and bursts into a tiny fire that, when seen, closes the circle by travelling back into the eye and farther into the subconscious.

Sometimes these tiny fires become the very ideas that you need to resolve your challenge; sometimes they need to be tended and fuelled with more information before they flare into ideas. And, sometimes, these tiny fires smoulder for days, weeks or months before they blaze. However, if you take no action when that spark flares up in your mind, it burns out, turns cold and is forgotten.

The Workout: choose any product category that interests you. Select three to six teammates to brainstorm the customer demand and the required product features. Quiz (ask of the customer's needs who, what, where, when, how and why) and organize your insights by drawing a mind map. Repeat in three cycles: quiz for five minutes, then summarize your ideas by drawing a mind map. The final mind map should identify the two to three defining features of your successful product, to be mapped on the feature map.

Case Study: Viagra – The First Blockbuster Drug

In 1991, inventors Andrew Bell, Dr David Brown and Dr Nicholas Terrett (also Pfizer employees at Kent) discovered that chemical compounds belonging to the pyrazolopyrimidinone class were useful in treating heart problems such as angina. Terrett was named in the 1991 British patent for sildenafil citrate (later trade-named Viagra) as a heart medicine, and some experts consider him as the father of Viagra.

Terrett, named in the 1991 British patent, and one of the first to document the erectile side effect in 1994, became known as 'the father of Viagra'. Pfizer claims that hundreds of inventors were involved with the creation of Viagra and there was not enough room on the patent application to name them all, so only the department heads were listed. Dr Simon Campbell, who until recently was the Senior Vice President of Medicinal Discovery at Pfizer and oversaw Viagra's development, is considered by the American press to be the inventor of Viagra. Campbell himself preferred to be known as the father of Amlodipine (a cardiovascular drug), deferring to Terrett in this honour. 'I'm like Columbus', commented Campbell (never the modest type) on Viagra's development.

By I994, Nicholas Terrett and colleague Peter Ellis discovered during the trial studies of sildenafil as a heart medicine that it also increased blood flow to the penis, allowing men to reverse erectile dysfunctions. The drug acts by enhancing the smooth muscle relaxant effects of nitric oxide, a chemical that is normally released in response to sexual stimulation. The smooth muscle relaxation allows increased blood flow into the penis, leading to an erection when combined with something naughty. Dunn and Wood then worked on the crucial nine-step process to synthesize a sildenafil (Viagra) compound into a pill. It was approved by the Food and Drug Administration (FDA) on 27 March 1998 as the first pill to treat impotence.

Sildenafil's disputed paternity took a more interesting turn as doctors began noticing a remarkable side effect. Though it had only been mediocre reliever of angina, sildenafil was a reliable initiator of erections. Whatever questions surrounded the paternity of Viagra, the marketable product was undoubtedly the offspring of William C. Steere, Jr., the son of the prominent botanist William C. Steere, Sr. Steere was named to head the prescription drug division of the American pharmaceuticals firm Pfizer in 1985. Unlike his father, William Jr. had little inclination towards the academic, and had made his way to the top through the marketing ranks. A brilliant salesman and marketing tactician, Steere came to the job with a strong prejudice that the church-and-state division between marketing and R&D had outlived its usefulness (a conclusion drawn by most of Big Pharma in the free-market environment of the Reagan years). Steere's modest aspiration was to make Pfizer, a perennial also-ran, into the largest pharmaceutical company in the world, an aspiration goaded by the fact that Merck was the perennial 800-pound gorilla of pharmaceuticals.

At a time when the re-engineering movement was gaining traction, Steere re-engineered Pfizer's drug pipeline around two new kinds of management teams for every new drug developed at Pfizer: an Early Candidate Management Team; and an Advanced Candidate Management Team. Out was the idea that the cloisters of R&D should be free from market guidance; or free to throw a drug over the transom expecting marketing to take it from there. In-house synergies between marketing and R&D would assure a pipeline of successful drugs. The Early Candidate Management Team would assure that R&D knew the marketing prospects of candidate drugs as they were developing and testing them. This team would include representatives from research, marketing and sales to maintain a steady dialogue that would direct diseases to which drugs might be applied, dosages, trials and so forth. Once the drug was ready for FDA submission, the first team would hand the portfolio over the second, which was chaired by a marketing person. Steere explained, 'our goal was to communicate earlier on products to make sure that their development was such that when they entered the market, they'd be instant successes'.

Instant successes! Size matters! These were Steere's passions throughout the 1990s when Pfizer aspired to outperform its perennial rival Merck. Then came Viagra.

Never one to miss an opportunity, Steere put the compound through a crash screening process to come up with a marketable drug; essentially, he asked marketing to 'find' a 'disease' that regarded an erection as a 'cure'. Marketing coined a condition with the uninspiring name 'erectile dysfunction' (ED) and sildenafil was rechristened Viagra.

Unfortunately, there were details still to be worked out before Viagra could become an instant success. One of the stickier parts of FDA approval was that a drug was approved only for treatment of the specific malady specified in the FDA approval. Any other use (for example, of an angina drug for treating erectile dysfunction) would be considered 'off-label' and was strictly prohibited. Nor was there much chance that general practitioners were going to confuse angina and erectile dysfunction (ED).

Fortunately, once the felicitous effects of Viagra were identified, Steere's in-house synergy worked brilliantly. The medical affairs division funded studies on 'ED' and underwrote seminars on the subject. His salesmen were tutored on the biology of smooth muscle tissue (Erectile Anatomy 101), the physiological target of Viagra.

'Viagra crystallized some things I'd been thinking about', Steere told *Fortune* at the time. 'It struck me that a quality-of-life drug for aging would be a real winner. Look at the volume in cosmetics, which are basically nostrums that really don't do anything.' From Pfizer's standpoint, Viagra was a miracle drug: it cured a 'disease' of rich, pill happy seniors, with only a few side effects, none which couldn't be easily doctored.

Pfizer had also recently gained a powerful new tool in its marketing arsenal: direct-to-consumer advertising had recently been allowed by the Food and Drug Administration. In the 1980s, drugs were prescribed under the advice of physicians and patients were carefully guarded from knowing anything that might possibly hurt them. This fitted well with the physicians' own view of their profession; as counsellors, rationers and demi-gods lording over patient health.

But Viagra, coming as it did after the FDA relaxed its rules on direct-to-consumer advertising, was not just a commercial success, but a cultural revolution in a pill. Where the baby boomers had oestrogen, 'the pill', in the 1960s, their older selves now had Viagra and Austin Powers to keep the revolution alive. Viagra changed the billion-dollar porn industry, which changed internet entertainment marketing. Viagra's presence was so huge, its medical legitimacy established so rapidly, that teenage ravers worldwide were popping 'V' with their 'X' (though why a bunch of 18-year-old males needed any help is anyone's guess, least of all Pfizer's R&D department).

Viagra's impact on Pfizer was (we can only use one word) huge. First-year sales were $400 million (a then unheard of figure). In the US alone, physicians were writing 275,000 prescriptions for it a week. By 2000, worldwide sales were $1.5 billion. Large investors started calling Pfizer the best company in the industry; other companies were expected to perform as well. Bill Steere was a happy man (take that, Merck).

None of this would have been possible in the old pre-Steere Pfizer, where R&D developed the product and threw it over to marketing for sale. Steere's synergies had propelled an also-ran – both the firm and the drug – to the front of their ranks.

Not all was smooth sailing, though, as many lawsuits surrounded Viagra including the suit filed for $110 million dollars on behalf of Joseph Moran, a car dealer from New Jersey, who claimed that he crashed his car into two parked cars after Viagra caused him to see blue lightning coming from his fingertips, at which point he blacked out. Moran was driving his Ford Thunderbird home from a date at the time. Yet Joseph Moran's unfortunate black-out was little more than a bump on the very profitable road to fulfilment.

Questions: Viagra Case Study

1. Some might say that the marketing strategy for Viagra, no matter how successful it ultimately was, severely tested some ethical principles. Would you agree? If so, what should Pfizer have done differently? How would they explain this action to their stockholders?
2. How many drugs or food products can you think of that might be amenable to Pfizer's strategy of asking marketing to 'find' a 'disease' that regarded that particular food or drug as a cure?
3. Can you make a case for not allowing direct-to-consumer advertising; letting drugs only be prescribed under the advice of physicians? How, then, would you market your drugs?

Chapter 2: Questions for Review

1. What do we mean by recognizing the potential of an innovation?
2. 'Not-invented-here (NIH) syndrome', 'I already know it (IAKI)', 'Prove it to me (PITM)', and 'how on earth could my firm possibly do that?' have been said to be innovation's worst enemies. Do you agree? Why or why not?
3. Consider some of the ethical questions raised by the aggressive profiteering from human frailties by innovative medical suppliers and pharmaceutical firms. It is likely that no two people will precisely agree with each other's ethical perspective; each person carries their own moral compass, and each points a slightly different direction. Expound your own views in the classroom and encourage a larger debate.
4. It has been suggested that the US is more innovative than Asia or Europe. Do you agree or disagree? What is behind a national culture of innovativeness?

Chapter 2: Key Points

1. Steps for assessing the potential demand for an innovation:
   - For each customer segment sketch the consumption chain
   - Identify the trigger events that precipitate customer movement from link to link
   - Put in place procedures to alert you when the trigger is pulled (and plan your response)
   - Quiz to assess needs that may not be met currently
   - Create a feature map for each significant link in the consumption chain
   - Use your knowledge of the customer experience to create blockbuster services and products
   - Put the ideas you generate into your opportunity register.
2. The innovator's mindset:
   - Successful innovators are action oriented
   - When moving fast (innovating) complexity creates confusion and delay.
   - Innovators order and simplify complexity by:
     - identifying generic business models and action strategies for innovation businesses
     - stretching their own skills
     - exercising their ability to capitalize on uncertainty and to take calculated risks.
3. Innovation is seldom radical and completely new.

   Typically it is incremental, reconfiguring and redifferentiating existing services, business models and products, by reconfiguring existing value maps, or introducing entirely new kinds of solutions.
4. Reconfiguration is about:
   - Breaking down the barriers (technological, regulatory or organizational) that set limits on the features you can offer, or on the way that consumption chains can be configured
   - Building on your insights from the consumption chain analysis and feature map, looking to remove the limitations imposed by your existing core capabilities
   - Taking advantage of opportunities arising from the knowledge that underpins new innovations, the commercialization of those innovations and the value flows generated.
5. Your Analysis Toolkit consists of:
   - Quizzing, and organization of resulting insights through mind maps
   - The consumption chain
   - The feature map.

Further Reading

Baumol, William, (2002). *The Free Market Innovation Machine*. Princeton, N.J.: Princeton University Press.

Berne, C., Garcia-Gonzalez, M. and Mugica, J. (2012). How ICT shifts the power balance of tourism distribution channels. *Tourism Management* 33(1), 205–214.

Boyle, B. A. (2015). Influence objectives as antecedents to influence strategy selection within distribution channels, in *Proceedings of the 1995 World Marketing Congress* (pp. 277–283). Springer International Publishing.

Chernova, D. V., Voytkevich, N. I. and Ivanova, N. V. (2015). Methods of logistic infrastructure formation for enterprises manufacturing bottled water. *Asian Social Science* 11(5), 274.

Christensen, C. M. and Bower, J. L. (1996). Customer power, strategic investment and failure of leading firms. *Strategic Management Journal* 17, 197–218.

Clark, K. B. and Wheelwright, S. C. (1994). *Managing New Product and Process Development*. New York: Free Press.

Cohen, W. M. and Levinthal, D. A. (1989). Innovation and learning: The two faces of R&D. *The Economic Journal* 99(397), 569–596.

Dant, R. P., & Grünhagen, M. (2014). Special Issue: Dynamics of Marketing Channels in BRICS (Brazil, Russia, India, China, and South Africa) Economies. *Journal of Marketing Channels*, 21(1).

The Economist (2005, 15 March). An overdose of bad news, pp. 73–75.

The Financial Times (2005, 21 August). Merck to pay $253 million after losing Vioxx suit, p. 1.

Freeman, C. (1982). *The Economics of Industrial Innovation*. Cambridge, MA: The MIT Press.

Freeman, C. and Soete, L. (1997). *The Economics of Industrial Innovation*, 3rd edition. The MIT Press.

Griffiths, T. L. and Tenenbaum, J. B. (2006). Optimal predictions in everyday cognition. *Psychological Science* 45, 56–63.

Hoppner, J. J. and Griffith, D. A. (2015). Looking back to move forward: A review of the evolution of research in international marketing channels. *Journal of Retailing* 91(4), 610–626.

Howell J. M. and Higgins, C. A. (1990) Champions of technological innovation. *Administrative Science Quarterly* 35, 317–341.

Kahneman, D. and Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica: Journal of the Econometric Society* 47(2), 263–291.

Kahneman, Daniel (2011). *Thinking, Fast and Slow*. Farrar, Straus and Giroux.

Kipling, R. (2005). The Elephant's Child: From the *Just So Stories*. ABDO.

Kozlenkova, I. V., Hult, G. T. M., Lund, D. J., Mena, J. A. and Kekec, P. (2015). The role of marketing channels in supply chain management. *Journal of Retailing* 91(4), 586–609.

Liu, J., Guan, Z. and Xie, X. (2015). B2C E-commerce logistic channel structure in China. *WHICEB 2015 Proceedings*.

McDermott, Rose, Fowler, James H. and Smirnov, Oleg (2008). On the evolutionary origin of prospect theory preferences. *The Journal of Politics* 70 (02).

Mehta, R., Larsen, T., Rosenbloom, B., Polsa, P. and Mazur, J. (2015). Leadership, cooperation and performance in international marketing channels: An empirical investigation of the United States, Finland, and Poland. In *Proceedings of the 2000 Academy of Marketing Science (AMS) Annual Conference*. Springer International Publishing.

Osborn, A. F. (1942). *How to 'Think Up'*. New York, London: McGraw-Hill Book Co.

Ozsomer, A. (2015). Industrial networks as governance structures: A framework integrating channels, logistics and pricing. In *Proceedings of the 1993 World Marketing Congress*. Springer International Publishing.

Palmatier, R., Stern, L., El-Ansary, A. and Anderson, E. (2014). *Marketing Channel Strategy*. Pearson Higher Ed.

Reardon, J., Lee, J. and Vida, I. (2015). Modeling consumer distribution channel switching behavior: The case of direct vs. traditional channels, in *Global Perspectives in Marketing for the 21st Century* (pp. 1–4). Springer International Publishing.

Rosenblatt, J. and Calantone, R. (2015). Using the price/quantity model to indicate power in marketing channels, in *The 1980's: A Decade of Marketing Challenges* (pp. 14–19). Springer International Publishing.

Samouel, P., Pitt, L., Berthon, P. and Money, A. (2015). Vertical control and performance: The role of power, relational norms and transaction cost analysis in distribution channels. In *Proceedings of the 1998 Academy of Marketing Science (AMS) Annual Conference* (pp. 412–417). Springer International Publishing.

Shi, H., Liu, Y. and Petruzzi, N. C. (2013). Consumer heterogeneity, product quality, and distribution channels. *Management Science*, 59(5), 1162–1176.

Sol, H. G. and van Hee, K. M. (2014). Modelling Logistic Systems with EXSPECT. In *Dynamic Modelling of Information Systems* (pp. 269–288). Amsterdam: Elsevier.

The Wall Street Journal (2003) Drug Makers See 'Branded Generics' Eating Into Profits, p. Al.

von Hippel, E. (1994) 'Sticky information' and the locus of problem solving: Implications for innovation. *Management Science* 40 (4), 429–439.

Wierenga, B., van Tilburg, A., Grunert, K. G., Steenkamp, J. B. E. and Wedel, M. (eds) (2012). Agricultural Marketing and Consumer Behavior in a Changing World. Springer Science & Business Media.

CHAPTER 3

Business Models and Strategy

Learning Objectives

After finishing this chapter, you will

- Understand that your core capabilities consume your resources, and that your innovation is responsible for generating future resources to support the acquisition of future capabilities.
- Understand how capabilities (assets + competences) constrain the space in which you can effectively compete.
- Understand that most innovation is incremental and reconfigures and redifferentiates existing services, business models and products.
- Recognize that most innovative products owe much of their innovation to other marketed products, to competitors, to universities and to government laboratories outside of one's own firm.
- Be able to define a business model and know where the concept is applied in assessing and innovation.
- Learn that innovation requires the collaboration of five different types of people: idea generators, boundary spanners, evangelists, caches and project managers.
- Understand the origins and application of the scientific method for business analysis of innovation and how this differs from strategy.
- Understand that business models fail either because they fail to tell a convincing story or they fail to support their story with convincing financial numbers.
- Understand the components of value mapping and how they are used to support a story and to generate financial projections of costs and revenues for an innovation.
- Understand that value mapping is an extension of the demand-side and supply-side feature maps that were introduced in the last chapter.

After doing the *Innovation Workout*, you will be able to use **morphological boxes** to explore all the permutations of a product, market or service.

After reading the Mad Catz *case study*, you will be able to identify the roles that **different components** play in **generating costs and revenues**.

Business Models

Business modelling is the managerial equivalent of the scientific method – you start with a hypothesis, which you then test in action and revise when necessary. Unfortunately, in practice, 'business model' and 'strategy' can be among the most sloppily used terms in business. Too often they are stretched to mean everything, but end up meaning nothing; they suffer from a fundamental lack of formal language.

Business models earned a somewhat dodgy reputation during the dot.com era, where loosely knit promotional stories were used to justify huge wealth transfers from unsuspecting investors. For example, entrepreneur Jay Walker invented Priceline.com, a reverse auction for airline tickets, going on to extend his concept to hotels, groceries and gasoline. The 'story' as Walker told it was that consumers would tell him how much they wanted to pay for, say, a flight to Bali. Consumers could specify the price but not the airline. Priceline.com wanted to be a power broker for individual consumers. By representing the demand of millions of consumers, it would negotiate discounts and then pass on the savings to its customers, taking a fee in the process.

Beam me up

Priceline's on-again/off-again official spokesperson has been *Star Trek's* William Shatner, who agreed to do the spots for free in exchange for stock in the company. He was later 'replaced' by his *Star Trek* co-star, the late Leonard Nimoy (though Shatner still appeared in spots, running into Nimoy as his replacement). The arrangement turned out to be quite lucrative for Shatner who sold most of his Priceline stock shortly before its value plummeted in the dot.com bust. The company was later sold to Cheung Kong (Holdings) Limited, owned by Hong Kong tycoon Li Ka-shing who has expanded its global services through investments in Chinese online travel company Ctrip.

So, what is wrong with 'the story'? The biggest problem is Walker's assumption that companies such as American Airlines – which had made huge investments in its own proprietary Sabre pricing, reservation and seat inventory system – would actually be interested in playing by Priceline's rules, and losing huge sums of money in the process. Airlines retaliated by collaborating on the prices they sent Priceline, effectively undermining its price search model. Walker's 'story' was myopic – it failed to see beyond the consumers' problem; it specifically failed to account for the complexity of investments and dynamics on the vendor side. Walker's story was incomplete, and ultimately Priceline was forced to move to a traditional sales model where travellers are presented prices which they can take or reject. Priceline's offerings in groceries and gasoline (through partially owned affiliate WebHouse) were even less successful. In October 2000, WebHouse ran out of cash at the same time that it ran out of investors who were willing to put any more money into 'the story'.

What's in a Name? (Part 1)

It can be argued that Motorola's global decline began with one audacious, overreaching innovation: building a mobile network that would cover the earth. The Iridium satellite system was originally to have 77 active satellites, and as such was named for the element iridium, with a nucleus surrounded by 77 electrons. But, to reduce cost, that number of active satellites was reduced to 66 early in planning. The element with atomic number 66 is called dysprosium which in Greek means 'hard to get in contact with'. Understandably, the company was less than enthused with either dysprosium or its translation, and stuck with its original name. The system was ultimately sold for less than one-hundredth of its cost.

In case anyone thinks that internet entrepreneurs have a monopoly on flawed business models, think again. We tend to forget about ideas that don't work out, but business history is awash with 'stories' that on deeper inspection made little sense. Motorola invested $3.5 billion into its Iridium satellite system (the company incurred more than $6 billion in losses in its short life). Motorola's 'story' was that customers would pay a premium to be able to make phone connections anywhere at any time. To the delight of Motorola's engineers, Iridium more or less pulled off that technological feat, beginning operations in late 1998. Nothing about the Iridium system was particularly innovative. The main patents on the Iridium system were in the area of mass production of satellites, designed by the same engineer who set up the automated factory for the Apple Macintosh; each satellite contained a cluster of seven of the Macintosh's PowerPC 603E 200MHz CPU chips. But with a $3,000 price for a massive Iridium phone, plus international calling rates of up to $14 a minute, the company brought in only 15,000 customers before declaring Chapter 11 bankruptcy on 13 August 1999.

In late 2000, a group led by ex-airline executive Dan Colussy paid $25 million (about 0.4% of its original cost) for the entire network which now primarily serves the US Department of Defense. After Iridium filed for bankruptcy it cited its 'difficulty [in] gaining subscribers'; these 'difficulties' were elaborated by CNN writer David Rohde when he detailed how he applied for Iridium service and was sent information kits, but was never contacted by a sales representative, and encountered programming problems on Iridium's website and a 'run-around' from the company's representatives. Apparently the engineers felt that putting their satellites in orbit was all that was required for a successful business – end of 'story'. Ultimately, business models like these fail because they are built on faulty assumptions about customer behaviour. They are solutions in search of a problem.

What's in a Name? (Part 2)

Auctionweb was founded in San Jose, California on 4 September 1995 by computer programmer Pierre Omidyar, part of a larger personal site that belonged to his consulting firm, the Echo Bay Technology Group. The company officially changed its name to eBay in September 1997. Omidyar had tried to register the domain name EchoBay.com but found it already taken by the Echo Bay Mines, a gold mining company, so he shortened it to his second choice, eBay.com.

The irony of a careless employment of business models is that when used correctly, they force managers to think rigorously about their business. Business models are beneficial implements that articulate the activities, players and resources required of a business proposal, and describe how they work together as a value-creating system. Even during the internet boom, executives who understood the language of business models outperformed the naïve.

Meg Whitman was candid in her reasons for joining eBay in its early days – she was struck by what she described as 'the emotional connection between eBay users and the site' and realized that that the communities and services eBay had originated simply 'couldn't be done off-line'. Whitman saw these two characteristics lying at the core of the eBay business model, one that could be translated into an engine of value. Ever since, Whitman has enshrined 'the emotional connection between eBay users and the site' as a key competence in the eBay business, taking full advantage of the psychology and the economics that draw collectors, bargain hunters, community seekers and small business people to eBay. This helps eBay to make decisions about the scope of its activities that result in a profitable cost structure. Compare this with the pretext of Priceline, which naïvely assumes that consumers are only concerned with price and that sellers are unconcerned about loss of revenue; in fact, the reverse is the actual case.

Strategy and Business Models

Sound business models, whether articulated or not, underlie every corporate success story. Nonetheless, a business model is not the same thing as a strategy (though the terms are sometimes used without distinction). Business models describe the systems view of a business – its operations and its relationships with the world of consumers and vendors. Strategies, in contrast, derive from a military perspective that expects an action plan for winning in the rivalry with competitors, either current or foreseen.

Business Strategy

As overused as the word strategy is today, its provenance as a business term is remarkably recent. Perhaps the first widely read treatise that incorporated strategy as a business concept was historian Alfred DuPont Chandler's 1962 book *Strategy and Structure* that profiled the relationship between the strategy and corporate departments at General Motors and Sears. A scion of the DuPont family, Chandler used his pedigree and access to determine how the department and organizational structure of a firm relate to its mission – its 'strategy'. Chandler presciently devoted chapters to technological and market innovation and to the roles of functional departments (the latter had a defining influence on the curriculum and departmental structure of today's business schools).

Historian and economist Peter Drucker also began his studies of business strategy at General Motors as a consultant. Drucker's 1964 book *Managing for Results* was originally called *Business Strategies*. Both Drucker and his publisher rejected this title after informal test marketing. Drucker explained in the preface to a later edition that he was repeatedly told that 'strategy belongs to military or perhaps to political campaigns, but not to business' (Drucker, 1993: 00).

The work of both Chandler and Drucker was strongly influenced by both men's personal ties to General Dwight Eisenhower. Drucker worked closely with Eisenhower at Columbia University to set up the business school there; and Chandler was Eisenhower's biographer. It seems apt that historians, with their focus on governments and power, introduced strategy to business.

Competitive strategy ultimately requires doing something better than your opponents; it requires differentiating yourself in some way, either with products, or service, or cost, or whatever else registers on your customers' radar. Businesses can only outperform when they are unique; when competitors are forced to innovate in order to enter your competitive space. Any barrier to market entry is at most temporary. To erect new barriers for competitors, products and services need continual differentiation and redifferentiation. Continually evolving your basis for differentiation can only be done through innovation.

Capabilities in the Business Model

Innovations are conceived in terms of potential new consumers, applications of emerging technologies and new product market opportunities. But to build a successful model, these demand-side factors must align with the specific competences and asset bases of your firm. Where your business model lacks specific competences or assets, you need to acquire these by hiring experts, buying assets or forming strategic partnerships with firms that have the expertise you lack. Production and channel efficiency suffer when markets and capabilities are misaligned. In these situations, your rivals are likely to outcompete you.

Competences, asset bases and market opportunities never coincide completely, as shown in the Venn diagrams in Figure 3.1. A business can

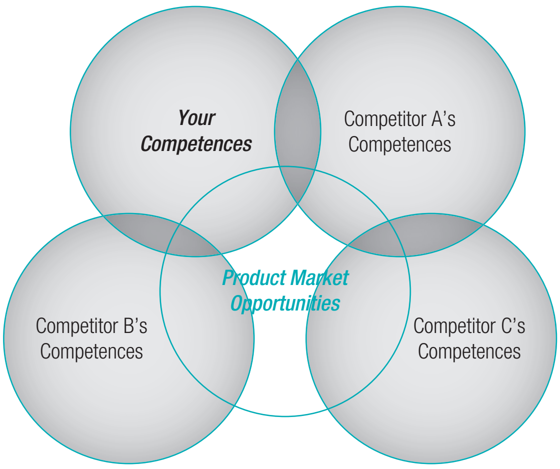

Figure 3.1 Mismatch of Markets and Competences

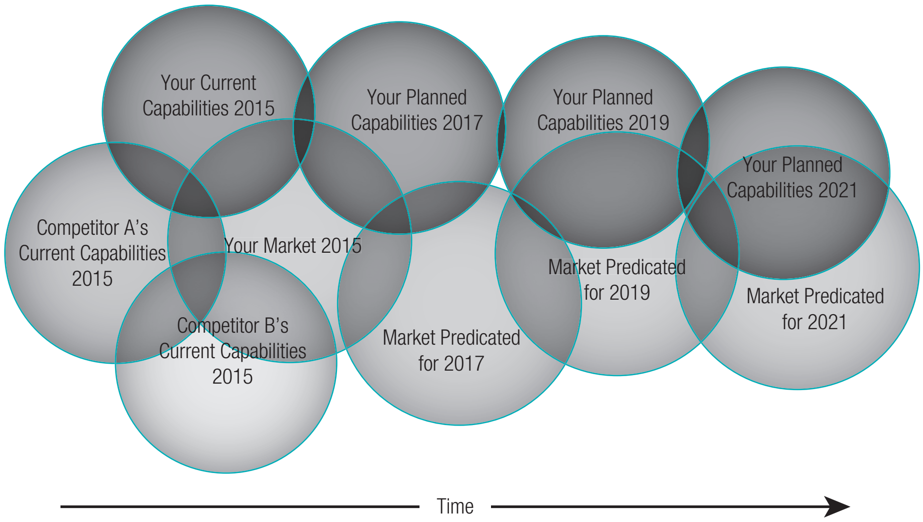

Figure 3.2 Innovators Compete in a Multitude of Evolving Markets

only hope for some overlap, knowing that hiring, purchase of plant and equipment and other strategic considerations are needed for the business model to flourish.

John F. Kennedy observed, 'Change is the law of life. And those who look only to the past or the present are certain to miss the future.' Indeed this is true in industry, where markets, finances and technology are continually in flux. Successful managers pursue a policy of adaptive execution, essentially sequences of experiments and piece-wise construction of business models that reflect changing competitive landscapes and consumer expectations. This requires that as markets and consumer demands change, the firm's business model is continually updated to add specific competences or assets. This can be accomplished by hiring experts, buying assets or forming strategic partnerships with firms that have the expertise your firm currently lacks, as depicted in Figure 3.2.

Simply chasing markets by hiring employees and buying assets can quickly bankrupt a firm. Rather firms must constantly be aware of opportunities for repurposing their existing assets and skillsets to create or exploit new markets (for example see the mini-case Sony's Batteries). The firm's trajectory of capabilities should align with some market, but it doesn't need to be the firm's original market (Figure 3.3)

There are two kinds of competences that underpin an innovation: technological and market. The need to innovate to maintain competitive position in a market will be incremental if it conserves the manufacturer's existing technological and market capabilities; it will be niche if it conserves technological capabilities but obsoletes market capabilities; radical if it obsoletes technological capabilities but enhances market capabilities; and architectural if both technological and market capabilities become obsolete. The point to note is that market knowledge is just as important as technological knowledge.

Some incumbents have great difficulty with apparently incremental innovations that involve seemingly small changes that could easily be handled by their capabilities. For example, Xerox, the pioneer of the copier industry (albeit through their acquisition of Chester Carlson's technology) stumbled for years before developing a small plain-paper copier to challenge Japanese products. This can be explained by the fact that innovations are invariably built up of components, and thus building them requires two kinds of technical knowledge – knowledge

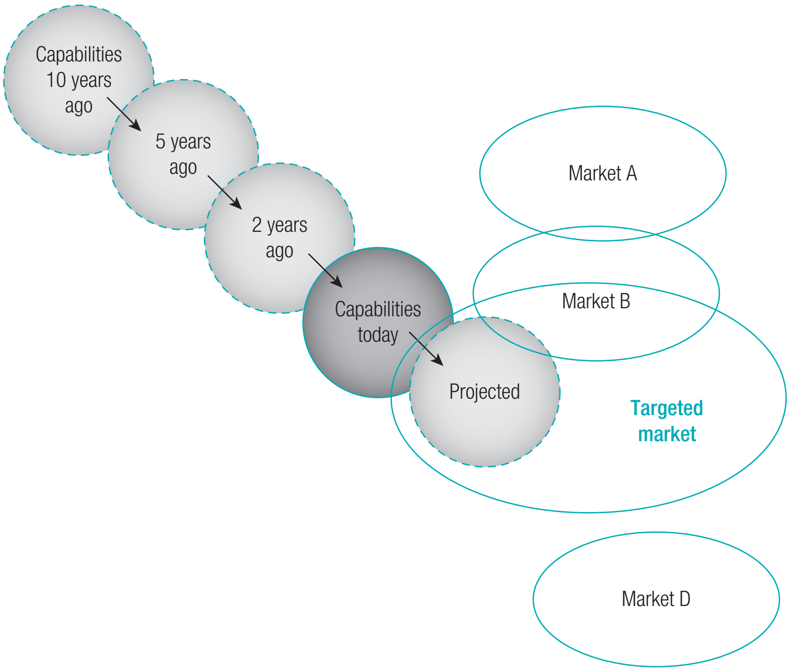

Figure 3.3 Evolution of the Market for a Particular Product Innovation, and the Demands on your Capabilities.

Sony's Batteries

The cutting-edge of current energy storage technology is the lithium-polymer battery that powers most smartphones, laptops, tablets and other consumer devices. Lithium is the metal with lowest density and with the greatest electrochemical potential and energy-to-weight ratio, so in theory it would be an ideal material for batteries. And indeed, lithium battery technology had been around for most of the 20th century. But the technology really took off in the 1990s, in the wake of the demise of another consumer technology – cassette audiotapes. The Japanese company Sony had, with Holland's Phillips, commercialized the Compact Disc (CD) technology for music in the 1980s; by 1990 CDs had completely replaced audio cassettes, and Sony found itself with factories full of old, unusable equipment for making magnetic tape for cassettes. Sony's scientists searched for another use for this equipment, settling on American chemist John B. Goodenough's invention of the LiCoO2 battery cathode, and French research scientist Rachid Yazami discovered the graphite battery anode. Sony discovered that instead of coating polymer tape with a magnetic film for data recording, they could coat it with a goopy paste that turned it into one of Yazami and Goodenough's battery electrodes to create a long-lasting, lightweight and powerful battery. In 1997, Sony lightened its battery even further by throwing away the metal battery casings, replacing them with a polymer pouch made of material similar to the cassette tape plastic. The lithium ion polymer (LiPo) battery was born. These batteries held their electrolyte in a solid polymer composite instead of a liquid solvent, and the electrodes and separators are laminated to each other, allowing the battery to be encased in a flexible wrapping instead of a rigid metal casing. Such batteries could be specifically shaped to fit a particular device, which is particularly useful for smartphones, radio controlled aircraft and consumer electronics with unique, idiosyncratic shapes.

Lithium ion technology advanced further, as it has come to be a core automotive technology, largely as a result of the success of Elon Musk's Tesla auto company. Tesla automobiles can extract greater acceleration than class-leading Ferraris from lithium ion battery packs weighing 990 pounds, storing 56 kWh of electric energy and delivering up to 215 kW of electric power. These packs are built of 69 individual cells wired in parallel to create bricks; 99 bricks connected to create sheets, and 11 sheets inserted to create a pack made up of 6,831 cells. Cell temperature levels are maintained by a liquid-cooling system with sensors within the pack monitored by the car's software. Tesla manufactured over half the world's lithium ion batteries in 2016.

about the technology underlying individual components and architectural knowledge about how to link components together. If the innovation enhances both component and architectural knowledge, it is incremental; if it destroys both, it is radical; where only component knowledge is destroyed (for one or more components) the innovation is modular.

A firm can find itself unable to introduce its particular innovations, no matter how much they may benefit the firm and fill out its product or service offerings, because it lacks the capabilities to effectively deliver them. The firm then faces a choice: either it must choose to acquire more capabilities (which can be expensive) or choose to discontinue commercialization of the innovation (which in the long run might be even more expensive).

Industries, products and services follow distinctive change trajectories, and proper assessment of the particular trajectory on which you are competing is essential for an effective investment in capabilities. If the entire industry is in the midst of radical change, there will be an eventual need to dismantle old business models and acquire capabilities that align themselves with the emerging order. On the other hand, if the industry is experiencing incremental change, continual investment in redirecting and expanding your capabilities is in order. The need to understand industry change trajectories may seem obvious, but such knowledge is not always easy to come by. Companies misread clues and arrive at false conclusions all the time. Management and investment in capabilities demand (1) complete and up-to-date business models describing the company's operations and markets; and (2) knowledge of the particular trajectory along which the industry in which your company competes is moving.

The preservation or obsolescence of competences and assets of a firm can be seen to drive the evolution of that firm's markets and products along four distinct trajectories – radical, progressive, creative and intermediating (Figure 3.4).

Anita McGahan at the Rotman School of Management tracked over 200 firms during the 1990s to better understand firms' investment in plant and people over time. She found that where a firm's strategy (its plan for achieving a return on investments in capabilities) failed to align with the industry's change trajectory, profitability suffered commensurately (Figure 3.5 below). Failure resulted from obsolescence of the firm's products or services arising from two directions: (1) a threat to the industry's core competences; and (2) a threat to the industry's core assets – the resources, knowledge and brand capital that have historically differentiated the firm.

Radical change occurs when an industry's core assets and core activities are both threatened with obsolescence – businesses fail because of disruptive innovations that substitute for their core

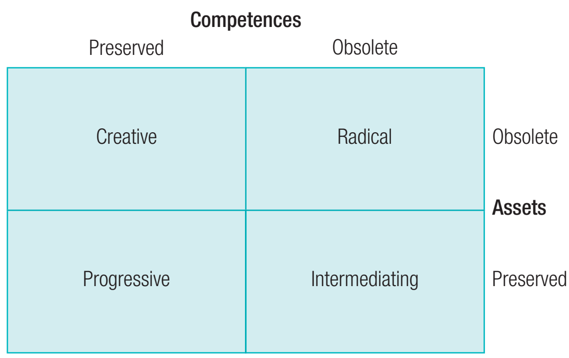

Figure 3.4 Evolution of the Trajectories of Firm Capabilities as Particular Technologies and Competences are Preserved or Grow Obsolete due to Market Forces

products and undermine their business models. The music and network television industries have undergone radical innovation because of the internet-enabled mobility of digital media such as MP3s and DivX files, and emerging competitor technologies such as video games. Under radical change, knowledge and brand capital built up in the industry erode, and so do customer and supplier relationships. During the 1980s and 1990s, roughly 20% of US industries went through some stage of radical change. When neither core assets nor core competences are threatened, the industry's change trajectory is progressive. Since 2000, this has been by far the most common trajectory; about 43% of US industries were changing progressively, including economically significant businesses of long-haul trucking and commercial airlines. In those industries, the basic assets, activities and underlying technologies remained stable. Innovators like Yellow Roadway, Southwest and JetBlue succeeded not because the incumbents' strengths became obsolete but because of a better understanding of how to take advantage of new technologies and squeeze more efficiencies out of their networks.

The other two change trajectories – creative and intermediating – have received less attention. Creative change occurs when core assets depreciate quickly but core competences are stable. Some industries, for example the news media, have always dealt with this scenario. But over the past decade, many new industries face the challenge of rapid asset obsolescence and must continually find ways to restore their assets while protecting ongoing customer and supplier relationships. For example, telephone equipment maker Ericsson saw its competences threatened by competition from consumer electronics firms; it solved this by transferring the most difficult of these, its handsets, to consumer electronics giant Sony, leaving it free to concentrate on the more lucrative operator equipment market. About 6% of all US industries are estimated to be on the creative change trajectory.

Intermediating change occurs when core competences are threatened with obsolescence, while core assets retain the capacity to generate value. For example, in the 1990s, Swiss watch makers watched their sales decline rapidly as consumers became convinced that analogue clocks were considered obsolete. They joined forces with designers from many countries to reinvent the Swiss watch. The result was that they could considerably reduce the pieces and production time of an analogue watch. In fact it was so cheap that if a watch broke it would be cheaper to throw it away and buy a new one than to repair it. They founded the Swiss watch company Swatch, and called graphic designers to redesign a new annual collection. The enormous success of Swatch was fuelled by new competences of clever industrial and graphic design. In the 1980s and 1990s, around 32% of industries went through some form of intermediating change.

Buying Competence at Cisco

Cisco Systems is a name intimately associated with the rise of the WWW throughout the 1990s. It developed a reputation for expanding its capabilities through clever acquisitions. Shortly after going public in 1990, Cisco (the name is an abbreviation of San Francisco and Cisco's logo is a stylized Golden Gate Bridge) went on a buying spree, acquiring 73 firms from 1993 to 2000. By late March 2000, at the height of the dot.com boom, Cisco was the most valuable company in the world, with a market capitalization of more than $US 500 billion.

This had not always been the case. During its first decade after it was founded in 1984 the company acquired no businesses at all, sticking to selling routers and only routers. The market was growing rapidly, and Cisco went public in 1990. But three years later, a faster and cheaper piece of hardware – the switch – threatened its business. Cisco engineers scrambled to produce their own switch, but realized that they could not acquire the capabilities to produce one anytime soon. Thus came their first acquisition in 1993 of Crescendo Communications for $95 million which got them into switches – fast. Cisco's engineers grumbled that they could have produced their own switch in time. But the deal worked. Cisco got into the market ahead of the competition, most of Crescendo's executives stayed with the company, and switches became a core Cisco business. The switching unit today generates nearly $10 billion in annual revenues.

Since then, using acquisitions where it is unable to develop internal capabilities quickly enough to be competitive, acquisitions and partnering with other companies have enabled Cisco to retain its market dominance. Cisco has made inroads into many network equipment markets outside of routing, including Ethernet switching, remote access, branch office routers, ATM networking, security, IP telephony and others.

What began as a one-off response in an emergency soon evolved into a long-term strategy, an essential part of the Cisco culture. While most big tech companies rely heavily on research and development (R&D) to create products and business lines, Cisco, after Crescendo, decided to strategically use acquisition to expand its capabilities: in 1995, Cisco acquired its way into firewalls and cache engines. In 1998, internet telephony. In 2003, with the acquisition of Linksys, a home-networking company, Cisco made its first big move away from corporate customers into the consumer market and in 2006 acquired Scientific Atlanta, a set-top-box manufacturer.

The vast majority of Cisco's acquisitions have been targeted technology buys: small start-ups with 50 or less engineers whose products link back to Cisco's core competencies, routers and switches. If there is a secret to Cisco's success, it is this: Cisco has come to realize that the acquisition of technology really isn't just about technology. 'For us', says Ned Hooper, Vice President of Business Development, whose former company LightSpeed was acquired by Cisco in 1998, 'The people are the most strategic asset'. If, after the acquisition, Cisco loses the technologists and product managers who created, say, the Linksys router, then it has lost the second and third generations of the product that existed only in those employees' heads. That, says Hooper, is where the billion-dollar markets lie. And that is where Cisco's acquisitions are aimed. 'We need the expertise', he says. 'We need the people.'

In the classic mergers and acquisitions world, if you can't measure it, you don't trust it, but that's not how Cisco operates. In addition to balance sheets and business models, Cisco scrutinizes would-be acquisitions' cultures and visions. The group holds meetings with everyone from junior engineers to top execs, observing who speaks and for how long, gauging how open the company is to debate and discussion, and watching how team members treat one another. 'We look for cultures that empower people', says Hooper. Cisco doesn't do hostile takeovers, but it also doesn't want to buy a company whose people will head for the exits. Sometimes, an acquisition is torpedoed because of a simple gut feeling. 'I've had relatively junior people come to me and say, "I don't like the people", and we've walked from the deal. With Cisco, the acquisition is not the end but the beginning. The people we're acquiring have to feel the same way: It's the beginning of the next generation of that company.'

(Source: Morgan, 2009)

Business press has historically focused on radical innovation in industry, where relevance of an industry's established capabilities and resources is diminished by some outside alternative and relationships with buyers and suppliers come under severe attack. In industries being radically transformed, most companies are eventually thrown into crisis. Radical industry evolution is relatively unusual. It normally occurs following the mass introduction of some new technology such as digital cameras in place of film cameras. It can also happen when there are regulatory changes (as in the telecommunications industry of the 1970s) or because of changes in taste (such as the decline in smoking in the developed world).

An industry on a radical change trajectory is entirely transformed – but not overnight. It usually takes decades for change to become clear and play out. The end result is a completely reconfigured and downsized industry. The photographic industry – traditionally a chemical industry – has transformed into a specialized discipline in the consumer electronics/computer industry, with much of the value going to consumers.

News stories often focus on radical change and the innovators that rise to the challenge; but the reality is more prosaic. Intermediating and progressive change dominate the evolution of capabilities in practice. Only a small portion of change in capabilities was 'creative' or 'radical';

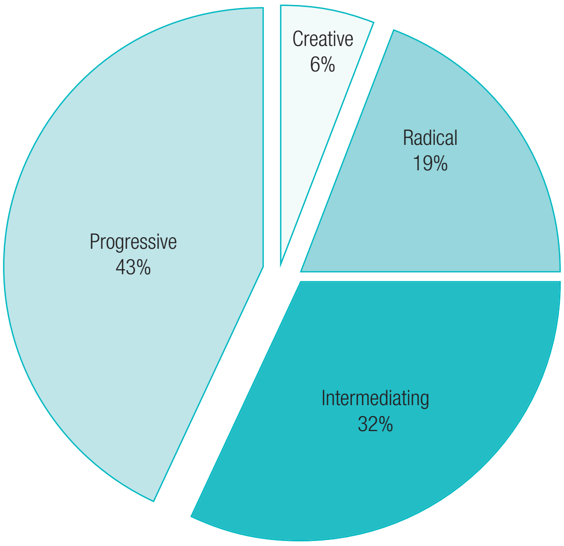

Figure 3.5 The Four Evolutionary Paths of Innovation in a Company's Products

and when such situations arose, there was a high risk of failure. Most firms seemed to be good at steadily updating their plant and equipment and their workforce to meet the challenges of an evolving market.

Storytelling

At heart, business models are stories – stories that explain how enterprises work. A good business model illustrates the intricacies of an enterprise by painting a mental picture. This may be elaborate, or simple and abstract; it may be still life, landscape, portraiture or combinations of several on a single canvas. It should answer fundamental questions about how we make money in this business; what is the underlying economic logic that will attract customers and revenue commensurate with our competences and resource usage.

The Prophet of Post-Industrialism

Sociologist Daniel Bell is best known for three particularly influential books: *The End of Ideology* (1960); *The Cultural Contradictions of Capitalism* (1976); and *The Coming of Post*-Industrial Society (1973). In *The End of Ideology*, Bell argued that the influence of both history and ideology had been subsumed by market forces (foreshadowing the influence of the storytelling of 'pop culture' and 'spin politics') and that genuine political debate would give way to technocratic guidance from social and cultural elites (foreshadowing political decision making guided by the storytelling of consultants, lobbyists and think tanks), substituting consensus for moral discourse. In *The Coming of Post*-Industrial Society, Bell outlined a new kind of society – the post-industrial society, arguing that post-industrialism would be information led and service oriented and would replace the industrial society as the dominant system. The post-industrial society would be marked by a shift from manufacturing to services, the centrality of new science-based industries, the rise of new technical elites and the advent of a new principle of social stratification.

Storytelling used to be simple; in fact until the 1960s a business school education was usually little more than time spent listening to retired executives tell stories (which they called case studies). The first half of the 20th century was dominated by businesses that were easy to understand – you were a retailer, or utility, or bank, or whatever, with straightforward business models and goals unique to each industry. But the growth of services and especially information industries that populate the post-industrial society spawned an ecological explosion of new species of business, often setting up barriers to competition simply due to the complexity of their business models. Globalization and outsourcing flattened competitive environments and shortened life cycles, making business models even more dynamic and varied. Telling a story – at least one which conveys an accurate portrait of the firm's operations and competitive landscape – is no longer simple. It takes technical skill as well as artistry to portray a realistic story of a modern business's value

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proposition. In comparison to good business storytelling today, the stories we told a decade ago come off as stilted, flat and drab as hieroglyphics on an ancient tomb. No wonder this crude storytelling got us into trouble during those heady dot.com days.

The story behind a successful business model represents a better way to create value than existing alternatives. It may offer more value to a discrete group of customers. Or it may completely replace the old way of doing things and become the standard for the next generation of entrepreneurs to beat. It may subtly fine-tune the internal operations of a business to such a degree that competitors find it hard to duplicate, as is the case with Walmart. It may consistently create customer experiences that are so trendy and exciting that competitors find it hard to duplicate, as in the case of Apple, all the while leaving competitors to scratch their heads wondering what exactly is the business model behind this magic.

Numbers Guys

Michael Milken was the undisputed champion of the junk bond, and a ponytailed computer programmer made it all possible. Milken headed the New York-based non-investment-grade bond (junk bond) department when Drexel merged with Burnham and Company in 1973, an operation that earned a remarkable 100% return on investment. By 1976, Milken's income was estimated at $5 million a year, giving him the influence to move his operation to his hometown Los Angeles in swank offices on Beverly Hills' Rodeo Drive.

Dan Bricklin's experiences analysing case studies at Harvard Business School with his primitive Texas Instruments calculator convinced him that there had to be a better way. Working with some of his old MIT professors, he adapted to work on one of the new personal computers, an old table-driven chalk-and-blackboard approach to production scheduling that had been in use since the 1930s. Tests on the Pepsi Cola case study convinced him that he had a winning business analysis tool, which he soon parlayed into a company: Software Arts, selling VisiCalc (Visible Calculator).

If VisiCalc was *the* 'killer application' for the new PC, then Milken certainly must have to be considered the killer applicant.

Michael Milken once commented that Bricklin's invention had single-handedly paved the way for the 1980s corporate megadeals. It certainly did for Milken, who remodelled his Beverly Hills offices in the early 1980s around a large X-shaped desk lined with personal computers loaded with spreadsheet processors. Prior to this time, bond salesmen received all of the analysis for dealing in securities on documents prepared by their New York-based research department. Securities inventories, prices, customers, profit margins, and so forth might at best be updated daily ; more likely weekly or monthly. With PCs, spreadsheets and data on inventories, market prices and customers at their fingertips, bond salesmen were no longer reliant on the static reports of a distant research department. Instantly tying numbers to their telephone narrative, salesmen could buy and sell, restructure deals and process new market information while they were speaking with customers; or across the X-shaped desk when talking with Drexel traders.

Milken's pay-off was a rapid expansion of the use of junk bonds in corporate finance and mergers and acquisitions, which fuelled the 1980s leveraged buyout boom. Drexel went from $1.2 million in fees to over $4 billion in 1986, making it the most profitable firm on Wall Street. A single transaction in 1989 sold $5 billion of high-yield bonds to help finance Kohlberg Kravis Roberts & Co.'s purchase of RJR Nabisco Inc. Because the perceived risk of default made investors skittish, the firms that could find buyers for junk bonds had the power to dictate their own terms to participate in the largest deals. Hostile takeovers often hinged on whether Milken issued a letter saying he was 'highly confident' of being able to provide the financing. With Bricklin's spreadsheet processor, he could usually assure himself of being on the winning side of even the riskiest trades.

At some level, business models, just like stories, are variations on a few archetypes giving voice to universal themes underlying all human experience. Business models are variations on the economics of demand, supply and production motivating all businesses. These in turn are merely reflections of human behaviour. On the one side are stories about the activities associated with making something – designing it, purchasing raw materials, manufacturing – the costs and resource usage narrative. The other side is associated with selling something – finding and reaching customers, transacting a sale, distributing the product or delivering the service – the revenue generation. A new business model's plot may turn on designing a new product for an unmet need; or it may turn on a process innovation. There is one big difference between stories and business models: business models tell investors where they make their money.

Tying Narrative to Numbers

Before PC spreadsheet processors became widespread, business planning usually meant producing a single, base-case forecast. At best, you did a little sensitivity analysis around the projection. The spreadsheet ushered in a much more analytic approach to planning because every major line item could be pulled apart, its components and subcomponents analysed and tested. You could ask what-if questions about the critical assumptions on which your business depended. You could model the behaviour of a business.

This was something new. Before the personal computer changed the nature of business planning, most successful business models were created more by accident than by design and forethought. The business model became clear only after the fact. By enabling companies to tie their marketplace insights much more tightly to the resulting economics – to link their assumptions about how people would behave to the numbers of a pro forma income statement spreadsheets made it possible to model businesses *before* they were launched.

Of course, a spreadsheet is only as good as its underlying assumptions or its model. It is easy to get lazy and assume that the business model or whatever can be modelled on a spreadsheet processor – nothing more or less. But this is an increasingly tenuous assumption as businesses grow more convoluted, complex and intangible. What exactly is Google's business model; or eBay's? Both are profitable companies. Value creation in both business models is driven by social networks and customer experience; try plugging those into a spreadsheet.

Business modelling needs a rich and dynamic language to represent how the entire business system works to generate reliable and meaningful numbers. Models' outcomes, in turn, must be compared to real outcomes as they develop. Success or failure of decisions, strategic initiatives, income and financials provide feedback on whether your model is working. Business modelling is, in this sense, the managerial equivalent of the scientific method – you start with a hypothesis, which you then test in action and revise when necessary.

Coca-Cola finds that Competitors can be Devious

Coca-Cola failed both its story and numbers tests when it concocted a sweeter drink, unofficially dubbed New Coke. New Coke was formulated in response to Pepsi's highly successful 'Pepsi Challenge' advertising campaign which took place in malls, shopping centres and other public locations. A Pepsi representative would set up a table with two unmarked cups, one containing Pepsi and one with (Old) Coke. Shoppers were encouraged to sip both colas, and then select which drink they preferred. Pepsi regularly won the 'Challenge' simply because parched, weary shoppers preferred the sweeter drink. If customers were asked within a minute of comparing drinks, they would usually respond that they preferred the illusion of glucose jolt from sipping the sweeter one. If they had been allowed a few more minutes, controlled laboratory tests revealed that they would complain that the sweeter drink left them queasy, with a bad taste in their mouth. Additionally, some participants

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recalled that Pepsi was served chilled while Coke was at room temperature. But the Coca-Cola Company didn't know that; at least not before it replaced its flagship soda with a sweeter Pepsi-bashing 'New' Coke in 1985.

Public reaction to the change was devastating. New Coke quickly entered the pantheon of major marketing flops. The subsequent reintroduction of Coke's original formula led to a significant gain in sales, with Coca-Cola learning a painful lesson along the way: that it should do its own marketing research in the future rather than relying on the advertising campaigns of its competitors.

When a business model fails, it is because the story doesn't make sense, or the numbers don't make sense. *Stories* fail to make sense when they make unrealistic assertions about technology, production capabilities or consumer behaviour. Rough tests of the story can be made fairly quickly using *consumption chain analysis* and *attribute maps*.

The *numbers test* is more difficult, because of risk inherent in the new on both demand and supply sides. On the demand side, it is likely that whatever is new in an innovation will not be appreciated by customers.

Finding an Innovation's Value Proposition

The context of the business model for an innovation is established by the firm's value proposition that ultimately drives its business model as well as strategy and technology choice.

The value proposition is the business's *raison d'*être – the justification for committing people and resources to the operations. The ecology of the market may allow different business models to find their own niche within the competitive environment. Swatch makes low-cost watches whose styles are updated weekly; Philippe Patek makes expensive watches that the company claims are 'timeless'. Each can be considered different solutions to the generating of retail profit in the consumer watch market. Each demands different technology and strategy to generate value. Yet the direction of influence is the same in both businesses: only once the idea or objective of the business – that is, the *value proposition* – has been articulated can management go about designing the business processes. Once business processes have been settled upon, management can make strategic or technology choices, though sometimes the processes will be selected to take advantage of a firm's particular strategic or technological advantages. The approach is Platonic: the value proposition has a permanency that is wanting in the ephemeral worlds of business processes, strategy and technology.

Value Maps

One of the earliest comprehensive value map methods to enter the business mainstream was a conceptual model of the value transformation in firms that was introduced by Michael Porter in his 1985 book *Competitive Advantage.* Business books were a small market in the 1980s, and Porter's book kick-started a market now worth $1–2 billion annually. Porter's idea derived from the economic intuition of production that every firm is a collection of activities that are performed to design, produce, market, deliver and support its product. All these activities can be mapped using a value map. A firm's value map and the way that it performs value-adding activities reflect its history, its strategy and the underlying economics in its markets.

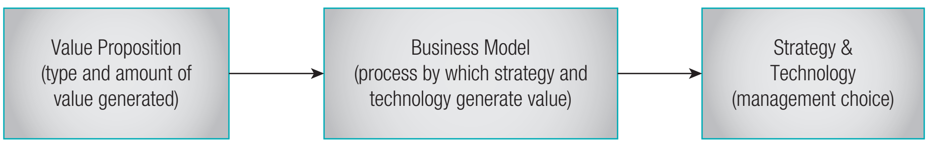

Figure 3.6 The Value Proposition for the Innovation

Thematic Maps

Edmond Halley, patron of Newton, student of magnetism, Latin poet and cartographer, is best remembered today as the 17th-century astronomer who predicted the periodic return of the eponymous Halley's Comet. But his greatest contribution to science was the introduction of the first 'thematic map' – a map that illustrates a set of facts and figures in a geographic format. Halley's map was the culmination of his two-year voyage as captain of the *Paramour* mapping the variations in the magnetic compass from true north. Halley's map ushered in the very modern notion that anything that can be measured – abstract or not – can be mapped.

In Porter's view there were eight sorts of activities in a typical value map. There were four types of primary activities – inbound/outbound logistics, operations, marketing/sales and service; and four types of supporting activities – procurement, R&D, human resources and infrastructure. *Competitive Advantage* was written in the early 1980s; the personal computer had just been introduced, and information technology was limited mainly to back-office accounting systems. The modern pantheon of corporate activities – especially knowledge-intensive ones – has evolved substantially since then. Today's value map must map a rich, complex and inherently knowledge-based set of primary and supporting activities. The rate at which new technology adds competitive niches means that any definition must be open ended; an entirely different environment than the one Porter faced in the 1980s.

The concept of 'mapping' value formation and flows in a business builds on an inherent strength of the human mind – we are better at understanding graphical maps of abstract concepts than we are the concepts themselves. 'One picture is worth a thousand words' goes one incarnation of the advertisement created by Fred R. Barnard for the trade journal *Printers' Ink* (now called *Marketing*/Communications) in 1921, where he suggested that advertisements with images are more effective than those without. Our minds seem to be able to take in more information at a glance with pictures, and here we use that fact to advantage by showing how to depict business models graphically.

1884: The Measurement Crisis in Geographical Mapmaking

During the last two decades of the 19th century, colonialism had caused cartographers to reflect on the shortcomings of their discipline in its ability to generate a world map. By late 1884, less than one-ninth of the land surface of the globe had been surveyed or was being surveyed. This patchwork of surveying had been confounded by a variety of standards of measurement. Each country had gone its own way, developing its own traditions from a chauvinistic perspective.

Without standardization, mapmaking could never provide an unambiguous language. England had a semblance of standards: Henry I decreed that the *yard* was the distance from the tip of his nose to the end of his thumb; the length of a *furlong* (furrow-long) was established by the Tudors as 220 yards, and Elizabeth I declared a *mile* to be eight furlongs (increasing the Roman mile of 5,000 feet to the modern mile of 5,280 feet). France was in much worse shape, having different standards from province to province: the most commonly used measure on maps was the *toise* which equalled six French feet (which were slightly longer than English feet) and was derived from half the width of the main gate of the Louvre. Yet it was ultimately the French Academy of Sciences that developed the 'metric' standard (from the Greek *metron* = 'a measure') that prevailed: a *metre* was one ten-millionth the meridian distance between the pole and the equator; a *gram* was the mass of a cubic centimetre of water; a *litre* was the volume of a cubic decimetre. The immediate effect of the metric system on mapmaking was to introduce a simple, universal language for expressing map *scale*. In October 1884 the US government invited 25 nations to the first International Meridian Conference, in which France and England agreed that the prime meridian would run through the Observatory at Greenwich, England, in exchange for the British adopting France's metric system. Only then did mapmaking embrace a universal and unambiguous standard of measurements necessary for mapping the world.

Mapping the interaction between the details of transactions, cost and revenues in a single transaction flow can actually be quite complex; but it is also at the core of many successful models of innovation. Thus any useful value mapping needs to be able to incorporate methods of capturing this added complexity to allow for (1) creation of independent models of *value* as well as *volume* of transactions modelling (2) incorporate specific *strategy and technology models*, i.e. the explicit or implicit models underlying management's strategic choice and the consequent future value creation, and (3) incorporate *growth models* implicit in the life cycle of the technology underlying the business model.

More importantly, particular management strategies may tend to affect one component differently from the other. Let's assume that management is assessing the merits (i.e. impact on future value flows) of a high-volume/low-margin product (think Saturn automobile) or of a low-volume/high-margin product (think Ferrari). The first strategy raises *volume* while lowering *unit value*; the second strategy raises *unit value* while lowering *volume*. If only value is considered, and not its components, the two might well be seen as equivalent. But if instead we think in terms of volume and value *components*, the comparative impact of different strategies on potential losses, risk and error become explicit.

Minnesota Mining and Manufacturing's Quest for a Viable Value Map

Minnesota Mining and Manufacturing (3M) began life in 1904 as a failure – two years of mining for gem-grade rubies and sapphires had yielded only common corundum. 3M's owners spent that winter pondering just what to do with their investment before finally moving into the decidedly less glamorous grit-and-sandpaper business (one of the few uses for common corundum). For the next decade, 3M struggled with low margins, excess inventory and cash flow crises. In 1914 it promoted William McKnight, an accountant-turned-sales manager still in his 20s, to general manager. One of McKnight's first investments was in buying a sink and glue bath for a small storage room, thereby turning it into 3M's 'laboratory'. Steady experimentation yielded its first success in a cloth abrasive named 'Three-M-Ite' (which remained in 3M's product catalogue for the next 75 years). This and other successes developed in McKnight (and 3M as well) an unrelenting curiosity and drive for progress through innovation that has become the hallmark of the company today, but back then was a determined, one could say desperate, drive to keep the company in business. McKnight, knowing that he would one day step down, sought to design an organization that would continually evolve and innovate. Among quotes attributed to McKnight are:

> 'Listen to anyone with an original idea, no matter how absurd it might sound at first.'
>
> 'Encourage; don't nitpick. Let people run with an idea.'
>
> 'Hire good people, and leave them alone.'
>
> 'If you put fences around people, you get sheep. Give people the room they need.'
>
> 'Encourage experimental doodling.'

(Source: Adapted from Collins & Porras, 2005)

Internet Business Models

The commercialization of the internet with the introduction of the dot.com domain in 1991, and the development of the WWW for transmission of multimedia (an idea broached by Tim Berners-Lee and others in 1993) opened several new venues for business. There was a great deal of experimentation directly after the WWW arrived, the survivors of these experiments pointing the way towards business models that were viable using the new medium. By the end of the 1990s, most of the internet business models used today had been introduced in one form or another.

Online catalogues (originally called internet shopping malls) were the first internet business models to gain widespread attention; they are also the simplest to implement. These basically post the information in traditional mail-order

Model	Value Proposition(s)	Key Competences	Problems	Examples
• ***Online Catalogue***	(1) Disintermediation	Large searchable catalogue that is several orders of magnitude larger than 'bricks and mortar' competitors	(1) High search costs (2) Low consumer engagement and information overload	• Geeks.com
• ***e-Tailer***	(1) Customer management (2) Inventory selection and control tightly linked to customer demand	(1) Sophisticated customer relationship management (2) Sophisticated demand forecasting, and translation to inventory control and marketing	(1) Order fulfilment is difficult, with inherent high levels of split shipments and long hauls resulting in inefficiencies compared to 'bricks and mortar' retailers	• Amazon
• ***Exchange***	(1) Best price discovery (2) Liquidity (3) Clearing and insurance	• Ability to match massive transaction volumes of bids and offers in real time	• Prone to fraud in price discovery and order fulfilment	• eBay
• ***Value Chain Integrator***	(1) Vendor management that is extremely efficient and tightly linked to customer demand (2) Customer demand is managed for complex products	(1) Efficient supply-chain management (2) Vendor management (3) Customer relationship management (often internet-centric) (4) Brand management applied to outsourced products	(1) Managerially complex (2) May be difficult to enforce vendor relationships without having a significant proportion of the consumer market	• Cisco, Dell
• ***Open-Source Alliance***	(1) 'Organic' contribution of producer services to the achievement of a common goal (often a product) (2) Producers are the consumers, ensuring a large market for whatever is produced (3) Reputation building for the contributors (4) Control over the design of the product for prosumers	(1) Strong sense of community purpose (2) Efficient communications system for complex problems (internet-centric)	• The business model is hard to rationalize in the context of traditional 'for-profit' business	• Apache, Linux, Wikipedia
• ***Distributive Network Infrastructure***	(1) Network effects (2) Search, access and communication services to users	(1) Large up-front sunk costs (2) Efficient operation of network	• High barriers to entry because of high expense and entrenched competitors	• AT&T
• ***Social Network Platform***	(1) Emergent new 'knowledge' from bringing together diverse and complementary data streams (2) Costless generation of customer knowledge (3) 'Viral' propagation of information, views and advertising	(1) Management of databases updated from many disparate sources.	• Data management requires sophisticated programming and highly scalable servers and storage	• Facebook, MySpace, Google, eBay, Amazon

Figure 3.7 Internet Business Models

catalogues to web pages, adding some provision for completing the purchase online, such as a shopping cart and checkout. Online catalogues derive their value from 'disintermediation' – providing low-cost substitutes for traditional channel intermediaries (middlemen).

The best of the online catalogue sites evolved into 'electronic retailers,' or e-tailers. As they evolved, e-tailers became value-adding intermediaries between producers and customers, taking responsibility for value selection and fulfilment, pricing and market segmentation. The major value proposition of this model is the vast reduction in inventory carrying costs, since, in theory, e-tailers can often simply take an order, and let someone else fulfil that order by shipping the inventory. Even payments processing may be outsourced to a bank. The primary value provided by an e-tailer is customer management that is translated into much more efficient inventory selection and display than can be achieved by 'bricks and mortar' retailers.

An ***exchange*** facilitates the trading of information, goods and services between buyers and sellers. Prices are 'discovered' through real time, on-the-spot negotiations, whether through one-to-one haggling or through multi-party auctions and exchanges. Exchanges offer three value propositions:

1. Best price discovery: the potential for finding the 'best price' for which a good can trade, for both the buyer and seller.
2. Liquidity: the ability to trade as quickly (up to real-time trading) or as slowly (generally not more than 10 days' limit for auction length) as sellers wish, while ensuring best price discovery.
3. Clearing and insurance: assurance that goods will be delivered and payments completed. In securities markets, this is accomplished by limiting trade in the market to select groups that are required to put up capital to ensure payments are made.

The ***value chain integrator*** manages a large number of separately owned businesses to create the cost savings and purchasing power of a traditional vertically integrated industrial firm, but with the scalability, flexibility and speed of response to new market challenges that are the hallmark of much smaller firms. It offers two value propositions: customer relationship management and vendor management, both of which can achieve economies of scale unavailable to competitors.

Open-source alliances, often which are not-for-profit, are perhaps the most puzzling of internet-enabled business models because of the difficulty in articulating the model's value proposition (which varies with the business) and its revenue stream (which need not exist at all). In an open-source alliance, a large number of companies or individuals embrace a common mission, with no single entity exerting complete control over the group. Open-source alliances offer four value propositions:

1. Reputation building for the contributors.
2. Market size is assured because the producers will be the consumers.
3. 'Organic' contribution of producer services to the achievement of a common goal (often a product). Customization of a complex product for the price of a small contribution (the customized services or code).
4. Control (at the margin) over design of the product. Because the producers are the consumers, their contributions determine their own satisfaction.

Distributive network infrastructure businesses are not really new, but have grown in sophistication and variety with the rise in use of the internet. Railways, electric power and canals in the past were network infrastructure industries that facilitated transport between a huge and variable set of geographical locations. The term 'internet' arose in describing it as a 'network of networks.' The ability of independent companies to add to the internet (often telephone and cable TV firms) extends the geographical reach of the internet to places not previously available. It also increases the bandwidth, which has allowed the internet to become an alternative to telephones (e.g., via Skype) or television (e.g. via YouTube). Such models offer two value propositions:

1. Network effects: economies of production scale as the network size grows.

2. Search, access and communication for people, data and services as the network size grows.

Social network platforms provide a data-centric platform where stakeholder interactions generate content that is actively distributed, managed and analysed by the business. The key competence in social network platforms applications is the management of databases updated from many disparate sources. Its most compelling applications are in creating dynamic social networks like Facebook and Wikipedia.

Innovation Workout

Morphological Boxes

The morphological research method – or more simply the graphical perspective that we call *morphological boxes* – is an orderly way of making complex decisions involving large numbers of features and business model components. Its aim is to achieve a schematic of all of the possible solutions of a given large-scale programme. This innovation workout draws on the brainchild of Fritz Zwicky, a former professor of astrophysics at Caltech. In 1933, Zwicky employed the morphological method to discern that a 'considerable fraction of the mass had been missed' in measuring the velocities of certain galaxies – this was the first known observation of the 'missing mass' of the universe – what later became known as 'dark matter'.

Morphological boxes offer a way to combine the parameters of a challenge into new ideas (parameter here meaning characteristic, factor, variable or aspect). You choose the number and nature of the parameters with an objective of selecting the combination that best represents your product or market description – e.g. young, edgy, conservative, iconoclastic, and so forth. Here is the blueprint.

Blueprint Specify your challenge.

Select the parameters of your challenge. To determine whether a parameter is important enough to add, ask yourself, 'Would the challenge still exist without the parameter I'm considering adding to the box?'

List variations. Below each parameter, list as many variations as you wish for that parameter. The number of parameters and variations will determine the box's complexity. Generally, it is easier to find new ideas within a simple framework than a complex one. For instance, a box with 10 parameters, each of which has 10 variations, produces 10 billion potential combinations.

Try different combinations. When the box is finished, make random runs through the parameters and variations, selecting one or more from each column and then combining them into entirely new forms. You can examine all of the combinations in the box to see how they affect your challenge. If you are working with a box that contains 10 or more parameters, you may find it helpful to randomly examine the entire box, and then gradually restrict yourself to portions that appear particularly fruitful. It's like hunting for stars in a box.

Let's look at an example involving the choice of an innovation in video gaming consoles.

Situation: I'm a marketing director for a video gaming company, and the company needs a new design for the next generation of gaming consoles. My challenge is: 'In what ways might I create a cost-effective new design for our console?'

Description: I analyse video game consoles and list their basic features. I decide to work with five features – the packaging, console casing material, electronics, supported video screens and methods of connecting the console to the video screen. I plan to use five potential options for each feature. Note that this is a simplification from real-world decisions of this sort, which may involve hundreds of features and a widely varying number of options for each feature.

Morphological box: I construct my box with the features in the columns and options in the rows.

Design search: The next step is to choose one or more options (one from each column) and connect them to create new product designs. These combinations may trigger new ideas or potential solutions, or additional features and options that should be included in the analysis.

Package	Console Casing	Electronics	Screen	Connectivity
Recycled Paper	Cheap Plastic	Basic	NTSC TV	Wired
Coloured Plastic	Hard Plastic	+Vibration	PAL/multi	Infrared
Cloth Case	Lexan	+Motion Sensor	1024×768	Wi-Fi
Hard Shell	Brushed Metal	+Television	1280×1024	+Internet
Metal with Velvet Cushion	Two-Tone Clamshell	+Body Suit	1080i (i.e., 1920 ×1080/2 interlaced)	+Other Consoles

Figure 3.8 Morphological Box for Video Game Console Design

Package	Console Casing	Electronics	Screen	Connectivity
Recycled Paper	Cheap Plastic	Basic	NTSC TV	Wired
Coloured Plastic	Hard Plastic	+Vibration	PAL/multi	Infrared
Cloth Case	Lexan	+Motion Sensor	1024×768	Wi-Fi
Hard Shell	Brushed Metal	+Television	1280×1024	+Internet
Metal with Velvet Cushion	Two-Tone Clamshell	+Body Suit	1080i (i.e., 1920 × 1080 / 2 interlaced)	+Other Consoles

Figure 3.9 A Particular Video Game Console Design

Cost-effective designs: The morphological box methodology is very useful in designing for maximum profitability – an objective that is important to managers and investors alike. This requires some additional inputs in the form of the marginal revenue (i.e. demand price or willingness to pay for an additional unit) and marginal cost of each additional unit. Marginal revenue can be gleaned from market research as well as the insights that salespeople and marketing staff can bring to the design. Marginal costs are the purview of the procurement, operations and production people. Obtaining these may be straightforward, in the case of extracting them from price lists of vendors; or may involve a more involved review of cost accounting data from manufacturing.

In the current example, five features each with five options generate a possible 3,125 different design combinations (not all of which may make sense to customers). Let's assume that we are designing to maximize the profitability of the product line, and that we have compiled the

Furthermore, as is increasingly popular with the wealth of market data available from online marketing services such as Amazon, Alibaba, Facebook and Google, we could analyse our sales and project a specific total demand (the demand curve, or graph of price × volume) for this particular gaming product. Let's assume that this curve is estimated to be:

$$\textit{Volume (units)} = (\$700 - \textit{Sales Price}) \times 10{,}000$$

The profit-maximizing design given this demand curve selects the following options for each feature (for a total projected sales volume of 4,700,000 units):

Clearly the choices and calculations for designing to particular objectives can become complex, especially when there are hundreds or thousands of features in the product, such as one

	Package			Console Casing			Electronics			Screen			Connectivity		
	Type	**W-to-P**	**Cost**	**Material**	**W-to-P**	**Cost**	**Features**	**W-to-P**	**Cost**	**Resolution**	**W-to-P**	**Cost**	**TV and Internet**	**W-to-P**	**Cost**
1	Recycled Paper	3	1	Cheap Plastic	3	1	Basic	0	15	NTSC TV	30	10	Wired	10	1
2	Coloured Plastic	12	1.5	Hard Plastic	7	2	+Vibration	3	25	PAL/multi	40	10	Infrared	25	5
3	Cloth Case	24	3	Lexan	12	6	+Motion Sensor	16	40	1024×768	40	40	Wi-Fi	30	25
4	Hard Shell	45	15	Brushed Metal	35	12	+Television	35	160	1280×1024	40	60	+Internet	45	30
5	Metal with Velvet Cushion	50	34	Two-Tone Clamshell	120	24	+Body Suit	120	600	1080i (i.e., 1920×1080 / 2 interlaced)	45	100	+Other Consoles	60	30

Figure 3.10 Morphological Box with Willingness-to-Pay and Cost Data for Video Game Console Design

might have to address in designing and automobile. Fortunately the structure of morphological boxes lends itself to computerization, where complex problems can quickly be solved using off-the-shelf programs. Fitting your challenge in a set of morphological boxes simplifies and condenses a complex problem, making possible informed decisions on very complex problems. Like our universe, every innovation has a mass of opportunities and permutations that limited human attention and information processing find impossible to fathom during the design and planning phases. The myriad of unrealized opportunities and designs possible for restructuring the business represent the 'dark matter' of any innovation. Firms that fail to explore this unseen mass of opportunities may very well be surprised when they show up in a competitor's product – or worse, in the angry reviews of disgruntled customers.

Option	Sales Price	Profit per unit
Hard shell package	45	30
Two-tone clamshell console casing	120	96
Basic electronics	0	–15
PAL/multi screen	40	30
Infrared connectivity	25	20
Total	***230***	***161***

Figure 3.11 Profit-Maximizing Design of a Video Game Console Design

Case Study: Mad Catz Interactive, Inc.

In 1987 a small group of engineers saw the 40% annual growth of the global video gaming industry as a unique opportunity to invest in what they predicted was destined to become the world's premier entertainment industry. By 1989 they had founded Mad Catz, with production facilities in Shenzhen, China, managed from their Hong Kong office, with design and marketing located in Southern California which brought them closer to their target gaming audience. For several years, Mad Catz operations revolved around a half dozen employees, generating after-market peripherals and accessories with innovative stylistic twists for Nintendo, Sony, Sega Dreamcast and Xbox game consoles.

By the late 1990s Mad Catz had grown to over 100 employees making controllers and other video game accessories under the Mad Catz and GameShark brand names, and selling through about 12,000 retailers globally. Sales in the US account for more than 80% of sales, with much of that accounted for by sales at Toys ‘R’ Us, where Mad Catz also OEMed[1] their ‘TRU High Frequency’ store brand of video game accessories. Toys ‘R’ Us was impressed enough with the quality and innovativeness of Mad Catz’ controllers that in 1997 Mad Catz was its Vendor of the Year (receiving, for their efforts, an effigy of the Toys ‘R’ Us mascot, Geoffrey the giraffe).

Total industry revenue for game console after market was about 400 million in 2006 with Mad Catz accounting for about one-quarter of the market; three competitors made up the remainder – Take Two Interactive with around 20%; privately held NYKO Technologies with 50%; and privately held Bigben Interactive at 5%. Competition was intense, and all of the companies were losing money in 2006. One of Mad Catz’ priorities was to revise their business model in a fashion that would ultimately assure profitability.

Mad Catz Value Map (Figure 3.12) consists of three relatively independent phases that add to value in the final game controller product – the electronics, the plastic casing with buttons and joysticks, and the packaging. Mad Catz visualizes these in terms of their demands on planning (i.e. their lead time), the degree of influence on the customer’s purchase decision (i.e. value added in terms of willingness to pay and impulse to buy), and the cost contributed to production, including allocation of fixed and discretionary costs.

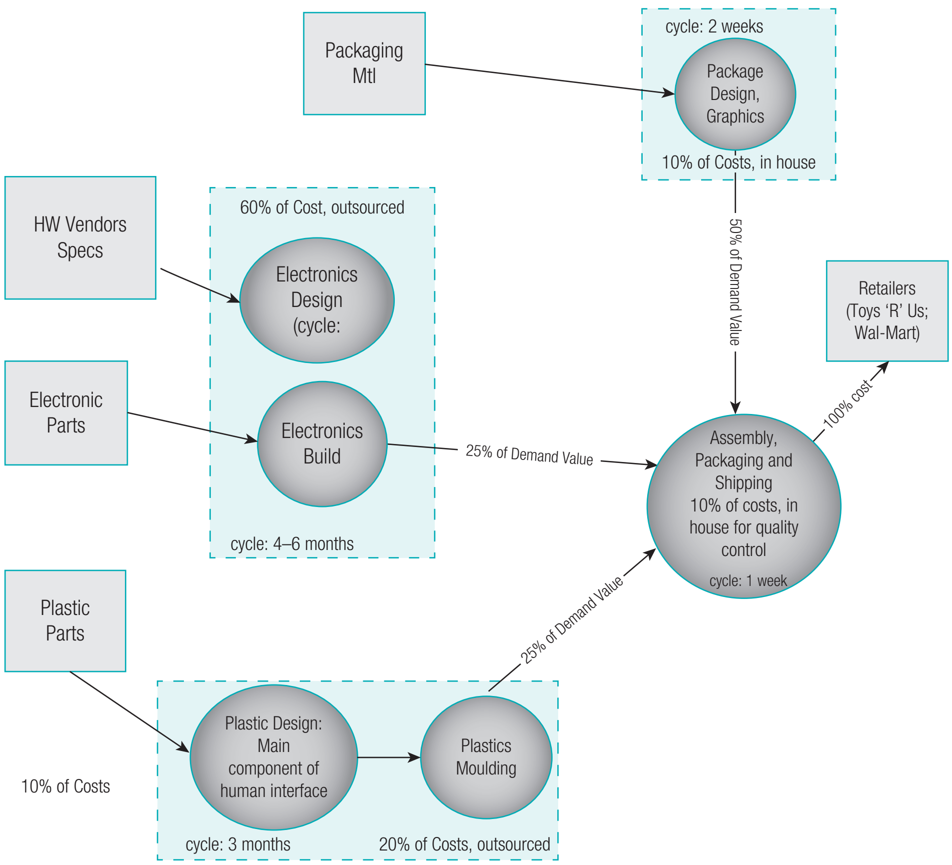

Figure 3.12 Mad Catz’ Value Map

	Value Added	Cost Added	Lead Time
Electronics	• 0–20%	• 60%	• 4–6 months
• Case	• 30–40%	• 20%	• 3 months
• Packaging	• 40–70%	• 10%	• 2 weeks

Figure 3.13 Value and Cost Generated by Game Controller Components

A glance at Figure 3.13 might convince you that there is little justice in business, since cost and value generation by component are inversely correlated. The most expensive component of Mad Catz' controllers, the electronic assembly, has the least influence on the buying decision of customers; the least expensive component, the packaging around the controller, has the greatest influence, being a big motivator of impulse buying.

This can be best understood in the context of the feature map (Chapter 2).

Game controllers are 'experience goods' – you need to use them before you really know whether you like them, even where gamers may have strong preconceptions about what they are buying. Electronics are a basic feature of controllers – love 'em or hate 'em. The plastic cases, with their unique location, look and feel of buttons, joysticks and the way they fit in the hand are differentiators, and if well (or poorly) received by the gaming community may even be exciters. Packaging, though, is the first thing a consumer sees, and in most cases is the only thing she or he is able to 'experience' prior to purchasing. For relatively inexpensive controllers such as Mad Catz', the packaging is the 'deal closer'.

Repeat purchases are different. After gamers have had a chance to use the controllers for a few days, they are likely to form a strong opinion about the *case* of the controller – either they are excited or enraged. You can't please everyone, and every controller will attract some of each type of opinion. In the short run (i.e. before the original purchase) the *energizing features* are those of the package – often the art on the box the controller comes in. In the longer run (i.e. before a repurchase of the Mad Catz brand controllers) the case will become the *energizer.* Electronics, on the other hand, are often outsourced, and Mad Catz electronics may end up being the same as those used by their competitors. Electronics are neither differentiators or energizers; because they are expensive, they are the ante that firms must pay up-front to get into the game.

Package and case features are entirely directed towards manipulating the *human interface* – visually, tactilely and psychologically. Advances in plastics moulding and digital photography have greatly expanded the options available for manipulating that interface

	Basic	Differentiator	Exciter
+	• Electronics	• Case	• Packaging, Case
• –	• Electronics	• Case	• Packaging, Case
• 0	• Electronics	• Case	

Figure 3.14 Feature Map of Game Controller

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through package and case design. The great challenge is how to choose the right mix of components to satisfy a given market. The solution to this problem is addressed in the Innovation Workout in this chapter.

Finding out what a market wants from a controller, on the other hand, may yield to more direct solutions. It will lie in the particular games users want to play with the controller. Grand Theft Auto gamers might describe their ideal controller as 'edgy and violent' while Dance Revolution fans might go for 'glitter'; Madden NFL players might go for home team logos, while those interested in fantasy games would opt for a mystical 'amazons and lizards' look-and-feel.

Where innovative minds may really meet their challenge is in designing controllers for entirely new markets. By 2007, broadcast TV audiences had rapidly dwindled and moviegoing had stagnated, replaced by internet-enabled gaming which emerged as the new pillar of the media world. The demand for controllers for games such as Second Life and World of Warcraft declined, as users by default settled on the clumsy riches of the computer mouse and keyboard. With new game consoles and new computer-based games continually entering the market, Mad Catz has ample latitude to innovate in the coming years.

Question for the Mad Catz Case Study

Given the split of costs in the Mad Catz business model, see how many different products you can 'invent' in your mind that are amenable to Mad Catz business model. Can you think of any that are not in the gaming industry?

Chapter 3: Key Points

1. Core capabilities consume your resources; innovations are responsible for generating future resources to support the acquisition of future capabilities. Because of this strategy, companies must keep a resource-based perspective.
2. Business modelling is the managerial equivalent of the scientific method.
3. Business models supporting an innovation are composed of (1) a story, and (2) financial analysis tied to the story components.
4. Stories behind successful business models have been getting progressively complex:
   - as technology evolves and offers more distinct types of opportunities;
   - as competition becomes more intense; and
   - as competitors get better at innovation.
5. Business models, like fictional stories, are variations on a few archetypes giving voice to universal themes underlying all human experience.
6. Complexity in today's business models requires an innovative response to providing financial support for the story supporting a new innovation.
7. Value propositions motivate the entire business model:
   - They are the first choice that needs to be made in commercializing an innovation.
   - There may be separate value propositions for each customer group for an invention.
8. Value maps graphically depict the core and supporting (inductive) processes of a business, value flows describe how their value is generated.
9. The environment box describes the outside parties (customers, vendors, competitors, etc.) with whom the firm needs to interact.
10. The fundamental unit of value is the transaction, which is a packet that carries costs, revenues and unit quantities.

Note

[1] Original Equipment Manufacturer (OEM) is used to describe companies that manufacture (and often design, too) products that are sold under a different company's brand name (e.g. Toys 'R' Us). The term is so widely used that it is common to hear it used as both noun and verb.

Further Reading

Amit, R. and Zott, C. (2001). Entrepreneurial Strategies for Wealth Creation. *Strategic Management Journal*, 22, 493–520.

Amit, R. and Zott, C. (2015). Crafting business architecture: The antecedents of business model design. *Strategic Entrepreneurship Journal* 9(4), 331–350.

Aral, S., Brynjolfsson, E. & Wu, L. (2012). Three-way complementarities: Performance pay, human resource analytics, and information technology. *Management Science* 58(5), 913–931.

Barnard, Fred R. (1921). One look is worth a thousand words. *Printers' Ink*, p. 96.

Barney, B. (2001). Is the resource-based 'view' a useful perspective for strategic management research? Yes. *Academy of Management Review* 26, 41–57.

Baumol, William, (2002). *The Free Market Innovation Machine*. Princeton, N.J.: Princeton University Press.

Bell, D. (1960). *The End of Ideology* (Vol. 3). New York: Free Press.

Bell, D. (1973). *The Coming of Post*-Industrial Society. Basic Books.

Bell, D. (1976, May). The coming of the post-industrial society. *The Educational Forum* 40(4), 574–579.

Bell, D. (1976). *The Cultural Contradictions of Capitalism*. Basic Books.

Bonczek, R. H., Holsapple, C. W. and Whinston, A. B. (2014). *Foundations of Decision Support Systems*. Academic Press.

Bowman E. H. and Helfat, C. E. (2001). Does corporate strategy matter? *Strategic Management Journal* 22, 1–23.

Brynjolfsson, E. and McAfee, A. (2012). *Race Against the Machine: How the Digital Revolution is Accelerating Innovation, Driving Productivity, and Irreversibly Transforming Employment and the Economy*. Amazon digital media.

Brynjolfsson, E. and McAfee, A. (2014). *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*. WW Norton & Company.

Brynjolfsson, E., Renshaw, A. and Van Alstyne, M. (2012). The matrix of change. *Sloan Management Review* (Winter 1997), 38(2), 37–54.

Burtch, G., Ghose, A. and Wattal, S. (2015). The hidden cost of accommodating crowdfunder privacy preferences: A randomized field experiment. *Management Science* 61(5), 949–962.

Chandler, A. D. (1962). *Strategy and Structure: Chapters in the History of the Industrial Enterprise*. Cambridge, MA: The MIT Press.

Christensen, C. M. and Bower, J. L. (1996). Customer power, strategic investment and failure of leading firms. *Strategic Management Journal* 17, 197–218.

Cohen, W. M. and Levinthal, D. A. (1989). Innovation and learning: The two faces of R&D. *The Economic Journal* 99, 569–596.

Collins, J. C. (2001). *Good to Great: Why Some Companies Make the Leap… and Others Don't*. Random House.

Collins, J. C. and Porras, J. I. (2005). *Built to Last: Successful Habits of Visionary Companies*. Random House.

Drucker, P. F. (1964). Controls, control and management, in *Management Controls: New Directions in Basic Research*. New York, McGraw-Hill, 286–296.

Drucker, P. F. (1993). *Managing for the Future*. Routledge.

Drucker, P. F. (1994). The Theory of Strategy. *Harvard Business Review* September–October, 95–105.

Drucker, P. F. (1999). *Managing for Results: Economic Tasks and Risk*-taking Decisions. Routledge.

Dyer, J. H. and Nobeoka, K. (2000). Creating and managing a high performance knowledge-sharing network: The Toyota Case. *Strategic Management Journal* 21, 345–367.

Eisenmann, T. R. (2002). *Internet Business Models and Strategies: Text and Cases*. New York: McGraw-Hill.

Freeman, C. and Soete, L. (1997). *The Economics of Industrial Innovation*, 3rd edition. The MIT Press.

Galbraith, J. R. (1982). Designing the innovating organization. *Organizational Dynamics* 10, 5–25.

Ghose, A., and Yao, Y. (2011). Using transaction prices to re-examine price dispersion in electronic markets. *Information Systems Research* 22(2), 269–288.

Gillon, K., Brynjolfsson, E., Mithas, S., Griffin, J. and Gupta, M. (2012). Business Analytics: Radical Shift or Incremental Change? In 33rd International Conference on Information Systems (ICIS 2012), Orlando, Florida.

Gordijn, J., Osterwalder, A. and Pigneur, Y. (2005). Comparing two business model ontologies for designing e-business models and value constellations. *BLED 2005 Proceedings*, 15.

Grant, R. M. (2002). *Contemporary Strategy Analysis: Concepts, Techniques, Applications*. Oxford, U.K.: Blackwell.

Griffiths, T. L. and Tenenbaum, J. B. (2006). Optimal predictions in everyday cognition. *Psychological Science* 45, 56–63.

Grover, R, Palmeri, C. and Elstrom, P. (2002, 25 March). Qwest: The issues go beyond accounting. *Business Week*, 66–68.

Gulati, R., Nohria, N. and Zaheer, A. (2000). Strategic networks. *Strategic Management Journal* 21, 203–215.

Hammer, M. and Champy, J. (1993). *Reengineering the Corporation. A Manifesto for Business Revolution*. New York: HarperBusiness.

Hill, C. W. L. and Jones, G. R. (1995). *Strategic Management: An Integrated Approach*. Boston: Houghton Mifflin.

Hitt, M. A., Ireland, R. D., Camp, S. M. and Sexton, D. L. (2001). Strategic entrepreneurship: Entrepreneurial strategies for wealth creation. *Strategic Management Journal* 22(6–7), 479–491.

Howell J. M. and Higgins, C. A. (1990). Champions of technological innovation. *Administrative Science Quarterly* 35, 317–341.

Huang, Y., Singh, P. V. and Ghose, A. (2015). A structural model of employee behavioral dynamics in enterprise social media. *Management Science* 61(12), 2825–2844.

Iansiti, M. (1993). Real-world R&D, jumping the product generation gap. *Harvard Business Review* May–June, 138–147.

MacCrory, F., Westerman, G., Alhammadi, Y. and Brynjolfsson, E. (2014). Racing with and against the machine: Changes in occupational skill composition in an era of rapid technological advance. In 35th International Conference on Information Systems (ICIS 2014): Building a Better World through Information Systems, Auckland, New Zealand.

Magretta, Joan (2002). *What Management Is: How It Works, and Why It's Everyone's Business*. Free Press.

Morgan, Timothy Prickett (2009, 9 July) Cisco taps chief strategy officer Mergers and acquisitions man, *The Register*, www.theregister.co.uk/2009/07/09/cisco_appoints_cso/, accessed 2 July 2016.

Osterwalder, A. and Pigneur, Y. (2010). *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*. John Wiley & Sons.

Osterwalder, A. and Pigneur, Y. (2013). Designing business models and similar strategic objects: the contribution of IS. *Journal of the Association for Information Systems* 14(5), 237–244.

Pagès, H. (1999). A note on the Gordon growth model with nonstationary dividend growth. *Bank for International Settlements Working Paper* No. 75, Basel Switzerland.

Porter, M. E. (1985) *Competitive Advantage*. New York: Free Press.

Porter, M. E. (2011). *Competitive Advantage of Nations: Creating and Sustaining Superior Performance*. Simon and Schuster.

Priem, R. and Butler, J. E. (2001). Is the resource-based 'view' a useful perspective for strategic management research? *Academy of Management Review* 26, 22–41.

Raphael, A. and Zott, C. (2001). Value creation in e-business. *Strategic Management Journal*, 22(6/7), 493.

Tambe, P., Hitt, L. M. and Brynjolfsson, E. (2012). The extroverted firm: How external information practices affect innovation and productivity. *Management Science* 58(5), 843–859.

Tapscott, D. (2008). *Grown Up Digital: How the Net Generation is Changing Your World*, 1st Edition. New York: McGraw-Hill Education.

Tapscott, D. (2014). *The Digital Economy: Rethinking Promise and Peril in the Age of Networked Intelligence*. New York: McGraw-Hill Education.

Williamson, O. (1975). *Markets and Hierarchies*. New York: Free Press.

Zott, C. and Amit, R. (2015). Business model innovation: Toward a process perspective, in C. Shalley, M. Hitt and J. Zhou, *The Oxford Handbook of Creativity, Innovation, and Entrepreneurship* (pp. 395–406). Oxford: OUP.

CHAPTER 4

Service Innovations

Learning Objectives

After finishing this chapter, you will

- Understand that the same concepts and features that are used to analyse product innovations can be applied to service innovations.
- Understand service innovations in a variety of fields using the innovation components presented in the last chapter.
- Understand how service innovations are developed and sold.
- Understand how service innovations in logistics and supply-chain management influence the success of other innovations through more efficient channel activities.

After doing the *Innovation Workout*, you will see some of the unanticipated problems that arise because of the dynamics of service operations, and the additional dimension of features that need to be considered in service innovation.

After reading the Amazon *case study*, you will be able to understand the importance of adaptive execution of strategies over the life of the business model.

Service Innovation

Slick, user-friendly products usually come to mind when consumers and corporations think of innovation. But leading companies, innovation consultants and academic researchers have expanded their definition of innovation beyond products to services. The initial impetus for the shift was the service nature of many of the dot. coms in the late 1990s. Services are steadily eclipsing products as the main venue for innovation as we evolve into a service economy, and products are increasingly used as platforms for delivering services (Freeman, 1982; Gross et al., 1995; Griffiths & Tenenbaum, 2006).

Services are processes that in some way or another solve a customer's problem, perform an activity that the customer cannot do him- or herself, or benefit the customer in some other intangible way. Services are often personally tailored to a customer's needs, and often demand face-time – face-to-face interaction with the customer and substantial exchange of information between customer and server. The sort of contract, relationship, mission or circumstances under which it is conducted will heavily influence the nature of work involved in providing a service. We can differentiate between:

- *Business-to-consumer* services such as financial services, retailing and leisure services
- *Business-to-business* services such as consulting, office equipment support and communications
- *Internal* services, such as information technology, accounting and human resources
- *Public* services such as police, education and health services
- *Not-for-profit* services such as churches and charities.

Whereas up to this point we have strategized mainly in terms of innovative products that incidentally require that we tailor some production, sales and support processes to make the innovation a success, in service industries we are interested in innovative activities that may incidentally require a product for success (e.g. a doctor providing vaccination will need the vaccine), but where strategy, implementation and success are all about the conduct of the activity.

The numbers of US workers involved in services has dramatically risen over the past century; Figure 4.1 depicts US employment in four categories: (1) *innovative services* which involve the regular creation of new information such as patents, research papers, legal reports and so forth; (2) *industrial* work, which involves the regular output of goods; (3) *service* work, typically meaning customer-facing services such as retailing, telemarketing and so forth; and (4) *agriculture*.

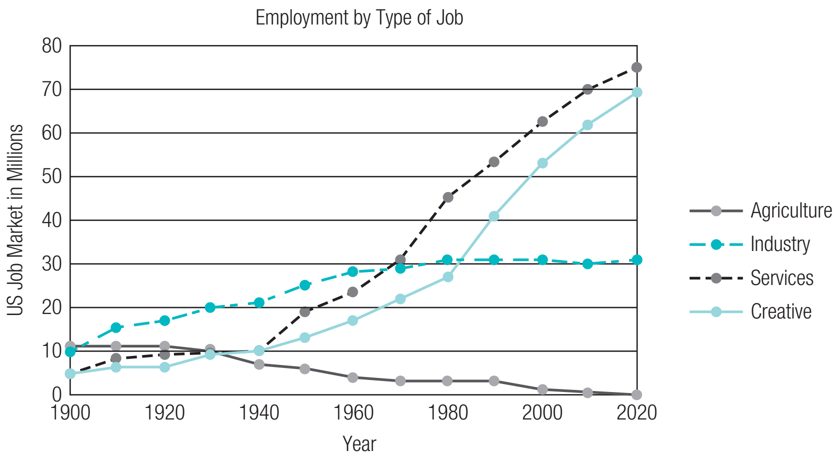

Figure 4.1 Rise of the Service Economy
Source: US Census Bureau, Bureau of Labor Statistics

The growth of innovation services in the 20th century was intimately tied to the growth of technology, in particular logistics, communication and computing technology. Work restructuring involved some 'outsourcing' of tasks, and when a sufficient market grew for these outsourced tasks to support it, another service job was created. Often these tasks were deskilled and formalized: jobs that previously required specialized skills were structured and standardized so that they can be given to the lowest cost worker. For example, a hamburger stand in the 1950s would have depended on the speed, judgement and skill of a short order cook to satisfy customers' orders. A modern hamburger stand would limit the menu, purpose build kitchen equipment for specific items, allow cooks and order takers to change jobs at a moment's notice, and generally minimize any specialized knowledge needed for any specific task. Even communication would be standardized around polite, pre-scripted phrases:

'Welcome to our restaurant, may I take your order?'

Service activities must be *scalable* – e.g. we may only have 10 retail customers come into our store today, but we need to be prepared to have 100 tomorrow; and we should prepare to efficiently and effectively keep the store running over many years. For this reason, we expect to make service activities *routine* – in fact, delivering routine service in a way that makes every customer feel uniquely serviced is one of the great challenges of service of all walks today.

Two aspects in particular are prominent features of services – (1) they are activities rather than tangible products; and (2) they are customer facing, involving direct and repeated interaction with customers at a face-time level.

Many of the efficiency innovations in services today are reminiscent of an earlier efficiency revolution – the *Scientific Management* revolution initiated by Fred Taylor, father of the stopwatch-and-clipboard approach to factory management. 'Taylorization' cut the cost of Henry Ford's Model T in half; it yielded similar gains for Isaac Singer (sewing machines), Cyrus McCormick (reapers), and Samuel Colt (firearms).

Taylor's *ideas* about the production of cars *replaced materials*, *labour*, *and overhead* that had previously been required to produce a Model T. In Ford's 'taylorized' Highland Park plant, one man could now do what three or four had done before, and later did the same at Chevrolet's plant in Flint. The rise of innovation has created many more opportunities to 'taylorize' every aspect of our life, segmenting and deskilling labour-intensive tasks, and transferring them to the lowest cost provider. The rise of the internet and cheap global communications and logistics often makes it possible for such segmented and deskilled jobs to be transferred to low-cost bidders halfway around the world (Friedman, 2005). The net effect of such task restructuring, deskilling, segmentation and global outsourcing has sometimes been socially unsettling. But it is also a fundamental part of the growth of service innovation that ultimately enriches our lives and provides us with enormous market choice (Cohen & Levinthal, 1989; Hill & Jones, 1995: 352).

Because so many services are purely dedicated to conveying information between firm or professional and the consumer, firms increasingly look to information technology for the innovations that can improve productivity. Information technology seeks to encapsulate expertise and deskill work. Product expertise initially resides in the heads and notes of a few designers and engineers – people unlikely to man call centre phones. One of the first steps in setting up the after-market call operations is to transcribe this knowledge to a user manual on a computer database. The more information on the database, the less technically skilled need be the call centre employees, which is the reason that such databases are said to 'deskill' jobs.

It is easy to forget and consequently undervalue the importance of warranty and after-market services. Brands can fail solely due to poor after-market service. Rather than failing because of poor quality, failure is too often the result of users failing to understand a product, thinking it too complex, and thus becoming discouraged with it. As products grow inherently more complex, the need for effective consumer education and after-market support are increasingly differentiators in crowded markets.

Services now provide the primary settings for innovation among executives at high-profile companies in the technology industry (Jana, 2007). Many developed economies have ceased to generate much gross domestic product (GDP) from goods – rather they have become service economies. The 10 industries with the most dramatic salary growth are all in this service-providing sector, ranging from employment services to education to health care. Globally, service workers now outnumber farmers for the first time in history.

Services have in the past tended to be provided locally, because the expertise behind the service resided in individuals, workshops or stations on a transportation network. The rise of two-way communications networks – first telephone, then the internet – combined with desktop computing power changed this, though. Starting in the 1980s, software innovators used desktop computers to offer the services of professionals through their software. For example, Intuit encapsulated the expertise of tax accountants and financial planners in its TurboTax and Quicken software, and PGMusic offered piano and guitar lessons interactively through its Master Class software. The growth of the WWW in the 1990s offered the ability to connect everyone in the world to services provided by an individual on location, or through servers with computing power much greater than a desktop PC; e.g. eBay and Craigslist offered the same advertising services as local newspaper classifieds, but were not limited by local circulation; large web retailers now provide live instant messaging with a consumer representative while shopping online (Hamel & Prahalad, 1994; Christensen & Bower, 1996).

Internet bandwidth and desktop computing power continue to grow exponentially, making possible the delivery of almost any 'local' service to a global customer base. The revenue potential is similarly global, but without incurring rapidly increasing costs. Add to this levels of standardization and control that are not possible in locally provided services, and service innovations are truly revolutionary.

At the time of writing, two service industries are probably being changed fastest by service innovations – financial services and the medical profession. Searching for a loan, buying insurance and trading stocks are all 'local' services that have migrated to the web. Stock trading sites were consistently the fastest growing dot.coms in the mid-1990s (Lawrence & Lorsch, 1967; Hambrick et al., 1993, Johne & Storey, 1998; Johnston & Clark, 2001).

The medical profession is silently being transformed through outsourcing and the shift towards self-service. The outsourcing of prescriptions to generics sold across borders (for example, from Canada to the US) has shown the potential to dramatically lower drug prices, albeit with some risks that go with less intense monitoring. Sites such as WebMD and Wikipedia offer health information online that many patients use both to flag health problems and to provide a second opinion.

Definitions and practice in service innovation are still in flux, with many conflicting opinions on how to innovate. An internet search on 'service innovation' retrieves mostly financial and supply-chain innovations. In this chapter I will try to relate some of the advances that have been made in these services, looking closely at services in finance and operations, where recent innovations have contributed significantly to firm competitiveness. Overall, services can be analysed in the same way that we have analysed products and processes in this book – as a bundle of features with (1) market appeal, (2) production constraints and (3) financial constraints. To emphasize this point the remainder of this chapter will review some services that are important in the economy, and show how we can understand these in terms of features and channel activities. We start with logistics services, which have comprised over the past century between 5% to 15% of the global economy.

Container Services: The Logistics Revolution

'Necessity is the mother of invention' and no period in recent American history has fostered more invention than the Great Depression. It was during this trying period in 1937 that a 24-year-old gas station attendant Malcolm McLean delivered his first export delivery from North Carolina to the New Jersey docks. By 1945 he had 162 trucks, hauling primarily textiles and cigarettes from North Carolina to the north

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east. After World War II he added 600 trucks and hired veterans to drive them. By 1954 his was the eighth largest and third most profitable US trucking line. During this growth, McLean's obsession with making ocean shipping efficient grew even more intense. Loading and unloading in the early 1950s took at least eight days on each end of each route. This long delay created security problems – in those days, nearly 5% of the total value of a ship's load was lost in unloading and loading. Longshoremen's unions were notorious for their Mafia connections – a problem dramatized in Marlon Brando's movie *On the Docks* – providing a steady additional 'income' to unions and their bosses.

McLean's solution was to seal the pallets of inventory inside a large, locked, metal boxes called containers. McLean didn't invent containers, but he championed their use in his own company. Recognizing in particular that a particular kind of ship – the oil tanker – travelled with empty top decks, in 1955 McLean bought an oil tanker, reinforced its top and sailed it from Newark to Houston with 58 containers on board. He subsequently acquired the Waterman Steamship Company as a base of operations, and got out of trucking. One of McLean's key moves was to *not* patent the container – what might be considered an early experiment in open-sourced hardware. Instead, he backed the people at the Fruehauf trailer company to develop the containers, and insisted that the technology be made available to the entire industry, including all his competitors. By the mid-1960s, The Port Authority of New York committed to spend $332 million to build a container port at Elizabeth, New Jersey. In April, 1966, in his first transoceanic sailing, his Sea-Land Service sent a ship from Port Elizabeth to Rotterdam, delivering his load four weeks faster than any alternative. By the late 1960s, Sea-Land was highly profitable. It played a key role in delivering supplies for the Vietnam War. In 1969, McLean sold the company, with it ultimately ending up in the hands of the CSX railway and the Maersk shipping lines. McLean continued to innovate, promoting the idea of giant ships circling the globe at the equator, with smaller ships loading and unloading the giants. Containerization ultimately reduced shipping and loading costs by 80–90%. Port turnaround times, which had been as high as three weeks, dropped to 24 hours. Containers also took the place of many warehouses – they are essentially their own warehouse.

The rapid growth of the Chinese economy in the 1990s spurred new innovations in scale. By 1996, the largest container ships could hold 5,000 TEUs, far more than even McLean's 'Econoships'. His ideas of loading and unloading around the globe became real. Today the largest new ones can carry 19,000 TEUs (though no ports in the western hemisphere can handle ships that large). There are over 30 million TEUs in use worldwide, with 5–6 million in transit at any given time. An estimated 27 containers a day – 10,000 a year – fall off ships due to high seas, floating dangerously in sea lanes for up to two weeks due to their tight construction. Currently, trade between China, India, the US and Europe accounts for 65% of the more than 250 million containers moved around the world each year. The container has allowed foreign-owned enterprises to transport massive amounts of production to Asia while creating jobs for design, financing, shipping logistics and marketing and retail logistics for Europe, the US and Japan – countries which also keep much of the profit from products.

Features that might be important to customers for logistics services are presented in Figure 4.2.

	Basic	Differentiators	Energizers
Positive Impact	Ships from A → B	Speed, Local pick-up	
Negative Impact		Cost	
Neutral			

Figure 4.2 Demand-side Feature Map for Container Services

	Core Features	Non-Core Features
Increases Costs	Air transit	Packaging
Decreases Costs	Volume	

Figure 4.3 Supply-side Feature Map for Container Services

Crowdsourcing and Internet of Things

Two of the most exciting products kick-starting the 'Internet of Things' were conceived by a few friends knocking back a few cold ones. It started in a local bar, where members of the Interaction Design Institute in Ivrea would regularly share ideas over their local drinks. The bar was called 'Arduino' after a medieval King of Italy. The Interactive Design Institute students were on a budget, and could not afford the BASIC Stamp hardware that was then running about $100 a board. One of the teachers, Massimo Banzi, contributed a wiring design by Colombian student Hernando Barragan which was placed in the public domain with a request for the research community to make it lighter, less expensive and available to the open-source community. The idea grew into one of the most popular open-source computer hardware and software companies offering kits for building digital devices and interactive objects that can sense and control the physical world. Many robots and the 3D robotics drones were built on the 'Arduino' platform. Over 300,000 official Arduinos had been commercially produced, and over 700,000 official boards were in users' hands.

A crowdsourcing idea was taking root in the UK, benefiting from the wealth of micro manufacturing technology growing out of the expanding smartphone industry. In 2006 British inventor Eben Upton assembled a group of teachers, academics and computer enthusiasts to devise a computer to inspire children. His product, the Raspberry Pi, is a series of credit card-sized single-board computers developed in the UK by the Raspberry Pi Foundation with the intention of promoting the teaching of basic computer science in schools. Raspberry Pis were originally more powerful than Arduino boards. The Arduinos tended to describe themselves as microcontrollers (small computers dedicated to the input and output of sensor and actuator data flows) whereas Raspberry Pis were computers

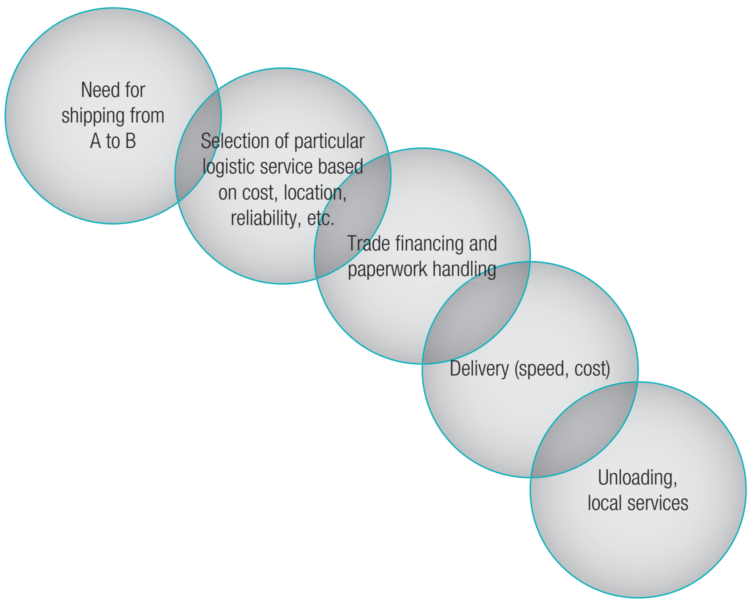

Figure 4.4 Consumption Chain for Container Services

	Basic	Differentiators	Energizers
Positive Impact	Set of sensors, actuators and CPU	Low cost, programmability	
Negative Impact		Processing power, speed, battery life	
Neutral			

Figure 4.5 Demand-side Feature Map for Hobbyist Microcontroller

	Core Features	Non-Core Features
Increases Costs	More powerful CPU, more sensors and actuators	
Decreases Costs	Use components from other industrial applications	

Figure 4.6 Supply-side Feature Map for Hobbyist Microcontroller

that could run operating systems like Debian and Arch Linux with programming in C, C++, Java, Perl and Ruby. Over 5 million Raspberry Pis have been sold to date.

Both systems are presenting themselves as core processors for swarms of small devices that can wirelessly link into high-powered cloud computing services to provide an Internet of Things robotics platform.

Circular Supply Chains

Until the Industrial Revolution, humans seldom needed to worry about the unused portions of production left behind – waste management was an afterthought, if any thought at all. Often such refuse was biodegradable, and population density was low, so people could always move. As the world has grown richer and more populous,

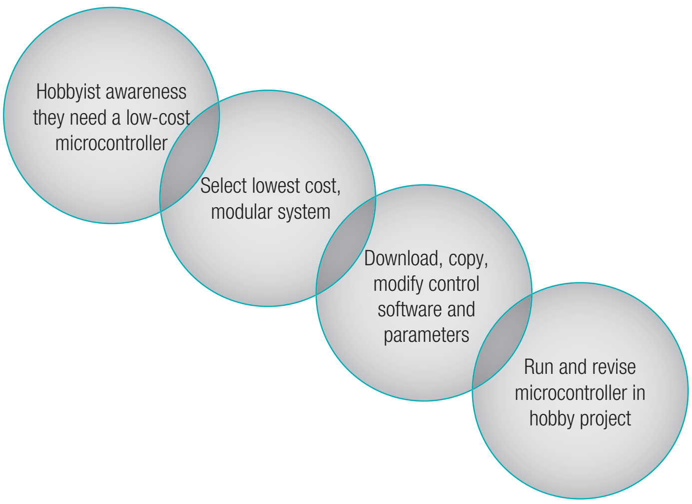

Figure 4.7 Consumption Chain for Hobbyist Microcontroller

mankind no longer has this luxury. Pollution, water shortages and energy consumption are significant problems globally in the 21st century as the world consumes more and more raw materials, throwing off a portion as waste.

One solution to the waste problem is to link the ends of the production chain: assure that any waste can be used as raw material for this or another product. A circular supply chain refers to a production model that is restorative by nature. Ideally, this implies that resources that are used for production enter an infinite loop of reuse, remanufacturing and recycling. Resources that cannot be fully salvaged, like energy, should be based on renewable sources.

The first great revolution in circular manufacturing was the development of plastics in the 1960s from petroleum waste from increasing consumption of gasoline and other distillates. Though plastics ultimately created their own waste problems, plastic T-shirt bags were initially sold to the grocery industry as 'environmentally friendly' replacements for paper bags.

Since the technologies for recycling can be difficult or uneconomical, several European companies have started marketplaces to crowd-source solutions:

The Restart Project: A social enterprise based in London that encourages people to use electronics longer, by teaching fundamental repair and maintenance skills. Through community and workplace events, it creates engaging opportunities for people to increase the lifespan of electronics and electrical equipment. It has currently run over 56 repair events and has inspired people in several countries to come up with similar initiatives.

Der Grüne Punkt: A network of industry-funded systems for recycling the packaging materials of consumer goods, in order to follow German packaging laws that require manufacturers to take care of the recycling or disposal of any packaging material they sell. Germany established 'dual system' of waste collection, picking up household packaging in parallel to the existing municipal waste-collection systems.

CIMV: A bio-refinery company that custom designs recycling plants to turn waste into commercially viable lignocellulosic plastic products, including plastics that have been integrated into clothing by Dutch company ***aWEARness***.

	Basic	Differentiators	Energizers
Positive Impact	Recycle waste	Socially conscientious	Socially conscientious (for some customers)
Negative Impact		Added consumer effort; conflicting retailer-producer incentives	
Neutral			

Figure 4.8 Demand-side Feature Map for Circular Supply Chains

	Core Features	Non-Core Features
Increases Costs	Complete use of waste	
Decreases Costs	Sale of by-products for reuse in other products or services	

Figure 4.9 Demand-side Feature Map for Circular Supply Chains

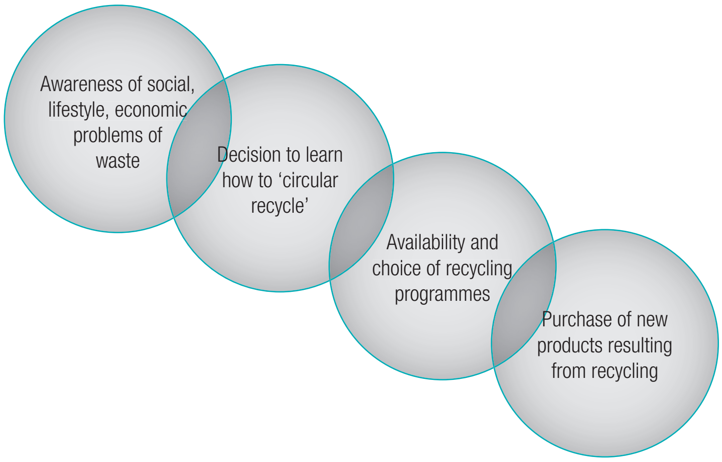

Figure 4.10 Consumption Chain for Circular Supply Chains

Companies developing circular supply-chain services often incur significant up-front investments, yet depend on their suppliers and retailers for their success. These suppliers and retailers may have conflicting incentives, since extending product end-of-life reduces their revenues. Consumers may also be reluctant to participate, complaining about increased work.

The Long Tail

The so-called *Long Tail* is the name of a book by Chris Anderson who popularized a concept broached in seminal work by Erik Brynjolfsson and colleagues (2006). The long tail concept is generally presented as a loose restatement of the 80/20 rule or Pareto probability distribution which had been observed in government statistics since the early 19th century. Pareto's distribution is well defined, and appears in indexing (Zipf distribution), city sizes (Yule distribution) and other areas where it may be given specialized names; in contrast the long tail is a concept concerning product demand distributions. Anderson argues that in internet markets, inventory stocking does not limit the number of products a retailer can carry, and e-tailers will tend to carry a lot of seldom-purchased items (conceptually a long tail trailing out to infinity). One UK digital music service found that sales exhibited a log-normal distribution rather than a power law; they reported that 80% of the music tracks available sold no copies at all over a one-year period (Elberse and Oberholzer-Gee, 2008)

Consumer Education, Warranty and After-Market Services

Even physical products are attached to a bundle of services, which may represent a substantial portion of cost. As products grow more complex, the set of features and user interface tends to grow complex as well. Consumers require services that will educate them on use and on the advantages of a particular product – otherwise the product would not be usable, and thus not saleable. Education can be delivered before the sale – e.g. via advertising for drugs, or demonstrations and trial offers for software, games and so forth; or it can be delivered after the sale – e.g. as helpdesk support for consumer electronics or software problems, and on-site service for computers. If physical services on a product are required, such helpdesks will tell customers how to receive this service. In many cases, information *is* the product – legal advice or medical diagnoses can be expensive, and only involve the transfer of information between a professional and client or patient.

Enhanced customer support is the proactive delivery of education, usage help and other services before, during and after the purchase of products or services. The need to reconsider consumer support has been driven by the rapid expansion of 24/7 web support, with innovations in interaction, forums and intelligence bases. Customer support is moving away from face-to-face support, and gravitating towards live chatting, mobile applications and social media, to serve customers at any time and place they please. These enhancements improve enterprises' perceived service quality, which is one of the determining factors for customer satisfaction.

Factors to consider in the general shift of methods for customer support are:

1. Politeness: a pleasant customer experience has become a critical competitive advantage;
2. Customers are increasingly intolerant of poor experiences and share their dissatisfaction within their social networks;
3. Customer experience is as important as price, reliability and performance today. Indeed, it is a major factor in the customers' perceptions of reliability;
4. Multichannel choice adds complexity as it requires continuity, consistency and correctness of interactions.

Customer support centres are becoming the eyes and ears of companies, and failure to use their available intelligence will diminish the entire organization's standing. Here are some examples of customer service innovations and the companies that manage them.

1. ***Adpoints*** (UK): Platform rewarding customers for watching and engaging with video-based advertising. The audiences can choose what they want to watch, where and when, and then give feedback on the advertisements.
2. ***EyeKa*** (France): Crowdsourcing platform connecting creative individuals with brands to boost their return on marketing expenditure. Enables people to accept a business challenge (animation, creative writing, video, graphic design, label and packaging) and propose an innovative solution to companies.
3. ***KBHFF*** (Denmark): Organic food cooperative has grown popular around the world today, and is based on a social enterprise model. Members volunteer to work three hours per month in the store to be allowed to shop at the KBHFF. Members are responsible for the management of the co-op's purchasing, distribution, financing and communication.
4. ***Logograb*** (Switzerland): Brand–customer interaction tool that enables customers to scan logos in order to generate and access real-time brand content such as product information, discounts and customers' opinions.
5. ***Sampleo*** (France): Product testing platform that allows companies to offer their products to customers in exchange for their review and feedback.
6. ***Staffino*** (Slovakia): Mobile application enabling consumers to give direct feedback on the quality of the Consumption Chain for Customer Service offered by companies' employees.
7. ***BrainSins*** (Spain): Cloud-based software that improves cross- and up-selling, offering customizable recommendations, personalization and gamification services.
8. ***Qubit*** (UK): Machine learning, statistical insights and allows personalization on e-commerce websites.
9. ***Inbenta*** (Spain): Language-based semantic search engine, with more than 100 clients, including Groupon and Ticketmaster.
10. ***Deskero*** (UK): Highly adaptable cloud-based supply-chain management tool for retailers.
11. ***Brand Embassy*** (Czech Republic): High-volume online platform for identification and easy engagement with customers across the social web.
12. ***Whisbi*** (Spain): Video agent technology able to synchronize in real time a normal inbound or outbound phone call with an interactive online experience.

	Basic	Differentiators	Energizers
Positive Impact		Customer's problem is solved	Customer is happy after the interaction
Negative Impact		Customer's problem is not solved	
Neutral			

Figure 4.11 Demand-side Feature Map for Consumer Education, Warranty and After-market Services

	Core Features	Non-Core Features
Increases Costs	Personalization of support	
Decreases Costs	Volume; Wikis, forums and other non-interactive customer support approaches	

Figure 4.12 Demand-side Feature Map for Consumer Education, Warranty and After-market Services

Express Mail

In 1965, as a Yale undergraduate, Fred Smith, the future president of Federal Express, wrote a term paper which concluded that the passenger route systems used by the US Post Office were ignoring an important market – overnight delivery. Smith conjectured that he could turn Post Office economics upside down. Post Office delivery optimized distance travelled where time was not a critical value and package handling was cheap. He wanted to compete for customers using new technology – i.e. transportation networks that took advantage of the increasing size

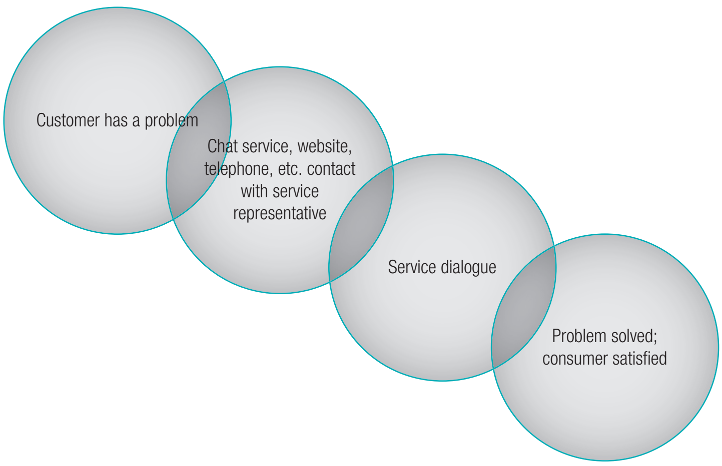

Figure 4.13 Consumption Chain for Consumer Education, Warranty and After-market Services

and speed of jets to restructure the geography of space, time and wealth. Smith saw that new air technology could let him ignore distance travelled, and instead optimize speed and handling to create new market value. Such a system would be designed specifically for airfreight that could accommodate time-sensitive shipments such as medicines, computer parts and electronics. The paper was returned with the teacher's comment:

> The concept is interesting and well-formed, but in order to earn better than a 'C,' the idea must be feasible.

Undaunted, after a stint in the military Smith bought controlling interest in Arkansas Aviation Sales, located in Little Rock, Arkansas, and officially began operation as Federal Express on 17 April 1973, with the launch of 14 small aircraft from Memphis International Airport. On that night, Federal Express delivered 186 packages to 25 US cities – from Rochester, New York to Miami, Florida.

Memphis, Tennessee was selected as the headquarters since it was the geographical centre of the original target market cities for small packages. In addition, the weather in Memphis was excellent, in that the airport rarely closed due to climatic conditions. Memphis International Airport was also willing to make the necessary improvements for the operation and had additional hangar space readily available.

A major part of the initial business was overnight flat letter delivery. Smith used his first-mover advantage, and linked and leveraged products off one another – taking advantage of network economies in the process – to 'lock-in' customers. Yet advances in technology undermined this business, as Group III facsimile – which used standard telephones to transmit images of flat mail at the speed of light – substituted for overnight delivery at very competitive prices. Within three years of its introduction, Group III faxes accounted for about 60% of international telephone calls. In the days before widespread email, businessmen increasingly took advantage of the asynchronicity of Group III fax to overcome global time differences. Federal Express quickly re-engineered its business around package shipping, especially for inventory expediting out of their Memphis entrepôt (Allen, 1984; Hammer & Champy, 1993; Tidd & Hull, 2003).

	Basic	**Differentiators**	**Energizers**
Positive Impact	Delivery of business and legal information from A to B	Speed	It absolutely positively needs to be there tomorrow
Negative Impact		Cost	
Neutral			

Figure 4.14 Demand-side Feature Map for Express Mail

	Core Features	**Non-Core Features**
Increases Costs	Overnight delivery	
Decreases Costs	Volume	

Figure 4.15 Demand-side Feature Map for Express Mail

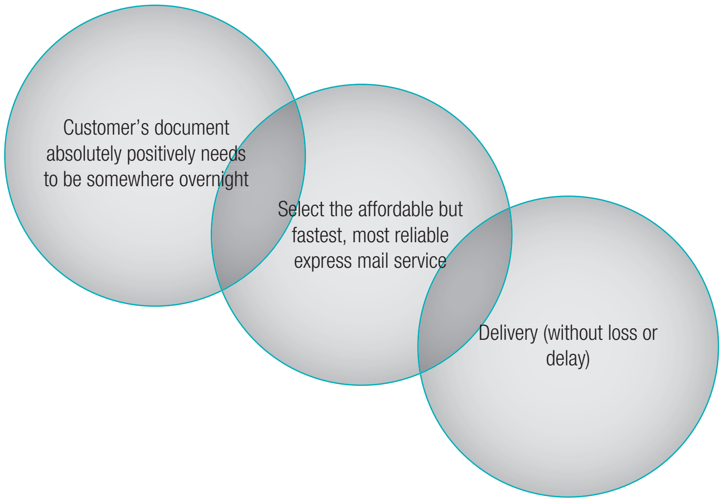

Figure 4.16 Consumption Chain for Express Mail

Hybrid Internet/Brick-and-Mortar Retailing in Hong Kong

Dallas-based 7-Eleven operates over 18,000 convenience stores worldwide, with roughly 70% located outside the US. In Hong Kong, China and Singapore, 7-Eleven stores have been run since 1981 by Bermuda-based Dairy Farm International Holdings Limited, with around 150 stores across tiny Hong Kong's 1100 square kilometres of land. Total annual sales in 2006 are around three-quarters of a billion dollars annually, and store sales transactions average US $1.25; virtually all sales are cash. In consequence, cash handling costs are around 15% of sales price, which adds a substantial amount to variable selling and administrative costs. Management recognized that volume, pricing, server efficiency and net income would all improve significantly by a move to adopt new electronic commerce services – indeed, many in management felt that the only way to sustain sales growth was through innovations in automated payment, operations and sales services.

To reduce costs of currency and coin handling, 7-Eleven examined suitable electronic payment methods. Credit cards tended to be costly for small transactions. This had resulted in several alternative payment methods – Mondex, Visa Cash and Octopus – in the late 1990s which were specifically designed for small cash purchases typical of 7-Eleven convenience stores. Though 7-Eleven experimented with several systems from 2000 to 2003, the Octopus contactless cash card was the most popular of the small payment methods from the start. The move to automated payment significantly reduced costs by reducing the need for checkout staff, and reducing back-office administrative costs.

Since 2000 7-Eleven had engaged various employees and outside consultants in focus groups to invent and assess other convenience store service innovations which might open new markets and customer sets. Innovations appropriate for 7-Eleven's Hong Kong stores tended to be unique first because high land costs meant stores were smaller, busier and more densely stocked than anywhere else in the world; and second because customer profiles and tastes differed from the rest of Asia. By 2003, a list of eight retail service automation projects (see Figure 4.17) were mooted at a company meeting.

The new services which were adopted were generally successful, generating a modest sales growth. 7-Eleven saw the success of these programmes as a 'proof of concept' and to the current day rely on similar focus groups to suggest and critique potential new services.

Automated Retail Service Innovation	Marginal Cost	Marginal Benefit	Adopted?	Comment
Mark Six (Lottery) Vending Machine	Medium	High	No	Legality issues; HK Government does not allow online betting on Lottery
Concert Ticket Vending Machine	High	High	Yes	Adopt: high growth potential, attracts customers who buy other items
Color Photo Development	High	Medium	Partly	Feasible, but store space concerns may limit to only a few of the larger stores
All-in-One Electronic Purchase Platform (for all of store's stock)	Very High	High	No	Risk of failure is too high
Digital Bus Route (information only)	Low	Medium	Yes	Phone enquiry terminal was added to kiosk; draws customers into store who buy other items
Entertainment Kiosk (MP3s, etc.)	Medium	High	Yes	Limited success to date
Internet Access Terminal	Low	Medium	No	Store space concerns
Self-Customized Greeting Cards	Low	Medium	No	Store space concerns

Figure 4.17 7-Eleven (Hong Kong) Hybrid Internet/Brick-and-mortar Services

	Basic	Differentiators	Energizers
Positive Impact	Convenience store services	Ability to handle local payment and delivery aspects of internet orders	
Negative Impact			
Neutral			

Figure 4.18 Demand-side Feature Map for Customer Service

	Core Features	Non-Core Features
Increases Costs	Local implementation of payment, storage and receiving for customer purchases	
Decreases Costs		

Figure 4.19 Demand-side Feature Map for Customer Service

Financial Services

The 2015 hit movie *The Big Short*, based on Michael Lewis's book of the same name, follows the exploits of four cynical, fringe Wall Street entities disgusted with the large banking institutions' manipulation of the markets. They make a decision to profit from the housing market calamity and the financial meltdown of 2008 upon discovering the market frenzy is being driven by worthless collateralized debt obligations (CDOs).

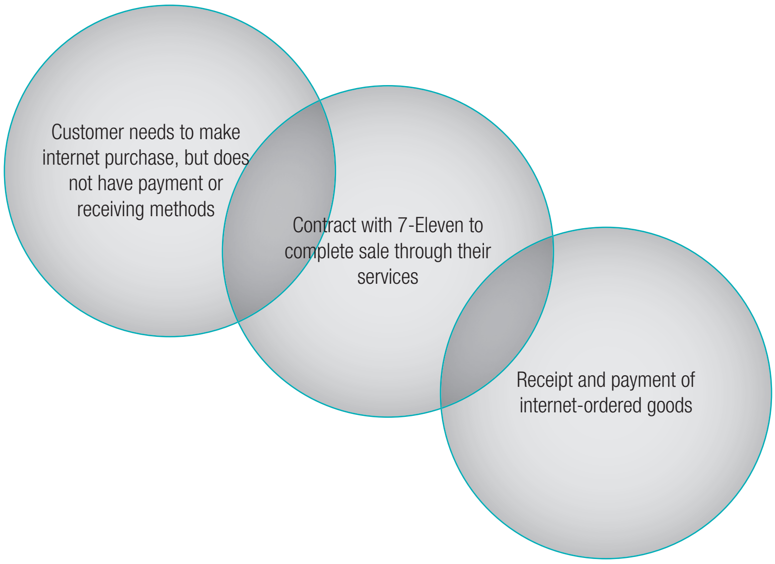

Figure 4.20 Consumption Chain for Customer Service

The roots of the 2008 financial crisis can be traced back to financial service innovations, including innovations in home financing, that expanded rapidly in the 1980s during the Reagan Administration in the US. The Reagan Administration pushed huge amounts of money into the US economy through relaxation of home lending and increased military budgets. This money found its way into the finance sector, motivating a shift away from fund management and analysis, towards commission sales of innovative new financial products such as the so-called 'junk' bonds and derivatives.

The transformation of finance from asset management to a commission sales industry has probably earned more positive and critical recognition than any other area in service innovation. That is only reasonable, as the most substantial amounts of money are in the finance sector, and that sector has been almost continually restructuring since the early 1980s. Perhaps no other sector has been so influenced by the

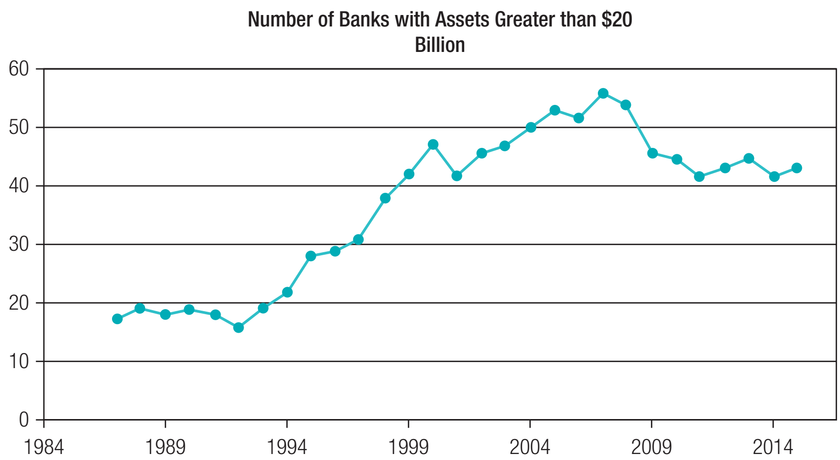

Figure 4.21 The Rise of the Megabanks
Source: FDIC (www.fdic.gov/bank/statistical)

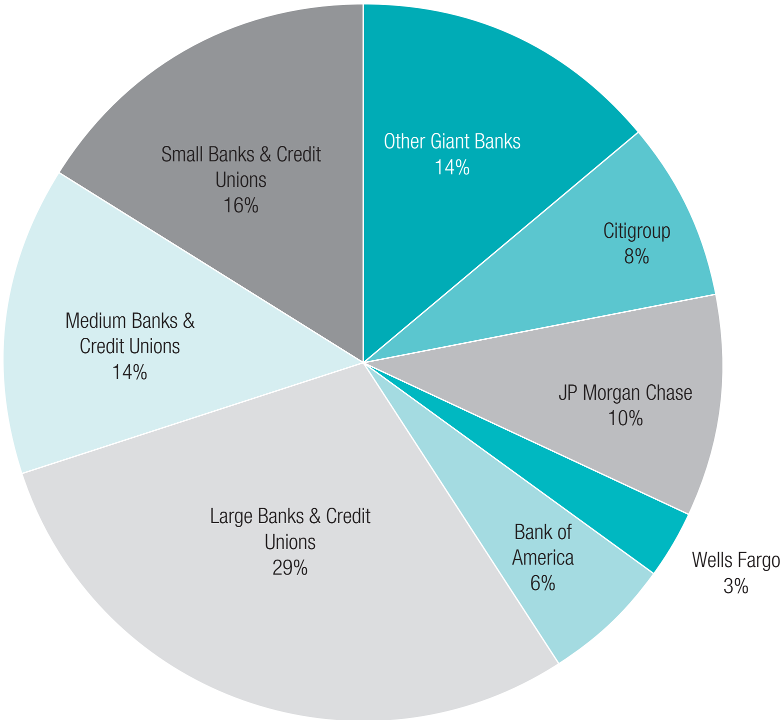

Figure 4.22 US Bank Market Share in 2005
Source: FDIC (www.fdic.gov/bank/statistical)

WWW and the global flattening that it has enabled.

Finance deals entirely with information – with products that are easily converted to bits and bytes. The industry's products are universally directed towards contracts that transfer money at some time, place and contingency, often in connection with an asset. For example, home mortgages transfer money for the purchase of a house, secured by the house, and contracting with the owner to pay in instalments over some future time period. Corporate stocks are contracts that share in the ownership of a firm, and for which elaborate secondary markets are constructed and operated.

From the 1950s through the 1970s, world banking was dominated by US banks, while in the 1980s Japanese banks expanded substantially. The race for size in banks was understandable: not only could large banks finance any deal, but they also could cross-sell an entire portfolio of services efficiently. Much of the innovation in banking services has involved figuring out how to make size a barrier to entry at the same time that it is a source of operating efficiency.

In 2005 marked the era of megabanks. In the midst of the home financing bubble the world's largest banks were gobbling up assets voraciously. This was the era of megabanks such as Mitsubishi Tokyo Financial, Citigroup, JP Morgan Chase and Bank of America.

Size became especially important in banking because with deregulation each bank needed increasingly to compete with foreign banks at home and abroad to be successful. Global banks needed to be able to meet the rising financial needs for lending, underwriting, currency and security trading, insurance, financial advice and other financial services for customers and investors with increasingly global operations.

Though the underlying components of financial services are comparatively limited, innovation in these markets can become very involved, because of payment timing, conditions on payment (e.g. bond covenants or derivative terms) and contingencies that impact contracts. Financial specialists have developed an involved colloquial language to articulate the features that characterize their products; innovations

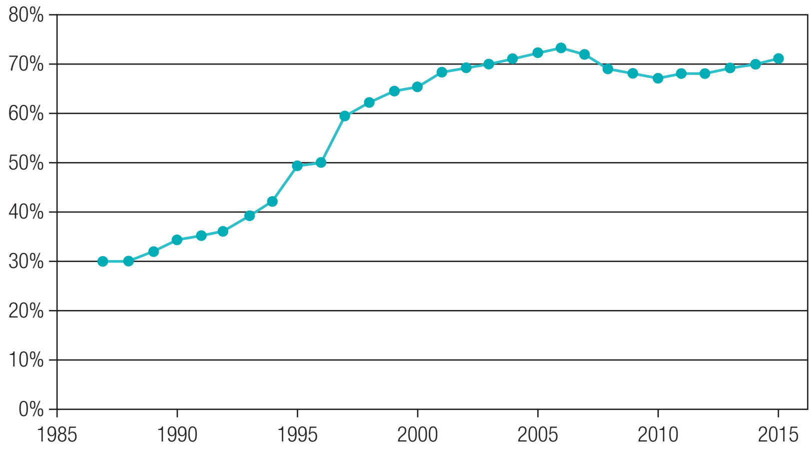

Figure 4.23 US Share of Assets Held by the Largest Banks
Source: FDIC (www.fdic.gov/bank/statistical). By 1999 the share of assets held by the largest banks was already 65%, at the height of the bubble in 2005 it had risen to 73%.

are conceived in terms of the restructuring and re-engineering of these features.

The success of financial innovations is measured by their ability to jointly meet the needs of borrowers and investors; ideally the amounts of money available will be equal, though this is difficult to assess in advance of marketing. Investors, and borrowers or businesses that need money for assets and projects are likely to have a wide divergence of needs, risks and timing of investments; only some of these will be known in advance of expenditures. Though financial markets exist to determine precisely how to price a given financial innovation to clear the market, they are predicated on the existence of financial products that can generate sufficient interest on both the buying and selling side. For this reason, as with other sorts of innovation, the ability to assess the viability of an innovation in advance of development and marketing is just as essential as it is for a tangible physical innovation.

Many recent innovations in financial markets have involved clever engineering of risk to make certain financial services more saleable; the resulting financial instruments are called derivatives. A derivative is any financial innovation whose valuation at a point in time is derived from some asset other than itself. There are potentially as many unique derivative innovations as there are unique mathematical functions on the current and future values of the underlying asset. The purpose of a derivative is to allow both the seller and the buyer to tailor their investment risk to meet the needs of their particular business model and planned projects.

Derivatives are a relatively recent innovation. In the late 1970s, Wall Street's finance community suffered from multiple crises – the New York Stock Exchange ended fixed commissions; this took place during a severe recession and oil price shock after effects of Iran quadrupling oil prices in the early 1970s, and many major banks hovered on the edge of bankruptcy. The increased risks borne by banks accelerated the innovation in financial derivatives, ushering in the first interest rate swaps, currency swaps, and zero coupon bonds, and variable-rate financing started to appear on financial markets.

One of the most successful financial innovations of the early 2000s was the *option adjustable rate mortgage* or option ARM. Option ARMs offered flexibility at the expense of complexity and risk. They allowed new homebuyers to afford a home in a rising market with a minimum of down payment. These were the critical features that sold the option ARM innovation:

1. *Assumptions*:
   i. your house value will rise enough to make refinancing worthwhile
   ii. your income will rise enough to cover your increased cash payments.

2. *Low payments* in the first one to five years (benefits homeowner).
3. *High* homeowner *refinancing costs* (benefits mortgage lender).
4. *High fees*/commission (benefits mortgage lender).
5. Lender is allowed to *claim the full monthly payment as revenue* on its books even when borrowers choose to pay much less (benefits mortgage lender).
6. Interest rates and up-front fees might be determined by a *hedge fund* (benefits mortgage lender).

Option ARMs accounted for as little as 0.5% of all mortgages written in 2003, but rose to 12.3% by 2006. They made up one-third to one-half of mortgages in the high-priced markets of California and Florida. Their initial low payments were only temporary, and the less a borrower chooses to pay up-front, the more is tacked onto the balance. This created a risk for lenders of customer default if customers were not able to come up with cash later in the loan cycle.

Two innovations drove the market on top of ARMs – the collateralized debt obligation (CDO) and the credit default swap (CDS). Where the debt in question is an ARM mortgage, CDOs may also be called collateralized mortgage obligations (CMOs). 'Swaps' are financial derivatives where one party contracts to swap cash flows with another. For example, a bank may have a large number of fixed-rate mortgage loans, while another bank may have a pool of variable-rate mortgage loans. Assume that each of the banks would prefer to have the other type of loan. Rather than cancel their existing loans (which would be difficult if not prohibitively expensive given a large pool of mortgage loans) the two banks could achieve the same end by agreeing to 'swap' cash flows: the first bank pays the second based on a floating-rate loan, and the second pays

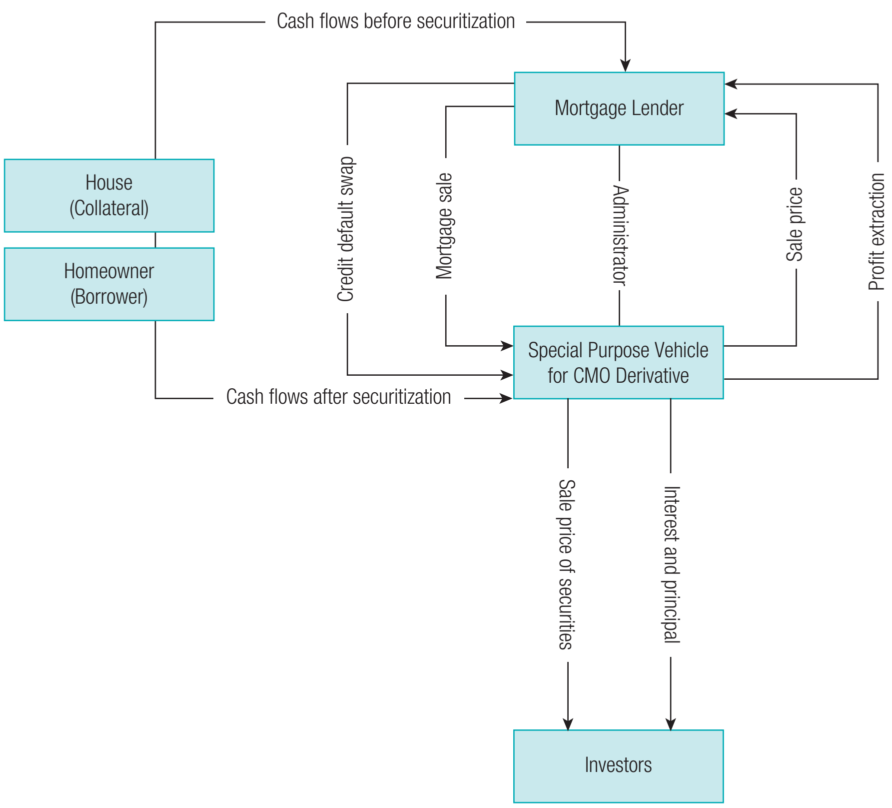

Figure 4.24 Features and Components of the Collateralized Mortgage Obligations Market that were a Major Factor in the 2008 Market Crash

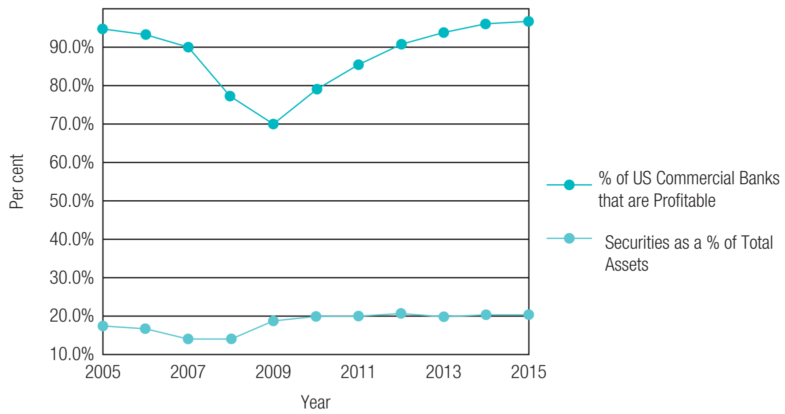

Figure 4.25 US Bank Securities Holdings and Profitability
Source: FDIC (www.fdic.gov/bank/statistical)

the first based on a fixed-rate loan (in practice, the two will net out the amounts). By swapping the cash flow, each has 'swapped' one type of loan – and one source of risk – for another.

Such swaps are just one example of mortgage-based derivative. Because of the huge size of the global housing market, the repackaging of mortgage loans, and associated risks of homeowners defaulting on their payments, has not only been a huge business but has also provided an arena for innovation in new derivative instruments. The previously discussed swap can trade off the risk of a change in interest rates, but buyers are necessarily limited to other banks who may have similar (large) cash flows derived from homeowners. To swap risk with a larger market of investors (i.e. to devise a derivative with more market liquidity) banks may turn to the derivative mentioned above: CMOs, first created in June 1983 by investment banks Salomon Brothers and First Boston. A CMO has a pool of home mortgage loans which provide collateral, a set of tranches (*tranche* is the French word for 'slice') and a set of rules that dictate how money coming in from the collateral will be distributed to the tranches. Investors purchase certificates of a tranche.

The banking system in the 2000s insulated itself well from ARM default by packaging ARMs into collateralized debt obligations (CDO) which were insured by credit default swaps (CDS), and these could further be manipulated to create 'tracking' CDOs that were not collateralized directly by underlying assets. Poorly performing option ARMs (i.e. where homeowners had stopped paying their loans) could be packaged with other, better loans and re-sold in chunks to investors. Banks ultimately sold a notional \$3 trillion of these kinds of assets to hedge funds and other big investors with

	Basic	Differentiators	Energizers
Positive Impact	Match buyers, sellers and inventories of assets	Risk vs. return on investment	
Negative Impact			
Neutral			

Figure 4.26 Demand-side Feature Map for the CDO and CDS Markets from a Banking Perspective

	Core Features	Non-Core Features
Increases Costs	Information collection and analysis	
Decreases Costs	Sales and order flow management	

Figure 4.27 Demand-side Feature Map for the CDO and CDS Markets from a Banking Perspective

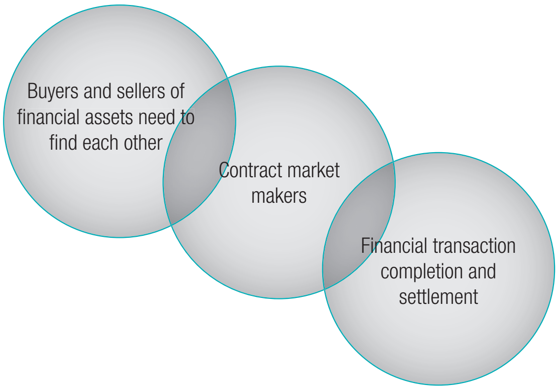

Figure 4.28 Consumption Chain for the CDO and CDS Markets from a Banking Perspective

appetites for risk. Fortunes were made, but the risks incurred ultimately brought down the market in late 2008, ushering in a global depression for the next several years.

Original Equipment Manufacturing Services

Flextronics International Ltd. (simply known as Flextronics or Flex) is an international supply-chain solutions company that offers design, manufacturing, distribution and after-market services to original equipment manufacturers (OEMs). It is the second largest global electronics manufacturing services company by revenue, behind only Taiwan's Foxconn. Flextronics offers turnkey manufacturing services to the world's leading electronics companies, including Alcatel, Dell, Ericsson, Hewlett-Packard, Juniper Networks, Microsoft and Siemens. The company's services range from design engineering through manufacture and assembly to distribution and warehousing. It manufactures and assembles printed circuit boards, electromechanical components, subsystems and complete systems for a wide range of makers of networking and telecommunications equipment, computers, consumer electronics and medical instrumentation.

Flextronics is an OEM for consumer electronics that are marketed under another brand (e.g. the Microsoft Xbox360). Its services fall into two main categories:

1. Contract manufacturing (CM) where companies send designs and prototypes of consumer electronics products to Flextronics, who take care of production set-up, supply-chain management, product quality control and the first stages of the distribution channel. This category accounts for 40% of Flextronics' contracts.
2. Contract Design and Manufacturing (CDM) where companies outsource product objectives, requirements and interface-usability guidelines to Flextronics' R&D. Once the product is designed and approved by the outsourcing firm, Flextronics is responsible for production and other downstream operations. This category accounts for 50% of Flextronics' contracts.

In early 2003, Flextronics was designing and producing mobile phones for the major brands. Engineers in Flextronics' research and development (R&D) repeatedly pointed out flaws in either requirements or designs that they received from clients; they also became convinced that they could develop and produce a much better telephone in-house than anything that currently existed in the market. It was at the suggestion of R&D that Flextronics embarked on its original design and manufacturing (ODM) project to produce the Peabody mobile telephone. The design was initially mooted with the intention of selling one of their clients on it, and then marketing and distributing through the client's channels. There was also discussion of developing the Peabody or Flextronics brand from scratch. The main attraction of the latter approach was the high markups on retailing of mobile phone handsets (vs. the extremely low margins in contract manufacturing).

Potential clients initially balked that the Peabody phone was too sophisticated, and that there was no way that Flextronics could complete the design prototype and produce it in less than one year. Flextronics countered by completing the design prototype in six weeks, and offering to commence production and delivery within another six weeks. Clients were impressed, but then fell back on more pedestrian complaints – that the Peabody phone was not invented in their own labs, that it did not fit into their current product line, or that there could be interoperability problems (though this seemed not to be a problem with CDM phones contracted to Flextronics).

Flextronics CEO Michael Marks was more candid in his assessment, noting that the ODM business was significantly different from manufacturing services.

Thus the prospect of selling the Peabody phone to one of its clients confronted Flextronics with concerns from other customers about exclusive deals on proprietary technology. These concerns could be followed up by customers withholding their key technology, or contracts, from Flextronics, and potentially switching their business to competitors like Hon Hai, Sanmina-SCI or Solectron who lack channel conflicts.

The prospect of Flextronics marketing the Peabody itself was not even considered, as Flextronics lacked both brand recognition in the mobile phone market and any marketing channels or selling expertise. An updated Peabody prototype was vetted at the 3GSM World Congress in 2005, and Microsoft showed some interest in selling under their brand, but to date the Peabody mobile phone remains a prototype only.

Despite the excellent reviews Flextronics received on its Peabody design, their troubles in making the transition from low-margin contract manufacturing services to high-margin branded retailing highlights the fact that the biggest profits are earned, and the strategic battles are fought, at the distribution channels and at the customer interface – not on the factory floor or in the design labs.

> With manufacturing, our customers don't really care who else we work with . . .rarely ask for an exclusive relationship. With design, we're getting much closer to what our customers care about. . .they don't want us selling the same product to others in the market. If we do an exclusive deal with one customer, the others get upset. Finding the right strategy in this market is probably the most interesting intellectual issue I have faced in my business career.

The consumption chain for the Peabody mobile phone seems simple enough, but recognize that without established dealer or distribution networks Flextronics is unlikely to sell many handsets.

	Basic	Differentiators	Energizers
Positive Impact	Telephone handset	(None)	
Negative Impact			
Neutral			

Figure 4.29 Demand-Side Feature Map for the Peabody Phone

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	Core Features	Non-Core Features
Increases Costs	Rich feature set	
Decreases Costs	Manufactured and marketed by Flextronics	

Figure 4.30 Demand-side Feature Map for the Peabody Phone

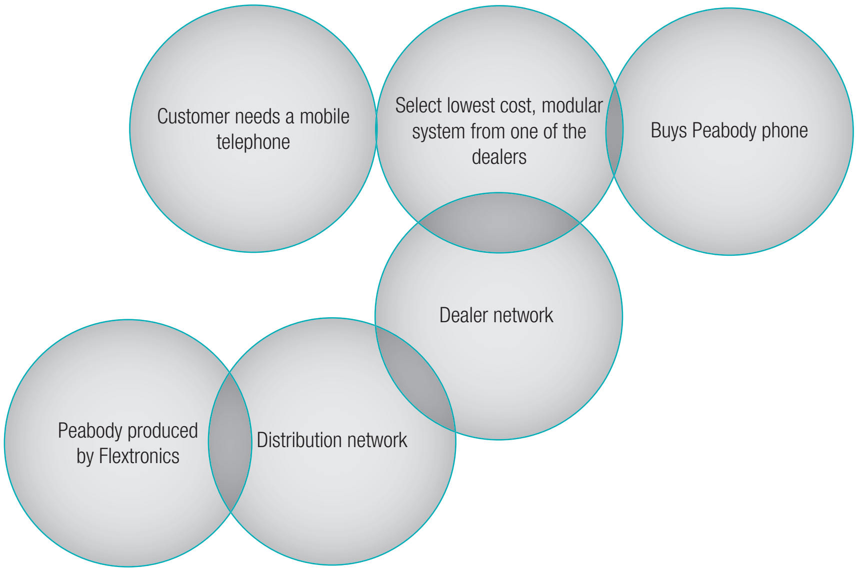

Figure 4.31 Consumption Chain for Customer Service

Innovation at the Margins of Society

Innovations sometimes gain their initial markets in venues where 'respectable' individuals and firms dare not tread. Perhaps no technologies are more powerful than those that disseminate information, interaction and propaganda. Since the late 1990s, critical innovations have involved the distribution of news, opinion, propaganda and media across the WWW. This explosion has triggered large-scale movements like the Arab Spring, Ukrainian Euromaidan protests, ISIS recruitment and other movements around the globe. Governments have, less than successfully, tried to control access to this new wealth of information in order to protect their status quo and the well-being of their people.

In Johannes Gutenberg's day, the majority of 15th-century texts were religiously focused, and the Papacy under Leo X was one of the printing press's most avid customers. Leo X chose to fund many of his projects through the sale of Papal indulgences – documents absolving their purchasers of particular sins. Sales were massive, and only Gutenberg's presses could print enough quality indulgences to meet demand. As a by-product, 15th-century Italy became the centre of Renaissance printing, giving birth to the Aldine Press from which were issued the celebrated editions of the classics. The Italian press also quickly innovated with the anti-science *Index of Prohibited Books* in 1559 (designed to protect the Papal status quo) and the pornographic *Aretino's Postures* in 1527 which initiated a subgenre of underground texts. Both quickly gained popularity among a mainstream audience, increasing the demand for printing as well as another Italian speciality – Venetian optical glass and eyeglasses. Nate Silver, in his book *The Signal and the Noise* (2012), observed that the 150 years following Gutenberg's press were ones of continual war, revolution and enlightenment intertwined.

The importance of information dissemination – via recording media, telephone lines and the internet – has fomented many debates over regulation of these technologies. When home video was developed, the format that started out with the largest market share, Sony's Betamax, was eventually beaten by VHS, the format adopted at the margins of society, in the adult entertainment industry where there was substantial demand. The television networks fought both formats because of their potential to fast forward through advertising, thus making it ineffective and robbing them of revenue streams.

Premium-rate telephone numbers, or 1-900 numbers, similarly grew through usage of various scams, adult entertainment and diversions such as psychic advisors. Services such as these might charge $2.99 for the first minute and 99 cents for each additional minute that they kept a caller online (and entertained), with substantial sums being paid by the telephone companies to the service providers.

The introduction of acoustic coupler modems for traditional telephones made possible bulletin board services in the 1980s, which were often used to illegally circulate copyrighted material such as music, books and pictures. These evolved into the more complex precursors of the WWW like CompuServe and AOL which attracted a mainstream audience. With the growth of the WWW in the 1990s, platforms became available for high transaction volume exchange between individuals. The fastest growing internet businesses in the late 1990s were stockbrokers who encouraged their clients to 'day trade' to boost commissions and ultimately set the stage for the market collapse of 2000 which wiped out pension funds and destroyed families. A parallel service arose in online gambling, with poker sites such as Ruth Parasol's PartyPoker.com bankrupting families and creating a permanent underclass of internet gambling addicts.

More recently the award-winning Netflix documentary *Hot Girls Wanted* details how misinformation disseminated through Craigslist ads and social sites is used to lure young women into the amateur porn industry. On a global scale, similar schemes are used to lure massive numbers of unwilling subjects into human trafficking. Many young women are relegated to interactive live cam sites such as LiveJasmin which is the 50th most visited site in the world, with revenues increasing 10%–20% every year since it launched in 2001.

Trade in other illicit products was facilitated by WWW innovations. The Silk Road was an online black market and the first modern *darknet* market – where users are guaranteed anonymity under the umbrella of the Tor network. In October 2014, shortly before it was shut down, there were 13,756 products listed, 70% of which were drugs. Other *darknet* markets such as Black Market Reloaded sold false drivers' licences, weapons, stolen credit cards and so forth. Anonymous payment for illicit goods is accomplished through cryptocurrency such as Bitcoin, invented by Satoshi Nakamoto and published in 2008. The system is peer-to-peer, allowing users to transact directly without an intermediary. Transactions are verified by network nodes and recorded in a public distributed ledger called the block chain.

The WWW, like all technologies, is a double-edged sword. It gives power to those who understand and harness it. But the abuse of that power holds potential to generate misery and abuse on scales previously unseen. In most cases, we might prefer to look the other way and avoid innovations at our social margins. But as this section has shown, the money involved is huge, and whether or not we pay attention to the dark underbelly of innovation, it is still likely to touch our lives in ways that are unpleasant.

Call Centre Services

Sam Swaminathan, CEO of Manjushree Infotech (part of the B.K. Birla Group) set up its call centre in 2000 in Kolkata, India to serve a single Health Maintenance Organization (HMO) in Tampa, Florida, US. The plan was to build a small set-up consisting initially of 25 employees which could be scaled up as business picked up and new clients were acquired. With an eye towards rapid expansion, Swaminathan determined that the initial call centre platform absolutely had to be scalable by at least two orders of magnitude in order to handle expected business at targeted service levels.

Companies like to locate call centres in India because of the employees. Employees have excellent English (even to the point of being able to speak with US regional accents) and can be hired for 10% of the cost of comparable employees in the US. Still, wages in India were rapidly increasing, chipping away at their labour price advantage. Even with a 10:1 cost advantage, cheap labour can only scale so far. Swaminathan needed to innovate if he was to stretch his resources to scale by at least two magnitudes of call volumes.

Call centre operations are essentially designed to deliver educational services. Education may involve solving a problem, discovering a feature or ascertaining whether a product is defective. The traditional call centre dialogue is two-way and verbal between the customer and a call centre employee over a wide-area voice telephone network. This suffers from all of the inefficiencies of traditional conversation – misunderstood phrases; linear presentation of facts and issues; and speed limited by articulation of the speaker.

Thus Swaminathan planned initially to build and debug operations consisting only of human responses to questions, but via an integrated data /voice/video wide-area telephone network. As more firms were added, the intent was to add voice recognition and response for a set of perhaps 20 to 50 of the most common queries for any given product, with the automated system turning control over to a human operator in the case that it could not satisfy the customer's query. Once working, such a system could automate close to 95% of call responses, at close to zero marginal cost per call.

The third phase of expansion would add the ability to respond either automatically, or with human intervention, to queries typed through the client's web page. Again, once working, such a system could automate close to 95% of web query responses, at close to zero marginal cost per call. Where the automated response system could not handle a query, it would be turned over to a call centre/helpdesk employee for response. Unlike voice calls, web response could not be immediate, but Swaminathan was targeting an average response time of four hours for queries, with 99% response within 24 hours.

A voice over internet protocol (VoIP) system, deployed at the Tampa Florida call centre, which routed calls to India, began operations on 4 January 2000 and within a year handled around 1,600 incoming calls a day. To assess the efficacy of operations, Swaminathan worked with the HMO to compare Manjushree Infotech's

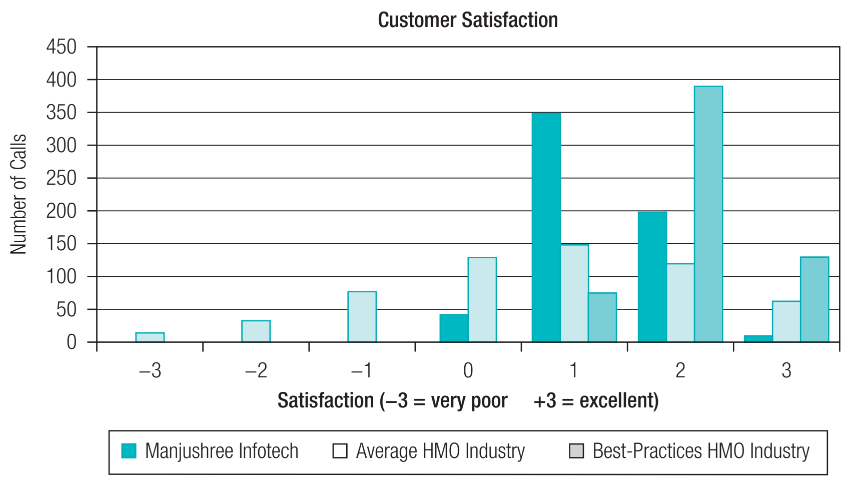

Figure 4.32 Call Centre Performance

	Basic	Differentiators	Energizers
Positive Impact	Customer gets help with a problem	Customer's problem is solved	Customer is happy after the interaction
Negative Impact		Customer's problem is not solved	
Neutral			

Figure 4.33 Demand-side Feature Map for Call Centre Services

	Core Features	Non-Core Features
Increases Costs	Personalization of support	
Decreases Costs	Volume	

Figure 4.34 Demand-side Feature Map for Call Centre Services

customer satisfaction for enquiries to those of the industry. Industry data was purchased from a clearing house that gathers a number of measures about customer satisfaction and call centre technical and business performance, and distils them into a seven-point satisfaction rating.

Comparing their company to the benchmark average and to a select best-in-class group, the company's management team could see that customer satisfaction with their support services (gathered by an unbiased industry source) was above average, but that there was still room for improvement. The steady monitoring of the customer satisfaction distribution as new technologies were brought online would help Manjushree Infotech to optimize its operations.

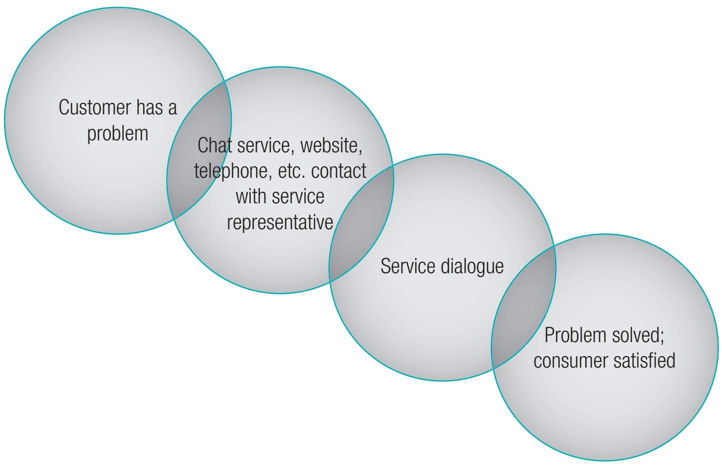

Figure 4.35 Consumption Chain for Call Centre Services

Innovation Workout: John Sterman's Beer Game

(Note: this workout uses software that can be accessed at the book's website)

The Beer Game – developed by MIT Professor John Sterman as a 'flight simulator' for management education – is a staple of introductory Operations Research classes, where it is used to provide students with insights into supply-chain management. Interestingly enough, its intent was not try to optimize the supply chain. Rather, Sterman discovered a formula that matches human behaviour, which the game implements. Instead, the purpose of the model is to mimic human behaviour and attempt to help it, in this case by providing increased knowledge down the supply chain (visibility).

I want you to use it here to experiment with possible delivery service innovations. If you really think that a computer is the answer to your supply-chain problems, then give it a try. Remember that any automated computer, any innovation, any change in the status quo ultimately gets implemented into the ongoing dynamics of the existing management and operations group; into the existing inventory and supply systems; and into the existing customer and supplier environment. Your innovation might not look as attractive once you've 'flight tested' it.

By the way, rather than playing this as a traditional board game (the way it was designed), we've included on our website one of the many computer programs available for implementing this game (or if you don't like the one provided with the book, you may visit John Sterman's site at MIT to find references to other computer implementations).

Playing the Game

The supply chain consists of four components (suppliers): retailer, wholesaler, distributor and factory. The customer makes an order to the retailer. The retailer (and the rest of the supply chain in turn) performs these tasks:

1. Get new stock from previous pending orders (variable name: received)
2. Get new requests for beer from downstream (variable name: demand)
3. Supply beer for the request and backorders (variable name: supply)
4. Make an upstream order based on inventory (variable name: ordered)

It takes one time slot (one week) for an order to be received by the upstream supplier, and two time slots (two weeks) for an order to be filled by that supplier, thus a three-week lag in all. These pending orders are remembered by each agent (variable name: pending).

Scoring is done by cost: inventory cost is stock on hand × \$0.50, but backorder cost (when you cannot supply enough thus have the demand unfulfilled, carrying over to the next move) is more expensive: \$2.00 per unfulfilled request.

Each supplier shows its inventory in a box just below its building. It turns red when the inventory is negative, showing the existence of backorders. Similarly, supplied orders are red if they are part of the backorder (i.e. are less than the requested number of cases of beer).

Case Study: The Identity Crisis of Amazon

In July of 2015, Amazon for the first time in history reported a profit – it was only \$92 million, practically a rounding error for Google or Apple. The profit came entirely from the rapid growth of Amazon Web Services, a service that had only been conceived in 2006. It is easy to forget that prior to 2006, Amazon had been a large, but consistently unprofitable, electronic commerce retailer (e-tailer). Jeff Bezos, the founder and CEO of Amazon, had recognized that his e-tailing model was broken since at least 1999, but was unable to immediately find an alternative that worked any better. This case chronicles the trials of Amazon in its early years to find a model suitable for its mix of e-commerce and logistics capabilities.

The Amazon.com that operated in the 1990s was a vastly different firm than the cloud services and logistics giant of today. The name originally reflected the vision of Jeff Bezos, to produce a large-scale phenomenon like the Amazon River; today it sells over $110 billion's worth of goods and services each year. The original goals of Amazon set the standard for the dot.com boom – grow at any cost, reach a critical mass at which network externalities kick in, and finance that growth through equity market and bank capital. This strategy was often referred to as 'competing for eyeballs', the scramble for customers' attention that would turn the virtuous cycle of positive feedback which would fuel growth. Unfortunately, that vision did not work out very well for Bezos, who almost lost the firm during the dot.com crash of 2001.

The initial market of Amazon was books, and its competitors were book superstores run by chains such as Barnes & Noble. On paper, the Amazon model certainly looked superior.

But, as with many other dot.coms, it didn't work out as well as anticipated. By around the year 2000 some analysts were predicting that Amazon would face bankruptcy. Bezos hustled to reinvent the company, and to this day his reinvention has not paused.

The problem that confronted Bezos in 2000 was that his internet-disintermediated business model – which he had predicted would be ultra-efficient – turned out to actually be *more* expensive than that of traditional retailers such as Circuit City and Best Buy. Once you included company-wide costs of fulfilling orders, promoting sales and finding new customers, the margin in the consumer electronics business at Amazon became a negative 42%. Every $1 of consumer electronics revenue shipped out the door cost Amazon $1.42. Compare that to profits and gross margins at Best Buy which are 3% and 23%; at Circuit City Group 2% and 21%. Gross margin for the consumer electronics business at Amazon was 8%.

The problem was simple. At a store, the customer actually has the merchandise in hand, and once past the cash register, the store has no more involvement with that inventory (except perhaps to restock). But the work would just begin at Amazon once the customer

	Amazon	Barnes & Noble
Number of stores	1 website	1,011
Number of employees	1,600	27,000
Titles per superstore	3.1 million	175,000
Total sales	$542 million	$3.1 billion
Sales per employee per year	$375,000	$100,000
Sales growth (last quarter of 1998)	306%	10%
Book returns	2%	30%
Inventory turnover per year	24%	3%
Operating income in 1998	–$29.2 million	$147.3 million

Figure 4.36 Amazon vs. Barnes & Noble

made a purchase; it faced the logistical problems of any delivery service or mail-order house. The business was plagued with high levels of split shipments and long hauls which resulted in higher-than-expected fulfilment inefficiencies.

This was the year that Jeff Bezos gave up on 'network effects'. FedEx may have loved the Amazon network, but the pay-off to Bezos was less certain. The share of the market possessed by Amazon was simply too small to take advantage of any network effects. This is also the year that Amazon suffered its identity crisis – the firm that had once been the darling of dot.com investors and had established the ground rules for internet competition was struggling just to survive.

Bezos quickly shifted his view of the Amazon business model to that of a 'fee-for-service' model. The more interesting question concerned who actually would be billed the fee – who Amazon saw as a paying customer. Of course there were the retail customers that would seek out books, CDs, consumer electronics and so forth. But Bezos also followed the lead of eBay in encouraging small retailers to use his services. Particularly on books and CDs, the price of used or discounted titles from the company's partners were displayed along with the price offered by Amazon itself, and Amazon, for a fee, would handle all parts of their partners' transactions. Amazon also began to provide its services to other large retailers with a recognized brand, but no internet presence – Toys 'R' Us was the most prominent of these recognized brands. The approach was beginning to look like traditional retailing in the age of 'Big Box' stores – offer the maximum selection of merchandise (in the case of Amazon perhaps six to seven million items) under one roof.

In its 2005 annual report, Amazon describes the services it provided, many above and beyond traditional retailing services, that allowed the company to stay competitive:

> We work to earn repeat purchases by providing easy-to-use functionality, fast and reliable fulfillment, timely customer service, feature rich content, and a trusted transaction environment. Key features of our websites include editorial and customer reviews; manufacturer product information; Web pages tailored to individual preferences, such as recommendations and notifications; 1-Click® technology; secure payment systems; image uploads; searching on our websites as well as the Internet; browsing; and the ability to view selected interior pages and citations, and search the entire contents of many of the books we offer with our 'Look Inside the Book' and 'Search Inside the Book' features. Our community of online customers also creates feature-rich content, including product reviews, online recommendation lists, wish lists, buying guides, and wedding and baby registries.

From 1998 onwards, Amazon had adopted another characteristic of physical retailers – an obsession with performance metrics. Amazon CEO Jeff Bezos called it a 'culture of metrics'. Bezos made sure that responsible employees had the latest inventory availability information, delivery date estimates, and options for expedited delivery, as well as delivery shipment notifications and update facilities – and furthermore that they were evaluated on how well they managed these statistics. This focus on customer has translated to excellence in service with the 2004 American Customer Satisfaction Index giving Amazon.com a score of 88, which was at the time the highest customer satisfaction score ever recorded in any service industry, online or offline.

Rather than guessing, Bezos also developed an obsession for customer satisfaction metrics for the Amazon website. Each site was closely monitored with standard service availability monitoring (for example, using Keynote or Mercury Interactive) site availability and download speed. Interestingly, per-minute site revenue upper/lower bounds were also monitored. These effectively constituted an alarm system similar to those in a nuclear power plant. If the revenue Amazon generated from a site fell below $10,000 per minute, alarms would go off. Furthermore there were internal performance service-level agreements for web services where a certain percentage of the time different pages must return in a specific number of seconds. As with employees, the web service providers were responsible for these targets and could be dropped when they failed to meet them. This obsession with 24/7 service was the Amazon online and mail-order counterpart to Walmart's greeters, associates and cleaning personnel – it was essential to making Amazon an attractive place to shop.

By 2003, Bezos' culture of metrics was pursued with a vengeance. A fully online business like Amazon could record every move a visitor made, every last click and wobble of the mouse. As the data piled up, you potentially could analyse all sorts of consumer behaviour, and even conduct controlled experiments by altering website algorithms, changing pricing or suggestions, and so forth, and profiling how customers responded.

Amazon began by developing its 'Creator Metrics' tool – essentially a flexible report generation tool. But soon it realized that standard statistical packages would better suit the needs of experimentalists with massive customer behaviour datasets that would be the envy of any marketing professor. Bezos began pushing managerial decision making to a new paradigm that he termed 'automation replaces intuitions': 'real-time experimentation tests are always run to answer these questions since actual consumer behaviour is the best way to decide upon tactics'. By 2005 Amazon had evolved a culture of experiments of which so-called A/B tests are key components. If an employee suggested that decision A was the best decision, this would never be taken at face value – the employee would initiate limited market testing on certain websites to see whether customers like A or B better (thus A/B testing). And if the firm decided to go with decision A, then that decision would be monitored after implementation, as customer satisfaction could be temporary. Amazon has found that as its users evolve in their online experience the way they act online changes. This means that Amazon has to constantly test and evolve its features.

The result is a system where humans are progressively being drawn further out of the decision-making loop – statistical algorithms handle the critical and strategic decisions for Amazon and monitor the activities implemented as a result of those decisions to see that they stay on track.

So successful has been this approach that Jeff Bezos is formulating future strategy around 'selling the store'. Through its partner programmes it is already running retail websites for many other companies, and now it is promoting a complete package of retail services like its own for anyone who wants to put up a store.

Amazon ultimately found its footing through persistence and constantly exploring options for expanding the business. Its definitive breakthrough came in late 2003, when Amazon employees Chris Pinkham and Benjamin Black presented a paper describing a vision for a retail computing infrastructure that was completely standardized, completely automated, and would rely extensively on web services for facilities such as storage. Towards the end of the paper they mentioned the possibility of selling virtual servers as a service, proposing that the company could generate revenue from the new infrastructure investment. Bezos embraced their vision and the first Amazon Web Service (AWS) for public usage was Simple Queue Service, offered in November 2004. Amazon went on to sell unbundled computing services through its data storage initiative, and a virtual service system called Elastic Compute Cloud. Because Amazon already has a huge server capacity and retailing tools finely honed by years of metrics analysis, it feels that these are services that it can potentially sell for more than other services providers (and charge premium prices as well).

Bezos claimed the advantage Amazon had over its competitors was the ability to effectively mate reliable, low-cost, extensible cloud services with the 'heavy lifting' of logistics, customer relationship management, inventory management and so forth. Ultimately this has grown to be Amazon's profitable core business. By 2010 Amazon had effectively outgrown its identity crisis.

(Sources: Howell & Higgins, 1990; Ward & Dranove, 1991; von Hippel, 1994; Demery, 2004; Marcus, 2004; SEC, 2005)

Questions: Amazon Case Study

1. Why do you think that the pursuit of network effects by Amazon (and many other dot.com companies) – what they called competing for eyeballs – was such a failure? Are network effects illusory? Or do network effects only apply to certain business models, and is retailing not one of them?
2. When in 2000 Amazon made its transition into being more of a traditional mail-order retailer, do you feel that this represented a viable model, or was Jeff Bezos just trying to justify his investment in company infrastructure (services, bandwidth, warehouses and so forth)?
3. Can you see problems with a 'culture of metrics'? Can human judgement be better than decisions based on statistical algorithms? Why do you think the culture of metrics worked at Amazon?
4. Why don't more companies A/B their decisions?
5. Is there any danger in taking humans out of the decision-making loop in a company? Do you think that Amazon will suffer (or perhaps already has suffered) from some of these problems?
6. Why would any company use the retailing computer services provided by Amazon rather than just renting them from a low-cost internet service provider? Is there any problem with a retailer giving up its customer data to Amazon?
7. What do you think is the best business for Amazon to move into in the future?

Chapter 4 – Questions for Review

1. Articulate the main features of a financial service and how these may be manipulated in innovation.
2. Articulate the main features of a logistics service and how these are manipulated to produce viable innovations.
3. Are there businesses that could be considered intermediate to purely physical 'products' and purely dynamic 'services' – businesses that combine the challenges of both?

Chapter 4: Key Points

1. Incremental improvement of existing products or business models is insufficient. You need to really make a difference.
2. Innovations provide the primary means for differentiating your product from your competitors'.
3. Digital services especially benefit from innovation. With no shelf space to pay for, purely digital services, no manufacturing costs and hardly any distribution fees, there are no 'hits', only 'sales' with the same margins as a hit. A hit and a miss are on equal economic footing, both just entries in a database called up on demand, both equally worthy of being carried.
4. These are the economics of the 'long tail'; in the 'long tail' profitable companies are the ones that offer the largest choice (they scale on database size, not factory output).
5. Digital goods can theoretically reduce distribution costs to near zero; opportunities for innovation exist in transforming physical distribution into lower cost and scalable digital distribution.
6. Successful innovation happens in four realms: new products; new technologies; new markets; and new ways of matching firm assets and competences to consumer needs.

Further Reading

Allen, T. (1984). *Managing the Flow of Technology*. Cambridge, MA: The MIT Press.

Amit, R. and Zott, C. (2015). Crafting business architecture: The antecedents of business model design. *Strategic Entrepreneurship Journal* 9(4), 331–350.

Aral, S., Brynjolfsson, E. and Van Alstyne, M. (2012). Information, technology, and information worker productivity. *Information Systems Research* 23, 849–867.

Aral, S., Brynjolfsson, E. and Wu, L. (2012). Three-way complementarities: Performance pay, human resource analytics, and information technology. *Management Science*, 58(5), 913–931.

Barss, P. (2011, 21 June) The erotic engine: How pornography has powered mass communication from Gutenberg to Google, *Anchor Canada*.

Bonczek, R. H. Holsapple, C. W. and Whinston, A. B. (2014). Foundations of decision support systems. Academic Press.

Brynjolfsson, E. and McAfee, A. (2012). *Race Against the Machine: How the Digital Revolution is Accelerating Innovation, Driving Productivity, and Irreversibly Transforming Employment and the Economy* (self-published).

Brynjolfsson, E. and McAfee, A. (2014). *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*. WW Norton & Company.

Brynjolfsson, E., Hu, Y. and Simester, D. (2011). Goodbye pareto principle, hello long tail: The effect of search costs on the concentration of product sales. *Management Science* 57(8), 1373–1386.

Brynjolfsson, E., Hu, Y. J. and Smith, M. D. (2006). From niches to riches: Anatomy of the long tail. *Sloan Management Review* 47(4), 67–71.

Brynjolfsson, E., Hu, Y. J. and Smith, M. D. (2010). The longer tail: The changing shape of Amazon's sales distribution curve. Available at SSRN 1679991.

Brynjolfsson, E., Hu, Y. and Smith, M. D. (2010). Research commentary – Long tails vs. superstars: The effect of information technology on product variety and sales concentration patterns. *Information Systems Research* 21(4), 736–747.

Brynjolfsson, E., Renshaw, A. and Van Alstyne, M. (2012). The matrix of change. *Sloan Management Review* (Winter 1997), 38(2), 37–54.

Burtch, G., Ghose, A. and Wattal, S. (2015). The hidden cost of accommodating crowdfunder privacy preferences: A randomized field experiment. *Management Science* 61(5), 949–962.

Christensen, C. M. and Bower, J. L. (1996). Customer power, strategic investment and failure of leading firms. *Strategic Management Journal* 17, 197–218.

Christensen, C. M. and Raynor, M. (2013). *The Innovator's Solution: Creating and Sustaining Successful Growth*. Harvard Business Review Press.

Cohen, W. M. and Levinthal, D. A. (1989). Innovation and learning: The two faces of R&D. *The Economic Journal* 99, 569–596.

Das Gupta, S. (2002, December) Building a Call Centre, *Network Magazine*.

Demery, P. (2004, May 5) The New Walmart? *Internet Retailer*, www.internetretailer.com/2004/05/05/the-new-walmart?p=1, accessed on 22 June 2016.

Elberse, A., & Oberholzer-Gee, F. (2008). *Superstars and Underdogs: An Examination of the Long Tail Phenomenon in Video Sales*, Division of Research, Harvard Business School.

Freeman, C. (1982). *The Economics of Industrial Innovation*. Cambridge, MA: The MIT Press.

Friedman, T. L. (2005). *The World is Flat: A Brief History of the Twenty-First Century*. New York: Farrar, Straus and Giroux.

Griffiths, T. L. and Tenenbaum, J. B. (2006). Optimal predictions in everyday cognition. *Psychological Science* 45, 56–63.

Gross, N., Coy, P. and Port, O. (1995, 6 March). The technology paradox. *Business Week*, p. 78.

Hambrick, D. C., M. A. Geletkanycz, and J. W. Fredrickson (1993). 'Top executive commitment to the status quo: Some tests of its determinants'. *Strategic Management Journal* 14, 401–418.

Hamel, G. M. and Prahalad, C. K (1994). *Competing for the Future*. Harvard Business School.

Hammer, M. and Champy, J. (1993). *Reengineering the Corporation. A Manifesto for Business Revolution*. New York: HarperBusiness.

Hill, C. W. L. and Jones, G. R. (1995). *Strategic Management: An Integrated Approach*. Boston: Houghton Mifflin.

Hovanesian, Mara Der (2006, 11 September) Nightmare Mortgages. *Business Week*.

Howell, J. M. and C. A. Higgins (1990). Champions of technological innovation. *Administrative Science Quarterly* 35: 317–341.

Huang, Y., Singh, P. V. and Ghose, A. (2015). A structural model of employee behavioral dynamics in enterprise social media. *Management Science* 61(12), 2825–2844.

International Labor Office (2007, January). *Global Employment Trends*.

Jana, R. (2007, 29 March). Service innovation: The next big thing. *Business Week*.

Johne, A. and Storey, C. (1998). New service development: A review of the literature and annotated bibliography. *European Journal of Marketing* 32 (3/4) 84–251.

Johnston, R. and Clark, G. (2001). *Service Operations Management*. London: Financial Times, Prentice Hall.

Lane, F. (2001) *Obscene Profits: The Entrepreneurs of Pornography in the Cyber Age*, Routledge Books.

Lawrence, P. R. and Lorsch, J. W. (1967). *Organization and Environments: Managing Differentiation and Integration*. Homewood, IL: Irwin.

Marcus, J. (2004) *Amazonia. Five Years at the Epicentre of the Dot-com Juggernaut*. New York, NY: The New Press.

Osterwalder, A. and Pigneur, Y. (2010). *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*. John Wiley & Sons.

Qiu, L., Rui, H. and Whinston, A. B. (2014). The impact of social network structures on prediction market accuracy in the presence of insider information. *Journal of Management Information Systems* 31(1), 145–172.

Rae, Jeneanne M. (2007) *Innovating Services in the Post-Six Sigma Era*, Peer Insight

Raphael, A. and Zott, C. (2001). Value creation in e-business. *Strategic Management Journal* 22(6/7), 493.

SEC (2005) United States Securities And Exchange Commission submission Form 10-K from Amazon. For the fiscal year ended 31 December 2004, www.sec.gov/edgar.shtml, accessed on 4 July 2016.

Shaw, M., Blanning, R., Strader, T. and Whinston, A. (eds) (2012). *Handbook on Electronic Commerce*. Springer Science & Business Media.

Silver, N. (2012). *The Signal and the Noise: Why so many Predictions Fail – But Some Don't*. Penguin.

Tambe, P., Hitt, L. M. and Brynjolfsson, E. (2012). The extroverted firm: How external information practices affect innovation and productivity. *Management Science* 58(5), 843–859.

The Economist (2011, 1 October) At a XXX-roads: The adult industry is seeking respectability – and profits.

The Wall Street Journal (2004, 29 June) In face of growing U.S. rivals, Europe's banks balk at talk that consolidation is needed, p. CI.

Tidd, J. and Hull, F. M. (eds) (2003). *Service Innovation: Organizational Responses to Technological Opportunities and Market Imperatives*. London: Imperial College Press.

von Hippel, E. (1994). 'Sticky information' and the locus of problem solving: Implications for innovation. *Management Science* 40(4), 429–439.

Ward, M. and Dranove, D. (1991). *The Vertical Chain of Research and Development in the Pharmaceutical Industry*. Mimeo, Northwestern University.

Zott, C. and Amit, R. (2015). Business model innovation: Toward a process perspective, in C. Shalley, M. Hitt and J. Zhou, *The Oxford Handbook of Creativity, Innovation, and Entrepreneurship* (pp. 395–406). Oxford: OUP.

CHAPTER 5

Marketing and Logistic Channel Management

Learning Objectives

After finishing this chapter, you will

- Understand how marketing and supply channels coordinate the sequence of activities that are required to bring a product from factory to customer.
- Understand how to use consumption chains to map the sequence of activities that comprise a *marketing or distribution channel*.
- Understand how channel capabilities are acquired and matched to the needs of the market.
- Understand that at least five types of individual are needed to expand a firm's capabilities into a new area of product or service innovation – idea generators, gatekeepers, champions, sponsors and project managers.
- Understand how marketing innovations such as cue-reward campaigns, neuromarketing and social marketing have influenced channel management.

After doing the *Innovation Workout*, you will see some of the unanticipated problems that arise because of the dynamics of channel activities.

After reading the Paxil *case study*, you will be able to understand the importance of the way that a channel strategy is conceptualized, and the impact that a particular conceptualization has on market acceptance of a product.

Channels

Marketing and supply channels coordinate the sequence of activities that are required to bring a product from factory to customer, or, for a service, the channel additionally controls contracting and settlement.

Channels have emerged to manage the complex hierarchies and markets in modern industry. Producers work with third-party service providers to stimulate demand for goods and services and achieve economies of scale and access to multiple competing consumer groups. Channel intermediaries provide value by mediating between producers and consumers by lowering costs of transactions and allowing managers to focus on their core activities. Third-party contractors such as shipping or advertising firms can consolidate particular channel operations from a variety of producers to gain economies of scale and share their expertise.

Channel intermediaries smooth the flow of goods and services, allowing firms to cope with uneven demand. This helps firms to better plan and control production activities by modulating possession, place and time utilities. Third-party channel services are better able to do this by serving a large number of producers supplying complementary goods and services with a common set of activities.

Channel intermediaries are able to achieve four key objectives that would otherwise be impossible for a single producer – *breaking bulk, creating assortments, reutilization of transactions* and *efficient search*.

Eight capabilities are managed channel intermediaries in pursuit of these four objectives – *physical possession, ownership, promotion, negotiation, provision of market information, financing, payment* and *risk bearing*:

Physical possession of inventory will be required at one or more points in the channel, depending on the cycle times required to produce, replenish, distribute and retail the firm's goods.

Ownership concerns property rights (a legal concept) and has grown increasingly contentious in the information age. Laws have traditionally addressed ownership of real and personal properties, ignoring intellectual assets (these will be covered later in this text). Particularly where items are large and unique, specific channel intermediaries have arisen to facilitate ownership and title transfer of goods. For very unusual transactions, these may require the services of a skilled lawyer. For less unique products, say houses, title transfer has been routinized and benefits from economies of scale.

Without a clear judgement on ownership, sales can be difficult. Unit sales of pirated media, for example, have been estimated to be several times the number of legitimate sales. There is a significant price differential between pirated and legitimate copies; for instance, a movie that at a theatre sells for $10 per ticket may be downloadable or streamable for free. This makes it difficult for legitimate channels to maintain any sort of competitive advantage. In some cases an entire legitimate market may evaporate, forcing industries to restructure. This happened to the music industry, which has evolved from selling expensive compact discs which contain the music to distribution via download services like iTunes and eventually to streaming services like Spotify and Apple Music.

The Pirates of Istanbul

The late 1980s saw a rise in overseas business schools and an increasing popularity of MBAs taught in English. One British textbook publisher found that in many emerging markets, their entire catalogue of business books was being made available from local pirates operating copy services that reproduced their texts in contravention of copyright laws. Pirates were able to obtain Xeroxed copies of nearly any British text on short notice, including the publisher's own.

One such alleged market was Turkey. Turkish intellectual property laws were weakly enforced and the publisher maintained only a small sales office in Istanbul that was unable to police illicit copies of its textbooks. A typical $75 textbook might be sold for copy costs of $5–$10, depriving the publisher of substantial profit. Adding insult to injury, customers were quite happy with the pirate's fast, reliable and friendly service in contrast to pointed complaints about the publisher's Turkish staff.

The publisher planned eventually to build up the Turkish market, and wanted to assure that in the long run its textbooks were selected over competitors. Its management in the UK contacted Turkish authorities to identify the pirates, discovering that distribution for the entire country was being run by two small groups of pirates in Istanbul.

Publishers typically distribute textbooks at marginal cost in many developing economies to thwart pirates. In the case of Turkey, this publisher simply agreed not to prosecute the pirates in turn for the pirates maintaining the quality of their copies. Its sales representative contacted the pirates, cutting a deal to make their entire business textbook library available for distribution by each of the pirate organizations for US$250,000 per year. To offset the cost it shut down its legitimate sales office, leaving the pirates essentially to act as local printers and customer representatives. The pirates made a profit; the publisher found the pirates to be faster and more efficient than its legitimate channels in that area; and the publisher's text maintained a presence in the Turkish market, which opened up future opportunities for expansion in that market.

Promotion of a product often demands specific talents, in addition to a wide range of customer contacts. The use of the WWW for electronic commerce has spawned a hi-tech cottage industry of graphic artists, multimedia and communications experts, and advertising types to construct online home pages which project the producer's corporate image, promote the producer's products and provide feedback on customer needs.

Negotiation is required for many big-ticket products, where price, options, customization and after-market service can be tailored to the needs of each individual customer. Automobile and home purchases are the most prominent examples of products in which negotiation is a central function in the channel.

The product ordering function has seen the most dramatic applications of information technology over the past two decades. Electronic data interchange, electronic commerce, online order forms, telephone direct orders and numerous other applications of computer and communications technology make it possible to place orders conveniently with cost savings passed on to consumers.

Market information is essential for production planning, and minimizing stockouts and other forms of risk which must be borne by channel members. Though existing applications in electronic commerce are only beginning to realize the potential for accumulation of market information, this has been an important application for computers over the past two decades. For example, Walmart has dedicated a worldwide telecommunications network and powerful Teradata supercomputers to provide itself and its vendors statistical synopses of demand patterns on a near real-time basis.

Financing is also required for expensive products, and is likely to be a significant factor in negotiation. Automobile and home purchases demand specialized financing. Sales of less expensive products, especially impulse sales, may be facilitated through the routine transactions financed with credit cards. Credit cards make the transfer of funds straightforward. They can also smooth the individual's cash inflow from income with the cash outflow from purchases.

Payment must be collected if producers and channel intermediaries are to stay in business. Payment presents an increasing problem as developed economies move away from cash transactions. Credit and debit cards have greatly facilitated this move, and have standardized and routinized transaction payments. Unfortunately, their use on open networks such as the internet is still suspect, and there have been numerous breaches of security that confirm suspicions. A considerable portion of the expense passed on to consumers and producers using credit cards for payment is needed to cover criminal abuse of credit cards. It may be difficult to protect against this abuse because of restrictions on consumer credit monitoring.

Risk bearing and insurance are important when products have a long production cycle (e.g. houses), where there is significant investment in inventories (e.g. jewellery), or where there are significant responsibilities incurred through warranties and for after-market servicing. Sales contracts typically state who bears the risk for performance of a product. This influences both price and marketability. For example, an automobile sold 'as is' will be worth less than one sold with a three-year, 50,000-mile warranty.

Modelling the Channel

We have already seen how we can represent marketing and distribution channels in addressing the 'commercialization' of an invention. Consumption chains provide us with a map of the sequence of activities that comprise a *marketing or distribution channel*. Channel objectives of *breaking bulk, creating assortments, reutilization of transactions* and *efficient search* can be represented within the consumption chain. The individual channel activities will typically be categorized by the particular role that they manage – *physical possession, ownership, promotion, negotiation, provision of market information, financing, payment* or *risk bearing.*

Consider how this might be implemented in the automobile purchase consumption chain described in Figure 5.1 which defines the very long sequence of channel activities that might be required by an automotive firm.

1. **Awareness:** provides *market information* and promotion for a potential solution to a customer's transportation problem;
2. **Search:** *efficient search* should quickly and easily direct a customer towards the firm's products and away from competitors;
3. **Selection:** the firm should *create assortments* of potential products that keep a customer interested and allow the customer to pick exactly the right product for their needs;
4. **Order and purchase:** typically involves *negotiation* over the package, accessories and ultimate price of the automobile;
5. **Delivery and receipt:** are both about *physical possession* and *ownership*, registered with the state, and coordinated with any financing;
6. **Payment and/or financing:** are naturally about *financing, payment* and *risk bearing*; the process is standardized for automotive purchases, so involves *reutilization of transactions* such that these transactions are routine for automobile purchases;
7. **Installation and assembly/storage and transport:** are about *physical possession* and *ownership* of the automobile in a form that is suitable for the customer;

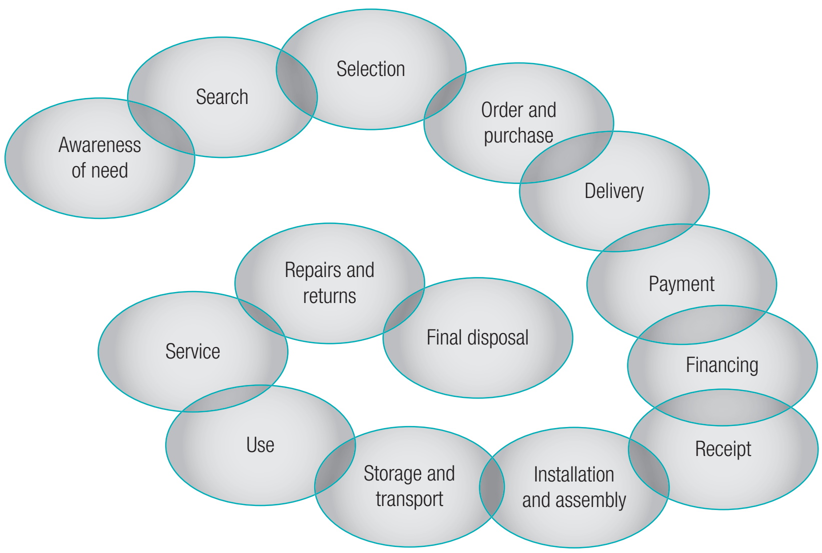

Figure 5.1 Customer Consumption Chain for an Automobile Purchase

	Basic	Differentiators	Energizers
Positive Impact	Advertising, product placement and so forth; information	Convey product information whenever customers in the target group are motivated to purchase, or to resolve a problem	Design, quality, status symbol
Negative Impact		Advertising is too aggressive as with 'spam'	
Neutral			

Figure 5.2 Demand-side Feature Map for the 'Awareness' Service on the Automobile Purchase Consumption Chain

8. **Use/Service/Repairs:** are again about *physical possession* and *ownership* of the automobile in a form that makes the car suitable and usable over the life of the automobile;
9. **Disposal:** in some jurisdictions, e.g. Germany, this can involve elaborate recycling of components of the product, and is an essential part of the *physical possession* and *ownership* of the automobile.

Each step of Figure 5.1's channel activities reflects a customer choice: either the customer moves on to the next link; or ceases to be interested in the product, in which case none of the subsequent links are visited. Moving the customer on to the next activity requires properly managing that channel activity. Management of channel activities can be depicted, for purposes of designing an innovation, in terms of our feature maps. That is, each activity on the consumption chain can be thought of as a particular 'service' where the firm is the customer. The objective of channel management is to:

1. Determine for each channel activity the critical *demand-side features* that must work correctly if the customer is not to leave the consumption chain and seek a competitor's product.
2. Determine for each channel activity the critical *supply-side features* that will minimize channel operation costs.

Consider how these channel activity-specific feature maps might look for just one of our automobile channel activities in Figure 5.1. Consider the 'awareness' activity that seeks to place our product offering in front of new customers who have never before heard of us.

Describing all of the channel activities, their objectives and activities, key features and cost drivers can grow enormously complex. This is one of the main reasons that, particularly for

	Core Features	Non-Core Features
Increases Costs	Expand the potential customer base, expand the brand and advertising reach of marketing campaigns	
Decreases Costs	Use word-of-mouth advertising only	

Figure 5.3 Supply-side Feature Map for the 'Awareness' Service on the Automobile Purchase Consumption Chain

start-ups, it is better where possible to outsource as many activities as possible, and concentrate management focus on the core tasks of the business.

Scientific Channel Management

Traditional trading and manufacturing businesses up until the 19th century were relatively simple affairs. Marketing and distribution favoured local delivery and consumption, and the concept of a 'channel' wasn't even mentioned. Management even for the largest colonial supply chains involving tea, opium, spices, furs and sugar was simple, slow and inefficient. Company management was simple: plantations and factories produced goods; retailers marketed those goods. Channels were simple and little consideration was given to their management.

That changed with the emergence of mechanized trading networks – in particular the railway networks that marked the shift from an agricultural to industrial economy at the end of the 19th century. Railways accounted for almost 15% of US gross domestic product (GDP) at the end of the 19th century. The expanded reach of railways demanded that farmers concentrate on single crops and improved efficiency of hybrid seeds to create large surpluses of grains for distribution throughout the US. This in turn drove down commodities prices, and incited groups such as the Granger movement to lobby on the part of farmers put out of business by railways mechanization. Universal access to rail transport was important, especially to farmers. The state of Iowa enacted legislation that required railways to provide service to within six miles (one day's buggy ride) of any farm in the state.

One of the colonial era's most treasured commodities was an oil that was distilled from the heads of sperm whales. Whale oil was prized as a clean, bright burning fuel (compared to the alternatives: dim, smoky pork fat or scarce beeswax) for the oil lamps that adorned drawing rooms and allowed scholars to work into the night in the 18th and early 19th centuries. As a result, by the start of the 19th century, sperm whales were all but extinct.

John Rockefeller – a man history seldom mentions as an environmentalist – built an oil refinery in 1863 in an industrial area of Cleveland called 'The Flats'. His oil was, indeed, an environmentally conscientious bid to 'save the whales' with alternative distilled petroleum oils that would burn brighter, cheaper and cleaner than even whale blubber. It was a success as a product, but he soon found that his supply channels were unreliable and expensive, and this repeatedly disappointed Rockefeller. Oil marketing and distribution channels were more complex than with any other product marketed, involving drilling, refining and delivery of a messy and sometimes dangerous liquid. Rockefeller sought to restrict what he felt to be the corrupting hand of the free market. Through a steadily broadening sequence of partnerships and acquisitions, he gained monopoly or monopsony control of railway stock and networks for oil shipment. He sought to simplify and consolidate the complex and widely distributed array of cars, rails, standards and entrepôts involved in the US railway system. His re-engineering of the oil distribution supply chain made Rockefeller the richest man in the world in the late 19th century and Standard Oil the US's largest company. Rockefeller retired in the 1890s just prior to the technological development – the automobile – that would propel oil into becoming the world's most important commodity.

Oil, railways, automobiles and other complex businesses in the 20th century hastened a separation of ownership and management that was further accelerated by the rapid expansion of stock markets in the early part of the century. This was a period of great innovation in management, much of it centred on channel activities. Two men in particular stand out as seminal thinkers that pushed forward the 20th century evolution of industry and channel management – Fredrick Winslow Taylor, author of *Scientific Management* (1912), and Claude C. Hopkins, author of *Scientific Marketing* (1923).

The foundations of modern industrial engineering and operations management theory lie in the analysis, empiricism, work ethic, efficiency and elimination of waste and standardization in best practices promoted by Fredrick Winslow Taylor. Taylor was a tireless promoter of his 'scientific management', constantly innovating and expanding his collection of techniques for squeezing efficiency out of production operations. The implementation of his methods in the design and engineering of Henry Ford's pioneering Highland Park plant, and later GM's Buick City, made him an immediate celebrity. Although demand for his services increased, throughout his life he never raised his original consulting rate of $35 per day. His methods demanded an ever-increasing level of managerial control over employee work practices, and over time necessitated a higher ratio of managerial workers to labourers than had previous industrial organization. This spurred important changes in ownership and control in large corporations, reflected, for example, in the hierarchical structure that Alfred Sloan put in place at General Motors.

Though Taylor died young, at 59, in 1915, his ideas continued to influence and evolve throughout the 20th century. During the 1940s and 1950s, the body of knowledge for scientific management evolved into operations management, operations research and management cybernetics. In the 1980s total quality management became widely popular, and the 1990s' 're-engineering' and Six Sigma 'knowledge management' and lean manufacturing can be considered the progeny of Taylor's scientific management movement.

Taylor reigned on the production floor; his counterpart in promoting a scientific approach to the management of marketing channels was Claude C. Hopkins. Hopkins was a popular copywriter for advertising campaigns at the turn of the 20th century, creating campaigns for the Bissell Carpet Sweeper Company, Quaker Oats, Goodyear tyres, Swift & Company and Dr. Shoop's patent medicine company (a prominent quack medicine which was profitable, but was quickly shut down by the government). Hopkins insisted that his copywriters research their clients' products and produce 'reason-why' copy. To track the results of his advertising, he used key-coded coupons and then tested headlines, offers and propositions against one another. He embraced empirical research about the effectiveness of his advertising. This was a very important innovation at the time, since marketing giants such as John Wanamaker were complaining, 'I know that half of my advertising dollars are wasted; the problem is that I don't know which half.'

Hopkins used his empirical analysis of various measurements to continually improve his advertising results, driving responses and the cost-effectiveness of his clients' advertising spending. He also championed 'branding' of products so that a company could share its marketing successes across products.

Hopkins was a master of overstatement. He claimed in his advertising that (to name just a few examples):

1. Schlitz beer cleaned its bottles 'with live steam', while neglecting to mention that every other company used the exact same method.
2. Cleopatra had washed with Palmolive soap (despite the scepticism of historians who suggested she washed with ash and clay) and so convinced millions of women into purchasing Palmolive.
3. Puffed Wheat was 'shot from guns' until the grains puffed 'to eight times normal size', which if indeed were true would make for some very expensive cereal.

Hopkins' greatest innovation came from marketing a product that he originally had dismissed as 'unsaleable' – toothpaste. The toothpaste was Pepsodent, and Hopkins took the job as a favour to an old friend. Pepsodent possessed the same basic features as all other toothpaste, but for some reason the owners of the brand chose to add mint flavouring to their toothpaste.

And there was a definite need for toothpaste in the early 20th century. As the nation had grown wealthier, people had started buying and eating larger amounts of sugary, processed foods. At the start of World War I, so many recruits had tooth decay and infections of the gum that the US government declared poor dental hygiene a national security risk. But people just weren't in the habit of brushing their teeth (or, for that matter, bathing).

The bigger problem from Hopkins' standpoint was that there was already an army of door-to-door brush salesmen promoting various tooth powders and elixirs to Americans, but without success and with most facing insolvency. No one bathed; no one brushed; and no one bought toothpaste.

Claude Hopkins set to work trying to figure out not just how to sell this 'unsaleable' product, but how to change the habits of an entire nation. With this he created rules to develop particular consumer habits that would benefit his product sales. Within five years he had turned Pepsodent into one of the nation's best-known products and in the process initiated the daily habit of tooth brushing across America, promoted by stars such as Shirley Temple and Clark Gable bragging about their 'Pepsodent smile'. By 1930, Pepsodent was sold in China, South Africa, Brazil, Germany and almost anywhere else Hopkins could buy ads.

Hopkins' genius was in re-engineering Pepsodent's consumption chain to become a continuous, obsessive loop of 'cues', 'rewards' and 'habits'. Today Hopkins' principles are used in video game design, food marketing, hospitals and so forth. Pepsodent's advertising campaign started by looking for a 'trigger' that would create a craving or obsession for product usage. Hopkins found this in an obscure dental term, 'mucin plaque'. Mucin or dental plaque is a biofilm attached to the surface of a tooth; the term 'mucin' has never been commonly used, but it sure sounded scientific. Hopkins crafted an advertisement for Pepsodent that read: 'Just run your tongue across your teeth … You'll feel a film – that's what makes your teeth look "off color" and invites decay.' In truth this film covers everyone's teeth all the time. It is a naturally occurring biofilm that builds up on teeth regardless of what you eat or how often you brush.

Pepsodent was a relatively unusual toothpaste in that it contained mint in its formula. Most other tooth products were bland or salty. The menthol in mint triggers the cold-sensitive receptors in the skin that are responsible for a cooling sensation when applied to the gums (it is similar in action to capsaicin in hot chillies that stimulates heat sensors without any actual change in temperature). With the right psychological preparation, the cooling menthol would overwhelm any perception of a film, and create an impression of cleanliness. Customers said that if they forgot to use Pepsodent, they realized their mistake because they missed the cool, tingling sensation in their mouths.

Hopkins notes that before the Pepsodent campaign, an estimated 7% of Americans had a tube of toothpaste in their medicine chests; a decade after Hopkins' campaign went nationwide, that number had jumped to 65%. By the end of World War II, the military downgraded concerns about recruits' teeth because so many soldiers were brushing every day.

The Elephant in the Drawing Room

The craze in the 18th and 19th centuries for billiards in English coffee houses nearly wiped out all of the African and Indian elephants in British colonies. Elephants were poached to near extinction for their ivory tusks. Indeed, in an era before plastics, ivory was the substance that would be used for any product that we would now want to make in plastic. The billiards industry offered a $10,000 prize for a replacement for ivory, a prize ultimately garnered by one John Wesley Hyatt. The winning entry took an explosive and modified it to create camphored nitrocellulose, or celluloid, through a process appropriately named the 'Hyatt gun method'. Nitrocellulose billiard balls were very affordable and became quite popular, but suffered a disconcerting tendency to explode upon impact. (Given the nature of billiards, this was not uncommon.) They were also quite flammable, and might spontaneously combust if left close to an open fire. One customer, an owner of a billiard parlour in the American West, complained 'he didn't personally mind that the balls occasionally exploded, except for the fact that every man in his saloon immediately pulled a gun at the sound'. Celluloid was the very first commercial plastic, and became widely used in film stock, artificial wool clothing (sweaters made from nitrocellulose became known as 'poof sweaters' for their tendency to spontaneously combust) and of course, smokeless powder.

Acquiring Channel Capabilities

Distribution and marketing channels are sequences of activities that are possible because of the underlying capabilities of the firm or partners which whom the firm contracts. Capabilities are often a constraint on innovation and market entry not only because it is expensive to acquire capabilities, but also because it is difficult to determine the value of what you have acquired when you invest in particular capabilities.

Assets are easier to buy, sell and value than are people; and competences nearly completely reside in the firm's employees. At least five types of individual are needed to expand a firm's capabilities into a new area of product or service innovation – idea generators, gatekeepers, champions, sponsors and project managers. Each class of individual has unique personality characteristics which make them good at what they do. Some may already exist in your organization (in fact every firm has an obligation to develop and promote individuals in each category that are good at what they do). Idea generators are good at sifting through large quantities of technological and market data to identify 'innovations' (Schon, 1963). Gatekeepers and boundary spanners are conduits for knowledge from other firms and labs. They are likely to be social and gregarious; happy to attend professional meetings and travel around the firm. Champions are the evangelists who 'get' the invention and are happy to sell innovation to the firm. They are enthusiastic, gregarious and tell a good story. They are also the first to understand the business model that will propel the invention to success. Sponsors are the coaches and mentors for the team that will bring the invention to market. They are often the senior level manager who provides behind-the-scenes support, access to resources and protection from political foes. Finally, project managers inject the discipline to complete the detail work, and may serve as a one-stop decision-making shop for the innovation.

Economist Eric von Hippel has suggested that innovations arise historically in one of two ways – by thinking about either functional or circumstantial activities surrounding the innovation. Functional innovation requires capabilities that can address the functional relationships between groups and individuals (e.g. customer and manufacturer). In contrast, circumstantial innovation requires capabilities that can address the circumstances in which a product (innovation) will be encountered (e.g. a cooking innovation when the product is consumed in a restaurant).

Most innovations do not arise from inside the producing firm. This fact has implications for capabilities that the firm needs to acquire, because if other individuals or organizations possess the capabilities to produce an innovation there is potential for outsourcing and buying capabilities on the open market; or for acquiring them through alliances – both are less risky than direct acquisition, though they may ultimately be less profitable as well. Innovations can be created in a firm's own laboratories (Teece, 1986); but they may also be procured indirectly from their competitors' laboratories. For example, when Toyota markets a new model of car, the engineering department of German car maker BMW is likely to be one of the earliest purchasers. These cars will be completely disassembled, measured, chemically tested and so forth until BMW's engineers are thoroughly familiar with Toyota's latest innovations. The same sort of engineering may be procured on the open market. For example, Porsche has for many years offered consultancy services to various other car manufacturers. Studebaker, SEAT, Daewoo, Subaru and Yugo have consulted Porsche on engineering for their cars or engines, and Harley-Davidson consulted Porsche on the design of its V-Rod motorcycle. There are also substantial resources invested by governments in university laboratories and science parks which are increasingly important as sources of innovation.

Crafting Effective Channels

Even if you create marvellous inventions, your customers will not care unless those inventions are precisely what they think they will need and that fact is communicated and presented to them through your channels. Business customers are especially impatient with any product that fails to help them gain competitive advantage. At the same time, your own firm cannot expect to maintain its competitive advantage unless the services and products, and all the complementary processes, lie mostly within the firm's core capabilities – their existing corporate inventory of assets and competences. Firms establish their core capabilities by investing in their people, investing in their assets and facilities, and firmly identifying and focusing on their mission. Core capabilities consume your resources; innovative services and products generate more resources. The creative tension within an innovation firm continually reviews and balances one against the other.

Our capabilities are defined by our competences (what we do well; perhaps better than any of our competitors) and our assets (the physical and intellectual property we own that erects barriers to entry for competitors). This fundamental equation (capabilities = competences + assets) determines the space in which we can effectively compete.

The first step in managing capabilities is to assess whether your existing capabilities are sufficient to remain competitive in your market. 'Sufficiency' in turn is a moving target; entry and exit of competitors, new product and service offerings, and new technologies will keep an innovator's market in flux. This, then, is more often a question of whether we are evolving our capabilities as the industry in which we compete evolves. It is the interplay of the capabilities of one's own firm and the competitive marketplace that directs strategy and investment.

Crafting effective channel operations is not necessarily straightforward; consumers may at times act irrationally or in defiance of the firm's best conceived marketing strategies. Consumer avoidance of disconfirming evidence, for example, is related to a third 'irrationality' that concerns the evidence that investors choose to accept as true. People generally tend to anchor on salient evidence – they overweight evidence that is vivid and captures attention; they prefer stories rather than data. They tend to be less critical of the source of information if they like the message. And they tend to overweight evidence that supports their existing belief and do not collect disconfirming evidence.

Channel Management and Firm Strategy

Drucker originally perceived strategy as a battle waged with competitors in the marketplace. Managers were able to draw directly on parallels from military strategy. Predictably, flaws in the metaphor raised immediate objections from several quarters. Wars are limited to a relatively short time frame, while firms may muddle on for decades. In the 1970s James March and Richard Cyert promoted behavioural concepts of organizational slack and managerial bounded rationality in describing the limits of strategy in practice, and why managers so often chose sub-optimal strategies. In the 1980s Oliver Williamson suggested that sub-optimal behaviour was a matter of degree, and in the long run the fittest will win out, subject to industry- and market-specific transaction costs. In the 1990s, sociologists like Mark Granovetter promoted the idea that culture strongly influences firm-specific strategy, as well as the optimal strategy in a market. For example, competition in Asia could be predicted to vary considerably from that in the US due to fundamental differences in culture. More recently managers have grown fond of integrating all of the considerations into a resource-based view (RBV) of strategy that recognizes that firms possess a unique 'personality' influenced by culture, transaction costs and bounded rationality, but also by a firm's specific history, managerial personalities and in general its unique capabilities. Activities in both vendor and consumer markets are constrained and moulded by the firm's capabilities in the RBV.

The dominant view of strategy and strategy formulation today is the RBV of firms' decision making. The RBV suggests that a firm's unique resources and capabilities provide the basis for a strategy. Strategies should be chosen to allow the firm to best exploit its core competencies relative to opportunities that arise in the external environment (Figure 5.4).

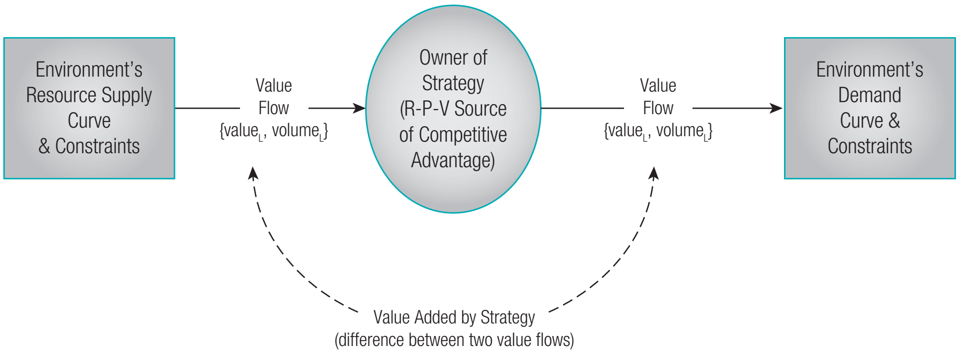

Figure 5.4 Resource-based View of Strategy

Vacuum Tubes: The Market for Niche Innovations

Vacuum tube amplification has been around for a long time. Thomas Edison first observed in 1883 that a current flowed between the filament of an incandescent lamp and a plate in the vacuum near it when the plate was connected to the positive end of the filament, but not when the plate was connected to the negative side. In 1899, J. J. Thomson showed that this Edison Effect was due to a stream of negatively charged particles, electrons, that could be guided by electric and magnetic fields. Further developments led Lee de Forest to patent the Audion triode vacuum tube (also known as a 'valve') which was immediately put to use in audio amplifiers. For more than a half century, these devices were the preferred choice for amplifying music.

Audio amplifiers based on transistors became practical with the wide availability of inexpensive transistors in the late 1960s, but they took a long time to reach that stage of development. The first patents for the transistor principle were registered in Germany in 1928 by Julius Edgar Lilienfeld. On 22 December 1947 William Shockley, John Bardeen and Walter Brattain succeeded in building the first practical point-contact diode transistor at Bell Labs for use in radar units (early tube-based technology did not switch fast enough for radar). Problems creating a working transistor triode needed for audio amplification required Bardeen to develop an entirely new branch of surface physics to account for the 'odd' behaviour of transistors.

From a design standpoint, transistors are much more flexible than tubes. They can enable very high power in a very small package. They don't inherently draw much power nor create much heat, nor require high voltages. Myron Glass, an engineer at Bell Labs, once quipped that 'nature abhors a vacuum tube' and went on to list the advantages of transistors for amplification:

- Small size
- Highly automated manufacture
- Low cost, low power dissipation, low operating voltage
- No warm-up period (vacuum tubes need 10 to 60 seconds to function)
- High reliability and physical ruggedness
- Much longer life
- Complementary devices allow much more flexibility in circuit design
- Ability to control large currents (even one ampere tubes are large and costly)
- Much less microphonic (vibration can create ugly noises in amplifiers)

Yet, with all of these benefits, there are to this day still high-end audio aficionados who prefer tube-based amplifiers, claiming they have a 'warmer' sound due to a more linear V/I characteristic. Since these amplifiers cost two to 10 times the price of comparable transistor amplifiers, this constitutes a serious market for niche innovations in vacuum tube technology.

Social Networking

Internet social networking has been seen as a cost-effective successor to traditional promotion methods, a use of the internet that was predicted in the 1990s. Consider, for example, film marketing, which suffers from inherent high cost and financial risk. internet social network promotion has grown over the past decade to play an essential role in film marketing. Studios tend to invest in expensive marketing campaigns to maximize revenue early in the release cycle. Marketing budgets for films tend to range between half to three times the production budget, with marketing campaigns handled by distributors and exhibitors. Trailers have been a mainstay of film promotion because they are delivered directly to moviegoers. Hollywood also spends about $4 billion per year to buy TV and print advertising. Product cycles have accelerated, and films typically do not show in theatres for more than 4–6 weeks. Thus studios are increasingly sensitive to advanced audience interest in movies, as well as advanced criticism arising from market positioning.

The immediacy and ubiquity of the internet has motivated studios to allocate significant sums to the internet social network market to stimulate and ascertain audience interest. For independent films this is becoming a major strategy for low-cost promotion. Because of large expenditures on promotion in print and TV, the internet is also attractive as an economical alternative. Over the past decade, internet social networking and marketing technologies have been increasingly adopted by film studios, incentivized by the internet's ability to target high-value customer groups through their search preferences. Cinema fans are increasingly likely to purchase tickets for movies with successful internet social networking promotions – for example: (1) through creation of stand-alone studio-sponsored per-film websites with uniform resource locators like www.brooklyn-themovie.com, (2) through viral marketing and free distribution of trailers on movie-oriented websites and (3) through rapid dissemination of content links by email and blogs.

In the late 1990s several compelling case studies emerged that suggested the potential of social networks. In 1999 *The Blair Witch Project*, an independent film shot for $22,000, managed to launch itself into a major release through clever use of social networks of Wicca aficionados. Their promotion through social networking included a groundbreaking campaign by the studio to use the internet to suggest that the film was a real event. The film went on to earn revenues of $250 million, making it the third highest-grossing independent film of all time. Over the subsequent decade, internet social networking and marketing technologies were steadily adopted by film studios, greatly assisted by the growth of dedicated social networking internet sites.

In 2003, the founders of MySpace promoted their social networking site with parties in Los Angeles with clubs and bands, to attract offline groups of people to use the site in the promotion of artists, music and cinema. Official movie release sites were at that time more effective than a MySpace promotional site. But when social networking programmes were added into the MySpace site, the film release achieved higher performance, though this was found to be dependent on the strategies adopted by studies for responding to messages within the social community.

In other realms of television and cinema entertainment, reality star Tia Tequila, who used MySpace to build her fan base, launched a lucrative career based on her posts and two million followers. Numerous independent cinema and music producers sought commercial success by leveraging the MySpace platform; for example, such a promotional approach found its way into the marketing of the 2008 film *The Dark Knight* which adopted a viral marketing campaign utilizing the film's 'Why So Serious?' tagline. Similarly, *Toy Story 3* (2010) was promoted by Pixar's YouTube advertisements that were cleverly posted to look like 1980s toy commercials.

Success of social networking in raising awareness of the otherwise unexceptional film *Snakes on a Plane* enticed Samuel L. Jackson to join the cast, and academics to start investigating models and experience in use of social media for cinema promotion. This resulted in a global research stream, with studies in India, France, Canada and other cinema industries.

The use of social media as an adjunct to statistical marketing models to both predict and manipulate cinema markets has risen in importance. Social media content can now effectively be used to predict real-world outcomes, analysing the chatter from Twitter.com to forecast box-office revenues for movies. Auctions like the Hollywood Stock Exchange predict movie successes with very high accuracy. Using similar approaches, recommender systems for digital music, media and entertainment innovations have become standard, and are built into playback software by Apple, Microsoft, IMDB and others. In many cases, these are integral parts of blogs and social networking systems that promote particular entertainment products, including cinema.

Neuromarketing: Frontiers in Customer Relationship Management

The application of emotion reading to marketing, law enforcement, judicial proceedings, health and other venues has a long history. For example, crime suspects in ancient China were told to hold a handful of rice in their mouths. If the rice stayed dry, they were absolved of their crime. In other societies, 'trial by ordeal' absolved possible criminals if they were not burned by hot irons, molten metal or boiling oil poured onto a hand or in their mouth. In other situations, interrogators might scrutinize involuntary facial micro-movements to determine whether a person was lying, or challenge their ability to walk over hot coals without being scorched.

The Prototype Database

Ichiro Asai is one of the best motorcyclists in the world, most recently winning the coveted 2001 SuperSports 600cc class FIM Asia Road Racing Championship. He also has one of the most daunting 'day jobs' in the world – as a test rider for Yamaha Motorcycles' prototypes at the factory's Sugo racetrack near Sendai, Japan. The softly spoken Asai described his job one afternoon during some free time at the Sugo track:

> The bikes need to be driven at 110% of their capabilities. We really push the bikes past their limits. The test driver's job is to discover design flaws, whether it is in the chassis, motor, suspension, ergonomics or any of a thousand other aspects of the bike.

None of this seems particularly surprising until Asai relates the terms of his contract with Yamaha. 'I have my job up until the first time that I crash the motorcycle. Any damage to their prototype and I will be fired immediately.' This is a bracing revelation in light of the fact that motorcycles, unlike most other forms of transportation, suffer what engineers call 'capsize instability' – they fall over.

Yamaha spends millions of dollars on R&D, prototyping and homologation which can take up to ten years and tens of thousands of test laps in a typical design. Its prototype is an extremely expensive individual unit, and one that is not easily replicated. Once the design is stable, production is simply a matter of stamping out the finished motorcycles. In motorcycles and many other tangible goods, the majority of cost is incurred up-front, in the generation of ideas – not at the end, when materials are being used.

The use of the electrical measurement to detect emotion dates to the time of its invention by Italian physiologist Luigi Galvani in his paper on animal electricity in 1791. The seminal study of psychosomatic bioelectric effects appeared in the 1870s in the study of basal skin resistance and stimulated skin resistance in connection with psychological state. It was suggested that this work could be applied to the fields of criminology and hypnotherapy, among other uses. Independent studies found evidence of correlation between electricity and human emotions. So-called electrodermal studies were seen as one way to read human emotional responses through observations of physiological changes, such as sweating and involuntary muscle contractions. Such primitive emotion reading was employed for a variety of purposes, from the spiritual to the forensic.

After nearly a century of laboratory studies by the early innovators, electrodermal response (EDR) was applied in a repeatable, scientific methodology, which led to practical applications and the use by early adopters. This provided a basis for wider use of EDR-based approaches. It also made EDR popular with practising psychotherapists. Others described clinical techniques for EDR measurement, while words were read to the subject from a prepared list. If a word on this list was emotionally charged, there was a change in body resistance, and this caused a reading. This allowed the EDR to become reliable sources of data for psychological questionnaires, foreshadowing their applications in forensics, marketing and surveys.

Early EDR devices were not simple to use. They were fundamentally Wheatstone bridge null detectors that ran a small current through the subject's palms or soles of his feet, while varying a resistor until a moving arm galvanometer read zero. They also lacked amplification: the electron tube had not yet been commercialized. This tended to make them inaccurate and inconsistent in their readings. This null configuration was useful in the early days, when temperature and humidity might make component values drift. When they drifted in the same direction, rough accuracy would be maintained. With the commercialization of vacuum tubes in the beginning of the last century, electrical engineers began experimenting with amplifying the Wheatstone bridge-galvanometer null detector set-up that existed.

Evolution from the early adoption stage of a technology to majority adoption required three capabilities to be in place: a standard user interface, a usage methodology and a technology market that has choice and is affordable. In affective EDR, all three of these had matured by 1930. They significantly increased the value of the technology to users, and spurred wider adoption by increasing their production, marketing and application.

Amplification made EDR much less troublesome to use, and made electrodermal measurements available to the majority of adopters by 1930. Polygraphs, as machines for measuring affective data streams were called, became widespread and affordable in the 1920s and 1930s. The methodology, user interfaces, theory and application of polygraphs in law and marketing were studied and standardized by William Marston. Marston was a remarkable innovator – a lawyer, inventor and comic book writer who created the character Wonder Woman, suggested to him by the two women, Elizabeth Marston and Olive Byrne, with whom he maintained a ménage à trois.

Parable of the Fish

Functional magnetic resonance imaging (fMRI) which measures change in blood flow related to neural activity in the brain and spinal cord has become a core tool in spinal diagnosis in the past two decades. Yet diagnosis has suffered a crisis of scientific method similar to that of drug R&D. Americans spend $90 billion annually treating back pain – roughly the same amount as is spent on cancer. Until the 1970s, the only remedy for back pain was bed rest, and most patients improved. With the advent of MRI in the 1990s, epidurals and surgery were increasingly prescribed, to treat the various 'causes' of back pain discovered in fMRI scans. Patient recovery decreased.

Enormous amounts of data are generated by fMRI scans, and this data is error prone and difficult to interpret as brain processes are complex and often non-localized. Partial least squares regression models have been widely applied in fMRI imaging to analyse and interpret the mass of data generated in these 15–20-minute scans. Unfortunately, such analyses are only as accurate as the data, and are limited by the reliability of the brain model that is used to describe the structural model's latent variables and factors.

The problem of fMRI data accuracy is illustrated in a widely cited article (Bennett, Baird, Miller & Wolford, 2009) that describes Dartmouth neuroscientist Craig Bennett's fMRI scan of a whole Atlantic salmon (purchased at a local fish market, and which, as Bennett dryly notes, 'was not alive at the time of scanning').

While the fish sat in the scanner, Bennett showed it 'a series of photographs depicting human individuals in social situations'. To maintain the rigour of the protocol the salmon, just like a human test subject, 'was asked to determine what emotion the individual in the photo must have been experiencing'. If that were all that had occurred, the salmon scanning would simply live on in Dartmouth lore as a 'crowning achievement in terms of ridiculous objects to scan'. But the fish had a surprise in store. When Bennett got around to analysing the fMRI data, it looked as if the dead salmon was actually thinking about the pictures it had been shown.

Not only has Bennett's study generated much mirth in a normally tedious field, but it has spawned its own slew of books – from both inside and outside of the field of brain imaging – critical of the statistical methods used to analyse all that data coming out of the fMRI machines.

One lesson should be taken away from these well-documented failures: all of the data collection and analysis in the world will not make up for the failings of a bad model.

Marston famously applied various affective, emotion-reading technologies in advertising for the Gillette company. He wrote in his advertising copy that: 'My study enables me to state lately that Gillette Blades are far superior in every respect to competitive blades tested.' Marston's public stature encouraged innovations in criminal law enforcement adopted by the Chicago Police Department, which promoted the application of new interrogation techniques based on affective technologies – particularly EDR technologies – and other law enforcement agencies followed Chicago's lead. The development of the polygraph integrated EDR measurement devices with respiration, blood pressure and perhaps temperature, and other physiological responses to stress. The layering of affective measurement devices reflected the limitations in any particular physiological measurement. Affective forensics were so effective, however, that legal and commercial use of lie detectors grew rapidly after World War II, with over 100 companies producing machines to read EDR data streams by the early 1950s.

These technologies are now mature, and EDR measurement devices are widely adopted, though interpretation is still controversial. EDR technologies appear in other contexts as well: biofeedback and protocols designed to help control epileptic seizures; relaxation and analysis within various spiritual groups; as a controller for video games and other computer interfaces; and in forensic interviews. Low-cost emotion-reading systems have been applied in entertainment devices since the 1990s, and are increasingly popular for a variety of tasks.

Innovation Workout: Feature Segmentation

Sometimes the solution to a problem lies within the problem itself. Taking a feature or activity and artificially splitting it into two parts allows you to take a challenge apart and then reassemble the parts into new ideas.

Feature segmentation divides a challenge into separate blocks which you can reassemble in different ways to create any number of alternative ideas.

Consider the problem faced by audiophile designers looking for ways to innovate on solid-state amplifiers, which are not seen to have some of the 'warmth' and 'authenticity' of traditional vacuum tube amplifiers.

We saw earlier that from a design standpoint, transistors are much more flexible than tubes. Some of the discriminators, the features that distinguish transistors from their competitive vacuum tube circuits, are:

- Sound tends to be 'cold' and 'mechanical'
- Highly automated manufacture, lower cost
- No warm-up period (vacuum tubes need 10 to 60 seconds to function)
- High reliability and physical ruggedness
- They control large currents, but don't inherently draw much power nor create much heat, nor require high voltages.

If we were to look for ways to make the transistor more competitive in the audiophile market we could try to segment one or more of these features to re-engineer the feature set.

Take the 'No warm-up period (vacuum tubes need 10 to 60 seconds to function)' feature. That could be re-engineered as a switch:

> Position 1: Instant on (for the person who requires instant gratification).
> Position 2: Circuit stabilization and room equalization for the particular location of speakers (corresponding to the vacuum tubes warm-up period).

Thus a transistor amplifier could be given some of the psychological character of a vacuum tube amplifier by offering room equalization after warm-up.

Consider another feature: 'Sound tends to be "cold" and "mechanical".' A single circuit design for a transistor amplifier could be re-engineered as two amplifiers:

> Amplifier 1: Pure solid-state transistor circuitry, with all of the low-cost, low power consumption, high power output benefits of such circuitry.

> Amplifier 2: Vacuum tube first stage for sound shaping; solid-state transistor circuitry for remaining amplification stages. This will impair the low-cost, low power consumption, high power output benefits of solid-state circuitry, but will add the warmth of vacuum tube sound shaping.

These are just two ways to extend the feature set of a transistor amplifier. Indeed, many approaches have been taken to making solid-state transistor amplifiers more competitive with vacuum tubes. In the extreme, engineer Bob Carver has added solid-state computer chips for sound shaping in transistor amplifier circuitry that are effectively able to imitate any tube amplifier at a fraction of their cost.

Case Study: Paxil – 'Mind Mapping' the Mind

Recent history has seen more than a dozen huge mergers of large pharmaceutical companies – as well as many failed attempts. The largest merger was Pfizer's (the largest drug company in the world, American) acquisition of Pharmacia (the eighth largest, also American) for $60 billion in 2001. In 2004, Pfizer had annual sales of nearly $53 billion, with GlaxoSmithKlein's (the second largest drug company in the world, British) sales at $37 billion. Indeed, all of the world's 10 largest pharmaceutical companies have been the result of one or more mergers. The only exception is Merck, the fourth largest drug company in the world (American), with 2004 sales of $23 billion. Still, the top 12 pharmaceutical companies control less than 50% of total world drug sales, and so there still seems to be a great deal of room for further mergers in the industry in the future.

There are three major reasons for the urge to merge in the pharmaceutical industry. The first and most important arises from the incredibly high cost (about $900 million in 2005) of developing and marketing new drugs. Despite average profit rates of about 15% in the industry, these huge development costs are getting out of the reach of even the largest drug companies, hence the need for further consolidation and globalization in the industry, even by today's largest industry players. The second reason is that management typically expects savings equivalent to 10% of the combined sales of the merged company. These can run in the billions of dollars per year for the largest companies. The third reason is that the combined sales force of the merged company can reach that many more doctors and hospitals, and thus increase sales. Although making a great deal of sense theoretically, most mergers in the pharmaceutical industry did not deliver the benefits expected. In all cases the merged company lost market share and faced reduced profits after the merger.

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Because of price regulation (and thus lower profit margins) and fragmented national markets, European drug companies are losing international competitiveness to US firms. All companies now face very strong competition from generics as patents (usually granted for 20 years from the date the application is filed) expire on many blockbuster drugs. Generic drugs usually sell for as little as 10–20% of the patented drug. By 2005, about 50% of all prescriptions were filled by generic drugs (up from 20% in 1984) in the US (saving consumers more than $10 billion). In recent years several drug companies were also hit by huge lawsuits for the alleged harmful side effects of their drugs. In 2004, Merck was forced to withdraw from the market its painkiller Vioxx (that had brought in $2.5 billion per year in revenues) for causing heart attacks, and faced thousands of lawsuits with potentially billions of dollars in damages.

Jan Leschly, tall, handsome, deeply tanned and charming, was fond of practising his backhand and forehand, even when he wasn't playing tennis. Leschly was a fierce competitor, ready to unload on colleagues with exhortations like 'if you're not keeping score, you are just practising' or 'never step on the court without expecting to win'. The son of a brewer, he wouldn't have been considered a Big Pharma type in the 1980s, but after a highly successful stint at Squibb where he built the drug Capoten into a $700 million a year best-seller (unheard of in that day) Leschly was executive hot stuff. Leschly left Squibb in 1990 to reassess his priorities (with a sojourn in Princeton's graduate programme in philosophy), emerging to take the job as the right-hand man to Jean-Paul Garnier, CEO of SmithKline.

Risks of Overdose in Tricyclics

Studies in the 1990s in Australia and the United Kingdom showed that between 8% and 12% of drug overdoses were the result of tricyclics, and it was thought that tricyclics might be involved in up to 33% of all fatal poisonings, second only to analgesics. Tricyclics were often the choice of suicides, because of their pleasant mode of action.

But many of these overdoses are accidents, due to what doctors call their 'narrow therapeutic index', i.e. the therapeutic dose is close to the toxic dose. Doubling the prescribed dosage may result in poisoning, with uncertainties that increase the risk of toxicity including advancing age, cardiac status and concomitant use of other drugs and alcohol.

Leschly's perspective on the drug business had evolved during his sojourn among the Princeton philosophers. Leschly had come to see pills not as chemicals, but as software. Moreover, he saw this as a rationale for the escalating prices of drugs. He would explain to visiting journalists:

> suddenly information technology was so essential that we realized we are an information company more than we are a pill company. Because it's the software, all the research, networking, marketing, that's so important in that pill. The pill is a piece of software!

Every successful software company looks for a killer app; Leschly's was an antidepressant called paroxetine. Brand name: Paxil. It was one of a number of drugs available for treating mood disorders; Lilly's Prozac was one, Pfizer's Zoloft another. None was new – they had all been around since the 1970s. Like Prozac and Zoloft, it was not really any better than previous generations of drugs (called tricyclics) at alleviating depression. But it had one huge advantage from a marketing standpoint: it was almost impossible to overdose on it, and that made it easy to sell to (generally risk-averse) general practitioners in an era of rapidly escalating malpractice liability.

Paxil was a powerful cultural product tailored to a generation of young, obsessive, upwardly mobile professionals who were not keen to relive their parents' experience with Valium. Valium, which had been touted as a non-addictive successor to the tranquillizer Librium in the 1960s, turned out, in fact, to addict its users. Valium's troubles had hobbled the tranquillizer industry ever since.

But SmithKline, in the period since Valium, had gained a powerful new tool in its arsenal. Direct-to-consumer advertising had in the intervening period been allowed by the Food and Drug Administration. In the 1960s, all drugs were prescribed under the advice of physicians; patients were carefully guarded from knowing anything that might possibly hurt them. This fitted well with the physicians' 'benevolent gatekeeper' role.

Leschly knew that he could avoid the opprobrium surrounding Valium only by telling the Paxil 'story' SmithKline's way. 'The Story', a new-age parable, often illustrated with brightly coloured diagrams and cartoon characters, unfolded like this. Paxil worked on a different brain chemical system than did older drugs. The name of this 'natural' brain chemical was serotonin. In some depressed patients, this chemical was lowered in volume because a certain brain synapse was 'overactive'. Paxil, by 'naturally' blocking reuptake of serotonin led, it was touted, to relief from depression.

Was 'The Story' true? Well, every component had elements of truth. But no one really actually knows what serotonin balance is. It has rarely been measured (and then, only in dead people) and it would certainly never be measured in any patient coming to a general practitioner (the procedure involved a spinal tap!). Indeed, it was known that in different populations, both low and high levels of serotonin had been associated with depression. Yet all this misses the point: 'The Story' was a simplification provided to help resistant physicians explain a complex and poorly understood biological process to recalcitrant patients.

Paxil sailed through Food and Drug Administration (FDA) trials, being approved for sale as an antidepressant in the US in early 1993. While trials were in process, Leschly had made sure that the company's marketing department had talked with its pharmacologists. Indeed, the marketing people came away with something useful. They found out from the pharmacologists that Paxil only affects particular neurotransmitter systems, not all. It is technically a 'selective serotonin reuptake inhibitor' from which the marketing department took away simply that it was 'selective', connoting a sort of 'cleanliness' which distinguished it from previous generations of 'dirty' drugs. This made Paxil seem somehow better. Marketing promptly commissioned a set of advertisements (which have become legend in medical marketing) depicting a pool table to show how other antidepressants were 'scattershot' and how Paxil was the clean, winning eight ball in the side pocket.

One of the stickier parts of FDA approval was that a drug was approved only for treatment of the specific malady specified in the approval documents. Any other use (for example, of an antidepressant drug for treating panic attacks) would be considered 'off-label' and was strictly prohibited. Such prohibitions were often difficult to enforce, because doctors could diagnose a particular set of symptoms as any one of a number of maladies.

Off-label proscriptions were a concern as Leschly's product development group thought about new outlets for Paxil, trying to enlarge their base of potential 'customers' by selling it as a cure for a number of related psychiatric disorders. There was the notion of a 'panic disorder', a highly agitated state of mind that might have specific or non-specific causes. Psychiatrists were pressed to define exactly what a 'panic disorder' was, except that they once used to prescribe Valium for it. There was also the better-studied phenomenon of the obsessive-compulsive disorder, which might include sub-disorders like bulimia, anorexia and so forth. Though the disorder was rarely seen (at least in the early 1990s) there were likely to be many undiagnosed cases out there, and it was just a matter of alerting and educating general practitioners to this lurking threat to mental health. And yet another opportunity raised itself: a phenomenon known as 'social phobia disorder'. This was another bona fide psychiatric disease, a debilitating lack of social confidence that led its sufferers to lives of isolation, loneliness and inability to perform many of the simplest tasks of everyday life. As traditionally measured, it affected very few people in the US or Europe (in fact it was known mainly as an 'Asian disorder'). But again marketing determined that there could be many undiagnosed cases, waiting for a prescription to Paxil.

To prepare the stage for Paxil's social phobia launch, Leschly's marketing department commissioned a huge publicity campaign to raise awareness of the disease, one that set the pattern for many to follow both at SmithKline and in the industry. The first step involved the hiring of a public relations agency to produce a free video on the disease and distribute it widely for use by network affiliates and independent TV stations (health stories of any sort guaranteed a minimal audience, and the fact that these were 'free' health stories was just icing on the cake). The second step was to underwrite studies by experts in the field, who would conclude that the disorder is debilitating and probably afflicts many more than originally suspected. Finally, while awaiting for FDA approval for a new use, a few small-scale studies off-label (i.e. where the drug is used for other than its approved purpose, which in Paxil's case was adult depression) were underwritten. Through these, SmithKline became aware of even more promising new markets in child and adolescent depression.

By 2000 Paxil's unrelenting expansion of 'markets' (i.e. diseases) treatable with Paxil had proved brilliant; Paxil was FDA approved for depression, panic disorder, obsessive-compulsive disorder and social anxiety disorder (the latter routinely described on nightly TV as affecting tens of millions of people in the US alone). At the end of 2000, Paxil had sales exceeding \$2.1 billion per year. Not bad for a drug that had languished on the shelves of SmithKline's labs for most of the 1970s and 1980s.

Questions: Paxil Case Study

1. Describe SmithKline's Paxil business model. Where does SmithKline make money?
2. What are its costs?
3. How did SmithKline use adaptive execution to develop its selective serotonin reuptake inhibitor (SSRI) antidepressant business? What firm competences does SmithKline possess that made it a successful competitor in the antidepressant market?
4. What was innovative about Paxil versus the other tricyclics? How did this help its commercialization?
5. With complex products, an important part of 'product design' is telling 'The Story' about the product, its use and its benefits. Describe how Leschly made the Paxil Story the innovation.
6. Challenge one of the fundamental assumptions of Paxil's business model by reversing it. Then define an 'anti-Paxil' product and business model that satisfies your reversed assumptions.
7. What are the commercially important features that make Paxil's business model successful and sustainable?

Chapter 5: Questions for Review

1. What do we mean by a channel? What is the difference between a distribution channel and a marketing channel?
2. Channel management has changed dramatically over the past two decades as a result of the growth of the internet. What channel activities have been most affected by the internet? Why do you think that these channel activities have been most affected?
3. How did containerization of shipments revolutionize the logistics industry and pave the way towards globalization?
4. Think of one product, service or industry. Explain the activities that comprise the channels for particular customer groups for this service or industry. How have advances in channel technology changed the structure of the industry? How has this changed the activities and resources required to successfully compete?
5. For the same product, service or industry, explain the changes in the past decade that have accelerated the forces of commoditization in industry. How has this changed the structure of the industry? How has this changed the activities and resources required to successfully compete?
6. For the same product, service or industry you chose in Question 4, identify opportunities for innovation in industry. What new products or services do you expect to see in 10 years in that industry? How will the industry and market structure be different in 10 years?
7. If companies are only interested in innovations that ultimately will be profitable, how can channels advance or hinder that profitability? Think in terms of both demand for the features of that product or service, and the potential quantities to be sold.

Chapter 5: Key Points

1. Marketing and supply channels coordinate the sequence of activities that are required to bring a product from factory to customer.
2. Consumption chains are a conceptual tool to map the sequence of activities that comprise a *marketing or distribution channel*.
3. Channel capabilities are acquired and matched to the needs of the market.
4. Channel activities have been significantly advanced by the low-cost capabilities of the internet, and by marketing innovations such as cue-reward campaigns, neuromarketing and social marketing.

Further Reading

Achrol, R. S. and Kotler, P. (1999). Marketing in the network economy. *Journal of Marketing* 63 (Special Issue), 146–163.

Ainslie, A., Drèze X. and Zufryden F. (2005). Modeling movie life cycles and market share. *Marketing Science* 24(3), 508–517.

Annett, M. and Kondrak, G. (2008). A comparison of sentiment analysis techniques: polarizing movie blogs, in Berger, S. (ed.), *Proceedings of the Canadian conference on Artificial Intelligence*. *Lecture Notes in Computer Science* 5032 (pp. 25–35). Heidelberg, Germany: Springer.

Ashley, J. W. (1962). Stock prices and changes in earnings and dividends: Some empirical results. *Journal of Political Economy* 70(1), 82–85.

Ashley, M. (2010). Digital conservation and access: Saving humanity's history in the petabyte age. *Virtual Archaeology Review* (April), www.scribd.com/doc/50085490/Ashley-M-Digital-Conservation-2010, accessed on 7 January 2012.

Asur, S. and Huberman, B. A. (2010). Predicting the future with social media. In *Proceedings of the IEEE/WIC/ACM International Conference on Web Intelligence* (pp. 492–499). Washington DC: IEEE Computer Society Press.

Ball, R. and Brown, P. (1968). An empirical evaluation of accounting income numbers. *Journal of Accounting Research* 6(2), 159–178.

Banerjee, N., Chakraborty, D., Dasgupta, K., Mittal, S., Nagar, S. (2009). R-u-in? exploiting rich presence and converged communications for next-generation activity-oriented social networking. In *Proceedings of the 10th International Conference on Mobile Data Management* (pp. 222–231). Washington DC: IEEE Computer Society Press.

Boehm, B., Clark, B., Horowitz, E., Westland, C., Madachy, R. and Selby, R. (1995). Cost models for future software life cycle processes: COCOMO 2.0. *Annals of Software Engineering* 1(1), 57–94.

Boucsein, W. (1992). *Electrodermal Activity*. New York: Plenum.

Brin, S. and Page, L. (1998). The anatomy of a large-scale hypertextual web search engine. *Computer Networks and ISDN Systems* 30(1–7), 107–117.

Cestaro, V. L. (1995). A comparison between decision accuracy rates obtained using the polygraph instrument and the computer voice stress analyzer (CVSA) in the absence of jeopardy. *Polygraphy* 25(2), 117–127.

Cleland, S. (2009) Googleopoly IV – the Googleopsony case: how Google extends its search monopoly to monopsony over digital information. White paper, McLean VA: Precursor LLC. www.googleopoly.net, accessed on 7 January 2012.

Critchley, H. D., Melmed, R. N., Featherstone, E., Mathias, C. J. and Dolan, R. J. (2001). Brain activity during biofeedback relaxation. *Brain* 124(5), 1003–1012.

Dimoka, A., Pavlou, P. A. and Davis, F. (2011). NeuroIS: the potential of cognitive neuroscience for information systems research. *Information Systems Research* 22(4), 687–702.

Dutta, A. and Roy, R. (2003). Anticipating internet diffusion. *Communications of the ACM* 46(2), 66–71.

Fisher, D. and Smith, S. (2010). Consumers bite on the social web about the film *Snakes on a Plane*. *International Journal of Electronic Marketing and Retailing* 3(3), 241–260.

Garfield, E. (2006a). Citation indexes for science: a new dimension in documentation through association of ideas. *International Journal of Epidemiology* 35(5), 1123–1127.

Garfield, E. (2006b). The history and meaning of the journal impact factor. *Journal of the American Medical Association* 295(1), 90–93.

Gurbaxani V. (1990). Diffusion in computing networks: the case of BITNET. *Communications of the ACM* 33(12), 65–75.

Hopkins, C. C. (1923). *Scientific Advertising*. New Line Publishing.

Jianhua, T. and Tan, T. (2005). Affective computing: a review. *Affective Computing and Intelligent Interaction*, LNCS 3784. New York: Springer, 981–995.

Kleine-Cosack, C. (2006). *Recognition and Simulation of Emotions*. New York: Wiley.

Kuhn, E. (2009). CNN politics – political ticker: Google unveils top political searches of 2009, http://politicalticker.blogs.cnn.com/2009/12/18/google-unveils-top-political-searches-of-2009/, accessed on 7 January 2012.

Mabry, E. and Porter, L. (2010). Movies and MySpace: the effectiveness of official web sites versus online promotional contests. *Journal of Interactive Advertising* 10(2), 1–15.

Mabry, E. F. (2010). Engaging audiences: an analysis of social media usage in advertising. M.A. thesis, Baton Rouge, LA: Agricultural and Mechanical College, Faculty of the Louisiana State University.

Marich, R. (2009). *Marketing to Moviegoers: A Handbook of Strategies and Tactics*, 2nd edn. Carbondale: Southern Illinois University Press.

Nirvana (2016). Storage Resource Broker for Life Sciences, p. 5, www.ga.com/websites/ga/docs/nirvana/life_whitepaper.pdf accessed on 22 June 2016.

Penn, M. J., Zalesne, E. K. (2007). *Microtrends: The Small Forces Behind Tomorrow's Big Changes.* Hachette Digital, Inc.

Ramaratnam, S., Baker, G. A. and Goldstein, L. H. (2008). Psychological treatments for epilepsy. *Cochrane Database of Systematic Reviews* 16(3).

Reiss, JaSC (2011). *Selling Your Film Without Selling Your Soul*, 3rd edn. Los Angeles: The Film Collaborative.

Rogers, E. M. (1983). *Diffusion of Innovations*, 3rd edn. New York: The Free Press.

Saritha, S. (2010). Google file system. Master of technology degree seminar report, Kochi, India: Department of Computer Science, Cochin University of Science and Technology.

Schon, D. A. (1963). Champions for radical new inventions. *Harvard Business Review* 41, 77–86.

So, S. and Westland, J. C. (2010). *Red Wired: China's Internet Revolution*. Hong Kong: Marshall Cavendish.

Taylor, F. W. (1914). *The Principles of Scientific Management*. Harper.

Teece, D. J. (1986). Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy* 15, 285–306.

Telotte, J. (2001). The Blair Witch project: film and the internet. *Film Q* 54(3), 32–39.

Varian, H. R. (2007). Position auctions. *International Journal of Industrial Organization* 25(6), 1163–1178.

Weber, L. (2009). *Marketing to the Social Web: How Digital Customer Communities Build Your Business*. New York: John Wiley and Sons.

Westland, J. C. (1992). Congestion and network externalities in the short run pricing of information system services. *Management Science* 38(7), 992–1009.

Westland, J. C. (1995). Cinema theory, video games, and multimedia production, in Reisman, S. (ed.) *Multimedia Computing: Preparing for the 21st Century*. Middletown, Idea Group Publishing.

Westland, J. C. (1998). Some conditions for cost efficiency in hypermedia. *Information Processing and Management* 34(2–3):309–323.

Westland, J. C. (2002). Transaction risk in electronic commerce. *Decision Support Systems* 33(1), 87–103.

Westland, J. C. (2008). *Global Innovation Management: A Strategic Approach*. London: Palgrave Macmillan.

Westland, J. C. (2010). Critical mass and willingness to pay for social networks. *Electronic Commerce Research and Application* 9(1), 6–19.

Westland, J. C. and Clark, T. H. K. (2001). *Global Electronic Commerce Theory and Case Studies*. Hyderabad: Universities Press (India).

Zanette, D. and Montemurro, M. (2005). Dynamics of text generation with realistic Zipf's distribution. *Journal of Quantitative Linguistics* 12(1), 29–40.

Zufryden, F. (2000). New film website promotion and box-office promotion. *Journal of Advertising Research* 40(1/2), 55–64.

CHAPTER 6

Entrance Strategies – Choosing your Competitive Arena

Learning Objectives

After finishing this chapter, you will

- Understand that as markets and technologies change and evolve, your capabilities need to evolve to keep up with the changing demand for products and services.
- Know how to decide where you will acquire new capabilities (assets and competences) based on an analysis of your existing and planned products/ services by growth, profit and revenue size.
- Be able to use real options analysis to factor risk into your decisions on where capabilities will migrate in the future.
- Understand the use of three particular options in developing an entrance strategy: positioning options, scouting options and stepping-stone options.
- Know how to optimize entry through early engagement of the potential customers; the 'first three customers' rule.

After doing the *Innovation Workout* you will be able to perform **force-field analysis** to analyse the dynamics of your entry into a competitive market.

After reading the Triumph and Victory Motorcycle *case study* you will be able to understand the roles of **image and brand history** in packaging new technology.

Assessing the Competitive Terrain for an Innovation

Successful innovation requires that the firm attain and retain strategic focus in two ways. First, strategy needs to choose competitive terrain, selecting those business arenas to compete in that represent your best chances for profitable growth. Second, strategy must set priorities on the perceived competitive opportunities in each of your selected arenas – these will largely be determined by the product and service ideas you've come up with. You are likely to be most successful by choosing intermediating or progressive change in your capabilities when charting the current terrain; then use that as a basis for selecting your future arenas.[1]

These tasks are made more difficult as the need arises to invest in new capabilities, and divest of old ones, as consumer markets evolve. Figure 6.1 depicts this migration in pursuit of changing markets. Clearly there are many markets in which the firm might compete; one objective of strategy is to make a decision on which market will actually be pursued.

Not all the customers you serve today, the products or services you sell today, the distribution channels you use today or the geographical areas in which you operate today are going to fit with the new business domains you are creating. Identifying opportunities to stop investing in a particular activity is every bit as important as coming up with innovations to propel future growth (von Hippel, 1988). Unfortunately, firms often pay insufficient attention to the need to prune outdated operations in their firm as they become obsolete. Every budget line, skilled person, good technologist, or expert sales or service person dedicated to the pursuit of a business arena without a good chance at profitable growth is a resource going to waste (D'Aveni, 1994; McGrath & MacMillan, 2000: ch. 7).

The best place to start is to develop simple stratification maps, which highlight the contributions of your business activities to your current performance. Stratification maps analyse the contribution that each component of your business is making to current performance. The most attractive of these components will be the key to deciding on future markets; the least attractive are the candidates for pruning.

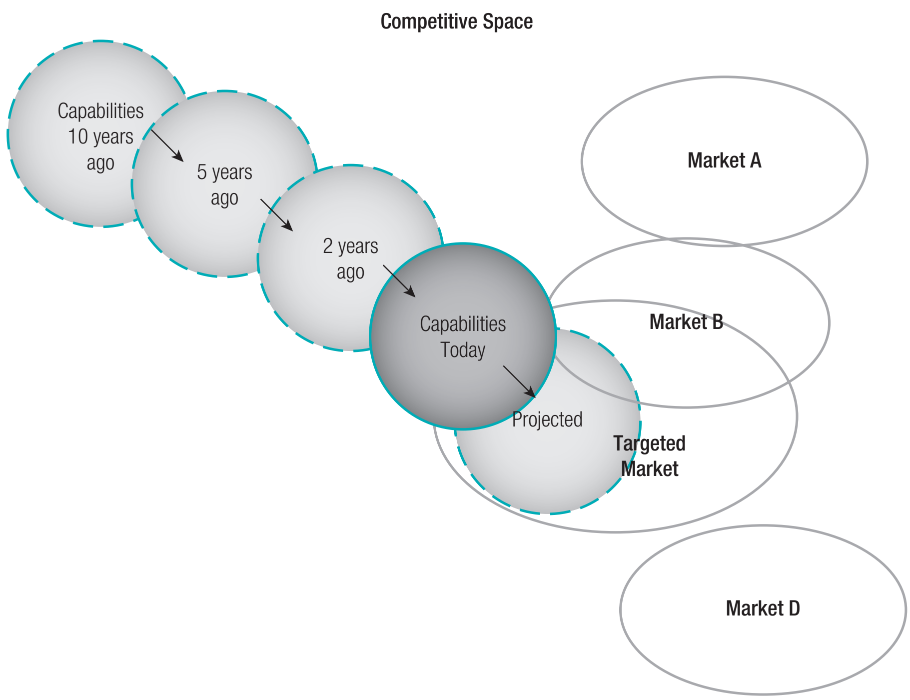

Figure 6.1 Strategic Migration of Capabilities in Pursuit of Markets

The 'Mighty Wurlitzer'

Emerson was famously quoted as saying, 'If a man can write a better book, preach a better sermon, or make a better mousetrap than his neighbor, though he lives in the woods, people will beat a path to his door'. But, as any inventor can tell you, that's not the way it works in practice. No one more vividly illustrates this than pipe organ builder Robert Hope-Jones.

The pipe organ has ancient roots, but only grew in popularity through its association with the Church. Early Christians were enamoured neither of the Cross nor the organ, two objects that would later grow to symbolize the house of God. In the early years, too many Christians met their end on a cross; or alternatively as food for the lions in the Roman circuses to the accompaniment of a primitive pipe organ called a hydraulis. Not until the 11th century did the pipe organ start appearing in churches, ostensibly to provide a clear, euphonious 'human voice' that could be heard over that of discordant monks and parishioners. We would hardly recognize the organ of the 11th century – keys the size of two-by-fours, with an action so stiff that the organist, forced to wear leather gloves, came to be known as an 'organ beater' (really). Keys got smaller over the ensuing centuries, but there were no great leaps forward until Hope-Jones appeared on the scene.

In the late 19th century (before television, I might add) evening entertainment often included a visit to the local bandstand or orchestra – every community had one. But getting a large group of talented musicians together to practise and perform could be a daunting task. A viable substitute was to hire the local church organist to play symphonic and popular pieces. Thus did the 'orchestral organ' begin. It was only natural that when silent movies came onto the scene at the turn of the 20th century, the preferred accompaniment would be a piano or (better) a 'theatre organ' – essentially an orchestral organ with additional 'traps' – drums, cymbals and other percussion instruments. The incentive: having to pay only one musician, who while playing a pipe organ could produce sounds approaching those of an orchestra of dozens of players.

Many of the innovations which lead to the perfection of the theatre organ were the work of one man, the electrical engineer Robert Hope-Jones. Hope-Jones was chief electrician with the Lancashire and Cheshire Telephone Company, and expert in low-voltage electrical circuits. His work with the church in Hooton Grange led to its application to the pipe organ. Churches were wealthy in those days, and Hope-Jones left the competitive field of telephony to tackle the lucrative field of church organs, producing a continuous flow of patents for electrical innovations in low pressure air valves for organs, and new types of pipes.

Business was good. By electrically connecting the keyboard to the air valves (rather than the clumsy mechanical valves of the day) Hope-Jones could place his consoles anywhere that the church wanted, giving them incredible architectural flexibility.

Hope-Jones was versed in the theory of acoustics and electricity, which gave him an advantage in his invention of very slender low-voltage magnets (one under each pallet-valve) and the use of two different precious metals as rubbing contacts; design features which significantly improved the operating characteristics of organs. Charles S. Barker, Aristide Cavaille-Coll, Father Willis and other builders had applied their own electric parts to it, but these were made from heavy machinery and required high voltages for operation. Cables were thick, many stop actions utilized sliding strips of wood under pipes, swell shades were not electrically moved, and large pedal valves were still hard to open quickly. Hope-Jones overcame key and switch contacts that oxidized quickly, low amperage from inefficient batteries, cables limited in length by their weight and even pneumatic tubes that leaked.

The Hope-Jones Electric Organ Co. in England, first at Battersea and then at Norwich with Norman and Beard, built more than 40 organs. But success did little to endear Hope-Jones to either parishioners or organ builders. By 1903, sabotage of Hope-Jones organs was epidemic in England, and Hope-Jones's family were threatened with violence. He and his wife quickly packed their bags and boarded a ship for America

He eventually ended up in Elmira, New York, where he employed about 50 men, many of whom followed Hope-Jones from England (Mark Twain once made a $100,000 investment in the Elmira factory). In the United States, he built around 38 organs in total. A pivotal contract for Robert Hope-Jones was that of the organ for Carnegie Hall in New York. Andrew Carnegie was

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still around in those days, and personally signing off on additions to Carnegie Hall. Hope-Jones prepared a tour de force of pipe organ innovation, including theatrical additions such as drums, lightning and storm machines and so forth. Unfortunately, when Carnegie saw Hope-Jones's demonstration of the installed theatre organ, he simply walked out, exclaiming that Carnegie Hall was a concert hall, not a bawdy theatre.

Depressed, Hope-Jones's business languished, and he himself lost resolve. His wife left him and the factory went into bankruptcy. Eventually, Hope-Jones sold his patents, name and goodwill to a manufacturing company named Wurlitzer, a small producer of musical instruments including some automatic organs. They saw the Hope-Jones organ as something to further their production line.

From the very first public projection of movies by the Lumiere Brothers on 28 December 1895 in Paris, silent films were almost always accompanied by music. Music was essential, contributing to the atmosphere and giving the audience vital emotional cues. Small town and neighbourhood movie theatres had pianos, but from 1915 onwards most large city theatres had a 'The Wurlitzer-Hope-Jones Unit Orchestra' which would allow a single musician to play the film's orchestral accompaniment as well as take on the job of a sound effects crew. 'The Wurlitzer-Hope-Jones Unit Orchestra' quickly became just the 'Mighty Wurlitzer' in the eye of the public.

In 1914, just before silent movies initiated a craze for theatre organs all over the US and the UK, Robert Hope-Jones ended his own life. His suicide was fittingly innovative. In a dilapidated rooming house he hooked a rubber hose to a gas outlet, attached a T-junction placing one end in his mouth, and lit the other end to hide the smell of leaking gas.

Analysing your Current Business Portfolio

Each of your current business segments represents an investment in assets, competences and people that is directed towards making a profit from particular products. Some classes are more profitable than others. Your options for migrating your capabilities are commensurate with the opportunities for improving this portfolio. The problem is inherently more complex than managing a financial portfolio because the relevant arena for you might not be return on investment; rather it could be products, customer segments, geographical areas, branches, distributors or brokers (in a distribution-intensive business), or services. Your chosen categories will be your strategy drivers – the factors you deem most important in the evolution of your business (Utterback & Abernathy, 1975; Utterback, 1994).

To analyse your business portfolio, first collect data on how much revenue each business arena has generated in the past year. You then rank your business segments by building a table of the contribution of each segment to revenue, profit and growth (Figure 6.2 for a hypothetical company). Each segment is characterized by its contributions, as well as a quick qualitative assessment of what is actually going on with that

	Revenues ($millions)	Contribution ($millions)	Cumulative % of Revenue	Cumulative % of Profit	Annual Growth Rate	Classification
Segment 1	89	28	51.45%	32.56%	4.00%	Cash Cow
Segment 2	54	63	31.21%	73.26%	8.00%	Star Performance
Segment 3	25	5	14.45%	5.81%	15.00%	Marginal Niche
Segment 4	5	–10	2.89%	–11.63%	8.00%	Loss Leader

Figure 6.2 Business Segment Portfolio Ranking

segment. Unfortunately, big revenue generators are not necessarily the biggest contributors to profits, and smaller contributors may offer the greatest opportunities for future growth. Such complexities add to the difficulty in selecting future areas for competition and making the investments to evolve your capabilities appropriately.

Your portfolio ranking will provide you with a concise, relatively unambiguous portrayal of your business's business segments. From Figure 6.2, we can see that we would be likely to have grounds for divesting of business segments 3 and 4; the money, management attention and capabilities freed up could then be reallocated to segments 1 and 2 which are contributing the major share of profits and revenue. Consideration might be given, though, to the qualitative assessment given to segment 4, which describes it as a loss leader. If, for example, it is like the iTunes service, provided at loss in order to sell iPods then it cannot be eliminated without considering the complementary segment; on the other hand, it could be argued that the businesses were not segmented properly to begin with, and that this segment should have been included with the complementary segment.

One other factor that needs to be considered is growth in the market. Smaller segments may often have the capacity for growing quickly, though prior years' performance is no guarantee of future performance (as they say). In Figure 6.2, segment 3 is experiencing 15% annual growth. The smaller contribution may be due to start-up costs if it is a new product; or it may be due to more intense competition in the market (Chakrabarti, 1974; Dos Santos & Peffers, 1995; Chen, 1996).

Competitive Options

Eliminating activities from your agenda is as important as adding new ones. Looking at both sets of activities – the new and the existing – is essential in gaining control of your innovation portfolio (Coy, 1999).

The prior section described an approach to prioritizing the innovations from your opportunity register that are most likely to contribute future growth and profit. The next challenge is to figure out how to appropriately allocate resources to those opportunities that you elect to pursue. You'll use an approach to building a portfolio of projects that draws on real options, a modification of a highly successful financial technique where applied to non-financial investments in things such as labour, time and technology. Real options are inherently project oriented, directed towards operations which require management and resources, whereas financial options are normally limited to assessing financial contracts.

An important distinction rarely made explicit is that the purpose and nature of financial vs. real options are not the same. Real options actually provide a richer language for innovators than their financial counterparts. That is because real options take into account the manner in which management learns about their innovation and the particular steps that are taken to manage that risk of the life of the product or service. Thus real options come in three different forms – *positioning, scouting* and *stepping-stone* options. You will find that you manage them differently and expect different things from them.

Selling the Potato

The potato is probably the most widely consumed source of starches in the world, but its introduction into European cuisine four centuries ago was anything but easy. A root native to the Andes, it was introduced to Europe by conquistadors returning from the New World. Potatoes from the start were seen as sinister beings, hiding in the soil away from God's light. Anglican preachers forbade their flocks from eating the new food, but thought it suitable for Catholic countries. In Catholic Ireland, landless labourers rented tiny plots from landowners who were interested only in raising cattle or in producing grain for market. A single acre of potatoes and the milk of a single cow was enough to feed a whole Irish family.

Germans had none of the religious misgivings of the English, but thought the New World tuber boring. William the Great piqued their interest by planting a royal plot with potatoes, heavily and visibly guarding it, and informing all that his agricultural experiments were secret. Soon thereafter, potato plots popped up all over Germany.

Marie Antoinette helped make the potato popular in France, which she enjoyed so much that she took to wearing its blossoms in her hair. With the potato sufficiently en vogue, it was then served all throughout France.

Henry Spalding planted the first Idaho potatoes in the 1830s, and by the next decade Spalding's potatoes were popular throughout the US. In 1853, chef George Crum had an altercation with an unhappy customer – the railway tycoon Cornelius Vanderbilt. Vanderbilt kept sending his fried potatoes back, complaining that they were too thick. Out of spite, Crum sliced the potatoes razor thin, deep fried them until crisp and seasoned them with extra salt. Vanderbilt was enthusiastic about Crum's innovation, and 'Saratoga Chips' became a house speciality, later being mass marketed as potato chips.

Positioning Options

Positioning options create the right to *wait and see*. Investments that put the company in a position to capitalize on uncertain external events, should they occur – such as the emergence of a new market on the internet or of a successful technology that has been competing for market dominance – are positioning options. Such options are useful when the uncertainty you face is mostly out of your control but you need to be positioned to act in case fortune turns your way (Ross & Staw, 1993).

Positioning is appropriate when several competing outcomes could satisfy high-potential market demand, but it is not yet clear which outcome will dominate. Take mobile telephony in Asia. As of this writing, there are three different communication standards and massive uncertainty about which will ultimately become the standard. The plausible scenarios include the following: (1) a lock-in on one of the three standards, (2) preservation of the current multi-standard system, and (3) the emergence of some new standard or way of communicating that makes the current mobile concept obsolete. Given such uncertainty, a sensible route for an interested organization may be to make modest investments that will prepare it for any of the three scenarios; committing itself entirely to one or the other would not be prudent. We see this, of course, in practice, as telecommunications companies engage in a vast array of mergers, acquisitions of smaller firms, and joint ventures and alliances with larger firms while also aggressively lobbying regulatory agencies and investing in the development of standards (Scherer, 1979; Wageman, 1995). The reason to select a positioning option is to make the smallest possible investment and still buy time and flexibility to pursue the best course of action once it becomes clear (Rumelt, 1987).

The Father of Sudoku

Chain smoking, unkempt, in jeans and dowdy sweater, Maki Kaji is an unlikely corporate success story. He readily admits that he would rather spend his days hanging out at the racetrack than sitting in his president's chair at Nikoli, the Tokyo-based company (named after the winning horse in 1980's *Irish 2000 Guineas* race) that developed the hugely successful puzzle game Sudoku.

Kaji's education certainly didn't prepare him for success. In the early 1970s he began studying literature at one of Japan's most prestigious private colleges, but found it boring. He spent most of the time gambling and playing tennis, quitting college after his first year. He tried being a waiter, a roadie and a construction worker before setting up a small publishing business that indulged his love of gambling and chance.

Sudoku came from an earlier puzzle – Number Place – that Kaji saw in a US magazine in 1984; he rearranged the numbers and grids and released it in Japan. It was picked up more than a decade later by Wayne Gould, a retired Hong Kong judge whose promotion of the game led to an international craze. Now the game appears in more than 600 newspapers, on thousands of webs and in dozens of books in about 70 countries. Last year, 20 nations took part in the first Sudoku world championship in Italy.

Sudoku's success even caught Kaji by surprise. 'We have no idea what makes something popular, so we try them out on the readers. About once every five years, one suddenly takes off. It's as big a surprise to us as anybody else.' Nor has Sudoku made Kaji rich. Nikoli's team of 22 employees edits and refines the 1,000 puzzles that flood into the company every month, from their cramped quarters in an unfashionable business district of Tokyo, generating a modest US$4 million of revenue.

Creativity at Nikoli happens mostly elsewhere – in bedrooms, kitchens and commuter trains across Japan. Nikoli's puzzle writers design 90% of the games and work for a flat fee. Kaji draws them from a cross-section of ordinary Japanese: teenagers, housewives, salarymen and pensioners. Two-thirds of them are high school and university students; the oldest is an 81-year-old retired teacher. It's from this diffuse network of individuals with time on their hands that recent successes, including Kakuro and local hit Slitherlink, have emerged.

(Source: McNeill, 2007)

Positioning options tend to be most useful when the level of technical uncertainty is high but you have some idea of what markets and segments you eventually want to serve. Your uncertainty may stem from the lack of a dominant design or standard, from a lack of knowledge with respect to the technical feasibility of a given solution set, or from issues such as the regulatory acceptability of certain technologies. Since the major uncertainties have to do with alternative technological solutions, the idea is to take a limited number of positions at the lowest possible cost to hedge against making a single wrong bet, thus containing the damage done by any one position that does not work out.

For example, AT&T, from about 1998 to 2003, spent billions of dollars on taking attractive positions, acquiring cable companies such as Tele-Communications and MediaOne; entered into joint ventures with British Telecom and Japan Telecom, and worked with Microsoft for set-top box software, all in pursuit of a convergence of telephone, internet, gaming and television services on top of one technological platform. This is a market that AT&T could possibly dominate with their network position; but Microsoft, Sony and Nintendo may be in a better consumer position with their game consoles. For AT&T, billions of dollars is a reasonable price to pay for a positioning option when you consider the size of the potential industry, which may represent hundreds of billions of dollars in annual revenue.

Scouting Options

A second class of options, scouting options, can be considered as entrepreneurial experiments. They are investments made with the intention of discovering and/or creating markets for products and services by deploying capabilities that you have developed in potential new arenas.

Scouting options differ from positioning options in that they extend existing competences in directions that you believe will allow you to capture significant market opportunities. This kind of option might emerge from your insights that large opportunities can be within reach if you break a barrier. Scouting options are also used to discover opportunities to break through barriers. The reason for selecting a scouting option is thus to deploy or develop competences that allow you to ferret out high-potential markets that are highly uncertain.

Scouting options can take many forms. The most familiar is the sacrificial product or probe from which firms seek to determine the market's reaction to a bundle of attributes. These are options that are conscientiously managed as scouts – exploratory small investments made without necessarily expecting an immediate payoff, and designed to maximize what is learned about a market or particular technology. You use them to learn, to gather information. The idea is to send out your scouts using the smallest investment possible and to be ready to redirect your efforts once you find promising paths.

Scouting options tend to be used when you are not sure what combination of attributes the market will eventually prefer. By staking out several contrasting positions in a market, for example, you can systematically pre-test the market acceptance of an innovation. A similar line of thinking allows you to test your coverage for adverse contingencies. Scouting options can also provide you information concerning what data needs to be tracked, and helps develop the scanning and intelligence systems that will ultimately be needed when the product or service comes to market.

Later in the chapter, we will investigate in detail one particular scouting option that puts the offering into the hands of customers in order to aggressively get feedback on their reactions to its features.

It pays never to assume that you know what the customer wants. Customers can be remarkably inarticulate about what their real concerns are. This can be frustrating, but you often have to observe the customer in a buying or using situation to gain the insights you need (McGrath & MacMillan, 2000: ch. 7).

Genghis Khan's Entrance Strategy

12th-century Mongols were known for dramatic entrances. Under Genghis Khan, their army was incomparably superior to any other force on earth, wiping out, in their time, most of the European nobility, and subduing the powerful armies of the Caliph of Baghdad. Genghis was a great innovator in psychological warfare, generating his own propaganda which exaggerated the brutality and decisiveness of his conquests to frighten future opponents. He instituted a professional class of bookkeepers to inventory his spoils and to impose harsh but efficient taxation on the vanquished. He thrived through superior strategy and mobility, which allowed his army to cover thousands of miles in weeks, and conquer and keep large areas of territory even though often being vastly outnumbered. There was no Mongol infantry to slow them down. Horses outnumbered people five to one in Mongolia, and everyone was born into the cavalry.

Much of their superiority lay in their technology. Almost all of it was borrowed, but Genghis Khan improved each piece, integrating it into the development of Mongol tactics. Unlike European knights, Mongols were not burdened by heavy steel armour, but wore a silk shirt covered in light cloth armour in front, and none in back (which discouraged troops from retreat). When armour-clad knights were struck by powerful Mongol arrows, they were faced with the difficult task of removing the arrow embedded in their armour and their flesh. In contrast, when struck by an arrow the Mongolian's silk shirt would be carried into the wound by the arrow. Tugging gently on the silk around the arrow could free it with minimal additional wounding to the soldier. The Mongolian horses, unarmoured themselves and carrying soldiers clad in light armour, had much more endurance than the horses ridden by the opposing medieval knights. Mongols in battle would suddenly retreat, travelling miles into their own territory to wear out heavily armed opponents, only to turn back on them when they were thoroughly worn down. Technologically advanced siege machines built by Chinese technicians were used in attacking fortified cities. Between battles they were disassembled and carried on horses to be rebuilt at the site of the battle. Chinese fireworks were modified to produce brass cannon to shoot balls which could breach city walls and demoralize opposing troops. Greek fire was thrown from trebuchets to burn down cities and demoralize residents. Once the main battle and city siege was over, the Mongol army would follow the enemy leader until he was killed in order to prevent him from being a rallying point for his army after war. The Mongol logistical system was distinguished by its mobility and practicality, living off the land heavily, much as General Sherman did in his march to Atlanta. Heavier equipment was brought up by well-organized supply trains. An essential feature of Mongolian tactics was the use of 'kharash'. During a battle the Mongols would drive a crowd of local residents as a human wall, who would erect siege machines around the walls, forcing the king to attack his own subjects. Genghis Khan's cavalry was a highly efficient, disciplined organization, with superior military intelligence of a form not seen again until the 18th century. Operating in massive sweeps, extending over dozens of miles, the Mongol army combined shock, mobility and firepower unmatched in land warfare.

(Source: Weatherford, 2004)

Large companies commonly do worse at scouting than do small entrepreneurial companies, simply because the large firms have more money to spend. If you load yourself down with heavy fixed costs or massive sunk investment, redirection becomes much more difficult. Even fabulously well-researched and technically brilliant new products can disappoint in the market place.

Stepping-Stone Options

Stepping-stone options are a series of small investments that lead you towards a larger goal one small step at a time. They are consciously staged attempts to sequentially discover new competences to pursue highly promising but very uncertain potential markets or technologies. They are somewhat analogous to compound financial options, in which the value of a portfolio is a function of a sequence of investment choices (Cheng and Van de Ven, 1996).

You choose stepping-stone options when you want to expose your company to opportunities in which there is high uncertainty both about the final shape of a high-potential market and about the likelihood of being able to develop the necessary competences to serve it. Nevertheless, the potential opportunity is so big that it is irresistible. You start with small, exploratory forays into less challenging market niches and use the experiences gained there as stepping stones to build competences in increasingly challenging and attractive market arenas that you discover as you go.

Investments in stepping stones are thus made as a series of deliberately staged and sequenced options. Staged funding decisions are made only when key milestones are reached and a great many assumptions have been tested. As each milestone is reached, you have the opportunity to continue or to stop further development or even to sell, trade, licence or otherwise capture returns on investments in technological and market development to that point. The idea is to keep each successive round of investment to an absolute minimum and to reassess the project frequently (von Hippel, 1978).

The primary difference between stepping-stone and scouting options is that scouting options involve technology and competences markets once the competence is sufficiently well developed. Thus you can make deliberately parsimonious resource allocations designed to pursue carefully selected and increasingly challenging opportunities, with the objective of developing a new competence along an increasingly sophisticated trajectory and deploying it in unfolding markets.

The Kyocera Company in Japan used this approach to pursue the industrial ceramics business in the 1960s. Instead of investing to crack high-level applications like automobile engine cylinders or turbine blades (as did many other smart companies, General Electric included), Kyocera initially invested in low-end applications for known niche markets. For instance, the company developed ceramic scissor blades for the textile industry. Through this initial effort, the company resolved considerable technical uncertainty, such as how to process clays and how to make precise edges with consistent quality. This created an initial technological competence which, as it evolved, took Kyocera along a trajectory of increasing technical sophistication. The firm is now a major global supplier of semiconductor chip substrates and other materials for the digital age, spanning entire industries that were still in their infancy when Kyocera began ceramic development.

The best approach – positioning, scouting or stepping-stone options; or a direct launch with traditional one-shot strategic planning – depends on the precise character of the uncertainty you face. At their simplest, these uncertainties with the development of your innovation (which, remember, equals invention + commercialization) fall into either operational-technological uncertainties or market-related uncertainties (Schmookler, 1966).

Stepping-stone options are an embodiment of the dictum that you should 'take small steps – and fast' that worked so well for the 3M Corporation (see Chapter 3). They are a great strategy for opportunities that present both high technical and high market uncertainty, because the organization has significant opportunities for learning in both dimensions (Sitkin, 1992; McGrath and MacMillan, 2000: ch. 7).

Mini-case on Stepping-stone Options: Open-source Development vs. Proprietary Technology: The Case of 3D Robotics

Open-source development remained somewhat controversial up to the beginning of the 21st century. In the 1990s it found a foothold in successful projects like R, MySQL, Linux and other software projects. But open sourcing really took off in the 21st century when it was applied to a much wider range of industries: clinical trials of drugs, kick-starting technology products, and hardware platforms such as Raspberry Pi and Arduino. This expanding palette of applications came to the attention of Chris Anderson, former *Economist* magazine bureau chief in Hong Kong and editor-in-chief of *Wired* magazine. Anderson founded DIYDrones.com in 2009 with Jordi Muñoz to build drone control software for the Arduino hardware architecture. Anderson's open-source project ultimately grew into the Solo line of hobbyist drones to rival DJI's Phantom and Inspire drones featured in this chapter's case study.

2015 was a tipping point for drone hobbyists, with the announcement of 3D Robotics' Solo and DJI's Phantom 3 drones which both offered significant advances in performance and features at a $1000 price point. Both offered controllers with elegant ergonomics and user interfaces. Both recognized that aerial video and photos were 'killer apps' fuelling the consumer and professional market for hobbyist drones. Both offered 4K video at 30 frames per second and forward velocities up to 50 mph, assisted by easy-to-use control and editing functions.

The path to develop the Solo and Phantom took diametrically opposite development paths and business models in an instructive contrast of open-source vs. proprietary development. DJI mapped out a series of stepping-stone options at inception that reflected Wang Tao's engineering-centric inclinations. Its first products were improved controllers for electric helicopters. This gave it sufficient expertise in servo motor stabilization technology to move on to apply this technology to four motor quadcopters (vs. a helicopter's two main and tail motors). It also applied its expertise to camera gimbals, producing its own Zenmuse and Ronin lines. These stepping-stone paths came together in the Phantom line.

DJI's competitor, 3D Robotics (3DR), grew out of a project started in 2007 by the DIY Drones community to build a flight-controller based on the Arduino open-source electronics prototyping platform. The project was later strongly influenced by the lectures and writing of magazine editor Chris Anderson, the author of several books on the internet economy. Chris Anderson partnered with Jordi Muñoz, who provided the engineering expertise that he lacked, and proceeded to define a number of open-source hardware and software projects and online sites to develop 3DR's drone business. Technology for the Solo was developed at almost no cost to Anderson and Muñoz, who ultimately integrated it into their 3DR Solo quadcopter. Both companies' main market was photography; DJI developed its own internal competences while 3DR outsourced those competences to its open-source DIYDrones community. What DIYDrones failed to cover, it outsourced: Tarot developed its gimbal, which was built around a camera provided by GoPro which already held a solid position in personal action photography.

On paper, both approaches appeared to be competitive (especially to readers of Chris Anderson's books). But 3DR's approach, which delivered the technology at almost no internal cost, failed to build the company's own internal competences. Thus solving engineering or manufacturing problems for 3DR's products became a complex and lengthy process where employees needed to figure out what open-source contributors had actually contributed. These problems and delays were already appearing in the pre-launch phase of the Solo marketing as various promised sensor sets and capabilities such as sonar had to be dropped because problems could not be solved by launch date.

With the Solo, 3DR seems to have made a classical mistake for a growing company. It saw a similar product in the market and abandoned a winning strategy and target customer base where it had competences for one where it neither had the best product nor sufficient competences. But it did this with a twist which may just make this work. In 3DR's case, it abandoned the hobbyist model airplane and copter market for the photographic platform. The hobbyist plane/copter market emphasizes personalization of machines, whereas the photographic market needs stable platforms that can shoot from anywhere. Since DJI's photography-oriented products centre on the camera and gimbal (gimbals are essentially a micro-motor successor to the Steadicam®) its consumers prefer to have lots of control over camera positioning and functions without having to think about operating, customizing or repairing the flight platform (drone). 3DR's customers, in contrast, are interested in a huge choice of affordable components that can be swapped and upgraded like a hi-fi system or gaming PC. The increase in functionality of the Solo comes with an increase in hardware and software complexity.

Still, there may be hope for 3DR's Solo strategy. Rather than building its own camera and gimbal, it has relied on GoPro® and Tarot, which already have well-received products in their field, to provide the photography. Essentially, 3DR's Solo strategy makes its Solo drone an accessory for positioning the camera and gimbal. 3DR counts on attracting the GoPro® customer base to its platform. Indeed, this may ultimately prove a successful strategy.

These two strategies allow us to assess the merits of proprietary (DJI) vs. open-source (3DR) approaches to building a business. Let's directly compare the offerings of the two companies (Figure 6.3)

With Internet of Things business models, complementary products become more and more important. Their real power and value comes from tapping into public and community goods (like cellular networks, the internet, or US's GPS, China's Big Dipper (北斗 = Běidǒu) or Russia's GLONASS navigation satellites). Consider a feature map for the DJI Phantom 3 that plots the most important features.

Contrast this with the 3DR Solo, based on assumptions that these are the major competitors in this market space.

And compare these two feature maps with 3DR's previous 'hobbyist and mapping' products (terms used on their own website).

Features	DJI Phantom 3 Pro	3DR Solo
Price	$1260 (complete)	$1000 (base)
4K Camera	Yes	$400 extra
Jello Video	No	Yes
3-axis Gimbal	Yes	$400 extra
Flight Time	20 min	20 min
Fisheye	No	$200 to fix
1st Person Viewer (FPV)	720p @ 30fps	720p @ 30fps
Follow Me	Yes	Yes
Live Streaming	Yes	Yes
Built-in Video Editor	Yes	No
Sonar	Yes	No
GLONASS support	Yes	No
Orbit	Yes	Yes
Mimic	Yes	No
Intercept	Yes	No
SDK	Yes	Yes

Figure 6.3 Specifications *c.*2015 of DJI and 3DR Drones

The feature maps delineate the contrasts between the two products as striking. Additionally, these contrasts are emphasized by design and marketing: DJI remained true to its distinct and well-known Phantom body shape and

Phantom 3 Pro	Basic	Discriminator	Energizer
Positive	20-minute flight, 4K video camera, live video feed, easy to fly, SDK, orbit mode, FPV, 'follow me' mode	Lightbridge (video, control at 1.5 Km), mimic mode, intercept mode, sonar (for indoor flight), built-in editor, GLONASS support, price	
Negative		Poor customer support in US, Europe	
Neutral			

Figure 6.4 Feature Map for the Phantom 3

3DR Solo	Basic	Discriminator	Energizer
Positive	20-minute flight, 4K video camera, live video feed, easy to fly, SDK, orbit mode, FPV, 'follow me' mode	Hardware and software customizable, self-aware support (submit a service ticket from the app)	GoPro® Ready
Negative		Steep learning curve for customization, shaky gimbal control, price is about 30% higher than Phantom 3 for comparable system	
Neutral			

Figure 6.5 Feature Map for the 3DR Solo

white plastic with the Phantom 3; in stark contrast 3DR rolled out a sinister black Solo. DJI's drones were controlled by their proprietary Naza flight controllers; 3DR's Pixhawk and APM controllers originally were university electrical engineering experiments. Anderson developed software for them by initiating an open-source community of drone programmers who communicated through Anderson's DIY Drones website. The Naza hardware and software evolved in strict secrecy in DJI's labs, much like an Apple product might evolve; 3DR's hardware and software designs and code at any point in development were made available on codesharing site GitHub. As a consequence, a robust market for inexpensive Chinese versions of the APM and Pixhawk hardware quickly grew through eBay sales. Anderson had publicly expressed his opinion – in his book *Makers: The New Industrial Revolution* – that future technology is best developed through large-scale, democratic, open-source projects led by 'benevolent dictators' invoking crowdsourcing of ideas, utilization of available low-cost design and manufacturing tools and outsourced capital-intensive manufacturing. All of these featured in the growth of 3DR.

Apple perhaps best characterizes the proprietary approach. By 2015 it had grown to be the most valuable company in the world with a strategy that Anderson suggests may not have a future. In contrast, open-source projects like Linux remained niche players. Was the efficacy of open-sourcing truly as great as Anderson's promise?

Some of the early user reviews of the DJI Phantom 3 vs. the 3DR Solo offer insights into the advantages and disadvantages of each development approach, with DJI in general having a happier and larger customer base than its open-source rival. But Chris Anderson's strategy of 'crowdsourcing' his software and hardware rather than developing internal competences failed him; in 2015, Munoz left the company; 3DR reduced its workforce and exited the hobbyist drone market in 2016.

3DR Iris, X8, Y6	Basic	Discriminator	Energizer	Complementary Products
Positive	Various	Open source makes cheap hardware available from third parties	Hardware and software very customizable, allows for exceptional personalization	Large user community on the web
Negative		Steep learning curve for customization		
Neutral				

Figure 6.6 Feature Map for the 3DR 'Hobbyist and Mapping' Products Iris+, X8+, Y6

When to Use Options Strategies

The prior descriptions of functions for which the available options are useful can be summarized where the project space is mapped according to the level of uncertainty in: (1) technology and operations; and (2) market knowledge, volatility and speed of change (Romanelli & Tushman, 1994; Teece et al., 1997) (Figure 6.7).

Positioning options allow you to stake out positions in one or more technologies when you are reasonably assured that there will be a market for it, but don't know what form, or which competitor will prevail. Japanese companies such as Yamaha, Mitsubishi and Sony have excelled in staking out positions through patent applications that essentially build a productive wall around a commercializable technology (Venkataraman & Van de Ven, 1993).

Stepping-stone options give you small steps to take when technology is still developing (i.e. in the stage of ferment), consumer learning is anticipated to be high in adoption of products and services based on the technology, and there is great uncertainty in how the consumers would most like to see the products or services offered. Electronic commerce in the early 1990s was just such a high-tech risk/high-market risk service. Silicon Graphics founder Jim Clark originally promoted electronic commerce through interactive television, following the French Minitel model. With the rise of the internet from 1993 on, interest migrated to an internet platform, but following an 'interactive shopping mall' format (basically an online catalogue). Later shifts in the electronic commerce model abandoned the catalogue format for a stock market model (eBay); social networking mode (Amazon); build-to-order model (Dell); and various other successful formats. Few of the initial models did well, but they were important in refining the models that were eventually successful.

Scouting options are primarily vehicles for learning more about consumer needs, or the form and function they may expect from a particular innovation. They are needed because consumers in all areas are notoriously bad in articulating their real desires – particularly with products and services they have never experienced before. Consumers in effect say to the innovator, 'I don't know what I want, but I might let you know if you get it wrong'. Scouting options allow consumers to respond to particular sets of features before the innovator scales up for a full market entry. Since technology risk is low, it is possible to assemble various sets of

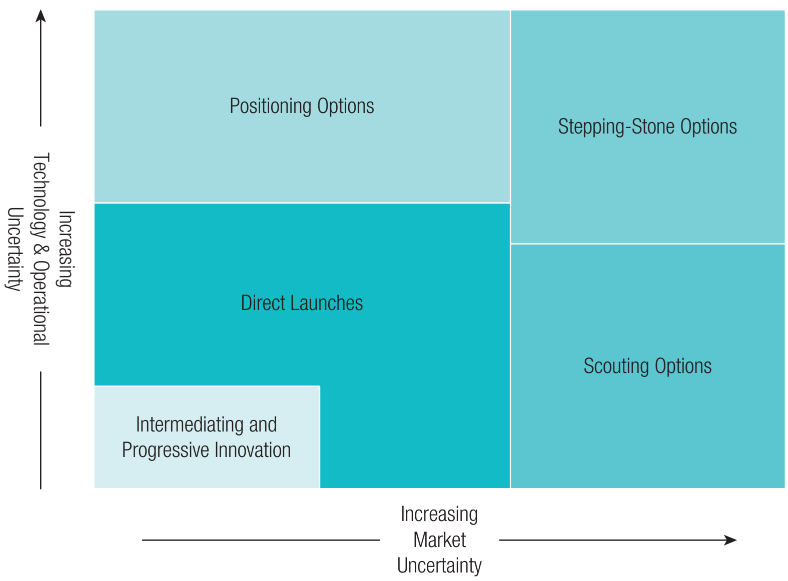

Figure 6.7 Project Options in Technology–Operations and Market Space

features cost-effectively and in a short time frame. Microsoft has earned a reputation in the past for presenting what has vindictively been termed 'slideware' or 'vaporware' – software that is announced or is alluded to be in development, but which is in reality introduced to see if demand exists for its feature set.

Where uncertainty is low, the firm is likely to know what customers want and how to meet that need. Thus direct launches of new products and services will likely be successful, and can be more timely than those that pre-test the market or technology through options. If the product is not entirely new; if it upgrades an existing product, then it is likely to be the result of intermediating or progressive innovation.

Whether it is a corporation or venture capitalist, or another source of funding that will provide the resources needed for your innovation, there will always be competition with other innovation projects based on a risk return trade-off that funding sources need to consider. Options strategies provide vehicles for managing risk, thus making funding decisions more palatable. Project risks and market entry strategies can be formally mapped in technology –operations risk and market risk space (Figure 6.8).

Mapping of technology–operations risk vs. market risk addresses one of the greatest challenges that successful companies face – the difficulty in balancing the needs of tomorrow's options (the longer-term-growth businesses) with those of businesses that are delivering cash flow today. Where competitive advantage is vested in technological and innovative expertise – both assets resident in the employees of the firm – the choice gets even tougher. Decisions about whether to allocate people and resources to speculative projects with pay-offs in the distant future vs. investing instead in today's profitable business present difficult, but necessary, choices.

The allocation of projects to positioning options, scouting options, stepping-stone options and direct launches can be useful as you try to sort out these sometimes conflicting demands. The core concept is to let your strategy and available resources guide your choice of how much emphasis to put on each of the categories in the figure. In general, you want a portfolio of projects that suits the environment in which you will have to compete. If you are in a fast-moving, highly uncertain industry, you will want to weight your portfolio more heavily towards options. If you are in a relatively stable or asset- and capital-intensive industry, you

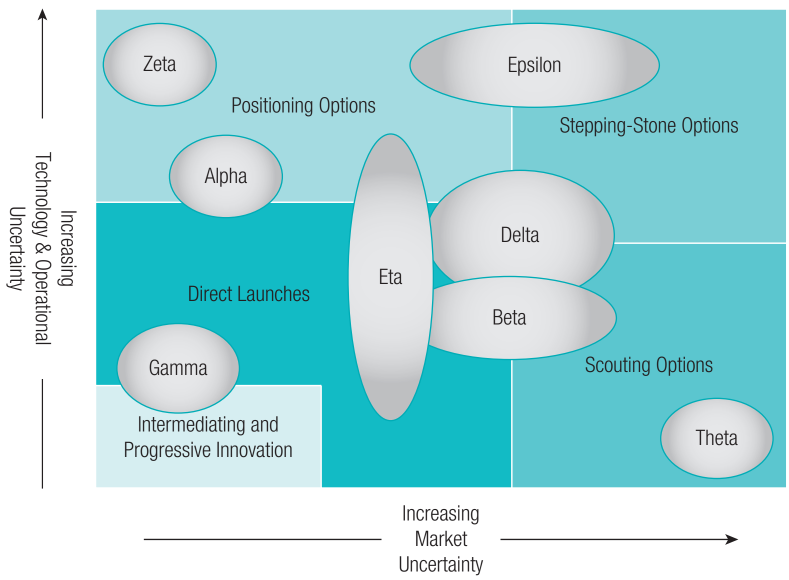

Figure 6.8 Example of Projects (Alpha, Beta etc.) Mapped in Technology–Operations and Market Space

should probably be investing more heavily in platform launches.

Another factor to consider is that nearly all innovation projects have a life cycle measured in years – there is both short-range and long-range resource usage, as well as short-run and long-run value generation. The maps in Figures 6.7 and 6.8 are snapshots – they do not tell you anything about the dynamics of the project, or its return. They only map out the risk component and suggest appropriate strategies. Thus, though you may have some idea of how you will allocate resources based on these maps, you are still missing a great deal of information needed for proper decisions. As we present material later in the book, we will address these other demands of decision making.

Adaptive Execution

Adaptive execution – knowing when to invest as well as how much – adds value because it gives us time to gather more information that, in turn, reduces uncertainty. Positioning, scouting and stepping-stone options are all tools to assist in our adaptive execution in entering the market for selling our innovation. They are the tools of *discovery-driven entrance strategy.*

Discovery-driven entrance strategy incorporates three main activities. First is the decision on your planned entry strategy. This will depend in large part on what you anticipate the competitive response will be, and your various options provide tools for anticipating competitive behaviour and response. Second is your plan for environmental scanning and intelligence collection. Some intelligence may be provided by your options, but the majority of intelligence will be gathered through scanning media and internet resources, and possibly from surveys and consumer testing. Finally, specific managerial actions will need to be dedicated to assessing and controlling progress as it unfolds. This is where managerial experience and intuition really pay off. Much of the success or failure of an innovation depends on the manager's intuition about unfolding developments and the people that make them happen; success also requires that managers actively intervene in situations that require leadership, motivation of people and evangelizing for the innovation (Chen and MacMillan, 1992).

To some extent, choice of entry strategy helps shape the nature and impact of competitors' reaction. But discovery-driven strategy can help you avoid debilitating competitive interactions by using better intelligence, speed and surprise to outmanoeuvre competitors; to use imagination and foresight, rather than your firm's physical resources, to compete successfully.

The Most Important Sales Are Your First Three Sales

Your first three sales of any particular combination of features that you envision for your innovation should be seen as qualitatively different from all other sales. They not only provide you with your first real feedback on the innovation; but they also provide the basis for word-of-mouth and viral marketing, both good and bad. Thus your entry strategy needs to identify the ideal initial customer groups that are needed for product success. Such testing is comparable to a software's 'beta' release, where working software is released to a limited group of users (often current users, or more sophisticated users) in order to create buzz while attempting to clean up any significant defects.

The initial step in choosing your first three customers relies on tools you have used previously. You should be able to map a fairly accurate consumption chain and link attributes of your offering to an attribute map for each segment. The challenge then is to go out there and secure a commitment to purchase from your first few target customers (von Hippel, 1986).

Good salesmanship plays an important part in your first sales. The innovator needs to possess the ability to get customers to make some kind of commitment to a given set of features – a particular innovation package – that the firm wants to deliver to this group, sometimes even before the product or service has been developed. These innovators see this commitment as affirmation of market acceptance of their new business model. One goes so far as to say that if they do not have some kind of commitment from several key stakeholders, they won't proceed, but will rather go back to their register and select another opportunity.

One note of explanation is due here on terminology. To keep our guidelines simple we speak of 'customers' to generically reference various key stakeholders that may be critical for the launch – distributors, suppliers, key skilled employees. Obviously, all potential customers are not equally attractive. Nor are you equally attractive to them.

There is a decisive moment in market entry that demands specifics – in company name and individual contact names, the reason for choosing them and the specific features of the innovation that you think will be attractive to them. Before any further spending you need to provide the names of at least three customers with a demonstrated willingness to buy. If you can't get an order, you should be able to get a letter of intent. If you can't get a letter of intent, you should be able to get a written expression of interest. If you can't even get an expression of interest you need to rethink your entire business model.

Where should you look for these all-important first few sets of customers? If you already have a business related to your innovation, then the logical place is to look to those you are already serving well and with whom you have built a good relationship. If you are a start-up, then look at potential competitors, and approach their best customers. You should stay aware of opportunities to tap into customers who are new to you – either because you are resegmenting a market or because you have achieved a technological or business model breakthrough that will reconfigure the relations between players. In the latter case, the target segment may not even exist yet and you need a strategy to bring these new customers on board. If your existing customers won't see the value in what you are doing, avoid them until the business is off to a good start.

Lead-Steer Customers

We previously mentioned 'beta' releases for software where working software is released to a limited group of users (often current users, or more sophisticated users) in order to create buzz while attempting to clean up any significant defects. Every innovation – product or service – has its counterpart in what are called *lead-steer customers*. These are the customers that will set the tone for your market entry, because there is no way to sell thousands of units without having sold three to begin with (Vasconcellos & Hambrick, 1989).

Unilever Discovers that its Lead-Steer Customers Do Not Care About Health

In one of the greatest advances of the century in food health, Unilever in 1973 filed a British patent application for a hardened, randomized margarine that reportedly contained only 3.2% trans-fatty acids. Trans-fatty acids were considered a leading health hazard arising from the huge global market for margarine and cooking oil; so serious is the health hazard that trans-fatty acids pose that New York banned them completely in foods served in the city after July 2008. Unilever's patent was lauded by European oil chemists as 'the greatest technological advance of recent years'. It permits truly tailor-made fats to be produced, at the same time allowing almost limitless variation of the raw materials used. By 1976 some European margarines with zero trans-fatty acid content and high polyunsaturate content were being produced by a modified process.

Despite its importance, the road to 'selling' this improved process was convoluted, and started with a graduate student who licensed a particular catalytic technology from a former professor. Although his innovation made sense in the final market, it didn't offer much in the way of exciter features to his target audience.

This was because the annual savings for a refinery manager to switch to the new catalyst were modest – perhaps $15,000 per year per converter. Moreover, the refinery manager wouldn't personally benefit from the savings, which would appear on the plant expense budget and were not part of the criteria on which refinery managers were evaluated. Should a batch of oil be lost, on the other hand, the manager would be held responsible and the cost could exceed $150,000 per batch. This high-risk/low-reward proposition to switch to the new catalyst was a predictably hard sell, and entrepreneurs got nowhere with their 'I'll save you money – trust me' pitch.

Lead-steer customers are opinion leaders in their industry who are likely to be well regarded by their peers. Corporations like those on the 'most-admired' lists published in magazines such as *Business Week* are prime candidates for lead-steer customers. Individuals who represent a segment that is highly desirable to you might be more appropriate for your particular innovation. The objective is to use these customers' enthusiasm about your innovation and business model to simultaneously test your assumptions about attribute maps and use their success with your offering to sell to others, to create buzz, to initiate viral, word-of-mouth promotion. Testimonials and actual experiences with real customers are critical if buying from you involves any kind of perceived consumer risk (consider, for example, medical innovations such as new drugs or surgical procedures).

In trying to sell to these customers, bear in mind that the buying decision may be complex. If you are trying to market to consumers, then a distributor or another channel partner will usually be involved. If you are trying to sell to companies, they invariably have multiple employees who are involved not only in making the purchasing decision but also at many different – and potentially crucial – links in your company's consumption chain.

Unilever Gets its Lead-Steer Customers to Care about Health

In the previous box we saw that the entrepreneurial student that invented Unilever's new margarine failed to consider the risk aversion of factory managers, resulting in a setback to selling his innovation. Out of desperation, the entrepreneur called on an old college friend who was running an oil refinery for the Unilever Corporation. The entrepreneur brought with him the professor who had developed the catalyst and who could credibly attest to its safety and quality. He even volunteered to donate the first batch of catalyst at no cost, just so his friend could try it out. His friend was persuaded to make the order. The catalyst worked well, and Unilever made the switch. In this industry at the time, the Unilever plants set the standard for what was considered cutting-edge. Once it became known that Unilever had adopted the product, nearly every other plant in the region switched over as well.

The entrepreneur had achieved two critical outcomes. First, for the individual refinery managers, he had removed the risk of switching to his catalyst; in the event something went wrong, they could credibly argue that they were simply following the best practice in their industry. Second, he had increased the downside of their not switching to his product, because a leading manufacturer was using it. This first sale led rapidly to the next few sales required. With momentum well established, the entrepreneur went on to convert the bulk of his target customer segment to the new catalyst within 18 months.

When planning your launch, you need to know the people involved in making the critical decision on whether to buy from you. You also need to get a feel for their needs and interests as far as the offering is concerned. Try to articulate to yourself, as best you can, your assumptions about how the sale will be closed. What will stop the sale? Who will try to stop the sale? Why would they stop the sale? What will clinch the deal? The idea is to be prepared to overcome obstacles to closing the sale before they arise.

You should be so familiar with these customers' consumption chains that you will have a good idea of how risky and difficult it will be for them to buy from you. How hard will it be for them to switch to your offering? How much will it cost them? If they need to learn to work with or operate your product or service, what is the training and adjustment burden? The greater the effort they must put into implementing your solution, the more you must convince them that the effort is worthwhile.

The first step towards choosing your first three sales is to prioritize potential customers according to the extent to which you believe they will generate substantial benefits by adopting your offering and the extent to which they perceive it to be a risky, effortful move (Figure 6.9 shows the resulting matrix, which you can use to help set priorities).

		Risk	
		Low	**High**
Benefit	**Low**	Second priority: You must expend time, effort and money to help manage the potential customers' risk. This may involve new research and technology, especially with innovations in medicine and food	Not a good prospect for initial sales
	High	First priority	Third priority: Warranties and price reductions are needed to convince the customers to buy

Figure 6.9 Prospects and Strategies for Initial Sales

The most important deals, in short, are those that secure the critical first few sales. The front end of the initial marketing plan should focus on how to target customers for these first few sales and how to reduce their risk of purchase (Van der Heijden, 1996).

Competitive Response

Generally you have to assume that you are entering a market where there are established competitors. (If you are entering into an entirely new market, you need not invest effort in analysis of past competitive behaviour.) A critical variable is the response of likely competitors, and the success of any new business proposition is critically dependent on the venture's insulation from early, debilitating, competitive attack. Unless you have overwhelmingly powerful sources of competitive insulation (such as patents in the pharmaceutical industry), the response you get will be shaped in part by the initial moves you make.

Two major factors dominate competitive response. The first relates to a competitor's motivation to challenge you in your arena. The second concerns its capacity to challenge you. Motivation has a lot to do with whether managers in competing organizations will feel threatened by your entry and feel that they must respond urgently. The degree of threat depends on how they view the competitive significance of the arena. If they have a sizeable commitment to a competing solution for the customers you are going to start selling to, they will have a greater motivation to respond (Day, 1990).

Using publicly available information, you can often get a rough estimate of which business areas fall into which category for your competitors, at least on a revenue basis. In addition, businesses to which a competitor has made long, accumulated psychological and resource commitments are more likely to be highly valued than new businesses. Another indicator of corporate commitment by your competitors is their relative effectiveness in a target arena. You can gauge this by assessing a competitor company's performance on the key drivers for that arena – if the firm regularly outperforms its competitors; then it must have a strong position and is more likely to seek to defend it.

Capacity to respond is also critical to a competitor's propensity to react to your move. Even with all the motivation in the world, a competitor without the resources, or without the appropriate skills or technologies, cannot do you much harm. On the other hand, a competitor with cash, high stock valuation or excess capacity possesses assets that could be mobilized against you, or a strong position in distribution, supply or standard-setting. Propensity to respond is a key indicator of the resources you will need to expend on market entry.

Competitive Tactics

The study of managerial strategy was originally conceived by Peter Drucker in terms that had their basis in military strategy. Though our understanding of management has evolved and expanded to incorporate operations, science and technology, the study of successful military tactics still has great relevance when planning a market entry and we can borrow much from them.

Offensive tactics

Rapid dominance: Spectacular displays of power to destroy an adversary's will to fight. A well-known example of dominant manoeuvres occurred when Japanese semiconductor makers advanced on the Intel Corporation's DRAM (dynamic random access memory) business in the mid-1980s. The Japanese firms cut prices on DRAMs for every target customer by 10% until Intel gave up on the customer. The eventual result of these cumulative attacks was the complete withdrawal by Intel from the DRAM market.

Planned attack/frontal assault: The direct, hostile movement of forces towards enemy forces in a large number, in an attempt to overwhelm the enemy. This is often referred to as a 'suicide strike', because it is often a commander's last resort when he or she has run out of strategies.

Flanking manoeuvre/pincer movement (double envelopment): The principle of the flanking manoeuvre is to be sudden and able to catch the enemy by surprise, causing them to overreact or retreat when they are surrounded from a few directions. Usually this type of flanking is concealed in an ambush.

Attrition warfare: Attrition warfare is a strategic concept which states that to win a war one's enemy must be worn down to the point of collapse by continuous losses in personnel and materiel. The war will usually be won by the side with greater reserves of this type.

Interdiction/control of lines of communication and supply: Often involves patent fights and forward contracts to ensure control of scarce resources.

Pre-emptive attack: To gain a strategic advantage in an impending war, the intention being to harm the enemy at a moment of minimal protection, for instance while vulnerable during transport or mobilization.

Divide and conquer: A strategy where small power groups are prevented from linking up and becoming more powerful, since it is difficult to break up existing power structures. Typical elements involve creating or at least not preventing petty feuds among smaller players. Such feuds drain resources and prevent alliances that could challenge the overlords.

Guerrilla warfare: A method of combat by which a smaller group of combatants attempts to use its mobility to defeat a larger, and consequently less mobile, army.

Defensive tactics

Mutual support: Locating weapons in ways that mutually support one another so that it is difficult for an attacker to find a covered approach to any one defensive position is an example of the application of the defensive principle of mutual support.

Scorched earth policy: A military tactic which involves destroying anything that might be useful to the enemy while advancing through or withdrawing from an area.

Trench warfare: A form of war in which both opposing armies have static lines of fortifications dug into the ground, facing each other. Trench warfare arose when there was a revolution in firepower without similar advances in mobility and communications.

Deceptive Tactics

Disinformation: The spreading of deliberately false information to mislead an enemy as to one's position or course of action. It also includes the distortion of true information in such a way as to render it useless. Thomas Edison was famous for disinformation campaigns in his war with George Westinghouse for the home electrification market. Edison electrocuted dogs, cats, and even an elephant to give the impression of dangers inherent in Westinghouse's systems.

Feint: Designed to draw defensive action towards the point under assault. It is usually used as a diversion to force the enemy to concentrate more manpower in a given area so that the opposing force in another area is weaker.

Force multiplication: A military tactic that is supposed to visually magnify a force, such as a division or an army, through means of using decoy vehicles or use of terrain to deceivingly create a much larger force than it really is.

First-mover Advantage

First-mover advantages arise from three primary sources: (1) technological leadership, (2) pre-emption of assets and (3) buyer switching costs. Within each category there are a number of specific mechanisms and more recent work has shown the advantages conferred on first movers can be best understood from a resource-based perspective of the firm.

Aggressive pursuit of customers makes sense where there are significant network effects and increasing returns to scale. This has been encouraged by the promise of what has been called 'first-mover advantage' – unfortunately, the first mover in any market does not always, or even often, hold the competitive advantage (Golder & Tellis, 1993). It is better to be a late mover when there are substantial benefits from letting the market leader:

- figure out exactly what the customers are willing to pay for and position their product accordingly,
- develop the underlying technology sufficiently for it to be robust with an easy-to-use interface;
- make do with today's technology, when the late mover can leapfrog with improved technology.

It is also beneficial if you are already a powerful firm in the market, with enough resources to come to the market late.

In contrast to popular myth, first-mover advantage is quite rare. It is much more common and widespread for successful competitors to enter a market later (Golder & Tellis, 1993; see also Chandy & Tellis, 1998, 2000; Shankar et al., 1998). Figure 6.10 provides a brief guide for whether or not to invest in becoming a first mover.

(Source: Eisenmann, 2003)

	First-mover Advantage	*Late-mover Advantage*
Returns to Scale	Network effects. Learning curve. Lack of scale economics.	Scale economics (if firm is large). Chance to learn from competitors' mistakes. Reverse engineering. Leapfrog with superior technology.
Switching Costs	High switching costs.	Low switching costs. Scale economics. Uniform pricing requirements

Figure 6.10 When Investing to Gain First-mover Advantage is Strategically Justified

Progressive

A classic example of a firm that pursued a guerrilla strategy is that of Progressive Insurance, which moved into the high-risk niche in automobile insurance. This niche move was actually met with relief on the part of some competitors. This is characteristic of a great guerrilla strategy: if established competitors find your chosen niche difficult to serve or a poor fit with their capabilities, they are unlikely to do anything to stop your progress. For several years, Progressive built its capabilities. Eventually, the company used the competences that evolved from serving its niche base to begin expanding into more attractive niches. Today, fully 15% of Progressive's portfolio of customers are in the standard (i.e. low-risk) segment, and the company ultimately hopes to mirror the industry at large, in which only 15–20% of all drivers are in its initial nonstandard segment.

Innovation Workout: Force-Field Analysis

Peter Drucker's 1964 book *Managing for Results* was originally titled *Business Strategies* – a title that was rejected by the publisher after test marketing. Drucker, with his keen background in European history, borrowed the term strategy from military and political campaigns, with allusions to winning battles. The term strategy wasn't widely used in business enterprises until the late 1970s, and then only with great resistance from entrenched academics.

A good market entrance strategy is like a good military strategy – it is designed to win, and to do so at a minimum of cost. The original proponent of cost-effective strategy was Sun Tzu, a general in the 6th century BC in the Chinese state of Wu. The objective of an entrance strategy is to avoid debilitating competitive interaction by using speed, skill and surprise, or by using imagination, innovation and creativity to outmanoeuvre your competitors.

In this vein, we can look for guidance to one of the most lucrative 'wars' in modern history – the weekly battle between the goliaths representing competing teams in American football. A good football coach does not say, 'There is one way all great football teams win games, and we must do it the same way'. Rather, a warrior tries to determine which positions on his team are strong and which are weak by testing and observing each individual football player. Then he replaces the weaker players, or teaches them to overcome or disguise their weaknesses. For example, if a defensive end is an ineffective pass rusher, the coach might teach him ways to trick the blocker. Only in this way can the coach bring his team's unique talents into play.

Like a firm or an army, a football team has one goal: to win. To win, the coach will develop a strategy to maximize the team's strengths and minimize its weaknesses. For instance, if a team has a weak defence, his strategy might be to control the ball and keep his defence off the field; if the offence is weak, he might teach his team to keep the other team deep in their own territory. By being aware of the positive and negative aspects of his team, the coach most efficiently uses football knowledge to win games.

It is the same with challenges. You must be aware of the positive and negative forces operating in a challenge before you develop a strategy for solving it. Your strategy should allow you to take advantage of the positive factors while eliminating or diminishing the negative ones.

The Japanese martial art of aikido (合気道) is designed to control an attacker by controlling and redirecting their energy instead of blocking it. It focuses on positive and negative forces, and how you control them to achieve your objectives. This is the basic idea underlying *force-field analysis* which was articulated in the West by social psychologist Kurt Lewin (1943). Force-field analysis allows you to see how positive and negative forces push and pull you towards a best-case or worst-case scenario.

Blueprint

1. Write the challenge you are trying to solve.
2. Describe the best-case scenario and the worst-case scenario; the best that can happen and the worst.
3. List the conditions of the situation. Conditions are anything that modifies or restricts the nature or existence of your subject. They are whatever requirements you perceive to be essential to solving a particular challenge.

In force-field analysis, maximizing strengths is the objective; minimizing weaknesses keeps you out of trouble. Consider how Steven Jobs and Stephen Wozniak created Apple Computers. In 1976, their principal strength was a unique design for a personal computer; their principal weakness was an utter lack of capital – between them they had $1,300.

1. Jobs maximized their principal strength by selling 50 as-yet-unbuilt computers to a string of computer hobby stores, based on their unique design.
2. He minimized their weakness by securing credit to buy parts, based on sales of unbuilt computers.
3. He added a positive force by using the profits gained from the sale of the first 600 computers to start work on the enormously successful Apple II.

Apple went public at the end of 1980 and after three weeks its shares were worth more than Ford Motor Company shares.

Once you identify the forces operating in your challenge, they become as negotiable as a mountain on wheels. You can either learn to live with the negatives by limiting your options and compromising your goals, or you can change their position and neutralize their impact.

Case Study: Triumph and Victory Enter the Market

Motorcycle sales in general have declined in recent years as the American and European populace has aged. But in the early 2000s sales were booming both for sports bikes and for larger 'cruisers' that appealed to middle-aged armchair renegades. How do you enter a market, the likes of which is dominated by a venerable brand like Harley-Davidson, famous for dominating the cruiser market? Harley motorbikes have been a part of American myth and history for a century. This is the challenge that faced John Bloor's revival of the prestigious British Triumph marque, and Polaris, a snowmobile maker that wanted to enter the market with an innovative new marque called Victory.

Motorcycles have grown popular both as recreational vehicles and as alternatives to automotive transportation in warmer climates. There are more than 5.5 million motorcycles registered in the US; California has roughly 12% of all US-registered motorcycles. Nearly 30% of all motorcycles in operation are located in four states: California, New York, Texas and Illinois. Registrations in both Louisiana and Texas have increased by more than 60% since 1997, which are the highest volume increases in the country. Figure 6.11 shows recent and projected sales of motorbikes (with cruisers such as those sold by Victory and Triumph broken out).

Triumph Motorcycles

Triumph, though a British marque, perhaps has the upper hand when it comes to its place in American motorcycle history. When Marlon Brando led a group of outlaw bikers in the

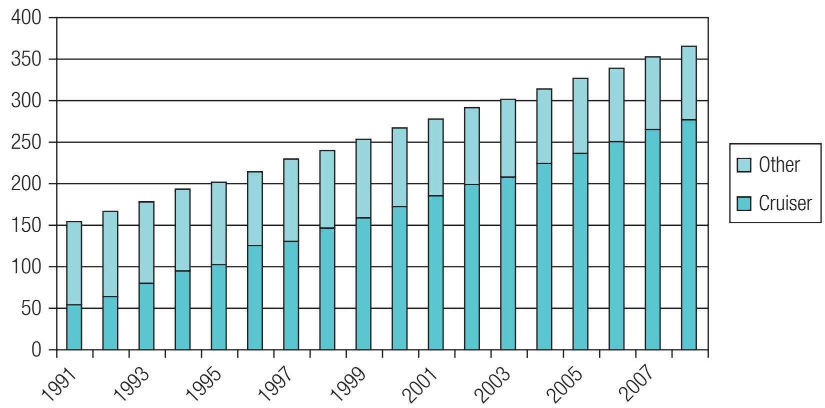

Figure 6.11 US Motorcycle Sales (000s) of 600cc and Above

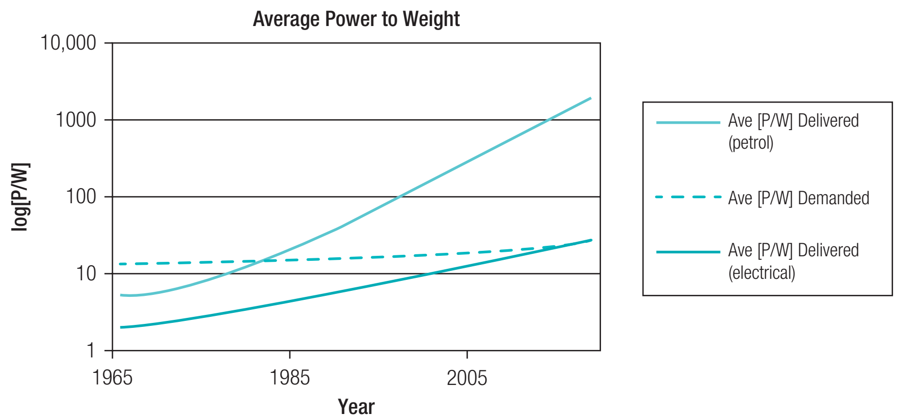

Figure 6.12 Motorcycle Power to Weight

1953 film *The Wild One*, he rode a Triumph. It was the obvious choice back then. Britain was the biggest motorbike maker in the world and Triumph was winning every race in sight. The firm was ended in the 1970s by years of bad management, only to be resurrected in 1983 by a coal miner's son and self-made millionaire named John Bloor.

Bloor initially invested $100 million to revive Triumph around three-cylinder engines that he thought were better to attract middle-aged men getting back into bikes. Big-bike sales were driven by older people with the money to spend on expensive toys. Many of these born-again bikers hadn't touched a motorbike since their teens, so were looking for something less demanding than the Japanese sportbikes in the market.

Triumph's annual sales have risen from 2,000 in 1991 to 33,000 today. Most buyers now are aged between 35 and 55. American sales (which make up 25% of the total 250,000 big bikes sold in the US) have soared since Triumph introduced the retro-styled Bonneville, and are now rising at an annual rate of 40%. The launch of a Harley-style cruiser-style bike has boosted sales further. Still, Triumph sells only a sixth as many bikes as Harley-Davidson.

The new company needed a strong and stable platform from which a range of competitive motorcycles could be developed, thus the concept of the modular range was born. This concept enabled the range to share common components, allowing a number of different types of machine to be constructed from the same base which, crucially, could all be built on one assembly line at the same time.

Design of the new range commenced in 1984 and by 1988 the company was ready to begin building a new factory (the old plant at Meriden had been demolished in the early 1980s). A 10-acre site was purchased in Hinckley, Leicestershire, England and construction commenced. As soon as the first phase of the site was complete, pre-production began and the first models were launched at the Cologne show of 1990. As production capacity steadily grew, Triumph set about re-establishing a network of export distributors. Two subsidiary companies had been established prior to production commencing; Triumph Deutschland GmbH and Triumph France SA, and over the next couple of years the network expanded to encompass most of the world's major motorcycle markets, culminating in 1994 with the creation of Triumph Motorcycles America Ltd.

By this time 20,000 new Triumphs had been built and in January 1995 the Triple Connection clothing range and the accessories range of products were launched to provide the Triumph customer with an all-round package of Triumph apparel and equipment.

Production now stood at around 12,000 units a year and as both retail sales and production capacity grew the company was able to develop more single-minded machines that

Segmentation Base	Characteristics	Description of the Target Customer for Triumph	Strategic Rationale/ Reasoning
Geographic Segmentation	Country/ Region	UK	Sales are rising by 15% a year, putting Triumph within sight of European rivals such as BMW and Ducati.
		Germany + rest of Europe	
		US	
Demographic Segmentation	Age (Range)	Younger generation (25–45)	Triumph should play on its brand equity for racing cars and target the younger strata for the sportbikes. Instead of buying bikes as a second vehicle, they should encourage usage as a primary vehicle. This segment would have to be high earning to be able to afford Triumph bikes and thus would consist of well-placed professionals.
	Sex	Males	
	Income	High income	
	Occupation	Professionals, well-to-do	
Psychographic/ Lifestyle Segmentation	Economy Minded	No	Although Triumphs are good value for features offered, they are not inexpensive.
	Outdoor Enthusiasts	Yes	The target segment would include middle-aged men seeking attention and probably coming back to riding after a while; thus seeking a comfortable yet stylish ride.
	Attention Seekers		
Use-Related Segmentation	Purpose	Racing, travelling, hobby	The awareness level of the customer base would be very high. They would be educated bike enthusiasts with high brand loyalty. Therefore, it would be beneficial for Triumph to target this segment as they would be pro this brand and would increase brand awareness by word of mouth.
	Usage Rate	High	
	Awareness Status	Enthusiasts, very high	
	Brand Loyalty	High	
Benefits Sought	Value for Money	Yes	
	Convenience/ Handling	Yes	Superbly tight, flicks easily through turns with no handlebar slap.
	Power	Yes	The 955cc triple is the best of both worlds, with the powerful torque rumble of v-twins and the high-end screaming that inline fours produce; it balances nicely, producing a very wide power band in which to be used.
	Design/ Good Looks	Yes	Emblazoned on the side of the tank is the original Triumph logo, a customer magnet.

Figure 6.13 Target Market for Triumph Motorcycles
Source: Triumph, www.triumphmotorcycles.com

did not rely on the modular concept. The first of these, the Daytona T595 and the T509 Speed Triple, were launched at the 1996 Cologne Show. The range diversified further with the introduction of the Sprint RS and ST, the Tiger and more recently with the launch of the TT600 and Hinckley's first twin: the Bonneville.

Victory Motorcycles

Victory Motorcycles' division of Polaris (the snowmobile manufacturer) took a different approach to market entry than did Triumph. Rather than going around Harley-Davidson's laid-back cruisers to find a market for middle-aged weekend cowboys, they took aim directly at Harley's customers. Victory entered into the heavyweight cruiser motorcycle category in the autumn of 1997, when the company's debut V92C cruiser landed on the cover of every major motorcycle magazine and racked up an impressive list of accolades.

Predictably, direct competition with the market leader would not be easy, and Victory got off to a rocky start. Due to what current General Manager Mark Blackwell calls 'big-time miscalibration problems', Victory motorcycles didn't arrive in dealerships until more than a year later, in December 1998 – much too late to benefit from any momentum created by the press coup a year before. Uneven quality control and underwhelming performance generated a distinct lack of consumer confidence in the new cruiser manufacturer.

This is the situation that Mark Blackwell found when he took over as General Manager of the Victory division of Polaris in September of 2000. Blackwell targeted 2002 as the year that he would relaunch Victory Motorcycles, with an aggressive five-year product development plan, reorganized engineering department and distribution network, and focused market vision.

Mark Blackwell had made his name in motorcycle racing, first in off-road racing in the late 1960s and early 1970s when he became the American Motorcycle Association's first 500cc National MX champion. After an eye injury forced his early retirement from racing, Blackwell, an MBA, moved on to manage Suzuki's off-road racing team and later served as Vice President of Sales and Marketing at Husqvarna, doing another term at Suzuki as motorcycle media relations director then director of its marine division, and then as Vice President for Sales and Marketing for Arctic Cat. Blackwell's knowledge of the powersports industry – and more importantly its customers – was intimate.

Blackwell was honest about Victory's missteps from 1997 to 2000 and, instead of apologizing, cited specific steps that he would take to overcome them and avoid repeating them in the future. Blackwell was also concerned that Victory might be perceived as just a snowmobile company jumping on the motorcycle bandwagon. Though Victory and Polaris did share staff through a matrix organization structure, the decisions were autonomously made for motorcycle designs, and Blackwell was the final authority. The organization gave Victory more financial clout than a typical start-up, which Blackwell felt was absolutely necessary in competing directly with cruisers from Harley-Davidson to Honda and Yamaha (Frank, 2002).

By the same token, Blackwell chose not to leverage the Polaris name, simply because of the price differential in products. Polaris management was worried about the reality of selling $15,000 Victory motorcycles, as opposed to $5000 Polaris all-terrain vehicles. They were concerned that despite consumer acceptance of the Polaris, a $15,000 cruiser was going to require a different level of prestige.

For an item that would be sold as a middle-aged man's luxury toy (and thus a discretionary expense) such concerns were justified. Nonetheless, the cruiser market was estimated to be worth $300 to $500 million over the coming decade for Polaris, and it displayed favourable demographics – better than snowmobiles in the same period. Heavy cruisers represented the most vibrant segment in the motorcycle industry; one driven by the demographics of middle-aged men more than product, and one with steady growth every year. Sportbikes, on the other hand, were highly product sensitive: if one year Honda, Yamaha and Kawasaki all come out with new sportbikes, you see a big jump in sales that year; if there are no new models the following year you will see smaller growth.

Victory, in fact, picked a better understood market and set of demographics than had John Bloor with Triumph. Cruiser design was conservative, while at the same time expensive. The idea was to recreate the hot-rodded conversions of World War II surplus police bikes that were popular in the 1950s. Harleys had gained their immense popularity because since the 1930s they had locked up most US army and police bike sales, and consequently, by the 1950s, huge numbers were available through war surplus markets. Hot-rodders would typically pull everything off these surplus bikes that was removable (this was called 'chopping' which led to the vernacular 'chopper' for cruiser-style bikes) in order to make them lighter, and thus faster and more responsive. This and custom paint and chrome work were responsible for the distinctive and unchanging style of the heavyweight cruiser.

The initial segregation of the Polaris and Victory businesses created some tension and inefficiency. Motorcycles and snowmobiles consist mostly of the same parts – a motor, a rigid frame, electronics, steering, seats and so forth. These parts are not interchangeable, but much of the technology can be shared and jointly developed. As a consequence, the plan was to separate operations, but to leverage the engineering expertise of Polaris in building a motorcycle that targeted the planned market, and finally reintegrate the two divisions once the Victory name had been established in the market.

One of the first moves to correct the missteps on Victory's V92C cruiser was to terminate the positions of 15 of Victory's shop technicians (about 20% of its workforce) and add six positions for degreed design engineers (the net salaries impact was about nil, given their salary differentials) significantly enriching the skillset of the company. Blackwell had found that spending more on the front end with the design saved significantly more on the back end in terms of time and quality. Better design not only meant happier customers; it also meant fewer quality control and production problems.

In addition, Victory's website allows the pre-ordering of up to 300 different customizations on any newly purchased bike. And customers may specify unique paint colours and designs, as well as future customizations. This has allowed to company to connect much more effectively with its customers.

Questions and Activities: Triumph and Victory Case Study

1. Map out a strategy for Triumph for the future, detailing:
   a. Objectives
   b. Tactics
   c. Information needed to implement strategy
   d. Risk of this strategy.
2. Map out a strategy for Victory for the future, detailing
   a. Objectives
   b. Tactics
   c. Information needed to implement strategy
   d. Risk of this strategy.
3. Draw and compare the Value Maps of Triumph and Victory, and show where each should concentrate their strategy in the future:
   a. If both of these companies are competing in the same) market space (cruiser, big motorbike), why have they evolved such different strategies?
   b. Where is the money made on your Value Map?
4. Describe where the four types of scaling will manifest themselves in the motorcycle business.
5. In your strategy, how should each company link its R&D and its customer relationship management? Why are these strategies different for the two companies?
6. How does the strategy you defined allow Victory to compete with 'classic' brands like Harley-Davidson?
7. How does the strategy you defined allow Triumph to compete with 'classic' brands?

Chapter 6: Key Points

1. As markets and technologies change and evolve, your capabilities need to evolve to keep up with the changing demand for products and services.
2. You decide where you will acquire new capabilities (assets and competences) based on an analysis of your existing and planned products/services by growth, profit and revenue size.
3. Risk (of failure or success) must also be factored into your decisions on where capabilities will migrate in the future.
4. Real options are a variation on the models for analysing options in financial markets.
5. Three particularly useful options in developing an entrance strategy are positioning options, scouting options and stepping-stone options.
6. Where risk is low, options do not need to be used, and direct launches are likely to be faster and less expensive:
   - The key to discovery-driven entrance strategies is early engagement of the potential customers.
   - Identify the first few customers for your new business model.
   - You cannot sell 100 items before you sell three. The first three customers are your most important in developing your entrance strategy.
   - Determine the priority that you will give them, using risk/benefit trade-offs.
   - Articulate the strategy you will use to persuade them to begin transacting with you by mitigating any risks that they may anticipate.

Note

[1] The seminal work by Chandler (1962) provides insight in how some aspects of competition and innovation are much the same as they were even in the first part of the 20th century.

Further Reading

Barnett, W. P., Feng, M. and Luo, X. (2013). Social identity, market memory, and first-mover advantage. *Industrial and Corporate Change* 22(3), 585–615.

Brush, C. G. (2015). Export entry in small companies: Effects of timing on strategy and performance. *Journal of Small Business Strategy* 7(3), 53–68.

Chakrabarti, A. (1974). The role of champion in product innovation. *California Management Review* 17, 58–62.

Chandler, A. D. (1962). *Strategy and Structure*. Garden City, NY: Doubleday.

Chandy R. K. & Tellis, G. J. (1998) Organizing for radical product innovation: The overlooked role of willingness to cannibalize. *Journal of Marketing Research* 35(4), 474–487.

Chen, M.-J. (1996). Competitor analysis and interfirm rivalry: Toward a theoretical integration. *Academy of Management Review* 21, 100–134.

Chen, M.-J. and MacMillan, I. C. (1992). Nonresponse and delayed response to competitive moves: The roles of competitor dependence and action irreversibility. *Academy of Management Journal* 35, 359–370.

Cheng, Y. and Van de Ven, A. H. (1996). Learning the innovation journey: Order out of chaos? *Organization Science* 7, 593–614.

Cleff, T. and Rennings, K. (2012). Are there any first-mover advantages for pioneering firms? Lead market orientated business strategies for environmental innovation. *European Journal of Innovation Management* 15(4), 491–513.

Coy, P. (1999, 7 June). Exploiting uncertainty: The real options revolution in decision making. *Business Week*, 118–124.

D'Aveni, R. A. (1994). *Hypercompetition: The Dynamics of Strategic Maneuvering*. New York: Free Press.

Day, G. (1990). *Market Driven Strategy*. New York: Free Press.

Doherty, N. A., Kartasheva, A. V. and Phillips, R. D. (2012). Information effect of entry into credit ratings market: The case of insurers' ratings. *Journal of Financial Economics* 106(2), 308–330.

Dos Santos, B. L. and Peffers, K. (1995). Rewards to investors in innovative information technology applications: First movers and early followers in ATMs. *Organization Science* 6, 241–259.

Eisenmann, T. (2003, 15 January). A note on racing to acquire customers. *Harvard Business School Press*.

Frank, A. (2002, October). An interview with Mark Blackwell, *Motorcyclist Magazine*, 23–25.

Golder, P. N. and Tellis, G. J. (1993) Pioneer Advantage: Marketing Logic or Marketing Legend? *Journal of Marketing Research* 30 (2), 158–170.

Huisman, K. J. (2013). *Technology Investment: A Game Theoretic Real Options Approach* (Vol. 28). Springer Science & Business Media.

Jang, Y. (2014). Dynamics of fast market entrance for young entrepreneurial firms providing products in markets: Innovation, organization and entrepreneurs. *Academy of Entrepreneurship Journal* 20(1), 75.

Jespersen, A. P., Krogh Petersen, M., Ren, C. B. and Sandberg, M. (2012). Cultural analysis as intervention. *Science Studies*, 25(1), 3–12.

Kim, W. C. and Mauborgne, R. (2015). *Blue Ocean Strategy, Expanded Edition: How to Create Uncontested Market Space and Make the Competition Irrelevant*. Harvard Business Review Press.

Lewin, Kurt (1943, May). Defining the 'field at a given time'. *Psychological Review* 50(3), 292–310. Republished in *Resolving Social Conflicts & Field Theory in Social Science*. Washington, D.C.: American Psychological Association, 1997.

Lieberman, M. and Montgomery, D. (1988). First mover advantages. *Strategic Management Journal* 9, 41–58.

Lieberman, M. and Montgomery, D. (1998). First mover (dis) advantages: Retrospective and link with the resource based view', *Strategic Management Journal* 19(12), 1111–1125.

Markides, C. and Sosa, L. (2013). Pioneering and first mover advantages: The importance of business models. *Long Range Planning* 46(4), 325–334.

McGrath, R. G. and MacMillan, I. (2000). *The Entrepreneurial Mindset*. Harvard Business School Press.

McNeill, D. (2007, 12 May). Numbers man. *South China Morning Post*, p. C1.

Peng, M. W. (2012). The global strategy of emerging multinationals from China. *Global Strategy Journal* 2(2), 97–107.

Romanelli, E. and Tushman, M. L. (1994). 'Organizational transformation as punctuated equilibrium: An empirical test. *Academy of Management Journal* 37, 1141–1166.

Ross, J. and Staw, B. M. (1993). Organizational escalation and exit: Lessons from the Shoreham Nuclear Power Plant'. *Academy of Management Journal* 36, 701–732.

Rumelt, R. P. (1987). Theory, strategy and entrepreneurship, in *The Competitive Challenge: Strategies for Industrial Innovation and Renewal*, ed. D. J. Teece (pp. 137–158). New York: Harper and Row.

Sahaym, A., Treviño, L. J. and Steensma, H. K. (2012). The influence of managerial discretion, innovation and uncertainty on export intensity: A real options perspective. *International Business Review* 21(6), 1131–1147.

Scherer, E. M. (1979). *Industrial Market Structure and Economic Performance*. Chicago: Rand McNally.

Schmookler, J. (1966). *Invention and Economic Growth*. Cambridge, Mass.: Harvard University Press.

Shankar, V., Carpenter, G. S. and Krishnamurthi, L. (1998). Late mover advantage: How innovative late entrants outsell pioneers. *Journal of Marketing Research* 35(1), 54–70.

Sitkin, S. B. (1992). Learning through failure: The strategy of small losses, in *Research in Organizational Behavior*, ed. B. M. Staw and L. L. Cummings. Volume 14 (pp. 231–266). Greenwich, Conn.: JAI Press.

Song, M., Zhao, Y. L. and Di Benedetto, C. A. (2013). Do perceived pioneering advantages lead to first-mover decisions? *Journal of Business Research* 66(8), 1143–1152.

Staw, B. M., L. E. Sandelands and Dutton, J. E. (1981). Threat-rigidity effects in organizational behavior: A multilevel analysis. *Administrative Science Quarterly* 26, 501–524.

Teece, D. J., Pisano, G. and Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal* 18, 509–533.

Utterback, J. M. (1994). *Mastering the Dynamics of Innovation: How Companies Can Seize Opportunities in the Face of Technological Change*. Boston: Harvard Business School Press.

Utterback, J. M. and Abernathy, W. J. (1975). A dynamic model of process and product innovation. *Omega* 3, 639–656.

Van der Heijden, K. (1996). *Scenarios: The Art of Strategic Conversations*. New York: John Wiley and Sons.

Vasconcellos, J. A. S. and Hambrick, D. (1989). Key success factors: Test of a general theory in the mature industrial-product sector. *Strategic Management Journal* 10, 367–382.

Venkataraman, S. and Van de Ven, A. H. (1993). Hostile environmental jolts, transaction set, and new business. *Journal of Business Venturing* 13, 231–255.

von Hippel, E. (1978). Users as innovators. *Technology Review* 80(3), 30–34.

von Hippel, E. (1986). Lead users: A source of novel product concepts. *Management Science* 32, 791–805.

von Hippel, E. (1988). *The Sources of Innovation*. New York: Oxford University Press.

Wageman, R. (1995). Interdependence and group effectiveness. *Administrative Science Quarterly* 40, 145–180.

Weatherford, J. (2004). *Genghis Khan and the Making of the Modern World*. Crown.

2

EXTERNAL FACTORS IN INNOVATION

An Introduction to Part 2

Creativity, markets and products themselves are not sufficient to ensure the success of your innovation. Many external real-world factors assert themselves in the process of commercializing an innovation, and these are only partly under the control of the innovator. Even the best-run strategies are imperilled by myriad confounding decisions about intellectual property laws, industry disruptions, technology acceleration and the competition for venture capital and finance. Where the innovator cannot control these, at least there is the possibility of predicting and understanding them at a deeper level that allows intelligent crafting of strategies.

Part 2 of *Global Innovation Management* addresses the external factors that influence the success of an innovation. Chapter 7 summarizes intellectual property laws with a focus on US law. The World Intellectual Property Organization (WIPO) has encouraged a convergence of patent and copyright laws around the world. US law influences patents in other parts of the world, and Chapter 7 provides a workout on writing a patent – an important task that is seldom covered in business or law schools – to help students gain a deeper understanding of patents. Chapter 8 summarizes what we know about disruptive innovation and technology acceleration, and how these necessarily dictate strategic planning and finance in technology companies. Chapter 9 assembles all of the prior topics into a financial framework that is useful for presenting the innovation and business model to potential investors.

Together, the chapters of Part 2 cover a set of topics on tools to manage an invention beyond its creative origins to its transformation into a business. These chapters focus on the competitive environment and business of innovation, providing action-oriented tools for commercializing great ideas. Emphasizing the necessary skills needed for the commercialization of an innovation, case studies present concepts discussed in the chapters, and introduce ideas and real-world problems that will arise in practice.

CHAPTER 7

Protecting Your Innovations

Learning Objectives

After finishing this chapter, you will

- Understand the motivation and history behind intellectual property (IP) laws.
- Understand the function and applicability of a patent.
- Understand the function and applicability of a copyright.
- Understand the function and applicability of a trademark.
- Understand the function and use of trade secrets.
- Know how to get started in setting up an IP strategy.

After doing the *Innovation Workout* you will gain valuable insights into managing trade secrets.

After reading the *case study* on how to write a patent, you will gain a broad knowledge of the background knowledge, research and strategic issues that are a part of writing defensible patents.

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Laws

Our laws reflect society's standards, values and expectations. They establish 'the rules of the game' in our personal interactions and business dealings, assuring us that we are being treated fairly (and that we treat others fairly in return). Laws establish our responsibilities and our rights to help us avoid or resolve problems before they become unmanageable.

Specific sections of the law govern our rights and responsibilities regarding new ideas. Our society's 'values' regarding ideas are currently in flux – churned by ever-evolving technologies for storing, communicating, searching, associating and advertising information, ideas and innovations. Our 'rules of the game' are evolving along with our values, which leads to a higher level of uncertainty and change in intellectual property statutes than nearly any other area of the law. Still, there are basic strategies and facts that the innovator needs to know to protect their ideas; this chapter covers those basics.

Ethics

'Ethics' is a branch of philosophy that involves systematizing, defending and recommending concepts of right and wrong conduct. The etymology of the word 'ethics' derives from the Ancient Greek word *ethikos*, which means 'habit' or 'custom'. Laws may be seen as an institutional or governmental implementation of ethics along with enforcement and punishment guidelines. Ethics is typically broken into three major sub-disciplines:

1. Meta-ethics seeks absolute axioms and theory;
2. Normative ethics prescribes 'moral' courses of action, which are likely to vary widely between people and cultures; and
3. Applied ethics studies real-world implementations and limitations.

Meta-ethics is divided two sub-disciplines: (1) *cognitivism* and (2) *non-cognitivism*. Cognitivism presumes the existence of absolute, knowable axioms of ethics. Non-cognitivism questions the knowability of these axioms, suggesting that humans are emotional, irrational creatures divorced from any certainty about truth or right and wrong. Non-cognitivists believe that ethics does not need a specific ontology, since ethical propositions do not refer – they are anti-realist. Though there are people who spend their lives pondering such weighty issues, most of us will find meta-ethical musings to be useless, or worse. The fact that important issues may be clothed in ethical ambiguity potentially allows clear abuses of power, position and so forth while deeming them ethically acceptable.

Normative ethics explores the questions that arise when acting morally. Normative ethics is most closely linked with legal systems because it attempts to establish standards for the rightness and wrongness of actions. Normative ethics seeks axioms and absolute frameworks that can potentially be implemented and enforced. It differs from descriptive ethics, which describes real-world moral beliefs, many of which are culturally rooted. In the business and institutional realms, normative ethics focuses on establishing standards for tangible resources such as wealth sharing, and intangibles such as reputation. As moral theories have grown more complex, the study of normative ethics has declined amongst philosophers, while meta-ethics, in the form of analytic philosophy and logical positivism, has grown in popularity. Since the 1970s, there has been a pronounced divergence in the study of ethics in political science, economics, business and law compared with the more abstract philosophical disciplines. John Rawls' seminal *A Theory of Justice* (1971) in particular supports moral argumentation in contrast to the abstractions of meta-ethics. Rawls' work addresses practical issues in political science, economics, business and law in the areas of human rights, wealth distribution and legal systems.

Consequentialism and *teleology* consider the consequences of an action in evaluating the rightness and wrongness of that action. In consequentialism, the ends tend to justify the means.

Utilitarianism as espoused by Jeremy Bentham and John Stuart Mill is an ethical theory that extends consequentialism in the sense that it maximizes a positive effect, such as satisfaction, welfare or personal preferences. Utilitarian constructs and arguments grew central to the development of economics in the late 19th and early 20th century. The influential British economist John Hicks contributed to consumer demand, general-equilibrium and value theory. The Hicksian demand function maps consumer demand over a bundle of goods that minimizes their expenditure while delivering a fixed level of 'utility' in the utilitarian sense. We have become inured to utility in business, law and economics to such an extent that drawing utility indifference curves, considering first- and second-order conditions for utility maximization, mapping consumer surplus and so forth seem quite natural while accepting completely the utilitarian philosophical underpinnings of our assumptions.

Postmodernism and *deconstructionism* in ethics tend to focus on critiques of society and culture rather than advancing axiomatic theories of ethics. Antihumanists such as Louis Althusser and Michel Foucault and structuralists such as Roland Barthes challenged the possibilities of individual agency and the coherence of the notion of the 'individual'. Jacques Derrida argued that access to meaning and the 'real' was always deferred, contending that 'there is nothing outside context'. Jean Baudrillard theorized that signs and symbols or simulacra mask reality in the consumer world (the consumer world, and most objects of business and economics, take a drubbing in postmodernist arguments). Post-structuralism and postmodernism argue that ethics must study the complex and relational conditions of actions. Zygmunt Bauman even argued that humanity has no chance of being repaired by some ethical principle. If this seems nihilistic to you, you likely would find many scientists, economists and industrialists would agree. People who innovate and build – whether in technology, businesses or social systems – want ethical guidance for the responsibilities they have taken on. They are most likely to be interested in applied ethics.

Applied ethics attempts to apply ethical theory to real-life situations. The discipline has many specialized sub-disciplines. The most important for product and service innovation are summarized in the following paragraphs.

Bioethics is concerned with the ethical questions that arise in the relationships among life sciences, biotechnology and medicine as technology makes new powers available to doctors and researchers. It addresses emerging biotechnologies that affect basic biology and future humans including cloning, gene therapy, human genetic engineering, astroethics and life in space, and manipulation of basic biology through altered DNA and proteins.

Business ethics considers the professional situations that arise in a business environment related to the conduct of individuals and entire organizations. The field is primarily normative rather than descriptive. Ethics implicitly regulates areas and details of behaviour that lie beyond governmental control. The emergence of a professional management class with limited relationships and sensitivity to other stakeholders has accelerated the development of the business ethics discipline.

Robot ethics is an emerging field of study, though one could argue that the seminal work in this field was Isaac Asimov's *I Robot*. The study of robot ethics will likely drive advancement in understanding of human ethics by forcing us to address gaps in modern normative theory and by providing a platform for experimental investigation without the involvement of humans. Such *in silico* studies are already standard in fields such as biology, cosmology and high-energy physics, and robots will provide a vehicle for *in silico* ethical studies.

Evolutionary ethics considers the role of evolution in shaping human psychology and behaviour. Such an approach may be based in scientific fields such as evolutionary psychology or sociobiology, with a focus on understanding and explaining observed ethical preferences and choices.

There are numerous other areas of applied ethics, with large groups of researchers. *Military ethics* deals with application of force and the ethos of the soldier. *Political ethics* makes moral judgements about political action and political agents. *Publication ethics* guides writing and publishing.

Many of the sub-disciplines of applied ethics justify ethical behaviour in terms of the *sustainability* of systems and agents being governed. The particular venues in which this is most pertinent today are presented elsewhere in this text where we discuss *sustainability*.

Stealing the Whole Company

At first it seemed to be nothing more than a routine case of counterfeiting in a country where faking it had become an industry. In mid-2004, managers at the Tokyo headquarters of the Japanese electronics giant NEC started receiving reports that pirated keyboards and blank CD and DVD discs bearing the company's branding were on sale in retail outlets in Beijing and Hong Kong. NEC hired a Hong Kong forensics firm, International Risk, to investigate the possible theft of its intellectual property – its brand, its designs, its electronic circuits, its patents. After two years and thousands of hours of investigation in conjunction with law enforcement agencies in China, Taiwan and Japan, the firm discovered something much more sinister than a few impromptu workshops turning out inferior copies of NEC products. The pirates were faking the whole company.

Evidence seized in raids on 18 factories and warehouses in China and Taiwan showed that the counterfeiters had set up what amounted to a parallel NEC brand with links to a network of more than 50 electronics factories. Production included home entertainment systems, MP3 players, batteries, microphones, DVD players and so forth, manufactured in mainland China, Hong Kong and Taiwan. The counterfeiters erected phoney NEC signs outside their factories, shipped their products packaged in 'authentic' boxes and display cases, carried NEC business cards, commissioned product research and development in the company's name and signed production and supply orders which were paid by the real NEC. Using the company's name, the pirates were not content just to copy NEC products; they even developed new ranges of consumer electronic products that would sell under NEC's brand. Steve Vickers, a former senior Hong Kong police officer and CEO of International Risk, observed that the pirates required factories to pay royalties for 'licensed' products and went so far as to issue official-looking warranty and service documents – with the real NEC receiving complaints and warranty service requests for these counterfeit products. Criminal networks coordinated all of the manufacturing and distribution, and collected all of the proceeds for goods that ultimately found their way onto retail shelves in Taiwan, China, Hong Kong, South East Asia, North Africa, the Middle East and Europe, right alongside legitimate NEC products.

'These entities are part of a sophisticated ring, coordinated by two key entities based in Taiwan and Japan, which has attempted to completely assume the NEC brand', observed Fujio Okada, the NEC senior vice president and legal division general manager, in written answers to questions. 'Many of these entities are familiar with each other and cooperate with each other to develop, manufacture and sell products utilizing the NEC brand. On the surface, it looked like a series of intellectual property infringements, but in reality a highly organized group has attempted to hijack the entire brand.' Mr. Vickers noted that 'the reality is that factories in China will produce what they are asked to produce'. 'The challenge is finding out who placed the orders and who funded it.'

Once aware of the full extent of the fraud, NEC acted quickly to disrupt the supply chain and market channels of the counterfeiters. Prosecutors in the southern Taiwanese city of Kaohsiung issued warrants for the local police to raid a warehouse and offices in the area where investigators seized 60 pallets of counterfeit goods, mostly audio products, carrying the NEC brand. Evidence collected in these raids also implicated factories in China, leading to late-night raids which were extensively covered in the Taiwan media, with television cameras on nine factories in the cities of Guangzhou, Zhongshan, Zhuhai and Shenzhen in Guangdong Province of China.

(Source: Adapted from Lague, 2006)

The Enigma

The Enigma machine was any of several German electromechanical rotor cipher machines used after 1918 for enciphering and deciphering secret messages. These were initially intended to securely communicate intellectual property and corporate secrets using emerging technologies in cable and wireless communications. Enigma was invented by the German engineer Arthur Scherbius, whose initial market was corporate. The

1920s boom in technology patents and commercial innovations was seen to be a fertile market for a device that could reliably encrypt commercial communications. Scherbius's Enigma was widely seen as the best encryption device on the market but, priced at $20,000 per unit, was too high for most corporations, who often felt that they could make do with less secure encryption. Scherbius innovated continually, improving the portability and interface of the Enigma. By 1927 his model D was widely used in diplomatic and military service by Sweden, the Netherlands, the United Kingdom, Japan, Italy, Spain, Poland and the United States. At that point Germany's military took notice of Scherbius's success, and appropriated the Enigma for its secure communications.

We will cover the parts of this law that are most commonly invoked to protect innovations, and show how – and how not – to incorporate these into a general strategy for protecting your innovation. This chapter constrains itself to US intellectual property law. The laws of most countries adopt similar principles, and it is common for intellectual property to be licensed in the US as well as any other jurisdictions in which it might be sold or used, simply because of the large size of the US market.

Intellectual Property Law

If you have come this far, you probably already have a very good understanding of your innovation and how you plan to develop it into a

The First Patents

Patents originated in Venice in 1474 where inventions, once they had been put into practice, had to be communicated to the Republic in order to obtain the right to prevent others from using them. This definition was conveyed through British law to the US colonial lawyers who drafted the Articles of Confederation. Thomas Jefferson

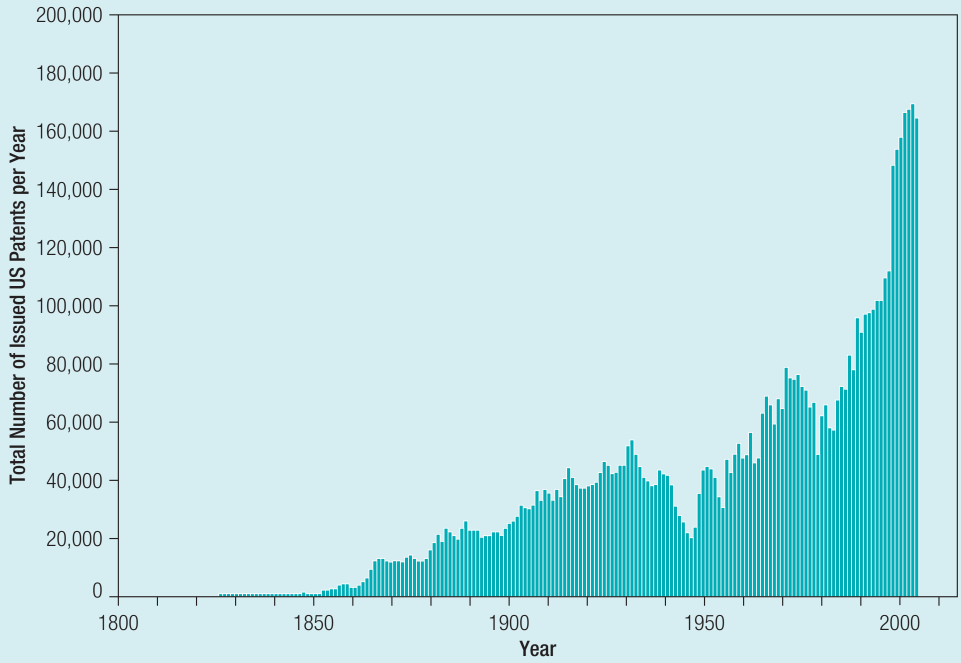

Figure 7.1 Patents Filed since 1800
Source: www.uspto.gov

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total
Japan	333	336	337	332	319	334	339	349	357	358	384	383	365	358	368	368	347	333	330	295	290	288	287	272	8063
United States	91	88	92	100	107	124	107	119	135	149	165	178	184	189	190	208	222	241	232	225	242	248	269	288	4191
China	6	7	10	12	11	10	12	13	14	16	25	30	40	57	66	93	122	153	195	229	293	416	535	705	3070
Korea, Rep.	9	13	16	21	29	59	68	67	51	56	73	74	77	90	105	122	125	129	127	127	132	138	148	160	2017
Germany	31	32	34	35	37	38	42	44	47	50	52	50	48	48	48	48	48	48	49	48	47	47	47	47	1065
Russian Federation	0	0	39	29	21	18	18	15	16	20	23	25	24	25	23	24	28	28	28	26	29	26	29	29	541
United Kingdom	19	19	19	19	18	19	18	18	20	21	22	21	21	20	19	18	17	17	17	16	15	15	15	15	440
France	12	13	13	13	13	12	13	13	13	14	14	13	14	14	14	14	15	15	15	14	15	15	15	15	328
Italy	0	0	8	7	8	0	7	0	0	6	8	0	0	0	0	0	0	9	9	9	9	9	8	8	105
Iran, Islamic Rep.	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	4	6	11	15	12	11	12	11	11	101
India	1	1	1	1	2	2	2	2	2	2	2	2	3	3	4	5	6	6	6	7	9	9	10	11	99
Canada	3	2	3	4	2	2	3	3	4	4	4	4	4	4	5	5	6	5	5	5	5	5	5	5	96
Ukraine	0	0	0	9	5	5	4	5	5	5	6	7	2	2	4	4	3	3	3	2	3	3	2	3	85
Brazil	2	2	2	2	2	3	3	3	2	3	3	3	3	4	4	4	4	4	4	4	4	5	5	5	82
Sweden	3	3	3	4	4	4	4	4	4	4	4	4	3	3	3	3	2	3	3	2	2	2	2	2	76
Poland	4	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	4	4	4	67
Spain	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4	3	3	3	66
Netherlands	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	2	2	3	3	3	2	2	53
korea, Dem. Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	7	0	8	8	8	8	0	51
Switzerland	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	51
Austria	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	50
Finland	2	2	2	2	2	2	2	2	2	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	49
Australia	0	0	0	0	0	2	2	2	2	2	2	2	2	2	3	3	3	3	3	2	2	2	3	3	44
Denmark	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	36
New Zealand	1	1	1	1	1	1	1	2	1	1	1	2	2	2	2	2	2	2	1	2	2	2	1	2	35

Figure 7.2 The 25 Most Innovative Countries by Patents Filed 1990–2013 (in 000s)

Source: The World Bank

was viscerally opposed to any sort of patent monopoly, but at the time of the Constitutional Convention was serving as ambassador to France. Alexander Hamilton is credited with including a patent and copyright clause in Article II of the US Constitution. The first US patent was issued on 31 July 1790 on a process for the making of potash.

Most of the world is today converging towards a common set of intellectual property laws. Where there are differences, these are usually small and tied to the industrial characteristics of the country. The World Intellectual Property Organization helps enable intellectual property protection around the world by providing its standardized patent framework and systems for streamlining applications to selected countries. Figure 7.2 shows the most innovative countries as reflected in patent applications, and Figure 7.3 tracks the change in applications. These may generally provide an idea of where to look for future ideas.

Country ranked by number of patent filings 2004–2013	Average annual increase in filings 2004–2013
United States of America	6%
China	54%
Japan	–3%
Republic of Korea	4%
European Patent Office	2%
Germany	0%
Russian Federation	5%
Canada	–2%
India	15%
Australia	2%
United Kingdom	–3%
Brazil	10%
France	0%
Mexico	0%
China, Hong Kong SAR	2%
Iran (Islamic Republic of)	33%
Italy	0%
Singapore	1%
Thailand	–1%
Indonesia	2%

Figure 7.3 International Patent Applications by Country
Source: World Intellectual Property Organization, http://ipstats.wipo.int/ipstatv2/keysearch.htm?keyId=221

profitable business. Yet here is a risk – substantial in an era when information can be communicated globally with the flick of a few keys – that someone else will beat you to the implementation of your idea, or that someone with more resources will crowd you out of your potential markets before you have a chance to implement your plans. This is where your knowledge of intellectual property law and the strategies for correctly using it can make the difference between success and failure.

Qualcomm's CDMA Patent

Irwin Jacobs and six others founded Qualcomm in 1985 to build on the pioneering work of Austrian actress and polymath Hedy Lamarr who perhaps is more famous for her nude appearance in the film *Ekstase* (1933) and other Hollywood films than her later work as a radio-communications inventor who assisted the US in World War II.

Qualcomm's patent for Code-Division Multiple Access (CDMA) – No. 4,901,307: Spread Spectrum Multiple Access Communication System Using Satellite or Terrestrial Repeaters – set the stage for the growth of CDMA, which in 2015 had more than 700 million users worldwide with a host of wireless solutions, ranging from internet access to global positioning technology. Today, Qualcomm designs and manufactures digital processors that are central to cell phones and cellular networks. The company has around 21,500 patents (Figure 7.4) and does not disclose terms of deals with its 200 or so licensees but recently said its standard fee is under 5% of a handset's wholesale price, which would be around $10 a phone.

Qualcomm is the world's largest mobile phone chip maker with 31,000 staff members around the world, around one-quarter of these legal staff in licensing. Despite this, the bulk of Qualcomm's profit comes from

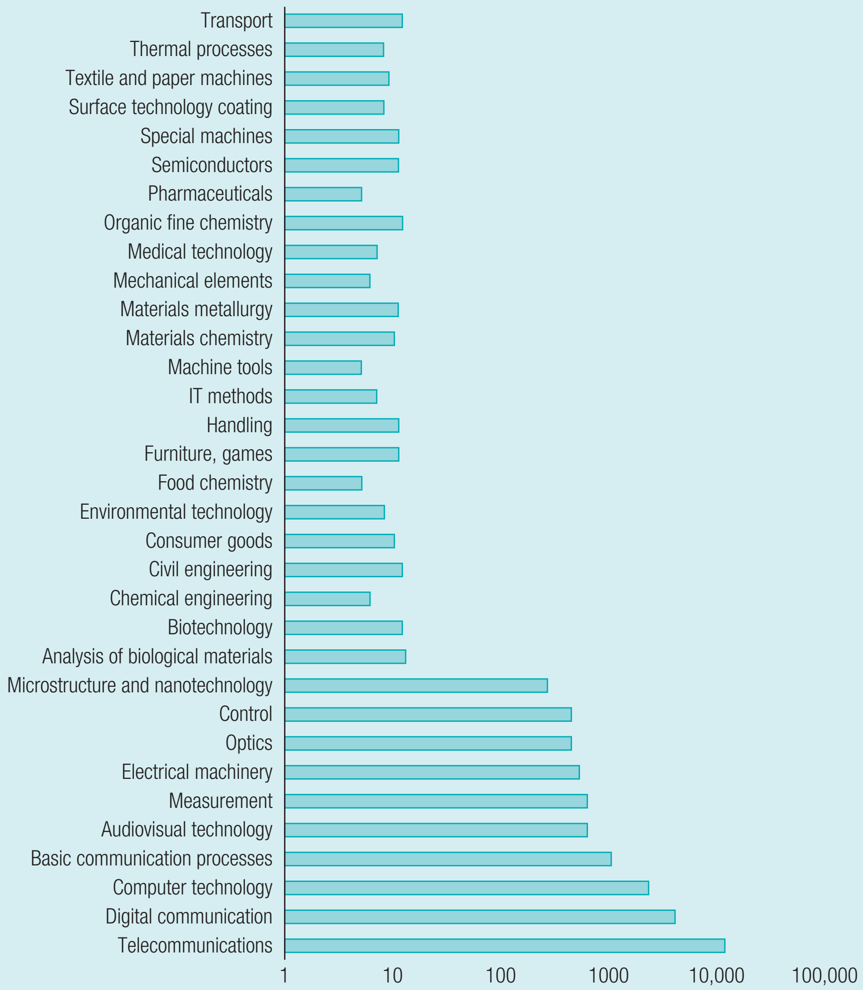

Figure 7.4 Distribution of Qualcomm's 21,500 Patents by Technology Category
Source: www.uspto.gov

patent royalties – $6.8 billion of pre-tax income in 2014. The majority of its revenue comes from selling processors and modems that run smartphones, a cut-throat business that keeps profits minimal. The cash influx from royalties helps fund research and development at the chip unit, which in turn creates patents for the licensing business.

(Sources: Mock, 2005; Your Story, 2015; Reuters, 2016)

Gemstar's Aggressive Patent Strategy

On 12 March 2001, an owlish Henry C. Yuen graced the cover of *Business Week* magazine, which asked the provocative question 'Will Henry Yuen take control of your TV set?' With a PhD in mathematics, Henry Yuen became a research scientist in 1989 at California Institute of Technology, where he came up with VCR

Plus+, a program that made him a millionaire. That technology ultimately went in nearly all VCRs, making it easier to programme the recorders.

Yuen didn't stop there, going onto acquire 90 more patents, all of them ostentatiously displayed on his office walls. He rode the market's enthusiasm for interactive TV to enormous power in the industry, developing the Gemstar-TV Guide interface and menu system for interactive TV. This channel-surfing interface – necessary for the hundreds of channels offered on cable TV – became the standard across the industry.

To make sure he profited from his patents, Yuen went on to earn a night-school law degree alongside his maths PhD. And he developed a penchant for suing his competitors over alleged patent infringement. He became so aggressive that one magazine described him as a 'patent terrorist'. Yuen's only response was 'I am no terrorist. A terrorist is someone who breaks the law. I am only doing what the US Congress and patent law allow'.

Cable executives saw it differently. 'He scares the hell out of us', said one. 'He can force his way onto our system because we need the guide, and he seems to be the only way to get one.' Cable giants John Malone and Rupert Murdoch launched a $2.8 billion hostile takeover of Gemstar in 1998, but Yuen countersued and ultimately forced a merger of interests. His opponents conceded that they 'could litigate for 50 years with Henry, or get half the company'.

By 2003 Henry Yuen had the entire cable industry under his sway, including some of the most notoriously aggressive deal makers in any industry. Along the way he made powerful enemies who felt trapped by his restrictive contracts and aggressive litigation. And that is about the time Gemstar-TV Guide began to unravel.

Someone tipped off the Securities and Exchange Commission (SEC) that Gemstar's revenues didn't add up, overstating revenues by at least $248 million, and Henry Yuen appeared to be profiting from stock sales at inflated prices. The SEC took Yuen to court and on 8 May 2006 found Yuen guilty of receiving $10,577,692 in ill-gotten gains from his fraudulent conduct, consisting of: (1) $3,022,452 in gross bonus compensation received by Yuen during the period of the fraud, and (2) $7,555,240 in excess trading profit he received by selling Gemstar stock during the period of the fraud. Yuen was ordered to pay a total of $22,327,231 in disgorgement, penalties and interest, and entered a permanent injunction against future securities law violations and a permanent bar from serving as an officer or director of a public company.

(Source: Bloomberg, 2001)

The Origin of Copyrights

Copyrights are a product of a specific invention – Gutenberg's movable type printing press. Prior to the press, copying manuscripts involved painstaking and expensive work by literate servants or slaves; the expense alone assured that distribution was limited. With the availability of cheap copies, printers began lobbying for protection of their property from illicit copying – basically a 'copy right' for themselves. In Britain, this led to the Licensing Act of 1662 which established a register of licensed books and required a copy to be deposited with the Stationers Company. Subsequent extensions of copyright laws have built on the publisher's perspective which gives them the right to make copies and excludes others from making copies. This was enforceable when copying involved expensive typeset and presses, but has grown troublesome as technology has pushed the cost of copy to zero.

Under the law, an innovator has at his disposal four types of intellectual property protection – patents, copyrights, trade secrets and trademarks. All provide specific rights to use (rights of publicity) and to exclude from use (privacy or exclusion). These rights come with obligations, some of which can be expensive. At the core of rights and enforcement of those rights is the idea of excludability – the ability to exclude others from use of the property – generally through 'tollboths' which artificially congest access to the property (but also saddle the industry with input and coordination costs). Advances in technology over the past several decades have steadily eroded the ability to create and operate such 'tollbooths', in many cases (e.g. in the music industry) completely subverting the ability of companies and the industry to enforce intellectual property protection.

Standards Wars

Screws came into common use around the 1st century BC in wine and olive oil presses and for pressing clothes. As metalworking advanced, screws were also made out of iron and brass, though often their threads, having been filed by hand, were imperfect and shallow. Screws produced manually were so expensive that they were sold individually and avoided in designs whenever possible. The Industrial Revolution finally brought mass production screw making to a level that inexpensive screws became the preferred fastener for numerous products. Despite all of these improvements, the two ends of the screw – the head and the point – left much to be desired.

On their pointy end, 18th-century machinery was not able to file screws to a point, and carpenters and other users had to drill a hole into material to get the blunt screw-end started. The familiar machine-made, pointed self-starting screw didn't appear until the mid-19th century.

At the flat end of the screw, no one seemed to be able to agree on what was the best screwdriver for applying torque to turn it into the fastened material. In the late 19th century, manufacturers explored numerous solutions, including magnetic screwdrivers and double slotted screws. Out of many experiments came a number of promising designs, but only one standard remains today.

Henry Phillips hit on the idea of an X-shaped socket head at the turn of the 20th century, a design that was first rejected and then enthusiastically embraced by the American Screw Co. American Screw in turn persuaded General Motors in 1936 to use the Phillips-head screw in manufacturing of its quality marque, Cadillac, which immediately made it popular elsewhere in the auto industry. As America entered into the Second World War, Phillips' design was adopted in manufacture of a huge assortment of vehicles. Automakers liked the fact that there is a degree of cam-out or slippage inherent in the Phillips design that allows automated screwdriving machines to pop out once the screw is tight.

Elsewhere the Canadian inventor Peter Robertson hit on a head design with a square recess (rather than Phillips' X-head) that is still a favourite among many woodworkers today, but otherwise is a standard nowhere in the world except Canada. Robertson had the bright idea to colour code his screwdrivers – green, red and black from smallest to largest – which improved efficiency. Fisher Body adopted Robertson's system on Ford's Model T production (each car originally used over 700 Robertson screws). Henry Ford was impressed with the system, estimating that Robertson saved him about two hours of work for each car. Ford asked for an exclusive licence for the use and manufacture of the Robertson screw in the US, an idea that Robertson unwisely rejected. The rebuffed Ford then approached Henry Phillips who had no such reservations about licensing. With Ford's shift to Phillips-head screws, the entire auto industry became locked into Phillips' standard just as World War II was ramping up demand for vehicles. The Robertson screw is still popular in Canada, particularly in boat building, but has otherwise slipped into oblivion.

While 20th-century innovators argued about the best way to design the flat and pointy ends of a screw, wars were being lost over the middle bit. Screw standards played an important part in the highly mechanized Second World War. In America, the auto industry had faced massive disruption in the period from 1905 to 1920 as around 300 automobile companies eventually merged or exited leaving three giants: General Motors, Ford and Chrysler. These giants imposed uniform standards on a massive industry, including screws, and not just on the ends. The American auto industry standardized on the global standard Unified Screw Thread UNC/UNF/UNEF (coarse, fine, extra fine) threads. In contrast, the British industry making tanks, airplanes and trucks retained its traditional BSW/BSF (British Standard Whitworth/British Standard Fine) threads. BSW/BSF threads are cut at a difficult-to-machine 55° angle, whereas UNC/UNF/UNEF are cut at 60°. This had huge consequences during the War, where at any one time in harsh environments such as those encountered during the North African campaign from 1940–1943, around one-third of British tanks were out of service because of lack of replacement screws. In the latter half of the Second World War all British military vehicles and equipment were forced to change over to screws made using UNF/UNC threads. The postwar consequence was a general European obsession with adherence to the metric system standards during rebuilding.

Patents

A patent is a temporary legal right granted by the government as a reward for a unique invention, giving the inventor the right to exclude others from using his or her invention. An invention is defined as a technological advancement that is useful, new and is not obvious to a person with ordinary skill in the field. Inventions can take many forms, from a machine or device to a method or process. They can be new compositions for an old product, or perhaps new uses of an old product. They can be an artificially created organism, or even a discovery about how plants and animals express their genes.

The three types of patents are:

1. *Utility patent*: protects a machine, manufactured article or process, and is granted for 20 years (before June 8, 1995 the duration was 17 years);
2. *Design patent:* covers a new and original ornamental shape or surface treatment, which need not have any utility. Design patents are granted for 14 years;
3. *Plant patent:* covers characteristics of plants that have been asexually reproduced, and is granted for 20 years.

To obtain a patent in the US, you need to file an elaborate application that completely describes your invention, and indicates how it differs from other patented inventions (available at www.uspto.gov). The form is filed with the US Patent and Trademark Office (USPTO), followed by a wait for approval averaging two years. On approval, you pay a fee, and are given rights to 'exclude' others from using your invention.

Unfortunately for patent holders, exclusion is not free. A patent is really just a licence to sue someone; and lawyers and lawsuits cost money. The substantial sums involved in defending patents may lead some innovators to look for buyers for their patents; ones with lawyers on retainer and deep pockets. Therefore, if you are dealing with a chemical or process invention, or any other improvement that does not need to be exposed to the general public and can be kept secret, trade secrets may be a better choice than a patent.

For this reason, there are other types of intellectual property protection that may be more suitable for a particular business situation. After all, the purpose of intellectual property protection is to assure that the innovator is protected enough to take strategic advantage of his or her innovation.

Hitachi's Evolving Patent Strategy

Hitachi's first President, Namihei Odaira, was once quoted as saying 'inventions are an engineer's lifeblood'. Since Odaira's days, Hitachi has made patent strategy central to its business planning, and among all Japanese firms in the 1990s Hitachi's patent strategy was by far the most successful. Hitachi earned \$455 million in patent royalties in 1996. In the same year, it paid some \$91 million in patent licensing fees. Thus, it made a profit of about \$364 million that year in its patent trade, and patents made an important contribution to the company's bottom line.

After 1945, Hitachi aggressively sought out and imported foreign technology in an effort to jump-start its industry. Gaining access to such basic technologies as those used in semiconductor manufacture, computer production, television manufacture and nuclear power generation, Hitachi focused on reverse engineering, then improving commercially important technologies in order to compete globally. And it then aggressively sought to patent these improvements in Japan, the US and Europe. Hitachi, and Japan's industry in general, sought to ensure that Japan had its own technology, patented by its own people. To this end, Hitachi dedicated a staff of specialists to wok solely on patents. Technical people were encouraged to apply their engineering skills to inventing things. This focus, common across industry, was highly beneficial to the Japanese economy, and by the early 1950s production surpassed pre-war levels. Between 1953 and 1965, GDP expanded by more than 9% per year and in manufacturing by 13% annually.

From the early years, Hitachi was one of the most aggressive filers of patents. In 1970 alone, Hitachi filed 20,000 patent applications. All of the company's technical achievements were reported to the patent department, which then checked them and filed the appropriate applications. The emphasis was on sheer number more than the quality of each patent (Hitachi was not alone in this as most Japanese companies competed fiercely in the patent arena, each company filing huge numbers of applications).

Significantly, in 1970 Hitachi adopted the policy of opening its patents. At that time Hitachi was losing money on all of this patent filing. In 1970 it earned $5 million but incurred expenses in excess of $95 million in licensing fees. To reverse these losses, Hitachi became the first Japanese company to go shopping for cross-licensing and royalty deals.

In 1979, Hitachi faced its first major patent challenge when Westinghouse charged Hitachi with patent infringement and petitioned the US International Trade Commission to block the import of circuit breakers from Japan (Westinghouse eventually lost the suit).

Hitachi decided to counterattack by directing its patent division to look for Japanese patents (not just Hitachi's but those of other Japanese companies as well) where Westinghouse might be infringing. Hitachi had dozens of US patents for electrical power transmission equipment, but it found that they were all patents for detailed features distinctive to Hitachi products. Hitachi's engineers were not particularly adept at developing the broad, basic patents on fundamental technology that Hitachi needed in order to countersue competitors such as Westinghouse. Though Hitachi owned huge quantities of patents, these tended to be so narrowly focused on specific implementations of technology that other companies found it easy to get around them with only minor product redesign.

This was a bitter lesson for Hitachi, which initiated a goal in 1981 to double the number of 'strategic' patents it filed each year. Hitachi's idea was to pre-emptively build a 'fence' of strategic patents around each of its major product lines – both current and planned. The idea was that if a competitor wanted to enter into an industry claimed by Hitachi, it would have no choice but to licence some of Hitachi's strategic patents. There is no point in obtaining a mountain of patents if they fail to give the company competitive leverage.

Hitachi divided its strategic patents into three categories, designated *gold*, *silver* and *bronze*. Those that other companies could not get around and that covered world-class, basic technology were in the gold category. Hitachi was one of the first companies to recognize the value of strategic patents, to scale up its patent investments and to make patents central to corporate strategy.

The emphasis on strategic patents was crucial to Hitachi's success over the next few years. By 1985, the entire patent operation had become profitable, as Hitachi saw royalties and licensing income expand.

Hitachi ran into more patent problems in 1986. During that time Micron Technology formally accused the Japanese semiconductor industry of 'dumping' (i.e. selling below cost to gain market share) and filed along with Texas Instruments a $300 million antitrust lawsuit against six Japanese electronics companies. This eventually led to the signing of the Semiconductor Trade Agreement between the US and Japan in 1986, which established 'fair prices' for Japanese memory chips. Texas Instruments used the period to renegotiate its licensing fee with Hitachi – it wanted to set the licensing fee for DRAM (dynamic random access memory) manufacturing technology at 10% of sales. It then filed suit with the US ITC and with the Texas courts. Hitachi countersued in the Texas courts and in Japan, charging Texas Instruments with infringing upon some of Hitachi's strategic patents. In the end, Texas Instruments settled out of court, at a licensing fee considerably less than Texas Instruments had originally asked. This represented the first major victory of Hitachi's strategic patent campaign.

1985 also saw Hitachi embarking upon a new campaign to – once again – double the number of strategic patents that it filed annually. In contrast to the previous programme, though, this was a programme to patent basic technology that might otherwise be overlooked or taken for granted. A third campaign was launched in 1990, to double the number of strategic patents yet again. Working under a 'patent first' slogan, this was an effort to patent the basic technology that would be needed to meet emerging market requirements and open up new technology streams.

This strategy paid off again when Motorola tried to force Hitachi out of the microcomputer market in the early 1990s. Hitachi was able to use its patents on 'overlooked' technology to counter Motorola's market entry.

A fourth campaign to once again double the number of strategic patents was initiated in 1995. This was slightly different than previous initiatives, because it was mainly concerned about obtaining global coverage for its strategic technologies.

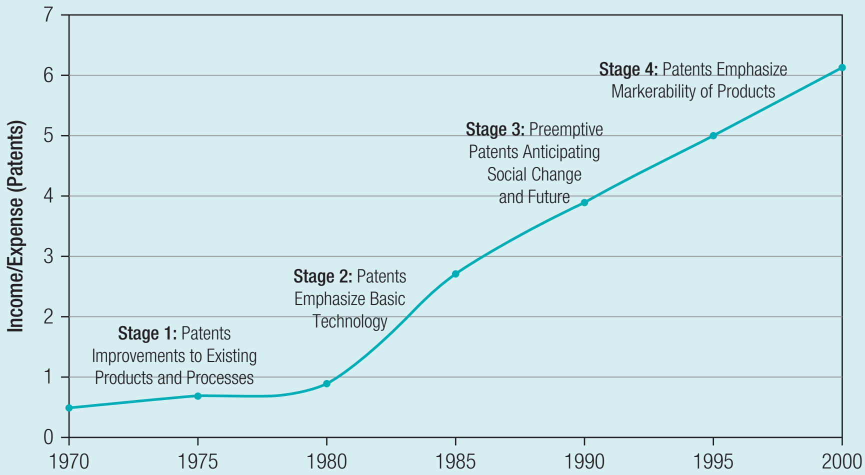

Figure 7.5 Hitachi's Income/Expense Ratio for its Patent Operation (1970–2000)
Source: Arai, 2000, Chapter 4

As you review the evolution of Hitachi management's patent strategy, consider: (1) the role that secrecy plays in Hitachi's IP strategy; (2) the strengths and weaknesses of Hitachi's stage 1, 2 and 3 IP strategies; and (3) whether you think that investments such as software and business methods should or should not be patentable.

Patent law is currently at the centre of controversy, partly because the corporate patent strategies have proven so successful over the past several decades, and partly because of the rapid advance in technology. The World Trade Organization has attempted to align the patent systems around the world, particularly with regard to certain controversial issues, such as what can be protected by patents and the issue of compulsory licences in cases of national need. A more fundamental issue was raised by law professors Michael Heller and Rebeka Eisenberg in a 1998 *Science* article (Heller & Eisenberg, 1998). They argue that current patent law can fragment intellectual property rights so widely that, effectively, no one can take advantage of them as to do so would require an agreement between the owners of all of the fragments. In fact this appears to be an increasing problem in the biotechnology and pharmaceutical industries, where complications involving the myriad patents covering gene expression, drugs, laboratory methods and so forth have squelched promising technologies.

The Selden Patent

One of the earliest recorded patent strategies played a pivotal role in the birth of America's car industry. Inspired by George Brayton's mammoth internal combustion engine displayed at the1876 Centennial Exposition in Philadelphia, George Selden filed for and received a series of patents for technologies underpinning the design of the automobile, ultimately selling them to a group of lawyers under the name of the Association of Licensed Automobile Manufacturers (ALAM). Despite never having built a working automobile, ALAM forced royalties out of nearly every car maker in Detroit – everyone but that of Henry Ford, owner of the Ford Motor Company. Ford's legal fight lasted eight years, generating a case record of 14,000 pages. The case was heavily publicized in the newspapers of the day and ended in a victory for Selden. Ford appealed and on 10 January 1911 won his case; a win based at least partly on his challenge to Selden to build a working car based on the patent. The resulting Selden car started up, chugged forward five feet, and promptly stopped, never to start again.

Jeff Bezos and 'One-click'

Jeff Bezos, founder of the online retailer Amazon.com, patented Amazon's 'one-click' checkout process, a process that was considered by many to be both trivial and obvious. Following the granting of this patent, Bezos used the Amazon.com website to argue that the patent process was flawed because – among other things – it was granting patents to 'trivial and obvious' processes like 'one-click'. Bezos went on to argue that software and software-based processes should not be patentable at all; that patent life should be shortened from their current 20 years to varying lengths that would reflect the innovation's life cycle; and that the USPTO, rather than trying to handle all aspects of patent review themselves, should create a centralized, searchable database of 'prior art' and give all competitors and interested parties six months to review patents pending for infringement. This searchable database has since been created on Google Patent Search.

Copyrights

Although derived from the same constitutional mandate as patents, copyrights resemble them only superficially. A copyright is a temporary right giving control over the use of an original work of authorship – texts, graphics, plastics, musical pieces, dramatic works, movies, audio programmes or visual creations. Copyrights protect the *form* in which an idea is presented – not the idea itself. Copyrights do not extend to abstractions, nor to technical designs. An idea for a movie is not copyrightable; the written script is.

Computer programs are copyrightable, giving programmers and the computer industry an effective security tool. Copyrights in computer programs over the choice of words or lines of computer code and their respective positions in an instruction represent the creative portion of the program and are critical to its operation. Patents are also available for computer code to protect innovative processes within a given program, but are much less used in the industry than are copyrights.

It's a Wonderful Life

The American Film Institute called it one of the best films ever made – *It's a Wonderful Life* (1946), directed by Frank Capra and based on an original story, *The Greatest Gift*, written by Philip Van Doren Stern in 1939. Capra bought the script for $10,000 from RKO Pictures who were so anxious to unload the project that they gave Capra three more scripts for free.

Shot in the spring of 1946, *It's a Wonderful Life* opened to moderate commercial and critical success. Over time, various mergers and acquisitions eventually put the film in National Telefilm Associates' library, where through a 1974 clerical error the copyright was not renewed. Once it entered the public domain, many television stations began airing the film without paying royalties.

The stations were in fact in error in believing that *It's a Wonderful Life* was out of copyright – it was more properly half in and half out. Although the film's *images* had entered the public domain, the film's *story* was still protected by virtue of it being a derivative work of the published story, *The Greatest Gift*, whose copyright had been properly renewed by Philip Van Doren Stern in 1971. By the 1980s (the beginning of the home video era) the film had become a perennial Christmas favourite and was shown multiple times on multiple stations throughout the holiday season.

The film's accidental public domain success is often cited as a reason to limit copyright terms. Frank Capra commented that 'it's the damnedest thing I've ever seen. The film has a life of its own now and I can look at it like I had nothing to do with it. I didn't even think of it as a Christmas story when I first ran across it. I just liked the idea.'

Copyright laws have been the subject of intense debate over the past decade as paper declines as a recording medium. With the advent of high-resolution computer screens and desktop printers, paper increasingly became an archival medium – used for long-term storage, but not for display. The attractiveness of search engines such as Google have eliminated the attractiveness of paper even for archives. The *Digital Millennium Copyright Act (1998)* rectified some problems associated with internet servers, communications and data storage. internet service providers are protected from prosecution for copies of copyrighted works that they might have on their servers, recognizing that this is a necessary part of their services over which they have little control.

The Bebop Alternative

Bebop composer and jazz saxophonist Charles 'Bird' Parker, Jr. was known for his innovative use of ninths, elevenths and thirteenths, creating a more colourful and rich harmonic sound than past jazz styles epitomized by the danceable swing of Benny Goodman and Glenn Miller.

'Bebop' is an onomatopoetic imitation of a characteristic quick two-note phrase that is played together by the lead instruments to introduce a solo or end a song; its music is distinguished by fast tempos, complex harmonies, intricate melodies and rhythm sections that lay down a steady beat only on the bass and the drummer's ride cymbal.

Parker based many of his bebop tunes on the chord changes from popular songs. A shortened version of the chord changes to Gershwin's 'I Got Rhythm' became so popular that it became simply 'rhythm changes' in the bebop lingo, and was the basis for Parker's tune 'Anthropology'; Parker's 'Ornithology' is based on the chords of 'How High the Moon'; 'Hot House' is based on chords from Cole Porter's 'What Is This Thing Called Love?'; and bebop standard 'Donna Lee' is based on the chord changes of the jazz standard '(Back Home Again in) Indiana'. The technical term for such tunes is contrafacts or contrafactions.

The extremely fast tempos favoured by beboppers often did not suit the original melody, and often further altered the original chords or even combined chords from two different tunes. This had a practical purpose: small, low budget record labels like Savoy, which documented the early bebop movement, often wished to avoid paying copyright fees for pop tunes.

Significant challenges to copyright (and patent) law have arisen from the success of free software such as GNU/Linux, Mozilla Firefox and the Apache web server. These projects have demonstrated that successful businesses can be created despite the absence of a copyright-enforced monopoly rent. These products use copyright to enforce their licence terms, which are designed to ensure the free nature of the work, rather than securing exclusive rights for the holder for monetary gain.

Some interesting complexities arise in categorizing products as either copyrightable or patentable in the computer industry, where the distinction between ideas and their physical implementation are often blurred. In particular, separate laws have been written to address photolithographic mask work – the two- or three-dimensional layout of an integrated circuit of transistors, interconnections, resistors and so forth which is photo-etched onto silicon substrate. Because of their functional nature, mask designs cannot be effectively protected under copyright law. Similarly, because individual lithographic mask works are not clearly protectable subject matter, they also cannot be effectively protected under patent law. Separate laws grant exclusive rights to mask work owners which are more limited than those granted to copyright or patent holders. For instance, modification (derivative works) is not an exclusive right of mask work owners. Similarly, the exclusive right of a patentee to 'use' an invention would not prohibit an independently created mask work of identical geometry. Furthermore, reproduction for reverse engineering of a mask work is specifically permitted by the law. As with copyright, mask work rights exist when they are created, regardless of registration, unlike patents, which only confer rights after application, examination and issuance.

Shifting Time and Space

Sony's Betamax videotape technology was in the early 1980s perceived to be a significant threat to the television broadcasters' business model. It allowed viewers to tape their shows, and then fast forward through sponsors' advertisements. The US lawsuit Sony Corp. vs. Universal City Studios (1984, the 'Betamax case') ultimately went to the US Supreme Court who determined home videotaping to be legal because viewers were deemed to be using it for '*time shifting*' of TV shows (e.g. watching late-night shows during the following day). This precedent was later successfully invoked in October 1998, when the Recording Industry Association of America (RIAA) filed a lawsuit against Diamond Multimedia – maker of the Rio PMP300, the second portable consumer MP3 digital audio player. Diamond successfully argued that MP3 players would be used for '*space shifting*' of music on CDs (e.g. ripping them off the CD so they could be carried around on the Rio player). The Betamax case was later invoked in MGM vs. Grokster (2005), where the high court agreed that peer-to-peer file sharing software was useful for time and space shifting.

Unlike a patent, there is no need to file for a copyright. Copyright attaches automatically as soon as the work is shown in a perceptive and reproducible form without the need for any formal application. As soon as a book is printed, a song is played or picture is hung, it is copyrighted. But, if you want to sue someone for infringement (or someone sues you) you need to prove that it's actually your original work. This is a lot easier if you have registered your copyright with the Copyright Office (a division of the Library of Congress) and submitted a copy as proof of authorship. Copyright lawsuits are similar to patent lawsuits, but quicker and less expensive.

Copyrights are long lived, and became even longer after the overhaul of the Copyright Act in 1978. Copyrights assigned to the original authors of a work last for 70 years after the death of the last author; if the authors are hired to write, or write anonymously, it is 95 years from publication or 120 from creation (the copyright extends to 31 December on the year of its expiration).

Trademarks and Other Commercial Identifiers

Trademarks are just one type of intellectual property (IP) protected by the USPTO under the rubric of *commercial identifiers*. These are used to distinguish your company, its products and services from those of your competitors. It goes without saying that these sorts of property – brands, names, logos and so forth – may over the long run be your most important assets. It is a mistake to treat them as the poor stepchildren of patents and copyrights. The three basic types of commercial identifiers are:

1. *Company identifiers*, such as a legal name or logotype that graces letterheads and offices;
2. *Service identifiers* that identify the services offered to customers; such as McDonald's 'supersize it' or the arched 'M' on their buildings;
3. *Product identifiers* include trademarks (brand names like Kleenex), or the Nike 'swoosh'.

Commercial identifiers offer a huge breadth of coverage – colours of products from automobiles to MP3 players; textures; container shapes; and other subtle or not so subtle design features are all potentially protected. But that protection may be limited to the specific markets in which a brand is known. For example, a well-known burger chain would have difficulty suing McDonald's Plumbing Supply over infringement, especially if the owner's name were McDonald.

Commercial identifiers are the IP rights that are most neglected, misunderstood and underestimated by innovators. Often the aspects of your product or business covered by commercial identifiers will be much more crucial to the success of the business than risky patent applications. 'What's in a name?' – more than you think: often those non-verbal cues entice and attract, without customers knowing exactly why, add to that reputation and quality image, and add the conveyance of what your product and company is about without even advertising. Commercial identifiers cover all of the subtle parts of your innovation that can make or break success more certainly than winning your patent lawsuit.

Trade Secrets

The last sort of IP protection is distinctly one-sided – there is no publicity, only privacy and exclusion. These are the laws that protect trade secrets, a particularly important and inexpensive IP right. But not every commercially advantageous material or process can be safely and practically kept under lock and key.

Secret Ingredients

The oldest trade secret still under protection by US law is *Merchandise 7X* – the 'secret ingredient' in Coca-Cola, which has remained a secret since its invention in 1886. In 1925, the only written copy of its formula Coca-Cola admits to having was retrieved from a New York bank (where it had been held as collateral on a sugar loan) and reverently laid in a safe deposit box in SunTrust Bank in Atlanta. That same year the company set a policy whereby no one could view the formula without written permission from the Board, and then only in the presence of the President, Chairman or Corporate Secretary. Furthermore, the rule dictated that only two company officials would be allowed to know the recipe at any given time, and their identities were never to be disclosed for any reason. The company has admitted to tinkering with the formula over the years (glycerine was added as a preservative, cocaine was eliminated, caffeine was greatly reduced, and citric acid was replaced with phosphoric acid). The formula was also changed in 1935 with the help of Rabbi Tobias Geffen of Atlanta to allow it to be certified kosher. Rumour has it that the 1925 copy of the formula now resides in a safe at Coca-Cola's Atlanta headquarters.

Merchandise 7X joins two other trade secrets in being fixtures of popular speculation – McDonald's *secret sauce*, and KFC's *secret blend of 11 herbs and spices*. KFC's security measures for the latter include blending those 11 herbs and spices at two different locations and combining at a third location prior to basting the chicken with them.

Other Contractual IP Rights

The rights and obligations offered by these four IP laws – addressing patents, copyrights, trademarks and trade secrets – don't necessarily fit the needs of everyone. In particular, many innovators may simply not have the resources to defend their IP in court. Thus there are various categories of legal contracts that are specifically intended to deal with IP rights. They provide contractual IP rights to all parties. For example, a company may acquire the contractual right to manufacture a patented product while the inventor obtains rights to royalties (a portion of the sales). Third parties in addition to the inventors can obtain exploitable rights; inventors can sell or lease their patent, copyright or commercial identifier rights to others (for example, in the case of this book, I have signed my copyright to Palgrave Macmillan in exchange for royalties). *Franchising* is a specific type of business that sells contractual rights to intellectual property (e.g. KFC or McDonalds).

Open Innovation

The concept of 'open source' originated with two related projects initiated in the 1970s in the US. Richard Stallman created the GNU project and the Free Software Foundation to create free software distributed under GNU General Public License to promote widespread redistribution and modification of project source code. The second group at the University of California – Berkeley improved AT&T's Unix operating system that spawned a family of Berkeley Software Distribution forks of Unix. Over the following four decades, open-sourced software became a dominant force in the industry, with products such as Apache, R, Linux, Java, MySQL and others growing to dominate their industries. The open-source model has inspired industrial and cultural movements such as the Creative

Commons and Zeitgeist Movement, clinical testing protocols in pharmaceuticals and numerous other projects in the sharing economy. In a sense, the movement harkens back to the communal industrial economies envisioned by Karl Marx, powered by today's communication technologies.

The popularity of open-source in the business community has been fuelled by a growing dissatisfaction with the manner in which abuse of the patent system has thwarted innovation and productivity, entrenched incumbents and generally been used in an anti-competitive manner. No recent case is more compelling than that of financier Martin Shkreli. Shkreli purchased, in 2015, the US marketing rights for Daraprim, used to treat life-threatening *Toxoplasma gondii* infections in HIV-positive individuals. He immediately raised the price from $13 per tablet to $833 per tablet, saying, 'If there was a company that was selling an Aston Martin at the price of a bicycle, and we buy that company and we ask to charge Toyota prices, I don't think that that should be a crime'. Though extreme, his practice was normal in the drug industry. A study by consulting firm Bain found that in the past 20 years those drug companies that consistently did well in various therapeutic areas were earning more than 70% of their sales from products developed elsewhere. They were profiting by buying patents and then increasing the price to the sick.

Drug companies that actually do research have themselves dissembled, citing the high cost of research and development. They have claimed that marshalling a major drug through clinical trials costs about $2.6 billion. But substantive research by Médecins Sans Frontières claims that new drugs can be developed for as little as $50 million and no more than $190 million, even taking into account the cost of those that fail during clinical trials. As new technologies, streamlined government regulations, evidence-based medicine and open sourcing of clinical trials advance, this number has fallen rapidly.

Henry Chesbrough, professor at the University of California – Berkeley and author of *Open Innovation: The New Imperative for Creating and Profiting from Technology* (2003b) has been influential in crafting open-source models appropriate to business and product innovation. Chesbrough cites the main difference between open-source and traditional proprietary software to be user and property rights. The defining feature of his business models is the release of innovations under licences analogous to Berkeley Software Distribution (BSD) software licences. Open innovation claims to provide a more distributed, more participatory, more decentralized approach to innovation, based on observations that that the WWW now allows any knowledge to be widely and quickly distributed. Companies today borrow intellectual property at a scale unprecedented in history, and patents are throwback to an earlier time when science was simpler and more personal.

Open innovation emphasizes the importance of research networks, sharing and Big Science. Over the past two decades, the medium of choice for research sharing and networking has been the WWW. The overarching architecture that connects the research, marketing, consumer and product development activities has steadily evolved with the expansion of bandwidth and computing power. Open innovation business models actively encourage companies to go outside the firm to actively avoid the 'not-invented-here' syndrome. Going outside means sharing technology with competitors where necessary – currently happening in self-driving cars, gene editing and numerous other areas; and to outsource production platforms to minimize price and maximize quality. Chesbrough emphasizes the centrality of information – the stuff encoded in patents as well as the communications systems to exchange information – asserting that open innovation is 'the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively'. These inflows and outflows of knowledge are enabled through particular artefacts of open innovation – *platforms*, *customer product completion*, *collaborative product design and development* and *networking*.

Platforms allow the sale of a partially completed product, for the purpose of providing a framework or toolkit for customers and other parties to access, customize, and exploit. Platforms have become especially evident in the Internet of Things market, a topic that will be explored in a later chapter. Platforms can appear as standardized processing chips, boards like the

Raspberry Pi and Arduino for hobbyists; software development kits (SDK) associated with hardware or software platforms from drones to operating systems; application programming interfaces (API) to network services such as Facebook and Twitter, and so forth. Network externalities from improved demand for the platform can more than replace patent royalties forgone by giving away intellectual property. Google realized this in sharing its Android operating system, and Tesla its battery technology.

Customer product completion recognizes the fine differences in demand that minor customization of a product can bring about. Customer interaction with the product has become standard practice in many industries. Harley-Davidson motorcycles are designed to be heavily modified using expensive after-market parts purchased from the dealers. Computers and audiovisual equipment, and other consumer electronics, are sold in modules that the consumer can mix and match to optimize their experience.

Collaborative product design and development has grown necessary for technologically complex products, and new computers, tablets and phones are typically developed through deep collaborations between factories knowledgeable about components and technology – often original equipment manufacturers who may also design equipment – and the marketing and development staff who are knowledgeable about customers.

Networking through consortiums, industry groups, standards-setting bodies and other venues can leverage the power of particular platforms in a way that is simply impossible inside a corporate R&D department. Open-source software is built on the networking concept, and services such as GitHub provide the tools to facilitate such networking on complex projects.

Thinking Strategically about IP

An IP acquisition and protection strategy is necessary for a business of any type or size. It is often even more important for innovators, because the only property they may own, and the core of their competences, will often be intellectual property.

Any expenditures on IP protection should outweigh their costs. There are three valid reasons for investing in IP protection:

1. Gaining and maintaining competitive advantage in your market;
2. Creating a new revenue source;
3. Enhancing the value of your existing revenue streams.

IP strategy starts by taking an inventory listing what assets (ideas, knowledge, processes, inventions, channels and so forth) are actually important to your business. Begin by doing the following:

1. Look at innovations in products of manufacturing methods that you and your associates or employees developed during the last two years (older innovations will already have fallen into the public domain).
2. Gather up any software, instruction manuals and promotional literature developed or published for the last five years (the grace period given to challenge any infringement).
3. Inventory all of your commercial names and logos, including business identities and product brands.
4. If you don't already have one, implement a record-keeping system to document innovations. You will need this for patent applications, but it is good policy anyway.

To help you with this task, you should revisit your *business model* which defines the assets you will need to compete in the market, and your *strategy model* which defines the assets that will generate value and how they will generate that value. Once you have your inventory, your next step is to decide whether IP protection by copyright, patent or trademark makes the most sense for each type of asset; and how much you expect that protection to cost you annually.

Innovation Workout: Computing your Risk for Keeping a Secret

Trade secrets are assets only so long as the firm and its employees can keep that secret. In times past, when a merchant accumulated a pile of gold, the customary way to protect these assets was to hide them by burying them or stuffing them in a vault. But it is impossible to bury an idea; at best you can keep it secret. And not all secrets are equally easy to keep. This workout shows you how to evaluate your secret, its complexities and its risks.

The Nature of your Secret

1. **(Type) What** are you keeping private (or secret)? Things that you would want to keep private fall into one of three basic categories.
   a. Information: previous events, memories, and other information.
   b. Physical objects: mementos, valuables, or other objects.
   c. Activities: current and/or future activities.

Figure 7.6 provides a visual representation of the risk associated with particular types of secrets and secret holders

2. **(Who) Who** will be searching for your secret? You may be keeping your secret from most of the known world … but generally speaking, only a few people would be truly interested enough in your secret to spend time trying to find it out. Determine who these people are. All of the people from whom we want to keep things private fall into one of three categories:
   a. General public: strangers, casual acquaintances, the world at large
   b. Close friends/relatives/spouses
   c. Officials: includes newspapers, government, employers, police or anyone with official standing in the community.
3. **(Time) How long** will you be keeping your secret (1 to 3 representing short to long duration)? Generally speaking, the longer you try to keep a secret, the more opportunity someone will have to discover it.
4. **(People) How many people** are actively involved in keeping the secret? The ideal number of people required to keep a secret is one.
5. **(Resources) What quantity and quality of resource** are available to those who would try to find out your secrets – resources being everything from time and energy, to money, to emotional resilience?

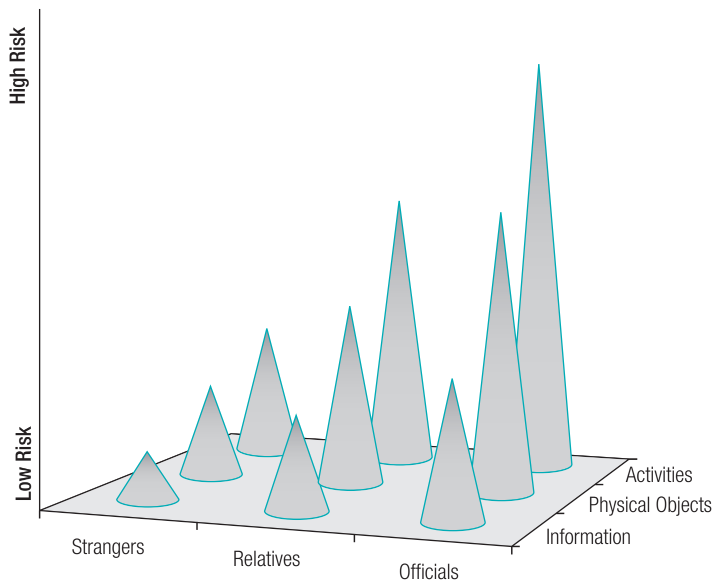

Figure 7.6 Relative Risk of Various Factors Involved in Keeping a Secret

a. Average: the standard for most situations
b. Above average: for those with access to extra help, money, time, etc.
c. Official: the highest risk rank is reserved for 'official' groups.

6. **(Suspicion) What is the level of suspicion** of those from whom you are keeping your secret (1 to 4 being from least to most suspicious)?
7. **(Motivation) What is the level of motivation** of those from whom you are keeping your secret (1 to 4 being from least to most motivated)?

The Risk Scorecard

What are the chances that you will be able to successfully keep your secret? Your numerical response to these seven questions above allows you to compute your relative risk:

Relative Risk = (Type + Who) × Time × People × Resources × Suspicion × Motivation

Relative risk score	Risk of divulging secret
Less than 25	Low
25 to 50	Average
50 to 100	High
Above 100	Impossible to keep this secret

Figure 7.7 Relative Risk Scorecard

Adjust your assumptions (and the associated numbers) to see how to optimally keep your secret and lower your risk score.

Case Study: The Anatomy of a Utility Patent

Every inventor faces a challenge early in their career of protecting an idea long enough to incorporate it into their own business and to profit from it. Most investors would not think about putting their money into a business which did not clearly have property rights to core intellectual assets. When these assets are machines, methods, designs or agricultural products, investors will very quickly ask about whether the inventor has a patent.

A utility patent application will consist of the following sections: *specification*; *title*; *patent cross-reference*; *background*; *brief description*; *drawings*; *description*; *claims*; *abstract*. These are briefly described below.

Specification: The specification is a written description of the invention and of the manner and process of making and using the invention that concludes with the claims to the invention.

Title of invention: A title may have up to 500 characters, but generally should be as short, descriptive and specific as possible.

Cross-reference to related applications: Google Patent Search, or findings from other search for 'prior art', are listed and summarized here. This in particular is important in arguing that the current invention has not been 'anticipated' by prior inventions, and is truly novel.

Background of the invention: This includes a description of the field of endeavour to which the invention pertains and of the US patent classification definitions or the subject matter of the invention. It should contain a description of specific documents related to the invention, and references to specific problems involved in the prior art.

Brief summary of the invention: This section should present the substance or general idea of the claimed invention; for example, the advantages of the invention and how it solves previously existing problems.

Drawings: Drawings follow specific guidelines and are numbered with corresponding statements explaining what each figure depicts.

Detailed description of the invention: In this section, the invention must be explained along with the process of making and using it, and should be distinguished from other inventions or standard industry practice. It should also describe the complementary parts that are necessary to completely understand the invention. The description should be sufficient so that any 'person of ordinary skill in the pertinent art, science, or area' could make and use the invention without extensive experimentation.

Claims: The claims define the scope of the protection of the patent. Whether a patent will be granted is determined, in large measure, by the scope of the claims. There are two categories of claims:

1. independent claims, which stand on their own, and
2. dependent claims, which depend on one or more independent claims providing insurance in case those claims are invalidated.

Claims are the key to having a defensible patent – and writing claims can be very tricky. Patent attorneys can provide the greatest assistance in formulating defensible patent claims. Properly formulating the broadest disclosure possible will allow an easy transition to draft patent claims. Patents did not always contain claims; indeed, in Europe patents did not typically contain claims before the 1970s, though they have been required by US patents since the Patent Act of 1836.

Patent claims use legal terminology to define the scope and extent of legal protection conferred by the patent. Claims define which subject matter is protected by the patent and serve as a 'notice function' in the sense that they warn what not to do to avoid infringement liability. A typical claim uses language such as:

> An apparatus for disciplining wayward students, said apparatus comprising a handle, a spring whip coupled to the handle, and …

Claims use precise language, and particular words have specific legal meanings determined by prior court decisions (e.g. the word 'comprises', when used in the claims of a US patent, means 'consists at least of' but the word 'consists' means 'consists only of', leading to a different scope of protection). Claims need to be specific, simply because the fewer the specifications in a claim, the more likely it is that the claim will have been anticipated by some prior art (i.e. another invention already patented) and be rejected during examination or found to be invalid at a later time for lack of novelty or obviousness.

This brings up three important sections of the patent law in the US that are more or less universally applied in patent granting (the items within quotation marks are key terms that serve as a basis for interminable wrangling by patent attorneys):

> 35 US Code § 101 addresses whether the claimed invention covers a subject that is eligible for a patent, and also requires demonstration that the claimed invention is 'useful' for some purpose.
>
> 35 US Code § 102 sets forth the doctrine of anticipation by requiring novelty of invention. It requires the applicant to demonstrate that the invention is new, and is not 'anticipated' from 'prior art' (i.e. prior patents or industry practice).
>
> 35 US Code § 103 states that, assuming § 101 and § 102 have been satisfied, the claimed invention would not have been obvious to a person having 'ordinary skill in the art'.

Abstract: The abstract points out what is new in the art to which your invention pertains and should not be longer than 150 words.

It is difficult without a patent attorney to properly construct and word an effective patent. Whatever property rights might be written into a do-it-yourself patent are likely to be far more narrow than necessary and this runs the risk of creating an unnavigable prosecution history that will almost certainly make the claims included in the patent difficult to defend. Still it is not at all uncommon for inventors to want to attempt to draft and file patent applications on their own. The cost of hiring an attorney to draft a patent application can price some inventors out of the market, so they are left with the choice of doing nothing to pursue their invention and dreams, or trying to do something on their own.

Inventors should try to complete as much as possible of a patent application and subsequently seek final advice in filing from a patent attorney. The inventor in this hybrid approach, to the best of his or her ability, lays out the technology, the background and the claims that are needed to protect his or her idea. The inventor should have a deep understanding of the technology and its commercial applications.

Web search tools like Google Patent Search and Google Scholar will be able to provide a wealth of information on prior art – i.e. components of the invention, or inventions that presaged the inventor's work. The inventor is likely to be much better informed about technologies, applications and components than a patent attorney. Once the pertinent facts are down on paper, these may be delivered as a patent draft to a patent attorney who can then revise it for maximum scope and defensibility in court. Patent attorneys offer a great deal of expertise concerning recent court cases, proper legal wording and evolving practice in the Patent Office. Doing your own patent draft and then consulting a patent attorney to finish the work, when done properly, should cost around one-third of what it would cost to leave the entire task to a patent attorney.

Once an inventor is comfortable with his or her grasp of the patentable material and any related inventions, a suitable approach to structuring his or her patents can be accomplished through a process of constructing possible claims.

Even at the initial filing stage what matters most is that claims are present and they have appropriate scope, with some being broad and some being narrow and quite specific. By authoring a very narrow and a very broad interpretation of your invention, you bracket your invention; you provide best- and worst-case scenarios for the originality and utility of the patent. In both the generic (broad) and specific (narrow) interpretations it is essential to describe how the various components are structured and how they relate to each other. It is necessary to describe the invention in sufficient detail so that someone else can construct a working copy of the invention. It is also essential to define what differentiates this invention from prior art.

Start by constructing a claim that defines your invention in broad terms, including only the most general of concepts. Then immediately follow this up with another claim that defines your invention with as much specificity and with every option you can think of. At this point, wording, use of proper legal or Patent Office language or even having completely logical prose should not be a concern. The task is simply to get ideas down on paper. A diagram can be of great help:

And interpreting the diagram that ultimately results into a claim using language such as:

> An apparatus for disciplining wayward students, said apparatus comprising a handle, a spring whip coupled to the handle, and …

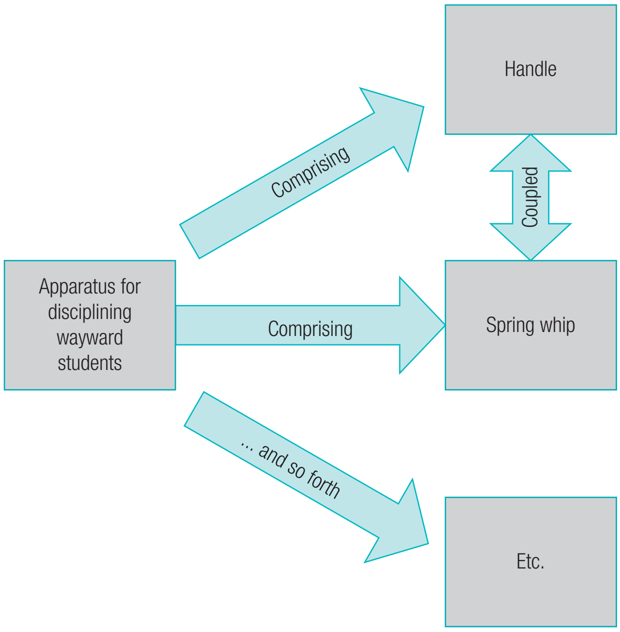

Figure 7.8 Patent Application Sample Drawing

There is also the concept of 'antecedent basis' that introduces internal reference points that make it easier to describe how to connect the elements. So try this claim:

1. An apparatus comprising:
   - an elongated handle having a first end and a second end; and
   - a spring whip; wherein said spring whip is attached to said first end of said elongated handle.

Let's say you want to add a rubberized grip to the handle, you would do this with dependent claims which build on a claim earlier to narrow the description to make it more specific. Some dependent claims to an apparatus for disciplining wayward students might look like:

2. The invention of claim 1 further comprising a grip disposed around said second end of said elongated handle.
3. The invention of claim 2 wherein the grip is made of rubber.

If your invention were really this apparatus for disciplining wayward students you would probably want to further describe the spring whip and explain that it has an attachment and a supple spring portion and the attachment is connected to the rubber gripped handle.

Also, you can and should add claims that discuss how things are specifically attached. An example would be:

4. The invention of claim 3 wherein the spring whip is attached to said elongated handle by insertion of a rivet through said attachment of the spring whip and into said elongated handle.

Notice here we wanted to refer to the attachment in order to explain where and how the rivet connects the spring whip with the handle. But we have not yet introduced the attachment as an element, and referring to it as 'said attachment' signals to the patent examiner that we are referring to something that we believe has already been introduced. So if we wanted to add this claim we might find it easiest to modify claim 1 as follows:

1. A shovel comprising:
   - an elongated handle having a first end and a second end; and
   - a spring whip, which is made up of an attachment leading up into a supple wire strand;
   - wherein said spring whip is attached to said first end of said elongated handle.

When working through the descriptions in a utility patent, it is useful to think visually, and to keep a scratch pad and pencil close to you for jotting down notes and diagrams. But you can see how patent writing becomes complex and tedious fairly quickly.

Most importantly, avoid writer's block by starting to write without concern for literary style or even the coherence of your prose. You can always revise. It is best to concentrate on the invention when writing a patent, not the literary form. A patent should be written over a period of weeks or months, with many revisions.

Case Study Challenge

By this time in the course, you no doubt have several ideas that you would like to develop commercially. Take one that you feel is patentable, and do the following:

1. Provide a short, descriptive and specific title for your invention.
2. Write a specification of the invention and of the manner and process of making and using the invention that concludes with the claims to the invention.
3. Use Google Patent Search to identify five related inventions, and specify any 'prior art'.
4. Describe the field of endeavour to which the invention pertains. Go to the USPTO site (www.uspto.gov) and look up the appropriate US patent classification definition for your invention.
5. Present the substance or general idea of your invention; for example, the advantages of the invention and how it solves previously existing problems.
6. Provide two drawings of your invention.
7. Explain the invention along with the process of making and using it. How will you distinguish the invention from other inventions or standard industry practice? Describe the complementary parts that are necessary to completely understand the invention. The description should be sufficient so that any 'person of ordinary skill in the pertinent art, science, or area' could make and use the invention without extensive experimentation.
8. Construct two independent claims, and one dependent claim, for your invention.

Chapter 7: Questions for Review

1. Describe the motivation and history behind intellectual property (IP) laws. Will these same factors be attributable to IP in the future? Why or why not?
2. Articulate the function and applicability of a patent.
3. Articulate the function and applicability of a copyright.
4. Articulate the function and applicability of a trademark.
5. Articulate the function and use of trade secrets.
6. What is an IP strategy? Are strategies directed to owning patents and copyrights the best IP strategy? Why or why not?
7. Why are many research organizations against the patenting of life forms?
8. Why are discoveries not patentable?
9. Discuss some of the limitations of the patent system.
10. Explain with the use of examples when it would be appropriate to use trademarks and copyright to protect a firm's intellectual property.
11. Explain why the patent system may not be working as originally intended.

Chapter 7 – Key Points

1. Intellectual property (IP) laws are a formalization of our customs and business practices.
2. There are four main categories of protection provided by IP law – patents, copyrights, trademarks and trade secrets.
3. IP laws are enforced through legal 'tool booths'.
4. Digital media and the internet present challenges to traditional enforcement of IP laws, and IP laws in practice are currently in flux.
5. The core competences a firm needs to acquire and the risk it must bear to innovate depend on the maturity of the underlying technology.
6. In the era of ferment, technology and standards are fluid and do not necessarily perform well. Risk is high, and commercialization of innovations should be approached with caution.
7. Once technologies are mature, and standards have been agreed upon, risk may be lowered sufficiently to warrant innovation.
8. Well-developed scientific theories provide the raw material for emerging technologies.
9. Profitability is determined by the nature of the innovation, barriers to entry in imitating it, understanding the complements required to complete the innovation, and the core-ness of the technology (i.e. can the firm cost-effectively compete on this technology?).
10. Innovations are categorized by the degree of impact that they have on firm operations, as a result of technical, market, architectural and component knowledge that is affected by an innovation.
11. The majority of innovations are 'incremental' in that they make no demands for significant change in firm competences or markets.
12. Innovation demands firm-wide change and involvement in the new business models, markets and products.
13. Nearly all mistakes commonly made by firms with respect to innovation focus on individual departments or individual styles of behaviour as being a 'silver bullet' that will bring about change.

Further Reading

Arai, H. (2000). Intellectual property policies for the twenty-first century. *The Journal of World Intellectual Property* 3, 423–439.

Arias, Tomás Gómez J. (1995). Do networks really foster innovation? *Management Decision* 33(9), 52–56.

Azurmendi, J. (1998). The violence and the search for new values, in *Euskal Herria krisian* (pp. 11–116). Elkar, 1999.

Becker, L. C and Becker, C. B. (eds) (2002). *Encyclopedia of Ethics*. Second edition in three volumes. New York: Routledge.

Bently, L. and Sherman, B. (2014). *Intellectual Property Law*. Oxford University Press.

Blackburn, S. (2001). *Being Good: A Short Introduction to Ethics*. Oxford: Oxford University Press.

Bloomberg (2001). Henry Yuen – TV guy, www.bloomberg.com/news/articles/2001-03-11/henry-yuen-tv-guy, accessed 22 June 2016.

Borg, Eric A. (2001) Knowledge, information and intellectual property: Implications for marketing relationships. *Technovation* 21, 515–524.

Chesbrough, Henry William (2003a). The era of open innovation. *MIT Sloan Management Review* 44 (3): 35–41.

Chesbrough, Henry William (2003b). *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Boston: Harvard Business School Press.

Chesbrough, H., Vanhaverbeke, W. and West, J. (eds) (2008). *Open Innovation: Researching a New Paradigm*. Oxford University Press.

Cools, Guy and Gielen, Pascal (2014). *The Ethics of Art*. Valiz: Amsterdam: Valiz.

D'Urance, Michel (2005). *Jalons pour une éthique rebelle*, Paris: Aléthéia.

De Finance, Joseph (1991). *An Ethical Inquiry*, Rome: Editrice Pontificia Università Gregoriana.

De La Torre, Miguel A. (2004). *Doing Christian Ethics from the Margins*. Orbis Books.

Derrida, J. (1995). *The Gift of Death*, translated by David Wills. Chicago: University of Chicago Press.

The Economist (2015, 28 November). Billion-dollar babies.

Fagothey, F. A. (2000). *Right and Reason*. Rockford, Illinois: Tan Books & Publishers.

Heller, M. A. and Eisenberg, R. S. (1998, May). Can patents deter innovation? The anticommons in biomedical research. *Science* 280, 698–701.

Hippel, Eric von (2011). Open user innovation, in Mads Soegaard and Rikke Friis Dam (eds), *Encyclopedia of Human-Computer Interaction*. Aarhus, Denmark: The Interaction Design Foundation.

John Paul II (1993, 6 August). *Encyclical Letter Veritatis Splendor*.

Lafollette, Hugh (ed.) (2014). *Ethics in Practice: An Anthology*, 4th edition. Oxford: Wiley Blackwell.

Lague, David (2006, 1 May) Next step for counterfeiters: Faking the whole company. *New York Times*, B6.

Lakhani, K. R. and Panetta, J. A. (2007). The principles of distributed innovation. *Innovations: Technology, Governance, Globalization* 2(3), 97. doi:10.1162/itgg.2007.2.3.97.

Lemley, Mark A. and Shapiro, Carl (2005). Probabilistic patents. *Journal of Economic Perspectives*, Stanford Law and Economics Olin Working Paper No. 288, 19, 75.

Levinas, E. (1969). *'Totality and Infinity', An Essay On Exteriority*, translated by Alphonso Lingis. Pittsburgh: Duquesne University Press.

Lin, P., Abney, K. and Bekey, G. A. (eds) (2014) *Robot Ethics: The Ethical and Social Implications of Robotics*. The MIT Press.

May, C. (2013). *The Global Political Economy of Intellectual Property Rights: The New Enclosures?* (Vol. 3). Routledge.

Menell, P. and Lemley, M. A. (2003). *Intellectual Property in the New Technological Age*. Aspen Publishers.

Mock, Dave (2005, 28 February). *The Qualcomm Equation*. American Management Association, downloaded 22 June 2016.

Newton, John, Ph.D. (2000). *Complete Conduct Principles for the 21st Century*. Nicer Century World Publishing.

Penin, Julien, Hussler, Caroline and Burger-Helmchen, Thierry (2011). New shapes and new stakes: a portrait of open innovation as a promising phenomenon. *Journal of Innovation Economics* (7), 11–29.

Rawls, J. (1971) *A Theory of Justice*. Cambridge, Massachusetts: Belknap Press of Harvard University Press.

Reuters (2016). Profile: Qualcomm Inc, www.reuters.com/finance/stocks/companyProfile?symbol=QCOM.O&WTmodLoc=HybArt-C1-ArticlePage1, accessed 22 June 2016.

Schutte, Corne and Marais, Stephan (2010). *The Development of Open Innovation Models to Assist the Innovation Process*. South Africa: University of Stellenbosch.

Solomon, R. C. (1984). *Morality and the Good Life: An Introduction to Ethics Through Classical Sources*, New York: McGraw-Hill Book Company.

USPTO (2015). Nonprovisional (utility) patent application filing guide, www.uspto.gov/patents-getting-started/patent-basics/types-patent-applications/nonprovisional-utility-patent, accessed 22 June 2016.

Vemuri, V. K. and Bertone, V. (2004). Will the open source movement survive a litigious society? *Electronic Markets* 14(2), 114. doi:10.1080/10196780410001675068.

Vendemiati, Aldo (2004). *In the First Person, An Outline of General Ethics*, Rome: Urbaniana University Press.

Wallach, W. and Allen, Colin (2010) *Moral Machines: Teaching Robots Right from Wrong*, 1st edition. Oxford University Press.

West, J. and Gallagher, S. (2006). Challenges of open innovation: The paradox of firm investment in open-source software. *R and D Management* 36(3), 319. doi:10.1111/j.1467-9310.2006.00436.x.

WIPO (2008). Chapter 2: Fields of intellectual property protection. *Intellectual Property Handbook: Policy, Law and Use*. WIPO.

WIPO (2015). Patents: Frequently asked questions. *World Intellectual Property Organization*. www.wipo.int/patents/en/faq_patents.html, accessed 24 June 2015.

Your Story (2015). Qualcomm and its huge patent portfolio you should know about, http://yourstory.com/2015/03/qualcomm-its-patent-portfolio/, accessed 22 June 2016.

Zhao, L. and Deek, F. P. (2004). User collaboration in open source software development. *Electronic Markets* 14(2), 89. doi:10.1080/10196780410001675040.

CHAPTER 8

Technology Dynamics and Disruptive Innovation

Learning Objectives

After finishing this chapter, you will

- Understand that every technology has a particular rate of advancement that is stable over long periods of time – this rate of progress is called technology acceleration.
- Understand that disruptive innovation and the so-called 'innovator's dilemma' are a consequence of technology acceleration greater than the acceleration of consumer demand. When this occurs, incumbent firms tend to be locked into existing customers, hampering their ability to adopt better performing technologies.
- Understand several unique features of technology innovations:
  - network effects;
  - brand and reputation effects;
  - technology acceleration;
  - disruptive innovation;
  - labour substitution and organizational scaling;
  - geographical substitution and scaling ('the world is flat' effect); and
  - open-source alliances.
- Understand that organizational scaling results from the substitution or augmentation of labour with better performing technologies.
- Understand that geographical scaling results from the replacement of physical products and transport with information.

After doing the *Innovation Workout* you will be able to employ visualization to help solve problems.

After reading the Yamaha Piano *case study* you will be able to understand the roles of technology acceleration in the changing landscape of an industry.

The Dynamics of Innovation

All innovation is inherently dynamic – it exists in an environment where underlying technologies and product markets evolve quickly. When innovations have a strong networking component – such as with social networking tools, standard formats or platforms and large industrial bases – the rate at which these external dictates of innovation strategy change is a strong determinant of success or failure.

Up to this point, we have treated product and service innovations as largely static, where technology and consumer expectations can be determined up-front and stay the same throughout the product life cycle. This is a useful simplification, but our strategies ultimately have to come to terms with an evolving technology and market environment.

In this chapter we discuss four phenomena that are consequences of the underlying dynamics of innovation and technological advancement: *technology acceleration*; *disruptive innovation*; *organizational scaling* and *geographical scaling*. All of these effects are fundamentally related, and reflect the competitive dynamics that are the consequence of laboratory research being commercialized.

Technology Acceleration

Much, if not most, science and technology advances through the work of communities of scholars who organize into social networks. When areas of research show promise of being marketable, performance will grow with the network and its research output.

The term 'technology' is commonly used in the sense defined by Joseph Schumpeter in discussing business cycles and development, but, in fact, the use of the term has changed significantly over the last 200 years. Before the 20th century, the term was uncommon and typically described useful arts. Its meaning evolved in the early 20th century when Thorstein Veblen translated the German concept of 'technik' into 'technology.' Today we envision technology as encompassing machines, utensils, weapons, instruments, housing, clothing, and communicating and transporting devices, along with relevant information and skills.

Research in many different arenas has shown that performance to price of commercially viable technologies tends to grow in a constant proportion annually over long periods of time. This growth is called technology acceleration, and is the basis of industry rules of thumb such as Moore's Law, which predicts a doubling of semiconductor chip performance to price every 18 months. Technology acceleration can be observed in most commercially important technologies.

Moore's Law

During a deep-sea fishing trip in 1965 (so the story is told) Gordon Moore, the co-founder of Intel and its CEO from 1979 to 1987, was musing on the fact that he had noticed in the four years after the first planar integrated circuit was discovered *that engineers were able to double the transistor density on a manufactured die every year*. He thought, 'Hmm, I wonder how often these things are actually going to double in terms of the number of transistors I can get on the chip'. And he thought, 'I know: however many fish I catch today, that's how many years it's going to be.' He got 18 fish; it was 18 months.

Whether this story is apocryphal or not, Moore's estimate that computing power for a given price would double every 18 months stuck. Moore's Law has proved surprisingly accurate. If the automotive industry had paralleled the computer's advances in value and efficiency, cars would now cost \$5 and would get 250,000 miles to the gallon.

(Source: Moore, 1997)

Niels Bohr once observed that 'prediction is very difficult, especially about the future'. The impacts of new ideas and environmental forces are almost never linear – though our predictions often rest upon this assumption. As a result, trends that we expect to drive the future exhaust themselves, while other unsuspected forces emerge, accelerate and overwhelm our best-laid plans.

Disruptive Innovation

Disruptive innovation occurs when a new idea helps create a new market with entirely different economics than the market with which it competes. Indeed, the new technologies often don't compete directly with the more established technologies they challenge, or where they do it is in the low-cost, high-volume arena. But as the newer technology evolves and refines, it eventually goes on to disrupt an existing market and displace the earlier technology.

Disruptive innovation – the term was coined by Clayton Christensen while writing his Harvard doctoral thesis – has been a popular Harvard theme for over a half century. Christensen went on to promote it through a very lucrative collaboration with HBS Press and it has since then become part of business vernacular. Though the phenomenon Christensen discusses seems to be very real, his ideas are neither new nor clearly articulated. Research on disruptive innovation dates back at least to Nikolai Kondratiev who developed the underlying theory, using it as a basis for Soviet five-year plans (Kondratieff, 1979). Kondratiev's work was extended by Harvard economist Joseph Schumpeter, who popularized the term 'creative destruction' and the argument that entrepreneurs disrupted long cycles of technology (1942). An industrial version of 'creative destruction' was taught in case studies at Harvard Business School by C. Roland Christensen from the 1950s through to the 1980s; Clayton Christensen took these themes and disseminated them to a wider audience in a corporate product marketing context. Christensen popularized disruptive innovation through case studies and the popular press, but offered little empirical study or new theory in support of the phenomenon. As a consequence, Christensen's work has sometimes been criticized as seeding confusion rather than insight. Harvard historian Jill Lepore (2014) has been particularly dismissive in public forums, arguing that the popular 'disruptive innovation' narrative was founded on 'panic, anxiety, and shaky evidence', and is interpreted in multiple incompatible ways in the literature and indeed in Christensen's own writings.

Academic sniping aside, strategic use of disruptive innovation gives a firm the potential to improve a product or service in ways that the market does not expect, typically first by designing for a different set of consumers and later by lowering prices in the existing market. Disruptive innovation is real, and empirical study supports the idea that it is a juggernaut that no amount of marketing or promotion can stop. We can perhaps gain only small comfort from noting that disruptive innovation is not new, but has bedevilled managers since the first Industrial Revolution. Yet this long history can help us to better understand and predict the ebb and flow of technologies, and to prepare as best as possible for what will come.

The rapid pace of modern research and technology development, along with social networks that can share new findings instantly, should be a good thing. But it fuels no end of managerial angst. Disruptive innovation fills managers, investors and employees with the fear that their current hits will prove ephemeral.

The difference between disruptive and sustaining innovation lies in the market, customer base and value networks that the contrasting innovations support. Sustaining innovations keep these intact. Disruptive innovations naturally disrupt markets and customers, because they are qualitatively different, and thus their underlying technologies need to be applied differently to solve problems. Market disruption has been found to be a function not of technology itself but rather of its changing application. Whereas sustaining innovations improve performance of well-known features, disruptive innovations change entire markets by introducing entirely new features. Consider, for example, the automobile. Early automobiles were expensive, slow, luxury items that did not disrupt the market for horse-drawn vehicles. The market for transportation essentially remained intact. Ford Model's T mass-produced automobile was a disruptive innovation that was built on many new technologies – vanadium steel, simple reliable engine, chip-proof paint, and so forth – that made it affordable and useful at a time when there was little infrastructure to support automobiles. Similarly, digital cameras built on several new, rapidly evolving technologies in image sensors, signal processing and storage to disrupt an industry built on silver chemistry, dyes and clockwork mechanisms. Digital images could be altered and distributed in ways that prints could not. In both cases, old and new technologies did similar things, but at different price points, and with different utility to the consumer.

Technology Acceleration in Microcomputer Hardware

When asked the speed at which computer technology is improving, it is common to hear Moore's Law cited. But, in fact, each component of a computer develops at its own pace. Figure 8.1 describes technology acceleration in various microcomputer components.

Technology	Number of weeks to double	Performance metric
CPU	74 (˜1.4 years)	Clock speed (in MHz)
Telecommunications switching	28 (˜7 months)	Clock speed (in MHz)
CD-ROM	26 (˜0.5 years)	Rotation speed
Printers	21 (˜5 months)	Resolution × printing speed (ppm)
Non-volatile RAM	25 (˜0.5 years)	Storage amount
Volatile RAM	28 (˜7 months)	Storage amount
Monitors	179 (˜3.4 years)	Size × resolution × frequency/point size

Figure 8.1 Microcomputer Technology Acceleration
Source: Westland & See-To, 2007

The first formal studies of technology acceleration were done in the late 1950s by economist Zvi Griliches (1957). He studied innovations in agricultural machinery and hybrid crops implemented in the 1930s and 1940s in the US which had resulted in increasing output per acre of around 2% annually (and, incidentally, decreased farm employment of around 3.3% annually). These trends subsequently continued into the 1990s by which time most farming in the US was done by large, integrated corporations and cooperatives.

Motorcycle Technology Acceleration

Figure 8.2 shows data on the technology acceleration in the motorcycle industry over the past 50 years, where the performance metric is the ratio of brake horsepower (bhp) to weight in kilograms (kg) for a set of motorcycles that have sold for around $8,000 in year 2000 dollars.

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Year	Model	bhp/kg
1950	Vincent Black Shadow	0.24
1973	Kawasaki Z1	0.36
1981	Suzuki GSX1100S Katana	0.46
1983	Kawasaki GPZ750 Turbo	0.48
1984	Kawasaki GPZ900R	0.48
1986	Suzuki GSXR1100	0.63
1991	Yamaha FZR1000	0.63
1992	Honda CBR900RR Fireblade	0.66
1998	Yamaha YZF-R1	0.85
2001	Suzuki GSXR1000K	0.94

Figure 8.2 Technology Acceleration in the Motorcycle Industry, 1950–2001

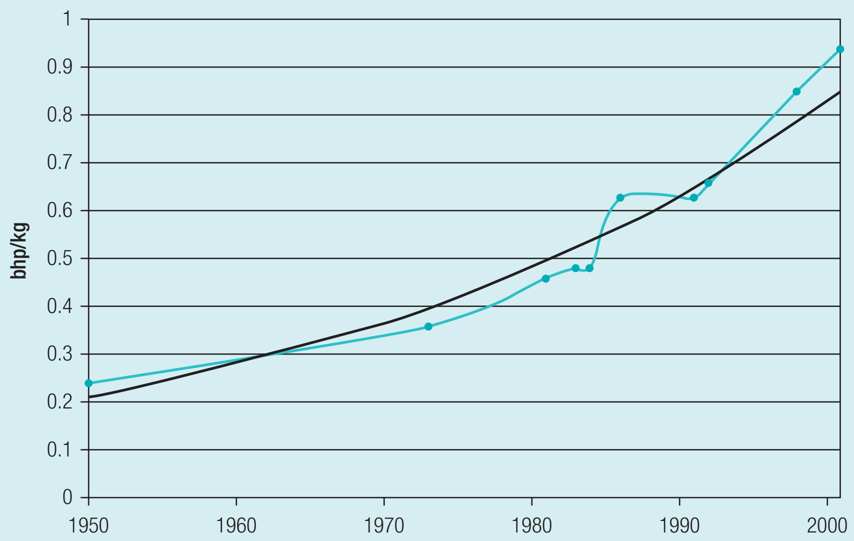

Figure 8.3 Motorcycle Power (Compared to Exponential Trendline for 2.1% Annual Growth)

Griliches' research demonstrated that the adoption of new technologies like hybrid corn was not a single event, but was instead a series of developments that occurred at different rates across geographical space. His study shed light on the numerous individual decisions and economic calculations that drove new hybrid corn technology forward. For example, he found that the hybrid corn varieties became available and were adopted by farmers in Iowa by 1934, but spread more slowly into other regions, reaching the Deep South, only as late as 1946. Adoption involved many individual decisions where farmers evaluated, for their own land, weather and markets, the potential profitability of making the switch to hybrid corn by calculating the increase in yield per acre due to using hybrid corn minus the cost differences in the seed.

One of the more influential studies in the exponential performance-to-price improvements in technology is due to economist William Nordhaus. Nordhaus compiled historical records of the cost of lighting a standard-sized room dating back (incredibly) to the Pleistocene epoch of cavemen and woolly mammoths. Since the starting periods of his dataset predated money, he standardized on a human labour hour of work as a currency unit. The study validated exponential performance-price improvement over long periods of time. This graph details the period from 1800 to the present, covering technologies of whale and olive oil lights (*c*.1800), petroleum lights (*c*.1850), carbon arc (*c*.1890), incandescent (*c*.1900), gas tube (*c*.1930), and most recently light-emitting diodes and other forms of ‘cool’ lighting.

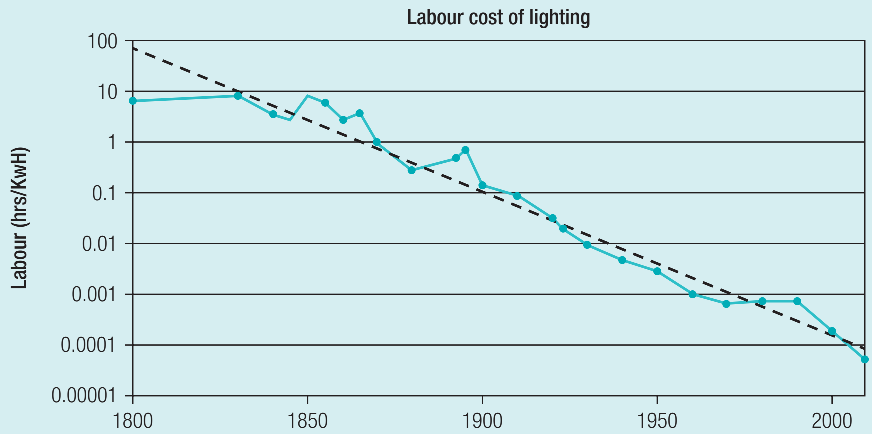

Figure 8.4 Labour Cost of Light
Sources: Nordhaus, 1996, 1998

Most technologies may display a constant proportional growth. But underneath this is a steady substitution of technology platforms. For example, computing power experienced about 60% annual growth since the 1920s, generating exponential of performance improvement over time. Platforms have evolved from the electromechanical card readers and unit record equipment to vacuum tube computers of the 1940s to transistors then integrated circuits with a variety of chemistries. A new platform typically would not be commercialized until it could at least perform as cost-effectively as the prior platform; and thus a sequence of platforms, each steadily improving performance to cost at 60% annually.

Technology acceleration in the 1980s and 1990s on computer platforms made possible the personal computer, the mobile telephone, digital cameras and numerous other mobile and other ‘embedded system’ platforms. In computers, it has also shortened product life cycles so dramatically that management now may pay more attention to product development and time-to-market than any other performance metric for the firm (see box on Dell Computer).

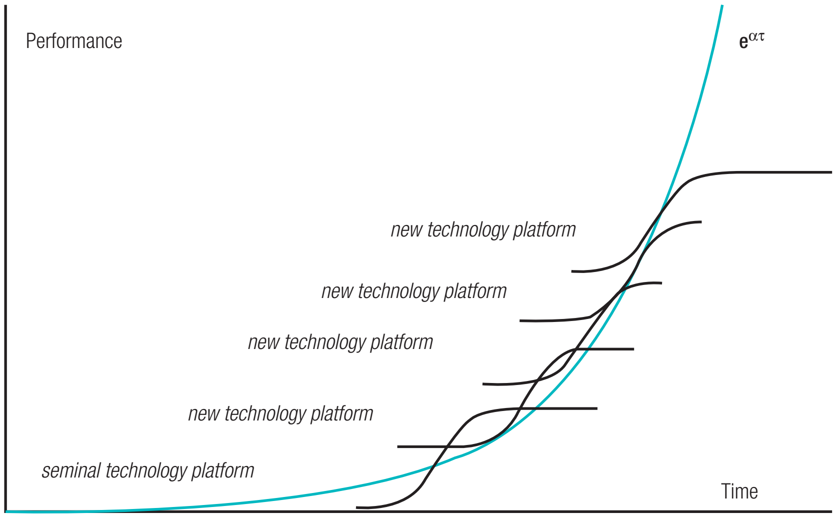

Figure 8.5 Technology Acceleration Across a Series of Technology Platforms

Dell's War on Inventory and Property

In less than 20 years, Michael Dell built Dell Computer from a small cluttered University of Texas dorm operation to a $25 billion a year company. Dell's business model has focused on re-engineering its supply chain to minimize the length of time that any inventory needs to be financed by Dell itself. It takes orders and cash up-front – since the advent of web shopping, from its well-designed and functional online store. It negotiates the best prices from suppliers, and forces many suppliers to hold all inventory until a few hours before Dell assembles the product (firms like Sony for monitors will even ship direct to the consumer, using Dell labelled boxes). To do all of this Dell's fundamental supply-chain objective is to replace as much *inventory* in the pipeline with *information* about supplier inventories and production, logistics, customer preferences and anything else that will minimize the inventory that it needs to finance.

Michael Dell realized early – while his competitors were still producing for stock in stores like Best Buy – that materials costs consumers 75% of a computer manufacturer's revenues. Lowering materials costs by 0.1% can have a bigger impact than improving manufacturing productivity by 10%. For most of the 1990s, when competitors carried one to three months of inventory, Dell carried only five days' worth. Because of rapid technology acceleration in chips, disk drives and other parts in personal computers, their materials' costs fall by around 1% per week. Carrying five days vs. one month of inventory results in savings of around 6% of materials cost – an amount that can exceed the computer maker's net income.

Some of Dell's inventory is designed to offset risks and fluctuations in demand – this is their safety stock. Safety stocks are both expensive in the volatile computer market and difficult to reduce. Reduction requires complete and accurate market information and forecasts about production and procurement. The combination of acquiring customer orders in advance of production with hourly updates of all information from customers' to suppliers' allows Dell to run a factory with five hours' worth of inventory on hand, including work in progress. This increases cycle time at Dell's factories and reduces warehouse space. The warehouse space is replaced with more manufacturing lines. Dell has traded *property* for *information*.

The substitution of information at Dell for operations that otherwise would demand substantially more inventory and property – real tangible operating expenses – shows just how important has become the shift to an information-intensive business world. The winners are competitors that control information; the laggards are those with too much property and tangible product.

(Sources: Christopher & Towill, 2000; Bruun & Mefford, 2004; Kapuscinski et al., 2004).

Growth Rates of Sustaining and Disruptive Innovation Technology Platforms

Disruptive innovations are new products, services, or business models that initially target small, seemingly unprofitable customer segments, but eventually evolve to take over the marketplace. Referring to Figure 8.6, the disruptive technologies are usually the next technology platform in line to be adopted by the industry (Clark & Fujimoto, 1991).

For example, in the hard disk drive industry (Figure 8.7), the growth of the personal computer was largely ignored in favour of the more expensive mainframe and minicomputer markets which was using 5.25-inch and 8-inch drives (Christensen, 1997). When a group of Quantum Corp. engineers proposed to develop a 3.5-inch drive for the new industry, Quantum helped them to found Plus Development Corp. solely to support the growing PC industry with 3.5-inch drives. Quantum had predicted that their stockholders would not let them devote significant resources to the low-margin PC market, yet they knew very well the rate of technology acceleration in the hard disk industry, as well as the growth of their customers' market demand. Quantum retained 80% ownership of Plus Development, and when demand for their large hard drives plummeted in the late 1980s they absorbed Plus Development, placed Plus's management in top slots at Quantum and shifted all of their production to 3.5-inch drives. By 1994, Quantum was the largest drive producer in the world, and exists to this day as a division of Maxtor (D'Aveni & MacMillan, 1990).

Quantum's is one of the few success stories during that period in the disk drive industry. Between 1976 and 1995, most drive manufacturers either left or shut down – during the period, 129 manufacturers had entered the market; 109 manufacturers left the market because of disruptive innovation from smaller drives.[2]

The process of disruptive innovation is almost impossible for incumbents to avoid – indeed it should be considered a Darwinian process that is essential to the health of industry (Tushman & Anderson, 1986; Tushman & O'Reilly, 1997). It starts when incumbent technologies, and producers in pursuit of more profit, deliver a level of technological progress far above what customers actually need and can use. This phenomenon of overshooting creates the opportunity for an upstart to come in with something that is cheaper and adequate for a group of customers that sustain the new industry. This new

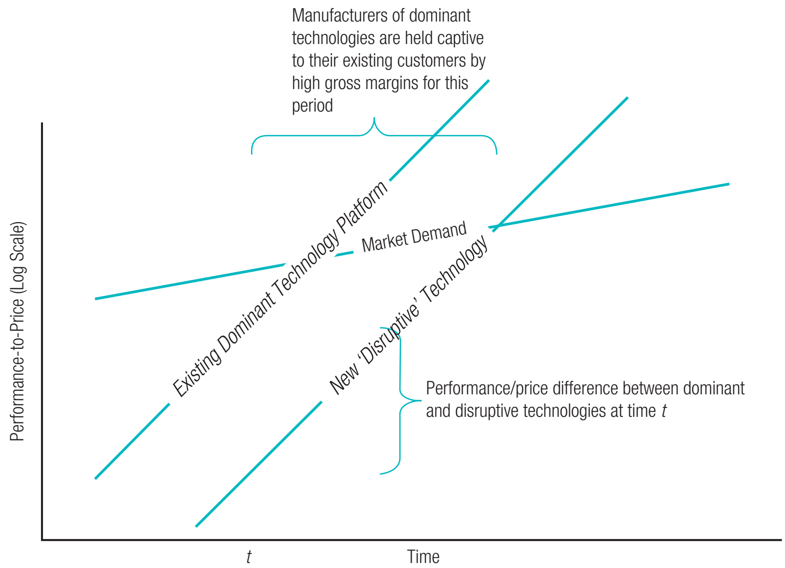

Figure 8.6 How Disruptive Innovation Comes About

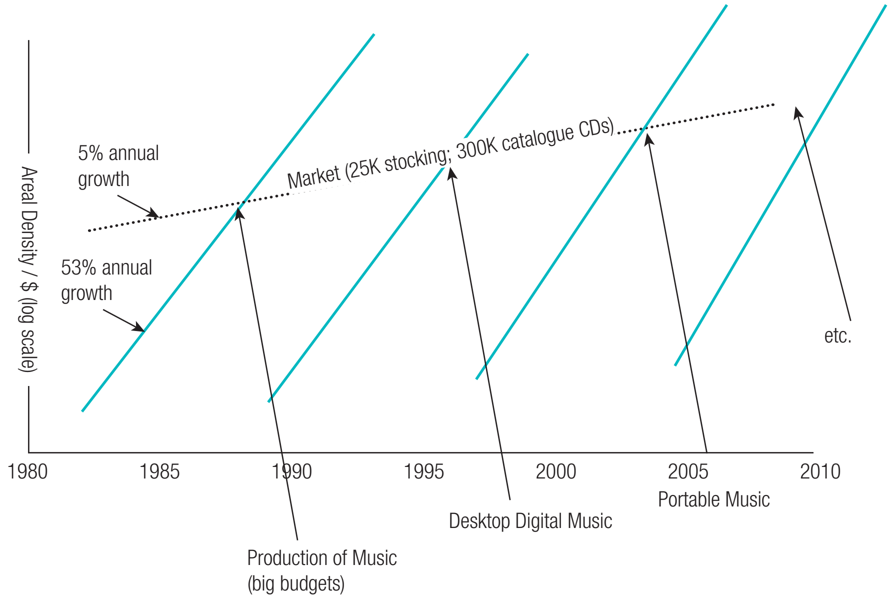

Figure 8.7 Advances in Hard Disks Open up New Markets

'disruptive' technology platform may be just adequate for these customers, but the technology is accelerating at a rate faster than customers' needs (Fisher, 1983; Cowen, 1998). Eventually it meets the needs of even the incumbent's customers and, because it is cheaper, can undersell the incumbent's technology (Joseph & Saloner, 1986; Cohen & Levinthal, 1994; Day, 1994).

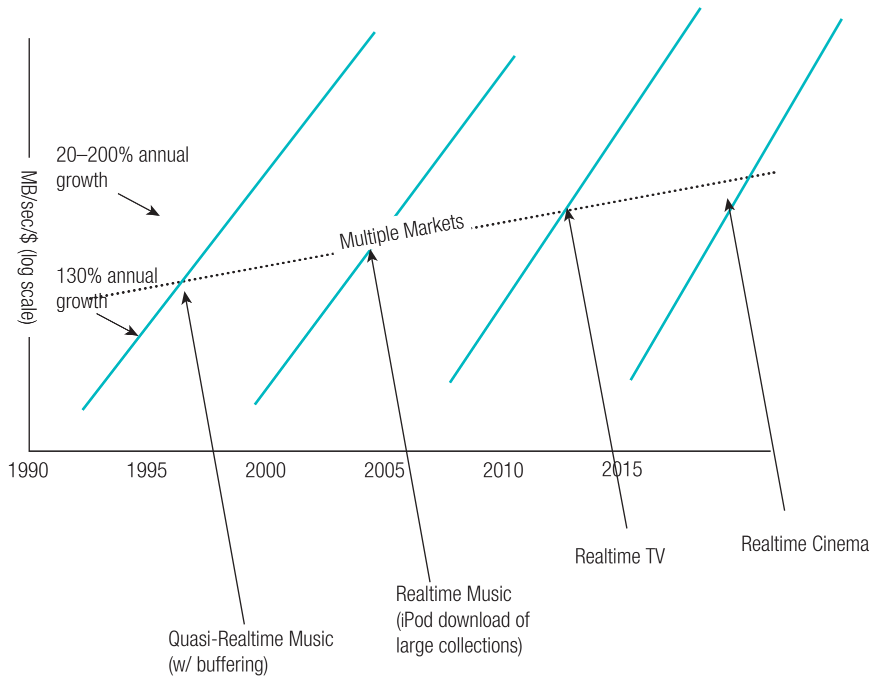

Figure 8.8 Technology Acceleration in Internet Download Speed Opens up New Markets

Industries encountering intense disruption in this way, as with the music industry disruptions depicted in Figure 8.8, offer new opportunities to those who master the cheaper technology – but only for a short time.

Disruptive Innovations in Excavators

Steam shovels (mechanical excavators) were invented in the early 1800s, cable operated arms powered by portable steam engines. The first general design change occurred in the 1920s, when the new gasoline engines replaced steam as a power source. For most manufacturers this did not constitute a disruptive innovation, as they could merely swap out the steam engine for a gasoline engine, and keep the rest of the mechanics intact. Diesel and electric power followed, again with no disruption of the industry. These machines were huge, and designed for general contracting such as road building, sewer excavation and building site preparation – these required large bucket sizes and the ability to move huge amounts of soil quickly.

Disruptive change in the excavator came from an unlikely quarter – aircraft technology developed for fighters in World War II. Hydraulics activators were developed both for retraction of landing gear and control of wing shape and attitude. Early hydraulic actuators were not very powerful, limited by the sealing material that was used; but their power was increasing at a 23% annual rate (Figure 8.9). The first hydraulics to the arm and shovel of an excavator was developed in 1947, but was too small for commercially viable tasks. Caterpillar devised a new business model, and targeted a new market. Caterpillar's small excavator arm was built as an attachment for the back of small industrial and farm tractors. They called them 'backhoes,' and identified residential jobs for contractors, farmers and so forth to dig narrow ditches for sewer, cable, flower beds and other excavations done by hand in the past. Limited by the power and strength of available hydraulic pumps' seals, the capacity of Caterpillar's early machines was minuscule and of no use in the more lucrative general contracting markets.

Caterpillar developed new metrics to advertise their products. Rather than measuring the quantity of earth that could be moved as the cable-driven manufacturers advertised, they emphasized: shovel width (narrow being better for contractors); and speed and manoeuvrability of the tractor. To bigger companies like Link Belt, they were not even a competitor, because they spoke an entirely different language to a different clientele.

Steady acceptance by the residential market sustained, and eventually grew, Caterpillar's business, as their excavators also grew. They introduced steadily larger diesel-tractor excavators until they could handle general contracting

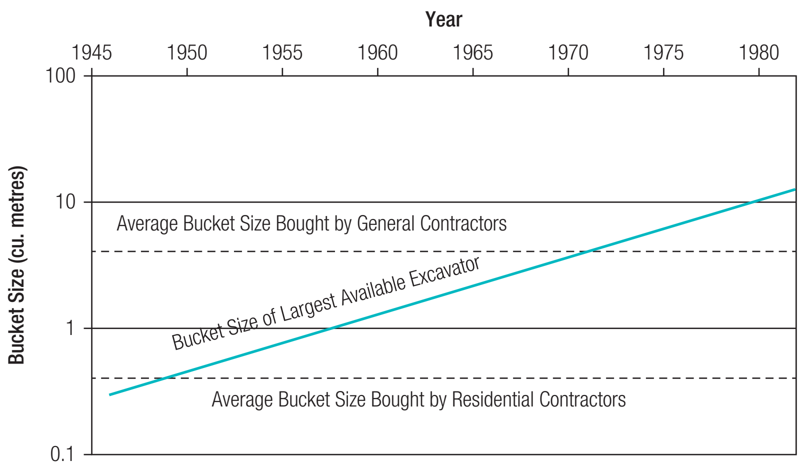

Figure 8.9 Excavator Bucket Size and Markets

jobs as well. By 1974, the hydraulic excavators had the muscle to lift 10 cubic yards of dirt, a rate of improvement that outstripped demand in any of the excavator markets. In contrast, the largest makers of cable-driven excavators, Bucyrus Erie and Northwest Engineering, concentrated on building better cable-driven machines for their most profitable customers (to do otherwise was not profit maximizing) and logged record profits until 1966. But after that their business plummeted as hydraulic excavators reached competitive capacities. Much of the shift was driven by labour unions and operators: hydraulics were significantly safer than cable-driven excavators – when a cable snapped due to an overloaded bucket, operators could be killed. And hydraulic excavators were less prone to breakdown. The shift to hydraulic excavators occurred quickly in the early 1970s. Only four of the top 30 excavator manufacturers in the 1950s survived this transition into the 1970s.

Disk Drives Become too Small for Human Production

Before the early 1980s, most hard disks had 8-inch or 14-inch platters and required an equipment rack and lots of floor space; large removable media disks were even referred to as washing machines. Most drew high-current and some required three-phase power hookups due to the large motors they used. Hand labour was extensive in their production – indeed, one reason they were large was that tolerances were not very tight. The advent of minicomputers and then PCs brought a demand for smaller 3.5-inch disk drives; at the same time, rising factory costs forced firms to move production off-shore to lower-cost Asian countries – especially Malaysia and Thailand. In the early 1990s, the Asian disk drive industry employed around 50,000 people assembling these drives. But as technologies advanced and spawned 2.5-inch, then 1.3-inch drives, the drives themselves became too small for human hands, and factories were forced to automate, even if the costs of production went up. By 2000, factory employment in the disk drive industry had dropped to around 5000 people, with almost no human hand ever touching a disk drive.

Organizational Scaling

Automation, global transportation and communication networks have brought about fundamental changes in the structure of organizations by substituting existing jobs with machines or outsourced labour. Technology acceleration plays a major role in organizational scaling – technologies that were once too expensive for organizational processes eventually improve their performance and drop their price sufficiently to replace human labour.[3] This influences work in three ways.

First, it has flattened the hierarchy of firms, eliminating vertical 'stovepipes' by enabling communication across and around organizational lines. Firms have become inured to the speed and efficiency of horizontal communications.

Second, downsizing has culled workers with lower skill levels from organizational ranks. Firms increasingly are composed of a small core of smart, adaptable employees who can learn to use technology to greatly enhance their effectiveness and efficiency.

Finally, global networks provide efficient market alternatives to internal production. Corporations such as Dell and Cisco produce little of their own product. Rather they act as integrators for a global array of suppliers. Many of the emerging economies around the globe owe their growth to the increasing success of internet-enabled value chain integration. In the process, workers around the world become virtual employees of Dell and Cisco; Dell and Cisco conversely are virtual organizations employing many, but with formal employment contracts for only a small professional core of employees.[4]

Hierarchy can be reduced and firms downsized because the speed and volume of information which can be automatically processed and shunted around the firm is several magnitudes greater than in the 1920s when Alfred Sloan implemented the philosophy of command and control through the hierarchical firm as an institution to run General Motors. Today competition focuses on time-to-market, innovation and quality – these are the minimum performance requirements required to survive. Flat firms with a focus on their core competencies can experience sustainable competitive advantages (Tapscott, 1995).

Increased availability of efficient market alternatives to formerly internal functions means that the 'make-or-buy?' question is increasingly answered with 'buy'. Organizations are able to develop around individual capabilities and proclivities, making efficient use of individual contributions to organizational goals in a shrinking world. By speeding up the communications between negotiating parties, many misunderstandings and dysfunctional behaviours found in group work are eliminated while helping people to avoid decision-making gridlock.

Technology has also transformed the way that work is parcelled into those familiar envelopes we call 'jobs.' We can expect this to accelerate over the next decade as robots and automatons take over more and more industrial tasks. The job is a recent phenomenon that evolved during the Industrial Revolution to synchronize work that needed doing in the factories of the time. Since power was not portable, factories were set up next to the streams or woods that fuelled their production, and people were expected to show up for their jobs when the machines required it (Schoemaker, 1992; Schoemaker & van der Heijden, 1992).

Competition based increasingly on time-to-market, plus the dispersion of necessary skills, have created an environment in which work parcelled into 'jobs' in 'offices' are counter-productive. Electricity and small engines have made power (and people) portable. Increasingly the work to be done is intellectual and can be done at home.

Organizational scaling has impelled the firm towards virtual corporations – which have no fixed pool of suppliers, workers or processes, but rather are continually rewiring themselves on the fly.

The Interrelationship of Science and Technology

Rogers' and Foster's curves are a product of the science that generates innovations. Science generates commercial technologies in three phases. The first 'fluid' phase marks the prototyping of laboratory technologies for custom applications in highly profitable areas such as the military. At this stage, there are still unanswered questions in the underlying science and standards have not been established. Most 'fluid' phase technologies never succeed outside of the laboratory. Quantum computing, in its current development, is more or less at this stage. The second 'transitional' phase begins standardizing components and defining consumer–producer relationships that will ultimately lead to a dominant design. In 2006, Sony's Blu-Ray optical recording technology based on blue diode lasers could be considered to be in 'transitional' phase. In the last 'specific' phase, a dominant design has emerged and proliferated, with mostly incremental innovation around this dominant standard. Some promising technologies (like Blu-Ray) never make it to this third stage, because many other technologies are competing simultaneously for dominance.

It is fundamental science, where the objective is discovery, that initiates the 'fluid phase'. Technology's objective is more focused on delivering usable inventions to consumers, wherever they may be. This phase of commercialization is marked by the exponential growth in development of technology, or an equally quick abandonment. Some of the most important consumers of technology are the scientists themselves, who benefit from automation and better measuring tools. For example, the sequencing of the human genome was made possible by robotic chemists that did the physical work, aided by powerful supercomputers to do the sorting, matching and storage of gene sequences and proteins. The explosive growth of the robotic drone since 2013 (as we will see in the DJI case study later in this book) was predicated on technologies in microfabrication, satellites and timekeeping. Science and technology feed each other in the virtuous cycle.

Everett Rogers conceived of the life cycle of a product innovation as a bell curve, a perspective which was later revisited in mathematical terms by Frank Bass.

Rogers' adoption curve (Figure 8.10) traces the rate of new adoptions following the growth rate in adoption – a low adoption rate during the time when technical details are still being worked out; a fast rate of adoption when the technology is widely adopted; and then slower

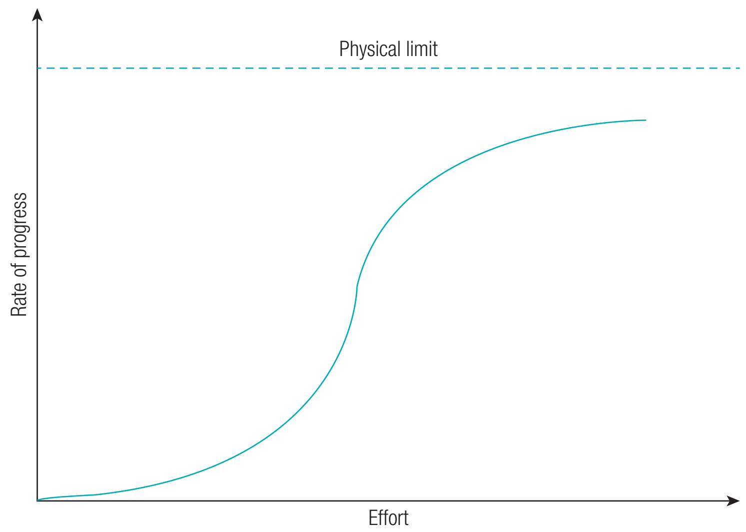

Figure 8.10 Rogers' 'Adoption of Innovation' Trajectory, with Key Events and Consumer Groups in a Product's Life Cycle

rates of adoption as the industry matures and alternative technologies enter the competition. Another perspective, envisioned by Foster as a cumulative growth total of adoptions, yields an S-curve that measures the total population of the community of adopters (Figure 8.11).

The early part of the S-curve is a period of idiosyncratic development, before the existence of standards or deep understanding of the technology. Many competing theories and trajectories exist, often promoted by strong and volatile egos, making any investments highly risky. As understanding evolves, standards are established and technology advances incrementally, generally through sober research, investment and hard work.

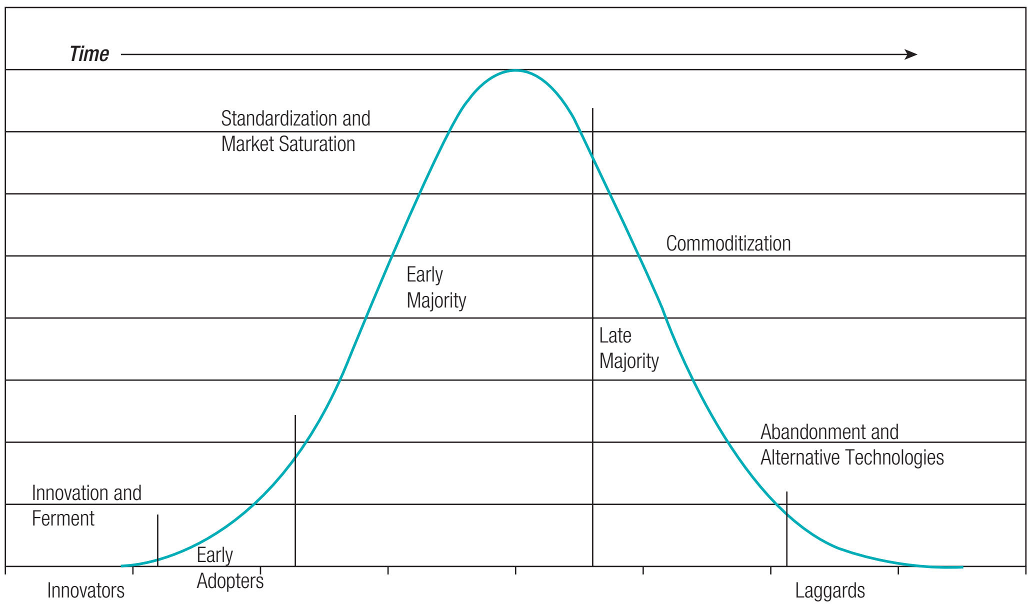

Figure 8.11 Curve for Innovation A

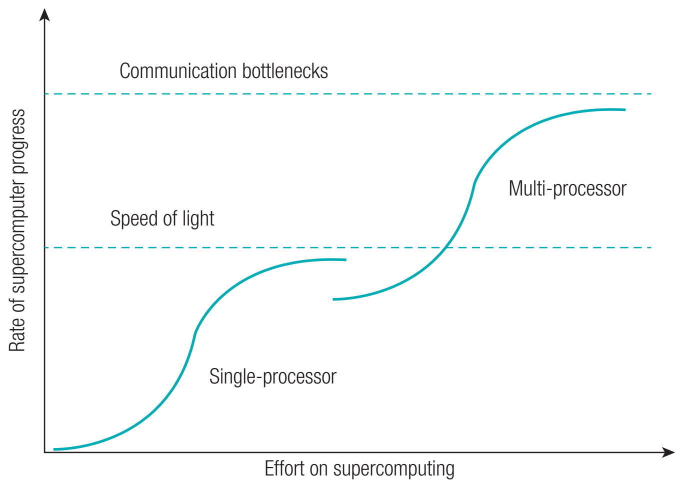

Figure 8.12 Sequence of S-Curves

The physical limits of the S-curve are constrained by the limits of scientific knowledge; often technology alone cannot push it back. For example, it has been predicted for some time that the advance of computing will stall as chip architecture scales down to a level where quantum effects prevail. In order to continue to double computing power every two years, as we have since the 1930s, we need a breakthrough. The next breakthrough seems to be coming about from experiments with quantum computing. In the past, major breakthroughs in computing pushed back physical limits about every 20 years, first when gears and solenoids were replaced by vacuum tubes in the 1940s, then transistors in the 1960s, and large-scale integration in late 1970s. The result is a series of stacked S-curves (Figure 8.12). Stacked S-curves tend to map exponential performance growth over time because the period of exponential growth in development of a single technology is extended by market forces that adopt substitutes as they develop.

Geographical Scaling

Each new technology has the potential to remap the 'distances' between people and places; this in turn demands that firms restructure the tasks they perform to remain competitive. Distances should be thought of here as any impediment that makes a particular business model infeasible – it could be cost, geographical distance or risk. In general, the remapping enabled by new information and communications technologies makes the world smaller and flatter. So pronounced has been the effect that it is perhaps more difficult to measure the shrinkage of the world today than it was even a decade ago.

New York and Boston get Cosy

We take for granted today the ability to pick up a telephone or send an email to anywhere in the world and expect the recipient to have that message immediately. But in times past, messages needed physical transport and their transmission time was restricted by geography. Consider the business dealings between New York and Boston (Figure 8.13).

In the early 19th century, the only way a New Yorker could manage a business in Boston was to send an emissary up by stagecoach. That took a day and a half, and a round trip could consume the better part of a week. Things got better as the roads improved, and even better with railways. Along came the telegraph service in the 1840s and 1850s, dropping the delay for pure exchanges of information (which could include monetary transactions) to zero.

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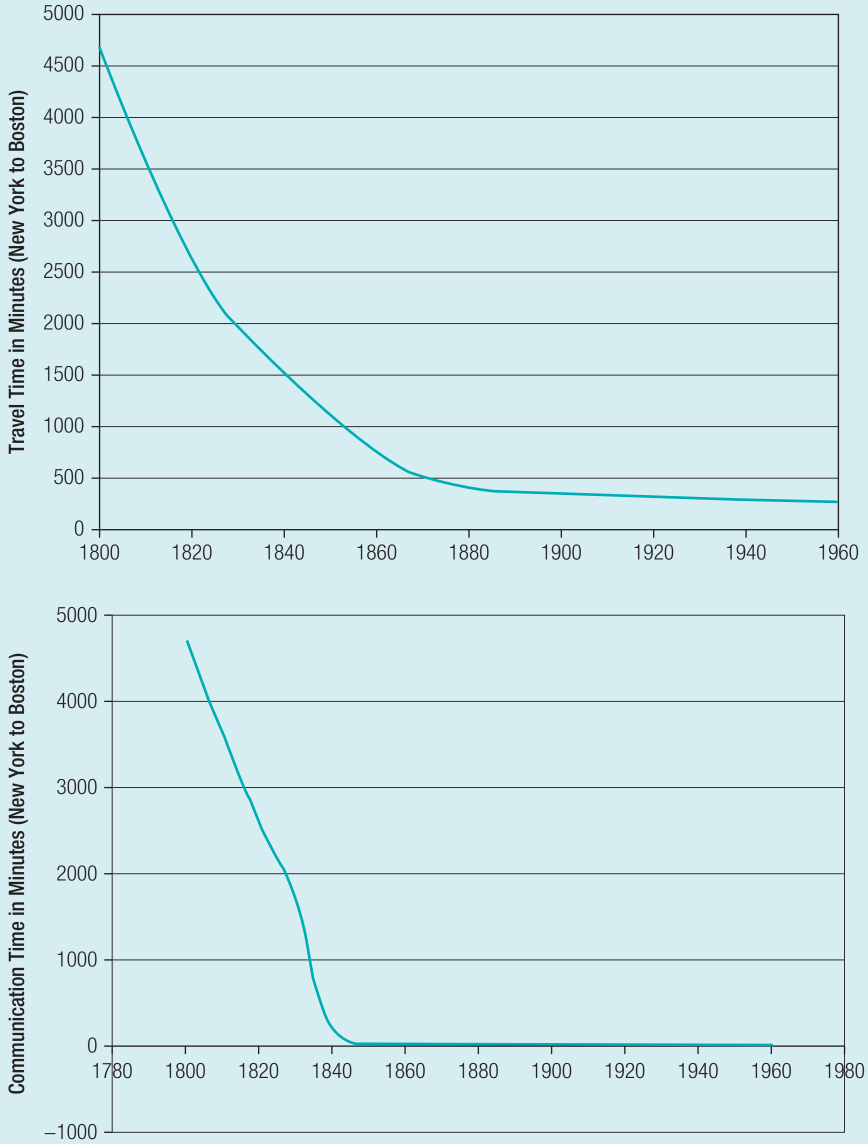

Figure 8.13 Travel (Top) and Communication (Bottom) Times from New York to Boston (in Minutes)

On the other hand, materials deliveries, plant inspections and just pressing the flesh are still subject to delays – though as railways, then cars entered the scene, these delays became progressively shorter. We can see how, as transportation and communication technologies advance, the world grows flatter and flatter. It doesn't happen all at once, but – one by one – the various delays in doing business fall to zero. A corresponding graph might show that not only are time delays falling to zero, but so are costs, providing one more incentive to flatten the landscape of business.

Some of the most dramatic shifts from geographical scaling have taken place in markets – both consumer and vendor. In today's markets, person-to-person selling is far too expensive for many (if not most) products. Still, it is the best way to nurture contacts, obtain sales and negotiate the best price. Communication technologies can pry open previously unavailable markets, and create new opportunities for previously orphaned products. It can do this by lowering the cost of person-to-person selling. The growth of telephone direct selling was only the most recent great communications revolution in the sales and distribution channel. The growth of internet selling has fostered a rich, new and exciting way to enter previously unavailable markets.

Consequences of Geographical Scaling

There are five effects that reflect the technologies that influence geographical scale – globalization, speed, service orientation, worker dispersion and virtual organizations.

Globalization introduces new competitors for the firm's products at the same time that offers it enormous economies of scale. Firms in global competition tend to compete on market share rather than short-term profit. Transportation and communications technology have created opportunities to compete globally in many additional product markets.

Speed – either in delivering a product or service to customers, or in getting a product designed, built and marketed – has come to define the contemporary age of 'web time.' Most computer technology companies tend to compete globally and seek market share through first-mover advantage.

Service orientation has grown more important because telephones, email and web chat have put the customer geographically closer to the firm. It has also increased the importance of reputation, since customers can influence other customers through chat rooms. A company's customer base becomes a 'global village' complete with gossip, local heroes and community spirit. Companies do well by treating customers well.

By radically changing the cost of managing people, information and geography, knowledge technology is generating huge leaps in scale economies, creativity and productivity. In the process, work is gradually becoming unstructured and asynchronous, evolving towards a 'jobless' workplace. In the process, we are creating *virtual organizations* where *worker dispersion* has increased dramatically.

Alliances

Relationship enterprises create value by forming alliances with complementary firms or individuals and leveraging this complementarity. There are estimated to be about 20,000 such relationship enterprises in the world today. The top 500 multinationals have an average of 60 major strategic alliances each. The largest and most important ones are in the aerospace, airline, telecommunications and automobile industries (Stinchcome, 1965; Tushman & Romanelli, 1985; Starr & MacMillan, 1990; Weick & Roberts, 1993).

Though their profits are not nearly as great as these multinationals, ostensibly not-for-profit alliances like Linux, the Apache Software Foundation and the Open Source Initiative have had an enormous impact on the structure of and competition in the computer industry. There has been some speculation that similar open-source projects will begin cropping up in other industries, perhaps even undermining the traditional free-market, monetary-based economic system. At least for the immediate future, though, these sorts of voluntary alliances are likely to be in software.

Outside of software, it has been estimated that alliances account for 30% to 40% of revenues for the top European and US companies. Relationship enterprises often extend beyond market or contractual obligations and share information, knowledge and learning, and attempt to reduce risk and increase profits by collaborating across the supply chain. As a result, competition declines across individual firms and increases up and down entire supply chains. In recent years, almost half of alliances have failed, primarily, it is conjectured, because of damaged working relationships rather than because the alliance failed to contribute to both businesses' strategic objectives (Ellis & Fellner, 1943).

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Innovation Workout: Visualization

A significant portion of the human brain is concerned with processing or creating visual information; indeed, more than 30 areas in the brain are dedicated to visual processing. Thus one might suspect that one of the more effective ways to create new patterns of information is through visualization. In the beginning, human communication was primarily visual. Even after language evolved, its tangible storage and representation through writing evolved from pictures (indeed, Chinese is still written with highly stylized pictures).

Albert Einstein said of his own innovative research:

> The words of the language, as they are written or spoken, do not seem to play any role in my mechanism of thought. The psychical entities which seem to serve as elements in thought are certain signs and more or less clear images which can be voluntarily reproduced and combined.

Sketching is a way of talking to yourself. It allows you to put your abstract ideas into a tangible form. Start by daydreaming; take a break from whatever you are doing, and either empty your mind, or at least don't impede the random flow of thoughts running through your brain. Occasionally, sketch what you see. Sketch as many alternative concepts as you think you see. You are your own audience; therefore, you can draw or sketch freely without worrying about what anyone will think.

Thomas Edison was known to have made hundreds of sketches and doodles while formulating his inventions. He would typically hand a stack of his doodles along with written and verbal explanations to his associates, asking them to organize his ideas into workable inventions.

Sketching, doodling or drawing are complementary to verbal expression – use them together to help create, refine and articulate new ideas.

To prepare you for the case study, try this challenge, one which Yamaha is most assuredly thinking about today.

The challenge: You have traditionally made world-class pianos, but two challenges have arisen. First, fewer and fewer people are playing pianos today, and thus have less incentive to buy your products. Second, computer technology has made it possible to generate any sound in the universe without having to produce it from a complex half-ton assemblage of wood and steel. Pianos could conceivably be the size of a wristwatch, if only there were some way to control the music coming out. In fact you suspect that many teenagers today would rather hold an instrument that looks like a game controller. Find a better (commercially, aesthetically, musically or however you define 'better') design for a piano.

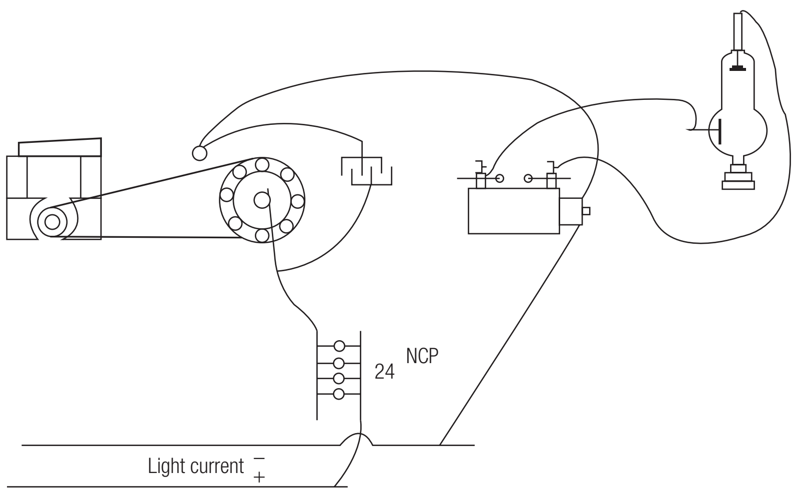

Figure 8.14 Thomas Edison's Sketch Thinking Through the Circuit for Energizing a Discharge Tube

Blueprint

1. Review a challenge you are working on. In your mind's eye, scan its various aspects. Write the challenge on paper and reflect on it for a few minutes: What doesn't fit? What are the major obstacles? The unknown? What do I want to understand?
2. Relax. When relaxed, you will find your intuitive consciousness uses images and symbols more freely.
3. Allow your intuition to offer images, scenes and symbols that represent your situation. You need not know what the drawing will look like before you draw it.
4. Provide a format for the challenge by drawing a boundary. This can be any size and shape you wish. The purpose is to separate the challenge from its surroundings and allow you to focus on the challenge. A boundary also gives your drawing its own atmosphere or depth and helps establish a wholeness which in itself is meaningful.
5. Draw as your mind wants to draw. Practise drawing without conscious direction. Try using your left hand (if you are right-handed). Imagine your lines and scribbles are dictating how you draw and place them. Do not censor what you draw – the drawing is private and need not be shown to anyone. Let the drawing flow from you onto the paper. Chance, or randomness, gives depth to your scribbling. It points to an unknown but active principle of order and meaning – indeed, think of this as the wisdom you are trying to draw out of your unconscious.
6. Make as many drawings as you need.
7. Examine your drawing. The drawing is a message from your subconscious. Look at the image as a whole and then at the separate parts. These are visual representations of your thoughts. Search the drawing for new insights into organization; or look for what is missing.
8. Write down the first word that comes to mind for each image, symbol, scribble, line or structure.
9. Combine all the words and write a paragraph. Free-associate, writing whatever thoughts come to mind; don't hesitate until you have finished writing. Compare the paragraph with your drawing. If you feel the need, revise your paragraph until you are comfortable that the drawing and the words represent the same thoughts in both visual and verbal language.

Case Study: Yamaha Piano

Yamaha was founded in 1887 by Torakusu Yamaha to make pianos. The company built up a reputation for quality (it won prizes at the 1904 World's Fair for its pianos and organs), but suffered with the rest of Japanese industry during World War II. When president Genichi Kawakami took over Yamaha in 1950, it only made a few pianos, mouth-organs, and wind-up gramophones.

Yamaha was always a leader in innovation. It had to be, because the markets were already dominated by European or American names like Steinway. By clever innovation and low pricing, Yamaha could differentiate itself from established brands.

And brand itself was an obsession with Genichi Kawakami. In 1954, to develop a market for pianos as well as the Yamaha brand, he started a music class for young children that evolved into the worldwide chain of Yamaha music schools (as well as showrooms for Yamaha's musical instruments). By the late 1980s, Yamaha had become the world's leading maker of musical instruments of all kinds, not just pianos.

America is Yamaha's largest market, and the one that has thrown up the greatest challenges to the elevation of the Yamaha brand in pianos. The ultimate brand recognition – the sort of prestige that went with, for example, a Steinway piano – seemed to elude

Yamaha. Unfortunately for Yamaha, either through cultural accident, successful marketing or something truly inherent in Steinway's tone, Steinway pianos produce the sort of tone that has been most sought after in North America for the past hundred years. The 'Steinway sound' is best characterized as having a strong, singing treble and a powerful bass, rich in high harmonics. Asian and European cultural tastes in piano tone incline towards different tonal palettes. Top European brands like Bösendorfer, August Förster and Bechstein emphasize the fundamental tone rather than the harmonics, with a tone that sustains at a lower volume, and a clean, bright and thin treble. This results in a much less powerful sound – one that Steinway aficionados complain is dull. But this tone has been traditional in Europe since before Steinway was founded. The top Asian brands such as Yamaha and Kawai in contrast have bright, brittle tones that are short on sustain – these are often preferred by jazz pianists for their crispness. It is claimed that the 'Asia tone' was traditionally due to the difficulty in obtaining hardwoods. The widespread substitution of at least some softwoods in the rim lowers sound reflection back to the soundboard, thus robbing Asian pianos of power. Still the exclusivity of, say, the Fazioli or Bösendorfer brand (both factories produce only a few hundred pianos per year) has assured the latter brands a mystique that eludes Yamaha. Sometimes as a good becomes rarer or more exclusive, the price of the good rises, which some customers may see as a premium signalling greater quality (though it is difficult to find fault with either Fazioli or Bösendorfer in tone or quality).

There is very little argument about Yamaha's quality control, though, and this has been compared to Steinway's less particular quality control. As one technician commented 'Steinways in general don't come out of the crate as eager to please their prospective owners as Yamahas do. They like to get a thorough working over by very skilled technicians, and then expect to be admired by everyone around them' (Fine, 2000: 146).

Traditional Acoustic Pianos

From 1700 to 1750, very few piano sales occurred anywhere. Pianos were just another keyboard novelty. From 1750 to 1800 significant technological improvements were made by the Erards in France, Silberman in Germany, and English piano makers Zumpe, Clement, Kirkman, and especially Broadwood. By 1800 Broadwood was selling 400 pianos per year compared with less than 40 by every other manufacturer. In 1850 there were probably less than 50,000 pianos manufactured worldwide. Shops were small and production techniques did not lend well to mass production. Steinway, made by a German family that had set up shop in New York City, was responsible for a steady stream of technological improvements (e.g. the wing-shaped grand piano) and volume-oriented process improvements that eventually elevated the piano to one of the most technologically advanced consumer products on the market. By 1900 the US had obtained one-half of the world market.

The second half of the 19th century saw widespread interest in the piano for the home in America. This led to an interest in the piano for the schools. During the peak period from 1890 to 1928, US sales ranged from 172,000 to 364,000 per year with the large uprights getting most of the market, selling at $200 to $300 apiece. The market received a boost in 1920 when the player piano became widespread, and about 250,000 were made annually up until the Depression. Piano sales slowly recovered after World War II, and by the 1970s Japan (and particularly Yamaha with an annual output of over 200,000 units) took over as the top producing nation. Throughout the 1970s and 1980s, Japan continued to produce about 400,000 per year. There are nearly one million produced each year now, worldwide. One can imagine, given a life expectancy of between 50 and 100 years, and the perhaps 50 million pianos sold during the past 100 years, how many millions there must now be, stored or in use.

Computer-Based Pianos

Piano technology has traditionally been about the quest for more sound. Indeed, the name 'pianoforte' (Italian for soft-loud) was coined by early piano makers who claimed they would fill a much larger room with sound than their contemporary clavichords, while offering dynamics that harpsichords could not.

By the 1950s, there were other ways to create more sound than by changing the design of the piano. Bands were shrinking and vacuum tube amplifiers became popular as these same bands were required to fill larger halls. It was simple economics – larger rooms meant more paying customers; smaller bands meant fewer players to pay.

Wurlitzer electric pianos ruled in the late 1960s and through the 1970s. Pianists looking for the right sound for a song were limited to a few guitar effects boxes. For example, the haunting opening chords of the Beatles' 'I Am The Walrus' were produced by a Wurlitzer piano heavily processed with guitar effects. On Supertramp's 'The Logical Song' Roger Hodgson split the Wurlitzer output through a Boss chorus pedal to give it a half-straight and half-modulated chorus sound. Otherwise pianists were stuck with a few 'acoustic' sounds amplified through primitive sound systems.

In 1980, an Australian company called Fairlight Instruments introduced the first version of the 'Fairlight computer musical instrument'. This was the first keyboard-based digital sampler. It could digitally record any acoustic sound and display as a visual image on a computer monitor. You could alter its wave-form with a light-pen. Once you were happy with the new creation, you could play it back using a standard-sized 88-note keyboard and store it on an 8-inch floppy disc.

Once Fairlight showed everyone the possibilities of digital sampling and manipulation, other companies jumped on the bandwagon. Yamaha came out with the analogue Clavinova, an electronic piano, and the DX-7 digital synthesizer in 1983. A company called New England Digital introduced a Fairlight-like machine called 'The Synclavier' in 1984, costing hundreds of thousands of dollars, but which was popular for advertising and movie scores.

In 1985, a company called Ensoniq introduced a keyboard synthesizer that came with a built-in sampler. It could hold anywhere from five to 40 seconds of material, depending on the memory installed. That made it a powerful machine to use on stage. At the same time, the Japanese company called Akai introduced a machine designated the s612. This was a rack-mounted sampler; it had 128 kilobytes of memory (huge for that day) meaning it could hold just eight seconds of sound at the lowest sampling rate. You could dump your samples to special 2.8-inch floppy discs, but these things could hold just one sample per side.

Meanwhile, a number of companies had come together to create the MIDI (music instrument digital interface) for communication between instruments and computers. This was an amazing breakthrough. Using MIDI controllers, musicians could hook all their gear together, and create and play unimaginably complex arrangements completely solo.

There was also another technological shift. Up until the mid-1980s, musicians used analogue synthesizers that built up sounds from oscillators and filters. The tones were purposely artificial. In 1987, keyboards went digital with the introduction of the Roland d50 – sounds could be altered digitally, and the d50 could communicate with other digital devices using the MIDI standard. Roland's keyboard was a huge success.

By the late 1980s we had all of what today we'd consider the basics: digital keyboards, digital samplers, digital sequencers, computers and specialized music software. The personal computer revolution of the early 1980s had driven up volume and driven down price to the point where a middle-class teenager could afford to go out and buy digital gear. The doubling of computer performance (Moore's Law) every 18 months quickly put all the power that musicians needed into their hands. Apple's Macintosh was an immediate hit with musicians, thanks to a software program called Protools created by Digidesign. Soon musicians had a thousand times more computing power to make music than the astronauts had when they went to the moon.

Before the early 1980s, most people believed that there was no artistic reason to simulate in electronics what could be done by a real musical instrument. For example, if you needed a guitar sound, you found a guitar. But as musicians embraced technology even further, a new set of rules and aesthetics began to emerge.

None of this was lost on Yamaha, who had been leading the market in analogue electronic pianos which were popular with touring bands since its first electric pianos were sold in 1976. These were similar in design to the Fender Rhodes Stage Piano Mark I, but produced a fuller, brighter sound which could cut through louder and more intense rock music. They were also quick to follow Fairlight into computer generated piano sounds (so-called digitally modelled pianos) with the DX-7 digital synthesizer (introduced in 1983).

From the brief history of the move from small shop production in the early 20th century, to the proliferation of digital instruments in the early 21st, several technologies – each with their own unique technology trajectories – appeared and were influential in the pianos that Yamaha developed. The market performance – as measured by subjective assessments of tonal quality, touch and various other factors in pianos – grew by around 2% annually (the acoustic piano's rate of technology acceleration in the first half of the 20th century). The endless possibilities of digital instruments raised expectations and initiated a wide range of requests from customers. Classical and jazz pianists demanded fast actions and rich tonal quality. Still, most of the money and sales volume was made at the low quality end of the scale; the brand reputation, which had an important influence on sales across all quality categories, was developed at the upper end of the scale.

Traditional small shop production methods, with precise selection of tonewoods, and attention to action tolerances, were needed for the best pianos. This is where the high-quality end of the market is satisfied, and Yamaha maintains its own custom shop to this day, making its high-end CFIIIS, S4 and S6 concert grands in these facilities. Performance to price here is growing at 3% annually. Most traditional acoustic pianos are made with computer-numerical-controlled robots in giant factories. Yamaha's R&D and design shops in Japan would construct prototypes, and lay out the machining specifications down to the finest detail on computer-aided-design software. These would be transferred electronically to their robotic factories, where the pianos were actually milled, routed, sawed, assembled and so forth until the instruments were finished. The technology trajectories of robotics and numerical machine control allowed organizational scaling to replace people with robots and computers in these megafactories, and through reductions in the cost of production improved the performance to price of CNC mass-produced pianos at around 7% annually.

From the 1960s on, analogue electric pianos like the Wurlitzer showed a price performance increase of around 12% annually. In Yamaha's own electric pianos, this was due largely to advances in circuits for frequency modulation synthesis. Yamaha's first digital sampling pianos (basically computers with keyboards) were fairly crude affairs. But as these evolved into embedded computer systems with piano keyboard-style controllers, technology acceleration rapidly rose to around 60% annually, in step with the general advances in core computer technology.

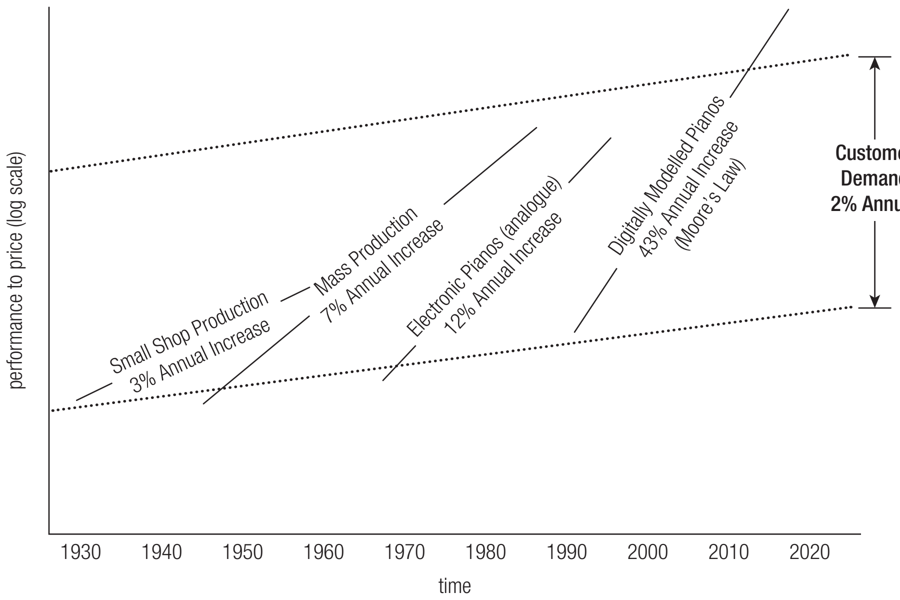

Figure 8.15 Technology Acceleration at Yamaha

Moving into the Future

With fewer people buying traditional pianos and acoustic instruments, Yamaha has been steadily shifting its core business towards electronics, as well as shifting more of its production to low-cost centres such as China and Indonesia. Today there are almost no sounds that *cannot* be reproduced accurately with computer-based digital signal processing (pianos and violins are the most difficult, and even these have been modelled quite successfully). Producing high-quality musical sound no longer requires artisans – it needs information technology. The 'user interface' often sells the instrument, and that is increasingly used to differentiate Yamaha from its competitors. Customer relationship management is necessary to get the 'user interface' right.

To some extent, there is a re-enactment of the player piano boom of the 1920s. A substantial portion (some sources have suggested as much as 40% of sales) of Yamaha's acoustic piano sales are now Disklavier systems, with solenoid key actuators, and laser-based velocity and positioning sensors on keys and hammers. Disklavier systems are factory installed on upright and grand pianos, the most expensive system running well over $300,000. These are not just playback systems (which would have been more important in the 1920 before the advent of broadcast radio) but also intelligent accompaniment systems that are very useful to piano students.

An increasing amount of effort and expense is being placed into digital pianos (as well as guitars, double basses and other instruments). Yamaha has developed many of the industry's best instrument models, especially for piano, over the past decade, and embeds these in the hardware of the pianos and digital synthesizers. This market has grown quickly. There are distinct advantages for customers. For city dwellers with small apartments, digital pianos need not be much larger than their keyboards; for those living in very dry, very wet or variable climates, digital pianos do not go out of tune; for touring musicians, they are portable, and many can be tuned with other instruments, or keys can be transposed at the shift of a slider. In all cases the sound (though unfortunately *not* the key action) can rival that of the company's best grands.

Questions: Yamaha Case Study

1. Define Yamaha's Business Model:
   a. Draw a schematic of Yamaha's business models, identifying major processes at Yamaha, the external parties that they transact with, and the value flows.
   b. Provide a 'narrative' describing where Yamaha makes its money:
      i. Identify where they should concentrate its strategy in the future.
      ii. Identify where it incurs costs and estimate how much these might be, given what you know about the price of pianos.
      iii. Identify where it earns revenues and estimate how much these might be, given what you know about the price of pianos.

2. Describe how and where network effects appear in Yamaha's business model.

3. Show how Yamaha has managed and increased the size of its virtual network of piano players (consider the learning curve, and Yamaha's expenditure on learning).

4. How do technology substitutes and the exponential acceleration of performance to price (e.g. Moore's Law) affect Yamaha's business?:
   a. Describe how Yamaha has managed the growth in demand for 'features' (sometimes called feature creep in software (the demand for performance of technology trajectory).
   b. Describe how the supply of technology performance trajectory for Yamaha has followed that of Moore's Law.
   c. Predict past and future times of disruptive technology innovation (draw the graph yourself). You don't have to be accurate, just make a credible argument for future disruptive innovation.
   d. Describe how the innovator's dilemma manifests itself at Yamaha Piano.

5. How should Yamaha link its musical instrument research and development R&D and its customer relationship management? R&D needs to design products that customers will want to buy in the future, and customer relationship management serves several functions: making sure that customers are satisfied with existing products; making sure that they know about new and upcoming products; asking them questions to find out what they want in new products; making them aware of new features that they didn't know they wanted.

6. How can Yamaha invest to compete with 'premium' brands like Steinway?:
   a. Show Steinway's technology trajectory (it builds traditional acoustic pianos, and does not use any computer technology)
   b. Will Steinway face a challenge from some sort of disruptive innovation sometime in the future? (Yes/No). Explain how and why.

Chapter 8 – Key Points

1. Most commercially important technologies grow at a constant rate, and thus expand their performance to price exponentially.
2. Lock-in to expensive but older technologies in a particular market can lead to the 'innovator's dilemma' where new entrants 'disrupt' the market through their innovations.
3. An innovation's life cycle is determined by physical and economic limits on its performance growth (the Foster S-curve).
4. Innovations require the development of new businesses that are predicated on new inventions and which often require new business models (entrepreneurship).
5. Disruptive innovations are even riskier; they demand that you educate investors, customers and other stakeholders.

Notes

[1] Schumpeter (1950) argued for the importance of disruptive innovations in maintaining a healthy competitive economy; see also Schumpeter, 1934, 1939.

[2] This may be compared to technologies with less radical jumps in performance such as the VCR in Klopfenstein, 1989.

[3] These effects are just one set of examples of systems that evolve when networks appear. For parallels in physics, biology and other fields see Barabási, 2003.

[4] The importance of adopting such standards for successful marketing has been studied at length in Farrell & Saloner, 1985; Liebowitz & Margolis, 1990, 1994.

Further Reading

Arthur, W. Brian (1989). Competing technologies, increasing returns, and lock-in by historical events. *Economic Journal* March, 99, 116–131.

Barabási, A.-L. (2003). *Linked: How Everything Is Connected to Everything Else and What It Means*, New York: Plume.

Barnett, Vincent L., Samuels, Warren J. and Makashava, Natalia (eds) (1998). Translated by Stephen S. Wilson. *Collected Works of Nikolai Kondratiev*, 4 vols. London: Pickering and Catto.

Bruun, P. and Mefford, R. N. (2004). Lean production and the internet. *International Journal of Production Economics* 89(3), 247–260.

Buchanan, J. and Stubblebine, W. (1962). Externality, *Economica* November, 371–384.

Chandy, R. K. and Tellis, G. J. (1998). Organizing for radical product innovation: The overlooked role of willingness to cannibalize. *Journal of Marketing Research*, 474–487.

Chandy, R. K. and Tellis, G. J. (2000). The incumbent's curse? Incumbency, size, and radical product innovation. *Journal of Marketing* 64(3), 1–17.

Coase, Ronald (1960). The problem of social cost. *Journal of Law and Economics* October, 3, 1–44.

Christensen, C. (1997). *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*. Boston: Harvard Business School Press.

Christopher, M. and Towill, D. R. (2000). Supply chain migration from lean and functional to agile and customised. *Supply Chain Management: An International Journal* 5(4), 206–213.

Clark, K. B. and Fujimoto, T. (1991). *Product Development Performance: Strategy, Organization and Management in the World Auto Industry*. Boston: Harvard Business School Press.

Cohen, W. M. and Levinthal, D. A. (1994). Fortune favors the prepared firm. *Management Science* 40, 227–251.

Cowen, Tyler (ed.) (1998). *The Theory of Market Failure*. Fairfax Virginia: George Mason Press.

D'Aveni, R. A. and MacMillan, I. C. (1990). Crisis and the content of managerial communications: A study of the focus of attention of top managers in surviving and failing firms. *Administrative Science Quarterly* 35, 634–657.

Day, D. L. (1994). Raising radicals: Different processes for championing innovative corporate ventures. *Organization Science* 5, 148–172.

Ellis, Howard. S. and Fellner, William (1943). External economies and diseconomies. *American Economic Review* 33, 493–511.

Farrell, Joseph and Saloner, Garth (1985). Standardization, compatibility, and innovation. *Rand Journal of Economics* 16(1), 70–83.

Farrell, Joseph and Saloner, Garth (1986). Installed base and compatibility: Innovation, product preannouncements, and predation', *American Economic Review* 76(5), 940–955.

Fine, L. (2000). *The Piano Book*. Brookside Press.

Fisher, Franklin M. (1983). *Disequilibrium Foundations of Equilibrium Economics*. Cambridge: Cambridge University Press.

Griliches, Z. (1957). Hybrid corn: an exploration in the economics of technical change. *Econometrics* 25, 501–522.

Hauser, J., Tellis, G. J. and Griffin, A. (2006). Research on innovation: A review and agenda for marketing science. *Marketing Science* 25(6), 687–717.

Kapuscinski, R., Zhang, R. Q., Carbonneau, P., Moore, R. and Reeves, B. (2004). Inventory decisions in Dell's supply chain. *Interfaces* 34(3), 191–205.

Klopfenstein, B. C. (1989). The diffusion of the VCR in the United States, in M. R. Levy (ed.) *The VCR Age* (pp. 21–39). Newbury Park, Ca.: SAGE Publications.

Kondratieff, N. D. (1979). The long waves in economic life. *Review* (Fernand Braudel Center), 519–562.

Lepore, J. (2014, 23 June). The Disruption Machine: What the gospel of innovation gets wrong. *New Yorker*.

Liebowitz, S. J. and Margolis, S. E. (1990). The fable of the keys. *Journal of Law and Economics* 33(1), 1–26.

Liebowitz, S. J. and Margolis, S. E. (1994). Network externality: An uncommon tragedy. *The Journal of Economic Perspectives* 8(2), 133–150.

Moore, G. (1997). An update on Moore's Law. Intel Chairman Emeritus Gordon Moore, Intel Developer Forum Keynote Speech, 30 September 1997, 8 a.m., San Francisco.

Nordhaus, William D. (1996). Do real-output and real-wage measures capture reality? The history of lighting suggests not, in *The Economics of New Goods* (pp. 29–70). University of Chicago Press.

Nordhaus, William D. (1998). Quality changes in price indices. *Journal of Economic Perspectives* 12(1), 59–68.

Palacios Fenech, J. and Tellis, G. J. (2016). The dive and disruption of successful current products: Measures, global patterns, and predictive model. *Journal of Product Innovation Management* 33(1), 53–68.

Pinkse, J., Bohnsack, R. and Kolk, A. (2014). The role of public and private protection in disruptive innovation: The automotive industry and the emergence of low-emission vehicles. *Journal of Product Innovation Management* 31(1), 43–60.

Rubera, G. and Tellis, G. J. (2014). Spinoffs versus buyouts: Profitability of alternate routes for commercializing innovations. *Strategic Management Journal* 35(13), 2043–2052.

Schoemaker, P. (1992). How to link strategic vision to core capabilities. *Sloan Management Review* 34, 67–81.

Schoemaker, P. and van der Heijden, C. A. J. M. (1992). Integrating scenarios into strategic planning at Royal Dutch/Shell. *Planning Review* (May/June), 41–46.

Schumpeter, J. A. (1934). *The Theory of Economic Development*. Boston MA: Harvard University Press.

Schumpeter, J. A. (1939). *Business Cycles*. New York: McGraw-Hill.

Schumpeter, J. A. (1942). Creative destruction, in *Capitalism, Socialism, and Democracy* (pp. 82–85). New York: Harper and Row.

Schumpeter, J. A. (1950). *Capitalism, Socialism, and Democracy*. 3rd ed. New York: Harper and Row.

Shapiro, C. and Varian, H. R. (1998). *Information Rules: A Strategic Guide to the Network Economy*. Boston: Harvard Business School Press.

Sood, A. and Tellis, G. J. (2005). Technological evolution and radical innovation. *Journal of Marketing* 69(3), 152–168.

Starr, J. A. and MacMillan, I. C. (1990). Resource cooptation and social contracting: Resource acquisition strategies for new ventures. *Strategic Management Journal* 11, 79–92.

Stinchcombe, A. L. (1965). Organizations and Social Structure, in J. G. March (ed.) *Handbook of Organizations*. Chicago: Rand McNally.

Tapscott, D. (1995). *The Digital Economy: Promise and Peril in the Age of Networked Intelligence*. New York: McGraw-Hill.

Tellis, G. J. (2003). *Effective Advertising: Understanding When, How, and Why Advertising Works*. Sage Publications.

Tellis, G. J., Prabhu, J. C. and Chandy, R. K. (2009). Radical innovation across nations: The preeminence of corporate culture. *Journal of Marketing* 73(1), 3–23.

Tellis, G. J., Stremersch, S. and Yin, E. (2003). The international takeoff of new products: The role of economics, culture, and country innovativeness. *Marketing Science* 22(2), 188–208.

Tushman, M. L. and P. Anderson (1986). Technological discontinuities and

organizational environments. *Administrative Science Quarterly* 31, 439–465.

Tushman, M. L. and O'Reilly III, C. A. (1997). *Winning Through Innovation: Leading Organizational Change and Renewal*. Boston: Harvard Business School Press.

Tushman, M. L. and Romanelli, E. (1985). Organizational evolution: A metamorphosis model of convergence and reorientation, in L. L. Cummings and B. M. Staw (eds) *Research in Organizational Behavior*, Volume 7 (pp. 171–222). Greenwich, Conn.: JAI Press.

Watts, D. J. (2004). *Six Degrees: The Science of a Connected Age*. New York: Norton.

Weick, K. E. and Roberts, K. H. (1993). Collective mind in organizations: Heedful interrelating on flight decks'. *Administrative Science Quarterly* 38, 357–381.

Westland, J. C. and See-To, E. (2007). The sort-run price performance dynamics of microcomputer technologies. *Research Policy* 36, 591–604.

CHAPTER 9

Financing and Valuation of Innovations

Learning Objectives

After finishing this chapter, you will

- Understand that innovators need strategies to manage both the consumer market for their product and the capital markets that fund their operations.
- Understand figures of merit, and which are most appropriate for their innovations and businesses.
- Understand the function of the behavioural model, the strategy model in forecasting the value of an innovation and its associated business model.
- Understand how a value cone displays risk and return.
- Understand the choice of discount factor to compute present value.

After doing the *Innovation Workout* you will be familiar with scenario analysis.

After reading the eBay *case study* you will be able to identify the roles of **behavioural models, strategy drivers** and **value metrics** in forecasting business value.

Two Markets

Every innovation competes in two markets: the *market for the innovation*, whether a product or a service; and the *market for investment* in the form of equity, loans or strategic partnerships and know-how. This dichotomization has grown in importance as financial markets have continually improved efficiency and sophistication. Many companies today have operated continually at a loss – the market for their products or services unable to cover their costs – and these losses must be funded by investors who have faith in the ultimate profitability of their business.

The markets for *innovations* and for *investment* are interdependent; product design and marketing decisions depend on having sufficient funds; and future operations and product sales ultimately drive investor valuations. In order to attract investment, an innovator faces three challenges:

1. *framing* the customer's need for this product or service, i.e. delineating the market for this product or service;
2. showing *venture capitalists* that a successful product can be made profitable and at the necessary scale, i.e. delineating the financial rationale for the business model and
3. *communicating* this knowledge and an excitement about the importance of the product and why you are the correct person to solve the customer's problem.

The *framing* challenge delineates – as clearly and simply as possible – the real business problem. What is it that customers want; why has no one delivered it before; why are you the correct business to solve the customer's problem? Investors expect a realistic assessment of the strengths, weaknesses, opportunities and threats facing this product and marketing. They want to know up-front that they are investing in an innovation, a business, and an innovator who has the necessary knowledge to address the complex decisions that will ultimately come up.

The *venture capital* challenge delineates – as clearly and simply as possible – the value of the business. In answering this challenge, an innovator must move beyond the invention – the product or service – and describe all of the components and activities of the business model in terms of revenue and cost streams. New and information-intensive businesses seldom have clear performance benchmarks set by comparable firms. Valuation, instead, rests on the innovator's vision and a story narrative about how and why the business model will grow and evolve in the future. This story must be compelling, with clear articulation of primary activities and features that are critical to the business's success. Furthermore, story variations provide a sound basis for intelligent 'what-if' analysis. Each activity and feature defined in the consumption chain and feature map will have an associated stream of revenues and costs. These are the basis for future *pro forma* financial statements for the business that are the basis for investment decisions. Present valuations and share price can be derived through net present value analysis.

The *communication* challenge is ultimately a sales pitch. It is at the same time simpler, more personal and more challenging than the framing and venture capital challenges. In answering this challenge, an innovator must think first about their audience – the potential investor that they want to sell on their business. What motivates them, what excites them and how long is their attention span?

The communication challenge starts with an 'elevator pitch'. If you only had a 25-second elevator ride where your potential investor was trapped into listening to you, what would you say?

You would find out what problems or activities truly interest and motivate your investor, and restate the problems your invention and business solve in terms of these investor 'hot buttons'. The idea is to pique your investor's interest with a claim, question or artefact, so they will listen to more of your sales pitch even after they are able to get out of the elevator. You would definitely *not* want to chase them out of the elevator with tedious details of your invention, business model and financials!

Communicating your invention and business model requires reframing in terms of the things that are important to the investor – and every investor is different. It is common as a basis to communicate how much money you want from an investor, what portion of the business you are selling them, and what return on investment they should expect. But you need to also show that the two or three discriminating or exciting features of your invention are recast as solutions to the investor's problem. Your story will include your vision for the future, potential competitors and pitfalls (and how you intend to handle these) and most importantly why you are the right person to realize your vision – why you are passionate about your business.

It is only at this point in this text that students have sufficient grasp of all of the areas involved in valuation of a company to successfully construct a business plan for an innovation. At this point we can delve into the ways that our decisions until this point on customers, competitors, channels, production and so forth are impacted in the financial numbers.

Sources of Financing

Innovation in established firms is typically self-funded, since established firms either have cash on hand or have established funding sources from banks or debt and equity markets. Start-ups, on the other hand, have difficulty finding sources of funds, and need more creative investment. Four sources are generally available to start-ups, and are distinguished by their management of risk – a task that usually involves some level of managerial involvement or covenant to limit the downside risk. The start-up's choices are:

1. *Crowdsourcing and peer-to-peer*: distribute risk over a large number of investors; investments are often votes of faith in a concept or person rather than being tied to return on investment.
2. *Seed accelerators*: manage risk through intensive management support to early start-ups; typically hold resources shared by many start-ups.
3. *Angel investors*: manage risk through extensive personal knowledge of the business and entrepreneurs; this may involve a degree of faith in a concept or person.
4. *Venture capitalists*: manage high risk through a knowledge of technology and markets, use of covenants and innovative use debt and equity, and several rounds of financing tied to achievement of goals.

The four approaches to start-up investing overlap, and use of a particular term may simply be a matter of convenience. Angel and venture capital investments are classes of private equity (equity raised from individuals rather than stock offerings) but are comparatively small, and generally used in the context of funding technology-intensive ventures. Indeed, venture capital was initially called 'adventure' capital, emphasizing the high risk and novelty of the investments. Angel investment was originally a Broadway theatre term, where it described bailouts for failing plays and musicals by wealthy fans. It is easy to see how these terms morphed into their current usage in a tech industry context.

Most start-ups receive funding, no matter what the source, contingent on their meeting certain performance benchmarks within a certain time frame.

Seed investment aims to fund the entrepreneur's product and market identification, start-up team creation and initial channel funding. Many start-ups prefer to self-fund at this stage, as investors tend to feel that entrepreneurs should have clearly defined these elements prior to asking for money. Often this seed money will come from family, friends, credit cards and other personal sources. In developing economies, seed investments may be available from micro-finance, though this is not typically used as a source of seed funding in developed economies.

First round financing typically expects a 'proof of concept' and product prototype, as well as one or two customers prior to financing. This will be small, perhaps covering three months of operations. Again, start-ups may choose to self-fund at this point. The objective of this stage of financing is a limited roll-out of product to a specific market, in order to test product design, channel design and consumer acceptance.

Second, third and subsequent rounds of financing will expect management to have successfully met any challenges highlighted after the first round of investment. Where management is considered to be lacking, investors may demand that outsiders be brought into the management team to provide the needed expertise.

Crowdfunding

Crowdfunding platforms such as Kickstarter and Indiegogo take the ability of stockmarkets to raise capital from a wide array of individuals and detach it from the accounting and regulatory oversight of traditional equity markets. As a consequence, many projects with highly uncertain returns are funded which otherwise might never be produced. Indeed, the greatest number of crowdsourcing projects comes from the arts: dance, manga and comic books, theatre and film (see the mini-case 'Crowdfunding the Creative Arts'). Crowdfunding platforms offer capabilities that are sometimes more important than fundraising. They also give start-up founders a unique opportunity to sell their idea directly to the consuming public, promoting marketing and brand awareness that is not directly available from other sources.

Crowdfunding the Creative Arts

Kickstarter has a well-deserved reputation as the go-to site to gain media attention and raise capital for small technological projects. It has raised over $2 billion for around 100,000 projects as of December 2015. What is often not realized is how dramatic an influence the Kickstarter platform has had on the creative arts and literature.

Figure 9.1 shows the breakdown of projects on Kickstarter, dominated by short films and music. In an era of GoPro and drone cameras, desktop computer video and music editing and internet publishing, artistic creation has been transformed, and individuals may be able to fund their visions with only a few thousand dollars.

Figure 9.2 shows that just putting a project up on Kickstarter does not assure success. Indeed, its most successful categories are Dance and Theatre, despite the fact that very few of these projects ever ask for funds on Kickstarter. The final graph, Figure 9.3, reveals that dance, music, comics, theatre and other arts seem to primarily be successful because they are not asking for much money. The majority of the $2 billion funded by Kickstarter goes to the more expensive technology, games and design categories.

Computer technology has now so greatly transformed the music, film, art and comic genres that individuals who have great ideas and artistic sensibilities can see their vision realized with little overhead or involvement of studios or expenditures outside of a desktop computer and some software. Future technology is likely to bring the same benefits to technology, games and design genres, opening up much greater opportunities for realizing creative ideas.

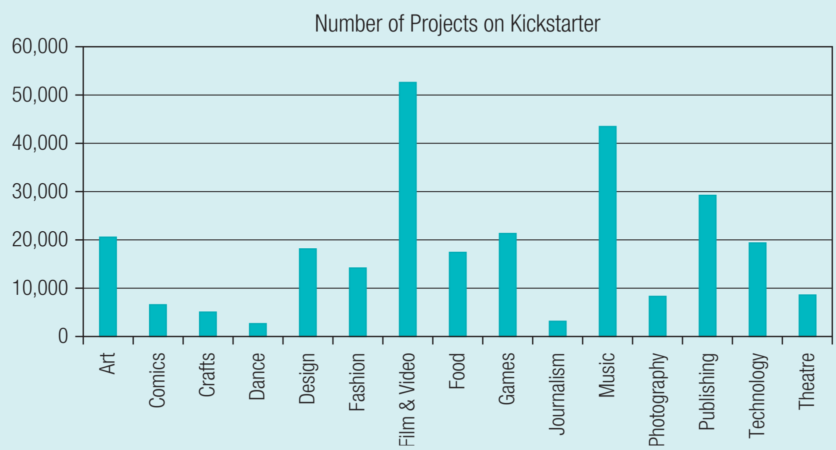

Figure 9.1 Number of Projects 'Kickstarted' as of December 2015
Source: kickstarter.com

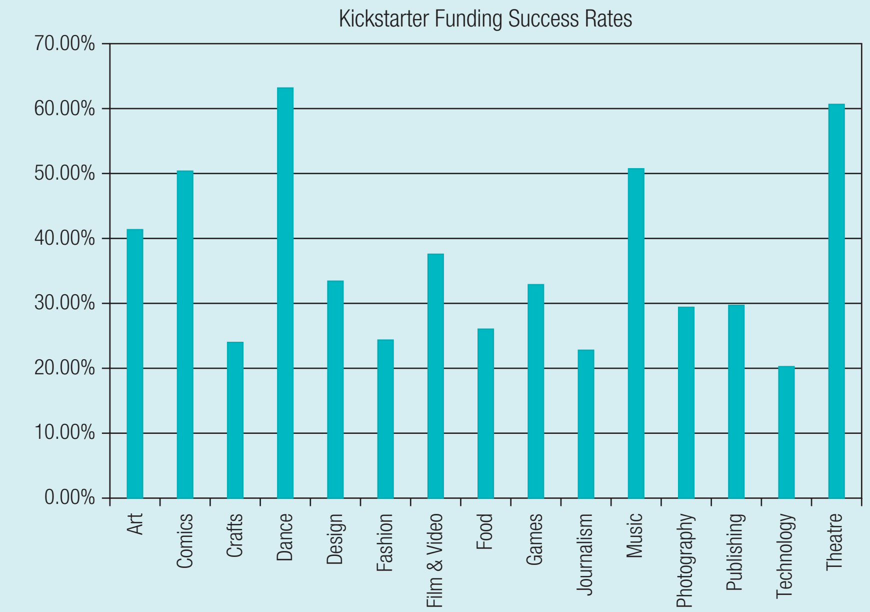

Figure 9.2 Projects' Success Rate by Category as of December 2015
Source: kickstarter.com

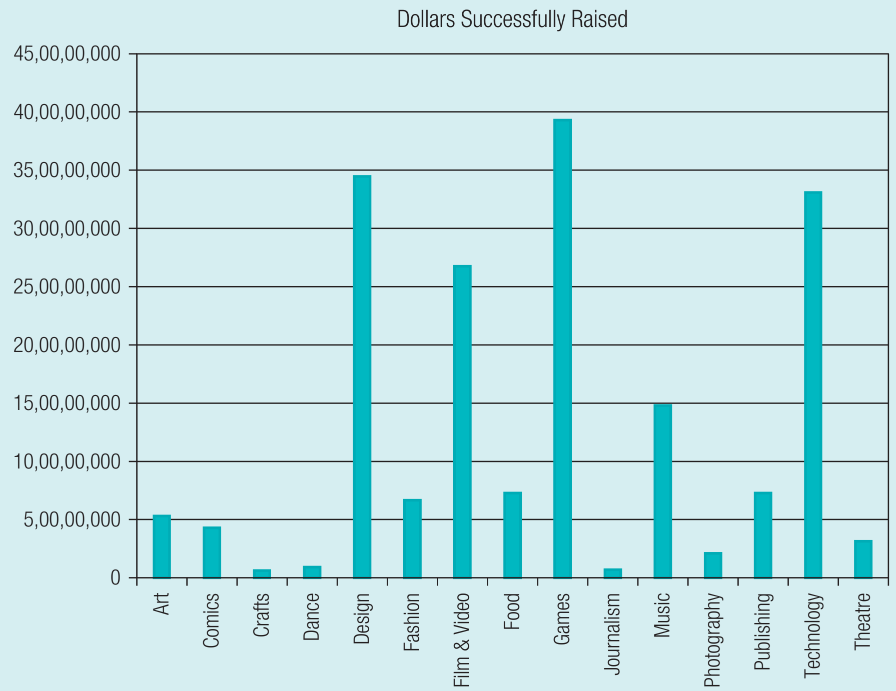

Figure 9.3 Project Money Successfully Raised by Category on Kickstarter as of December 2015
Source: kickstarter.com

Seed Accelerators

Seed accelerators are part investment, part short MBA programme. They are typically a short-term, cohort-based programme that culminates in a public pitch for funds. The two archetypes of this approach are: TechStars, which holds 13-week programmes for start-ups in Chicago, Boulder, New York City, Boston, Seattle, San Antonio, Austin and London in exchange for equity; and Y Combinator which offers Silicon Valley start-ups a three-month programme to receive seed money, advice and connections in exchange for 7% equity. Seed accelerators are an extension of the traditional government 'incubator' model, but applied to product-centric companies.

Angel Investors

Angel investors are wealthy investors who fund a business start-up, usually in exchange for convertible debt or ownership equity. Sometimes angel investors become aware of a start-up through crowdsourcing platforms like Kickstarter, though they may typically be differentiated from other crowdfunding investors by the size of their investments and knowledge of the product market. They may be retired entrepreneurs or executives interested keeping abreast of current developments in a particular business arena, mentoring another generation of entrepreneurs and making use of their experience and networks. Each episode of the US television show *Shark Tank* presents start-up ideas to a panel of five potential angel investors. The number of angel investors in the US ebbs and flows with the economy, but probably averages around 400,000. In the entire world, there are probably five times that many angel investors, with an increasing number from Asia.

Venture Capitalists

Larger scale start-ups in more aggressive markets will likely need investing and expertise on a par with traditional debt and equity markets. But without a track record, it is difficult for them to satisfy the regulators in these markets. The alternative is private equity venture capital investments. Venture capitalists typically expect similar levels of management and rigour to those that shareholders would require – indeed, their 'exit strategy' may be an initial public stock offering (IPO) to take the company public so that they can sell their investment at a gain. Venture capitalists may demand the start-up to take on value-added investors, productive board members, portfolio benefits, follow-on capital, guidance, access to experts and media exposure. In exchange, venture capitalists can tap a much larger pool of capital. Venture capitalists typically reserve additional capital for follow-on investment rounds and provide access to their networks for employees or clients to use the products or services.

Return on Investment

Arguably the single most important figure of merit that is common to all investors across all inventions is the return on investment or ROI. ROI allows one investment to be compared with any other investment regardless of market, use or other factors.

This is often cited as the most compelling reason to invest in innovation.

Doraszelski and Jaumandreu (2013) estimated net private rates of return (after depreciation) from innovation in Spanish firms to be around 40% on average, varying from 10 to 65% across industries (10% in food, drink and tobacco; 65% in metals). This finding was more conservative than studies which used traditional production function estimates, where net returns averaged between 54% and 200% across different industries. The German–UK consulting firm Frontier Economics analysed 55 Euro zone studies providing 109 estimates of private returns to R&D, dating from 1984 to 2009, finding that the mean rate of return is typically around 30% with median returns being slightly lower, typically 20 to 25%. Innovative companies realized a median profit margin growth of around 5% per year, or around 10 times the median.

To realize the innovation pay-off, though, aspiring innovators must prepare to compete in not just one, but in two markets – first in the consumer market for their new product or service; and second in the capital market to finance their innovation. Too often, though, inventors trust that if you build it, consumers will come, and someone else will underwrite the bill; however, where incomplete, market strategy alone is likely to starve their innovation of the funds needed to grow and thrive.

Financial markets for funding innovation are as challenging as consumer markets, but in different ways. Traditionally, financial analysis has looked to the past for precedents for a particular business, in the process of trying to predict future returns. Innovation denies that opportunity. A truly novel innovation will not have been tested before in the market, depriving the analyst of historical insight into the prospects for the innovator's new business.

Great strides have been made over the past two decades in the valuation and financing of ventures. Financial markets offer a growing and increasingly complex array of investments, sold automatically with trading latencies measured in milliseconds. The complexity of methods required for valuation of investments has grown even more rapidly. The time when ventures could be calculated on computer spreadsheets using published information and linear extrapolation has long since passed, replaced by ever more mathematically sophisticated and computer-intensive approaches. One chapter is – unfortunately – insufficient for more than a very superficial review of these methods. Consequently, this chapter limits itself to much more modest objectives of (1) describing what decisions need to be made in valuation of projects for commercializing an innovation, (2) identifying the data that must be collected, and (3) defining the objectives and outcomes should be expected of financial analysis for innovative ventures.

In a series of studies on the profitability of business innovations, William Baumol found that on average only around 20% of the value generated by innovations through improved productivity and lowered cost were realized by their inventors; the remainder was passed on through to the consumer. Variance was high between markets, and markets with stiff price competition tended to pass most of their profits on to consumers. Competition was not the only factor in this result. Many innovations depend on complementary assets in order that they be attractive to customers. Automobiles are only attractive where there are roads, gasoline stations and safety provided by rules of the road; sports cars may be unattractive where speed limits are restricted; digital music players are more attractive where online stores provide a wide selection of songs; desktop computers are useful only if software exists to run on them. These complementary assets may be tightly controlled by their owners, as is OS X by Apple. Other complements, such as roads and GPS satellites, may be offered as public goods, or paid for through excise taxes.

Even without competitors, there are some inventions that are better suited to particular industries. This is because every business has certain things that it does better than its competitors, others that it does adequately, and others that it doesn't do well at all. The degree to which a company has 'competence' in an area determines its set of 'core competences'. Specific inventions will do better at companies with specific competences; in the laboratory, marketing, production, or other area. The 'coreness' of an innovation's needs determines how well it is likely to do at a particular firm.

If there is no matchup of the innovation's needs and the core competences of the firm, then the firm cannot expect to compete in this innovation. If there is a matchup, then the profitability of the innovation will be determined by barriers to entry – how easily the product can be imitated. There are also significant interactions between the technology and the market. This interaction has been covered at length in Chapter 8, but was initially articulated in Abernathy and Clark (1985) as: *niche*, extracting additional value from existing markets; *regular*, building out and entrenching existing competences; *revolutionary*, disrupting and making obsolete existing competences; and *architectural*, creating new linkages between markets and technologies.

Abernathy and Clark were concerned with the impact that particular innovations have on firms' core competences and their markets. Incremental innovations preserve both competences and markets; revolutionary innovations create new markets, leaving old ones behind. Where a firm's market capabilities are destroyed, the firm's technology may still serve a niche community (e.g. high-end audio still has demand for vacuum tube amplifiers, despite the general move to solid-state technology). Where both are destroyed, the firm needs to shift rapidly to survive (e.g. Kodak's film business in response to the move to digital photography).

Henderson and Clark (1990) built on Abernathy and Clark's perspective to explain how innovations impact the firm's processes for making and marketing a product (i.e. its architectural knowledge) and its knowledge of the components of the product (i.e. its component knowledge). Incremental innovations preserve both aspects of the firm's production and marketing; radical innovations destroy both, forcing the firm to move on to new products. In between, there are modular innovations that keep production and marketing channels intact, so long as the firm can acquire the component expertise needed to produce the innovation – for example when Microsoft externally acquired technology from Sybase in order to remain competitive in database technology. Architectural innovations may arise in response to the loss of demand for products by rearranging components to come up with an ostensibly different product serving a different customer base. For example, Niklas Zennstrom and Janus Friis, the entrepreneurs who created peer-to-peer music sharing site Kazaa, repurposed their technology after legal pressures forced them to rethink the market for music downloads. The result was the popular Skype internet telephone service.

Returns on innovation make the activity worthwhile and attract firms to invest billions in becoming more innovative. But with so much urban mythology, ambiguity and outright misinformation concerning what exactly 'innovation' is, it can be hard for firms to know just what it is that they need to do to make themselves more innovative.

Rapid advances in industrial innovation have created a market for all types of innovators. Governments assure them streamlined immigration. Corporations pay premiums and shop the world for employees that can provide them an innovative edge. The metaphor of innovative entrepreneur is routinely used to flatter industrial magnates. Thanks to our business press, high-tech entrepreneurs are usually seen as being the most successful practitioners of innovation. But it is not really clear that any group has stopped to understand exactly how they go about doing this thing called 'innovating'. Advances in technology, materials, prices, taxes, demographics, regulation and so forth have in the past been a source of new value. In the past few decades, businesses have learned a great deal about the effective and efficient management of these advances in pursuit of wealth and competitive advantage. Documenting the tools and techniques that they have developed, and showing you how to put them to work in your own area, are the goal of this book.

The Role of Financial Analysis and the Market

Financial analysis and reporting play an essential role in a business's 'reporting-control' cycle. A firm's or project's performance is realized on many dimensions – profit, competitive positioning, strength of workforce and so forth. But only a few of these dimensions will capture the ongoing attention of management; and on even fewer of these dimensions does any particular stakeholder group possess levers of control. For example, common stockholders of publicly traded firms are provided with audited financial reports each year, and quarterly unaudited financial reports. These are intended to provide them the information they need for decisions about whether to buy-hold-divest from their inventory of the firm's stock. Time plays an important role, because shareholders' objectives are on maximizing future returns – the percentage stock price increase per year.

Perhaps the most difficult task in selling any innovation is providing a convincing story of what the innovation is worth. Unfortunately, this task is not optional – if you expect someone to invest in your idea, they need to know where they will make their money; what will be their return on investment.

All of this should suggest that, in practice, identifying the relevant financial information which will satisfy stakeholders' decision making

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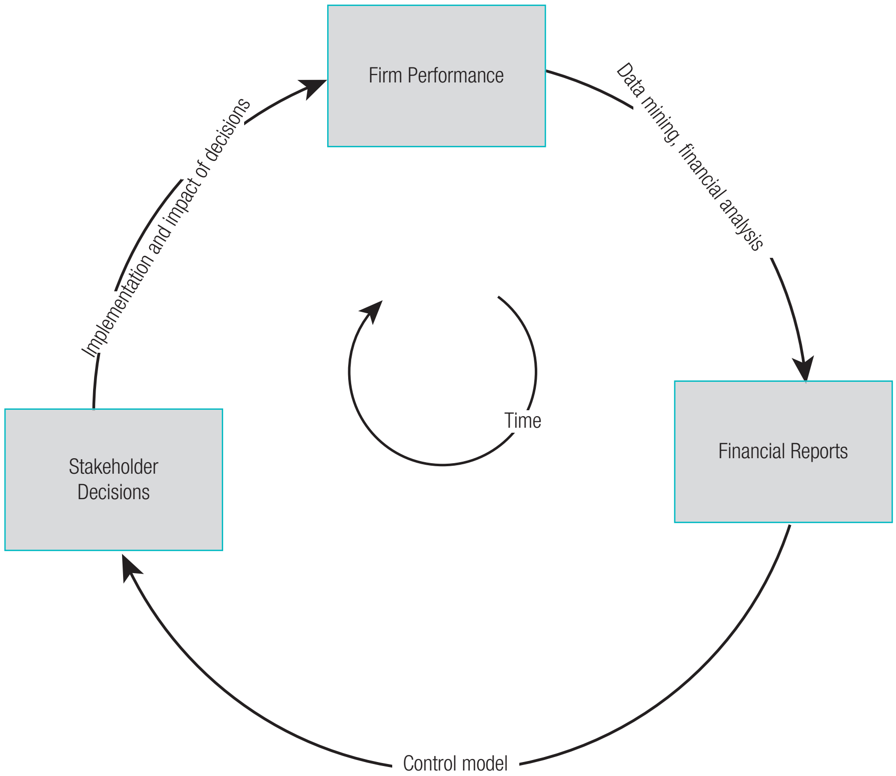

Figure 9.4 The Reporting-Control Cycle

is not a simple task. Financial reporting directed just towards the simple task of buying and selling stock is extensive and costly. The more complex and nuanced decisions involved in managing a firm's operations require the sophistication of advanced managerial and budgetary accounting models – and ample quantities of subjective managerial 'judgement'.

Rocket Science and the Reachability of Goals

In the summer of 1975 two Viking spacecraft were launched from Cape Canaveral to Mars. On 20 July 1976 the Viking 1 Lander touched down at its predetermined destination, Chryse Planitia, while the Viking 2 Lander touched down at Utopia Planitia on the opposite side of the planet on 3 September 1976.

Mechanical and scientific challenges aside, the essential problem faced by the Viking engineers was getting these landers from Cape Canaveral to their Martian destinations. Engineers need to answer two questions. First: 'Can you get there from here?'. This is called the problem of *reachability*. Obviously if there is no way to reach Mars with existing technology, any other engineering problems will be moot.

Even if the answer to the reachability question is 'yes' there is no guarantee that the trip could be made. The vehicle must be built with the proper *controls* in order to allow the chosen trajectory to be followed. And we also need systems to *observe* whether those controls have actually done what we expect them to. The latter *observability* problem needs to be solved if we are keep the rocket ship on its proper trajectory by adjusting its controls in what engineers call a 'closed loop' system.

Fortunately, there is a tool called the Kalman filter that allows engineers to determine the optimal trajectory out of all trajectories possible, identifying the one that incurs some minimum combination of time, fuel and other scarce resources.

It's not rocket science, but just about every country in the world is faced with trying to juggle two economic objectives: (1) achieve full employment without inflation, and (2) maintain a positive balance of international payments. These objectives need to be attained by manipulating controls such as interest rates and budget expenditures. It turns out that problems of reachability, observability and correct trajectories crop up in economics as well as in industry. To solve them, managers and planners turn to the Kalman filter.

(Source: Stengel, 1994)

Strategy Drivers and Figures of Merit

Strategy drivers are the 'levers of control' that management uses to direct operations – they are to a business what figures of merit are to engineering tasks. Since the actual strategy drivers may not be directly observable (e.g. customer satisfaction can be observed only indirectly) they are measured through *figures of merit* – observable, sometimes synthetic, measures that move in tandem with the strategy drivers.

Strategy Drivers

When corporate executives are asked what the most important goal of their decision making should be, they seldom say profits. Markets may demand fast product cycles; technological leadership requires new patents; stockholders are concerned about the share price. Figure 9.5 reflects the priorities of one survey of executives. This alone should warn that the value of a business model is not just about profits.

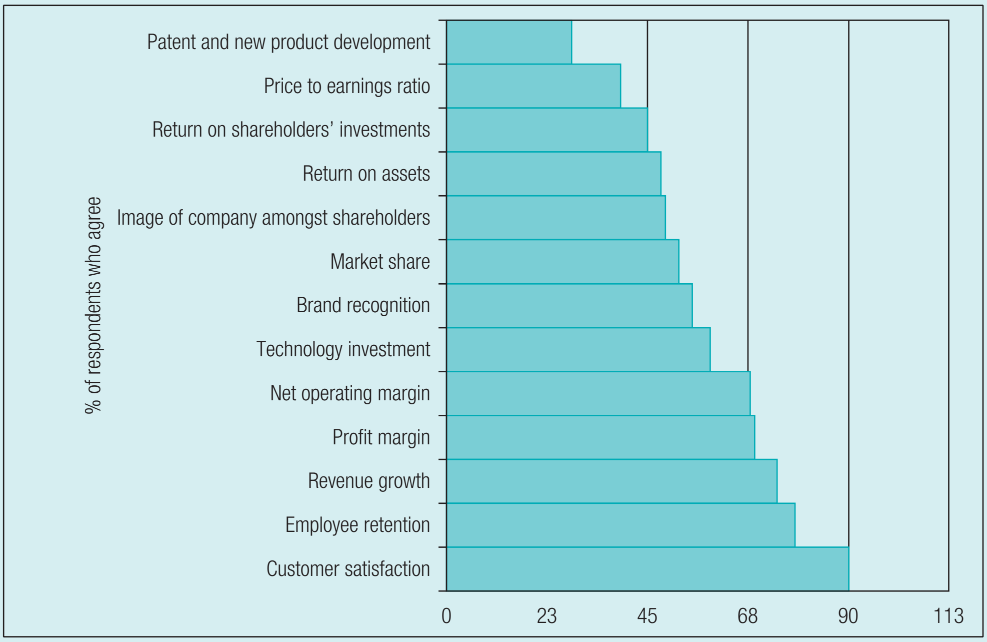

Figure 9.5 What is Most Important in Firms' Decisions
Source: Results of a survey of 250 executives across industry on essential performance measures, in Osterland, 2001

Return on Investment

Certain financial figures of merit are widely encountered, and we will review them here. The primary financial figure of merit is the annualized return on investment (ROI):

$$ROI = \frac{V_{t+1} - V_t}{V_t}$$

where V_t is the net value of an investment at time t and V_{t+1} is the value one year later. Several factors influence investors' assessment of the *hurdle rate* – i.e. the minimum ROI required for them to be willing to invest money. Investors are a type of consumer, but rather than paying price p for something of value v received immediately (the product or service), they pay price p for a promise to return $p + i$ next year. If v is not high enough, the consumer doesn't contract to trade; if i isn't high enough (i.e. higher than the hurdle rate) then the investor will not contract to invest. One significant difference between investors and consumers is *risk* – the consumer's transaction is over instantly; but many things can happen to the investor's money in a year. For this reason, at any $p \leq v$ the consumer will trade; but the hurdle rate has to be larger, strictly, than i to accommodate the risk of something happening in the coming year.

Figures of Merit: Shigeru Miyamoto's *Wife-o-meter*

One path to great innovation is to challenge the industry's figure of merit. Shigeru Miyamoto – master designer behind Nintendo's innovative and highly successful *Wii* console, and games like *Donkey Kong*, *Super Mario World* and *Goldeneye* – wanted in early 2006 to look beyond the traditional gaming market which was mainly competing on graphics speed and resolution. Rather than following the same old, but true, gaming conventions, Miyamoto started to think about games for the non-gamer – namely his wife. To do this, he needed a new figure of merit for game and console performance, one that would measure how appealing a game is to non-gamer. He called this the '*Wife-o*-meter' – a whimsical measure of the strength of his wife's attraction or aversion to a particular game.

His first experiment with this new figure of merit revolved around the game *Nintendogs*. Miyamoto, upon observing the interaction between dogs and his wife, figured that a game about animal interaction could expand the gamer base. 'When I eventually showed *Nintendogs* to my wife, she finally started to look at video games in a different way', he said. *Nintendogs* moved the Wife-o-meter up significantly, but Miyamoto knew he could do even better. The next major innovation for non-gamers was *Brain Age*, the brain training game originally marketed to the older Japanese market as a way to stave off senility. '*Brain Age* … this is the game that turned my wife into a true gamer', said Miyamoto.

Eventually, Mrs. Miyamoto would play *Wii Sports* and participate in the voting channel on her own, which Miyamoto said surprised him no end. 'This is a big event in my house, it would have been more expected for me to come home and find Donkey Kong eating at our table', he said.

Miyamoto points out that Nintendo, unlike its competitors, is a company that is solely focused on the gaming experience and nothing else. The Wii, a risky proposition, was the combined effort from the entire company and Miyamoto is extremely proud of the freedom given to designers thanks to the Wii Remote. For him, creative vision is paramount in creating a fun experience for the player. Miyamoto also hopes that games will promote communication. With Wii, people are playing together and exchanging ideas. In fact, the interaction of different people's Miis has inspired Miyamoto to create a special 'Mii Channel' where users can enter their avatars in popularity contests.

Miyamoto encourages the industry to 'always remember the human touch' when designing games. 'After all, if we can convert my wife, we can convert anyone.'

(Source: Huang, 2007)

Accounting and Auditing for Information-Intensive Innovations

Auditors have been grappling for many decades with calls to increase the scope of their audits to non-traditional measures of corporate performance – financial forecasts, brand valuations, valuations of intangible assets, social accountability, and so forth. For the most part, they have rebuffed any efforts to expand auditing because of concerns over objectivity and the ability to provide sufficient reliability of opinion (Aboody & Lev, 1998; Lev, 2000, 2004).

Accounting faces a significant challenge in keeping up with the transition of value creation from physical to intellectual resources. Stock market valuations of the Fortune 500 companies (which include many traditional industries such as oil and autos) has grown increasingly higher than the accountants' book valuations over the past three decades. This is driven by the growth of intangible intellectual and human assets – valuable things the firm owns, like patents, skills and so forth, that are not explicitly assessed in an audit, nor presented on the financial reports.

Information Assets

Microsoft founder Bill Gates once quipped that 'Our primary assets, which are our software and our software-development skills, do not show up on the balance sheet at all. This is probably not very enlightening from a pure accounting point of view' (Gates quoted in Economist, 1999). His point was that traditional financial accounting measures fail to capture the firm's wealth embodied in ideas, innovation and the potential for competition. Accounting concentrates on measuring the past. This is a far cry from the days when Vladimir Lenin assured his followers: 'Accounting and control have been simplified by capitalism to the utmost and reduced to extraordinarily simple operations – which any literate person can perform – of supervising and recording, knowledge of the four rules of arithmetic, and issuing appropriate receipts' (Lenin, 1918). Increasingly the assets of importance to industry – ideas, innovations, and technology – are not accounted for. This is depicted in Figure 9.6, which tracks the ratio of the book value of the firm that is computed on the financial statements divided by the value that investors (who pay real money to own a portion of the firm) think that the firm is worth.

Tobin's q is a statistic that is often used to assess market value. Tobin's q is the total price of the market divided by the replacement cost of all its companies. The statistic is reported in the Federal Reserve Z.1 Financial Accounts of the United States, released quarterly since 1945.

Tobin's q is interesting as it compares the financial valuation of firms (in aggregate) assessed by the accounting profession to the actual value that shareholders assign through real monetary transactions. If financial accounting is assessing value accurately, the two should be the same (assuming the market is efficient). In fact, that has not historically been the case.

One widely received explanation for q's divergence is that the replacement cost of company assets is overstated in the aggregate. This is evidenced by the fact that long-term real return on corporate equity is 4.8%, while the long-term real return to investors in the stock market is around 6.0%. Over the long term and in equilibrium, the two have to be the same. In fact, technologies are always improving, and worn-out assets tend to be replaced with cheaper assets using improved technology that assures they work as well or better than those they replaced.

Another explanation, which is not mutually exclusive, is that stocks are only one of many investments available, and that whatever pools of money exist at a particular time will be allocated over available stocks, bonds, property and other uses. When bond yields are high, investors drive down stock prices, simultaneously driving down Tobin's q.

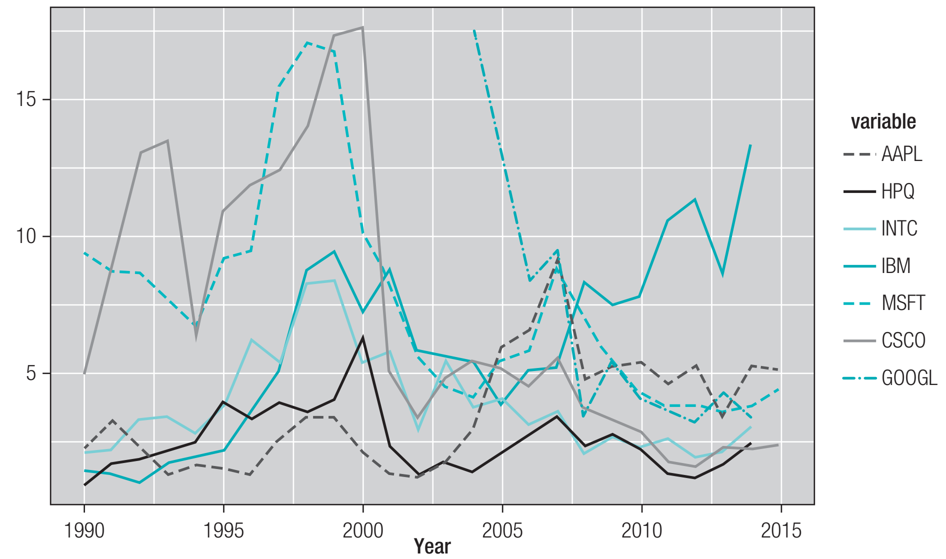

Figure 9.6 $\frac{\text{Stock market capitalization}}{\text{Accounting book value}}$ for 8 of 10 Largest Companies in the Fortune 500

(Amazon and Oracle have been excluded as their values fall outside the range of the graph)

Whatever forces influence Tobin's q, empirical evidences shows the arithmetic mean of q since 1900 has been 0.68. The ratio reached a high of 1.64 at the peak of the dot.com bubble, and lows in 1921, 1932 and 1982 of around 0.30. Figure 9.6 shows market capitalization vs. book value for 8 of the 10 largest technology firms.

Though not fully understood, the variance in individual firm values is largely a reflection of that firm's intellectual capital, consisting of three types of assets:

Humans: the value that the employees of a business provide through the application of skills, learning and expertise. Human capital determines a firm's overall ability to solve business problems and profit from ideas and intellectual property. Since people cannot be owned, human capital is inherently transient, and firms spend significant money and effort to maintain a stable, competent workforce.

Structure: the managerial organization, networks, proprietary knowledge and methods assumed by the firm allow human capital to directly contribute to achieving the firm's objectives. Intellectual property in the form of patents, copyrights, trademarks and trade secrets are typically classified as structural capital, because they benefit the internal operations of the firm.

Social networks: the network of relationships that people maintain across communities of customers, suppliers, researchers, regulators and so forth that can indirectly contribute to the firm's success.

Since the 1990s, the information-intensive parts of the US economy (and this is generally true throughout the world) have been consistently more profitable than industries requiring heavy investment in machinery and other fixed assets. Figure 9.8 illustrates this by comparing the investment in tangible (vs. intangible) assets compared to return on investment, rank ordering companies in the Fortune 500. The conclusion is that return on investment is strongly correlated with investment in intangible assets.

The rise of information economies is not limited to just one country, but is a global phenomenon, and one that increasingly integrates business across cultures and political boundaries. Urban planner Richard Florida has quantified this in a number of studies that investigate

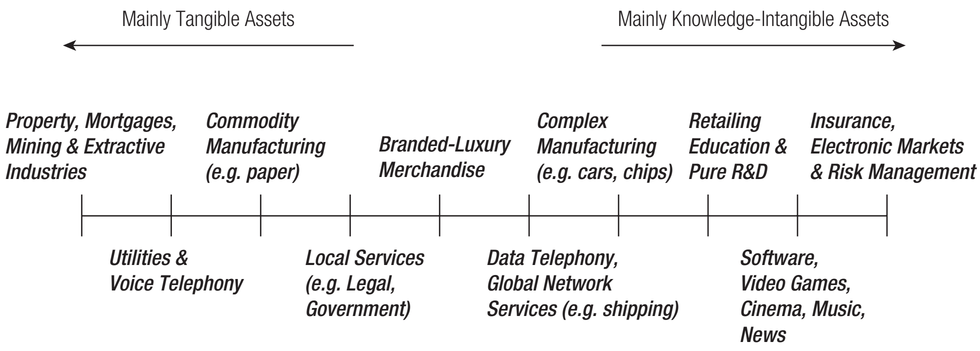

Figure 9.7 The Role of Intangibles and Knowledge in Various Industries

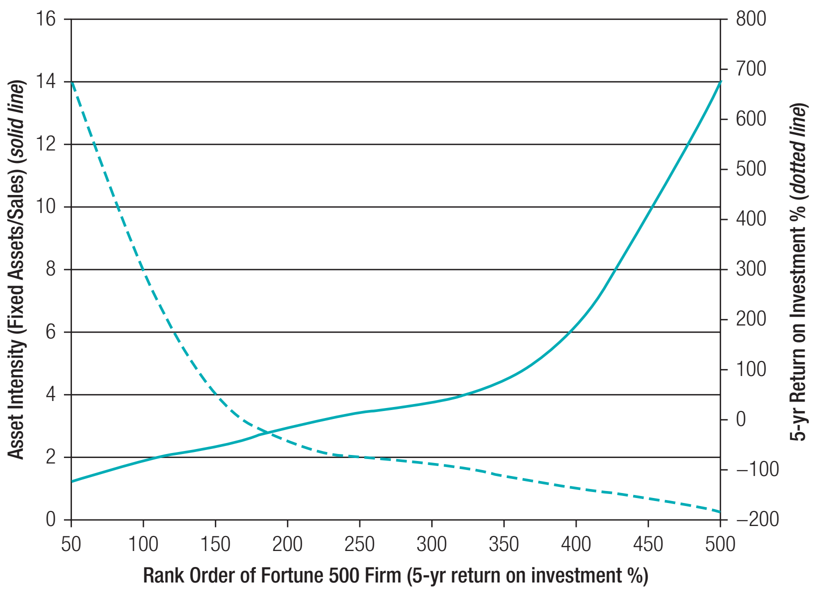

Figure 9.8 Firms with Smaller Fixed Asset Investment Have Been More Profitable *c*.2016

the role of information creation in the success of economies, showing that around 70% of income creation at the national level in current economies is driven by creative business, and by the nurturing of the creative class of workers. Florida has argued compellingly that economic performance today is heavily tied to 'creativity', and that this linkage is intensifying (Florida, 2004; Lee, Florida & Acs, 2004; Florida & Goodnight, 2005; Stolarick & Florida, 2006; Knudsen et al., 2008).

Big Data

The amount of data in the world has been growing exponentially for decades. The global data supply reached 2.8 zettabytes (ZB) in 2012 – or 2.8 trillion GB. Only around 0.5% of this is used for analysis. Most of this data and analysis is in the financial sector, of the sort that might conceivably be audited. Volumes of data are projected to reach 40ZB by 2020, or 5,247 GB per person (Figure 9.9), with emerging economies

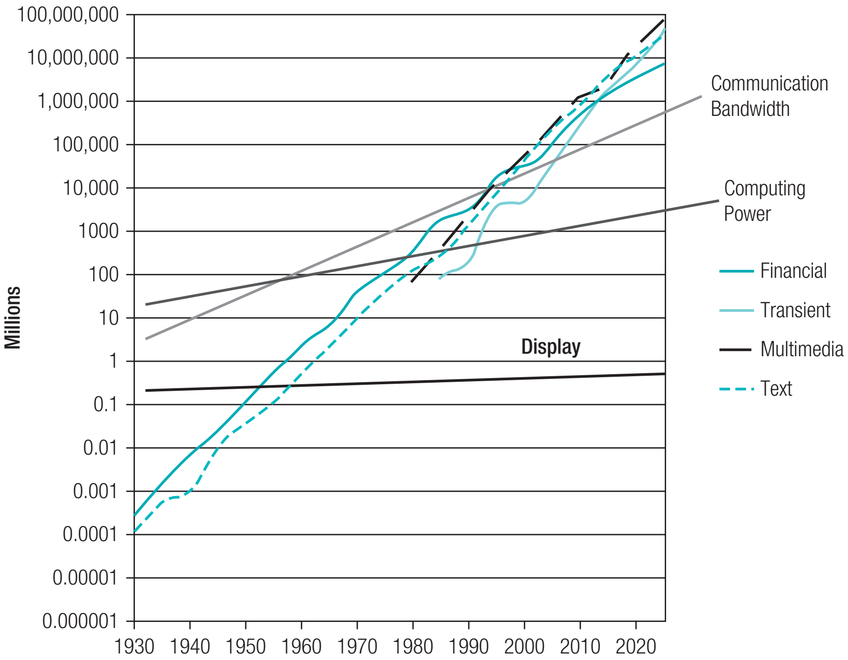

Figure 9.9 Data Volumes and the Era of Big Data

accounting for an increasingly large proportion of the world's total. When we refer to 'Big Data' it is this exponential growth, and the current gargantuan investments in data, to which we are referring. Information technology has become essential to every phase of information processing – capture, transformation and storage, and interpretation.

Data is approximately doubling every two years – slightly less than Moore's Law suggests that computing power is growing by – with about 5 trillion bytes of data for every person on earth. Spending on IT hardware, software, services, telecommunications and staff, that could be considered the 'infrastructure' of Big Data, is growing 40% annually. As a result, the investment per gigabyte (GB) from 2012 to 2020 is projected to drop from \$2.00 to \$0.20. There is a rapid migration of data from local 'islands of technology', such as corporate servers, mainframes, personal computers and portable devices, towards data investment in targeted areas like storage management, security and cloud computing (EMC, 2014).

Gaming the Research Strategy Drivers

Academics are required to publish as a central part of their job. But not all publication outlets are created equal. Publications are considered 'better' or 'worse' in loosely defined ways. Scholars have tried repeatedly to generate an unequivocal 'quality' metric for journals and their papers, so that their research output can be computed in terms of quantity x quality.

Over the past decade, the most important of these research metrics has been the ISI journal's Impact Factor from publisher Thomson Scientific (who purchased ISI from founder Eugene Garfield in 1995). ISI's Impact Factor and accompanying citation counts have been arguably the most influential metrics for the hiring and firing of academics and researchers. Interestingly, like most metrics they can be 'gamed' and apparently are.

To get an idea of the benchmark for the Impact Factor, consider that the widely read and influential *Harvard Business Review* scored a 1.148 Impact Factor in 2006;

most business journals score around 0.500 or so, and an Impact Factor of 1 is comparatively good. These benchmarks seem to be accurate for a broad swath of academic journals. But several clusters of business and information science journals, for example, seem to be garnering Impact Factors in the range of 3 to 4 – several times higher than *Harvard Business Review*. It turns out that editorial policy at these journals tends to strictly limit a paper's publication in the journal to a narrow group of topics, and to require their authors to extend their lists of citations with suggestions from the editorial board (lists of 90 citations for a single 20 page paper are not uncommon). Such editorial policies artificially inflate their own journal Impact Factor metrics, as well as the citation counts of individual papers in the journals for a small group of researchers.

Sales Revenue as a Strategy Driver

For companies such as Tesla and Apple, the most important driver of corporate value is considered to be sales revenue. Sales have the added advantage that they can be tracked independently from the accounting functions, for example by visiting stores and tracking inventory orders. Economist William Baumol suggested that, to satisfy stockholders, managers of modern corporations seek to maximize sales after an adequate rate of return has been earned. Baumol (1959) argued that a larger firm may feel more secure, may be able to get better deals in the purchase of inputs and lower rates in borrowing money, and may have a better image with consumers, employees and suppliers. He also noted that some studies have shown a strong correlation between executives' salaries and sales, but not between sales and profits (this point is contentious, as other studies have found the opposite). As a consequence, he has suggested that at least some companies – notably those in oligopolistic markets – would seek sales growth over profitability.

Figure 9.10 shows total revenue and cost curves for a hypothetical firm. The profit maximizing firm would produce a quantity of 30; but a sales maximizing firm would operate at quantity of 50, where profit was approaching zero. The kink in the total cost curve reflects potential additional costs of extra shifts, quality problems, or perhaps outsourcing that can arise when the firm operates beyond its 'normal' levels.

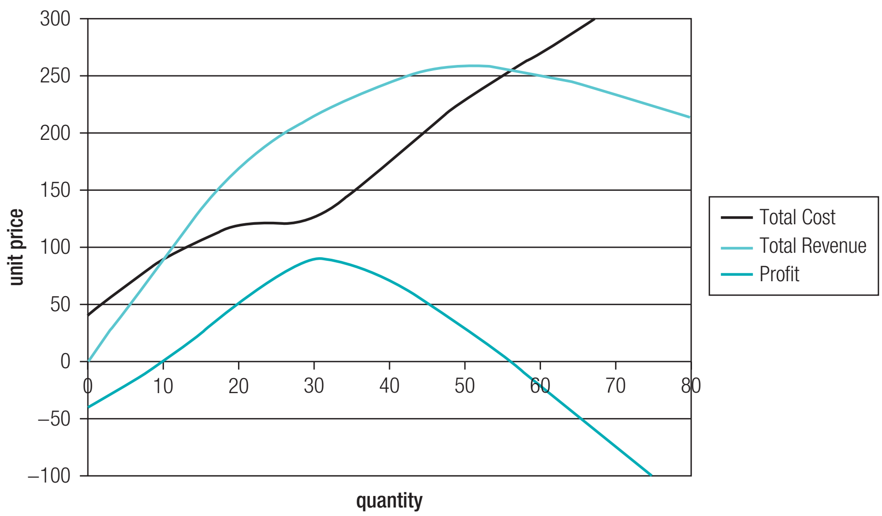

Figure 9.10 Sales Maximization vs. Profit Maximization

Strategy Models

The value of an innovation lies in the future, and in the plans that management has for commercializing that innovation. Consequently, the valuation of that innovation demanded by potential investors and creditors must make a plausible case for its ability to generate future value.

The *strategy model* has two parts – a compelling narrative story line about how, why and when cash will be generated from the innovation (the behavioural model); and a forecasting model that ties this out to the numbers. The strategy model is an extension of the business model; it is focused only on the main drivers of value generation (whereas the business model is likely to be more complex and nuanced, dwelling on technological, social and market issues as well).

IBM and the Automation of Accounting

One of the most radical financial innovations in history was introduced on 7 April 1964. IBM revolutionized the industry with its S/360 line of computers that became the mainstays of corporate accounting. The S/360 venture had been up to that time the largest private venture in American history, with $5 billion spent on five new plants and an additional 60,000 employees. The subsequent decade was marked by a sea change in the structure of corporate accounting departments. Within a decade, corporate accounting departments at Sears, Ford, GM, DuPont and other giants dwindled from huge 'bullpens' accommodating hundreds of clerks, to warrens of cubicles housing only 10% to 20% of their original number. The employees who retained their jobs found them dedicated to the care and feeding of computerized accounting systems rather than the actual accounting itself.

In many ways, IBM's accounting revolution in the 1960s paralleled a similar gamble during 1930–1932, at the start of the Great Depression, of continuing to produce at full capacity and spending $1 million on one of the first corporate research labs. In those days, IBM estimated that only 5% of business accounting functions were mechanized. IBM quickly introduced the Type 405 Alphabetic Accounting Machine, the 600 series punch card machines and a system of machines designed for the banking industry. Continued production during the Depression assured that only IBM was capable of handling the massive volumes of Social Security accounting that arose in the mid-1930s.

Any given innovation's strategy model consists of three submodels: (1) a *behavioural model* based on what we know about our prior behaviour (or some similar firm's prior behaviour); (2) a *forecast model* which lays out the future project scenario on a real options format for the innovation project; and (3) a *discounting model* which articulates our attitude towards the time value of money (Figure 9.11). In this structure, the forecast model sets out our plans for innovation R&D and market entry, the behavioural model assures that we make realistic assumptions about demand and costs, and the discounting model describes how aggressive we will be in demanding repayment of investments.

The last part – the discounting model – is often glossed over in traditional cash flow analysis; the rule of thumb is to use a risk-free rate. In venture capital, though, both risk and impatience may be embedded in the discount, and it is common to see hurdle rates of 40% to 70% in venture capital investments. There is also evidence that, in practice, managers act as if they demand substantially higher discounts than the 'risk-free rate'. Thus we require that assumptions concerning discounting be made explicit upfront when dealing with risky and uncertain high technology and innovation ventures (Diamond, 1991; Conner & Prahalad, 1996).

The Behavioural Model

Any pitch for the funding of a new and innovative product or service will revolve around a single question – 'Where do the investors make their money?' Venture capitalists, banks, shareholders,

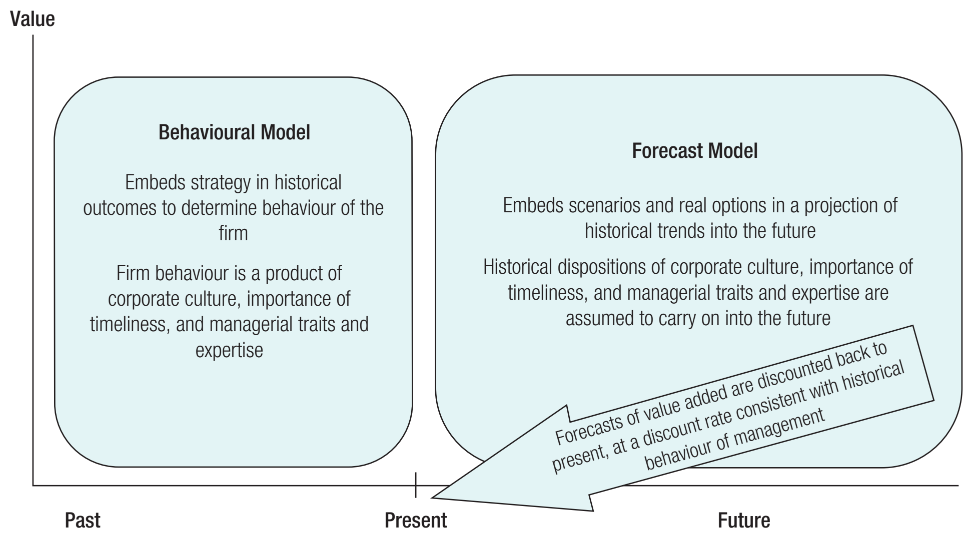

Figure 9.11 Components of the Strategy Model

family, or whoever else is asked to put money into a new business are concerned about how money is to be generated in the future, and how much of it they will receive from their investment. The behavioural model tells the story that ties the salient operating and business characteristics of your innovation to the generation of money in the future. If this linkage cannot be clearly articulated, it is unlikely that the innovation will be of interest to investors. Advances in technology, and especially the phenomenal expansion of the internet over the past decade, have made possible a vastly expanded set of available strategies for new business (these will be discussed at greater length in Chapter 12). Just as important is the fact that 'ideas' have become more important than 'things' in driving value.

Case Study: MySpace's Market Entry and Decline

When O'Reilly Media broached the concept of Web 2.0 in 2004 the two most highly touted Web 2.0 successes based on number of users were Skype and MySpace. Each benefited from having a major distribution partnership during launch: the founders of Skype also founded Kazaa, and promoted the Skype service by advertising it through the Kazaa network of desktop clients. MySpace was promoted through the extensive ResponseBase/Intermix database. In less than three years, MySpace leapfrogged early social networking leader Friendster to become one of the top five most visited sites in the US, with 46 million unique visitors and 25 billion page views in December 2005.

Sadly, this proved the highpoint for MySpace, which was subsequently acquired by Australian Rupert Murdoch's News Corporation in July 2005 for $580 million. With his Australian newspaper the *Daily Mirror*, Murdoch had essentially invented the modern tabloid, complete with lurid stories of alien landings and star gossip. Unfortunately, little of this tabloid expertise proved useful to the social network, and MySpace tanked under his ownership, leaving room after 2005 for upstart Facebook to dominate the marketplace. Murdoch sold MySpace to Justin Timberlake in 2011 for $35 million (6% of his purchase price). Timberlake laid off most of the staff, and completely relaunched the site in 2013, but it never regained its mojo.

Yet during its early years, there was reason for O'Reilly to cite MySpace as a Web 2.0 exemplar. It was launched by the former ResponseBase team within Intermix, a group with a strong background in direct email marketing cost per acquisition (CPA) campaigns which were

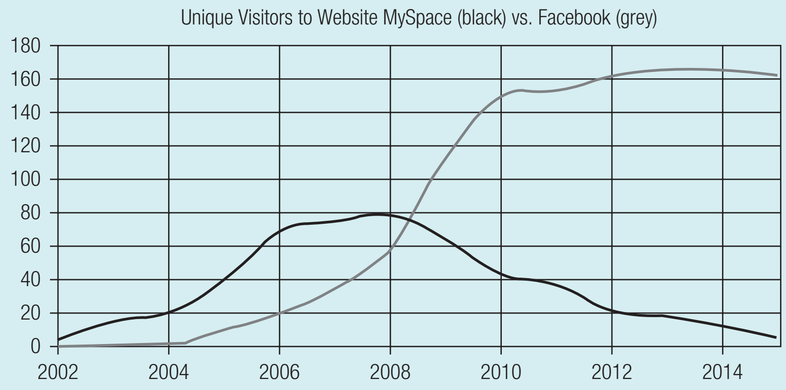

Figure 9.12 MySpace vs. Facebook

used to great effect in building MySpace's consumer base. After witnessing the initial success of Friendster and having the ResponseBase/Intermix resources at their disposal, they thought they could create a strong competitor. ResponseBase had a database of around 100 million email addresses and Intermix had a number of internet sites directed to teenagers, the MySpace target market.

MySpace took three months to build a site with similar features to Friendster, launching at the end of 2003. Its founders, DeWolfe and Anderson, started promoting MySpace by running a cash prize contest for Intermix's 250 employees asking them to invite friends to use the site. This had some success, but was limited to reaching only a certain size. MySpace then began promoting the site offline, sponsoring parties in Los Angeles with clubs, bands and party promoters. This began to build the buzz around the site, but more importantly attracted offline groups of people to use the site together. DeWolfe and Anderson were not only clever in market entry, but adept a responding to teenagers' needs, and adaptively executing their entrance strategy. When the small community groups of 100 to 1000 people started creating group profile pages around interests and associations, MySpace accepted this behaviour where Friendster did not. MySpace listened to user feedback and quickly iterated the product with rapid development cycles. MySpace added blogs, comment boards, message boards and instant messaging (IM) long before Friendster was able to upgrade its product given scalability issues. MySpace was also much better at addressing poor site performance (a normal problem in scaling up) whereas Friendster was not.

Small community groups were critical for the viral marketing that propelled MySpace to success. Once this initial audience had been established, MySpace leveraged Intermix's media buying and channel relationships, propelling it to number one status. It is unlikely that MySpace would have grown as fast as it did without employing this more traditional marketing tactic. Indeed, Murdoch proved that in the wrong hands a social network can be destroyed just as quickly as it can rise to success.

(Sources: Musser & O'Reilly, 2006; Ellison, 2007; Stenovec, 2011)

The behavioural model describes the 'behaviour' of the firm in generating value, given particular 'stimuli' by management. Management has only limited control over firm performance. For example, it can influence the product mix and level of output from its assembly lines; but it generally cannot influence exchange rates, the price of raw materials or the global economy. Yet the corporation's success depends on both controllable and uncontrollable 'drivers' of value.

Management's formula for generating future value is likely to differ from its past plans. Future strategies will also change depending on contingent events in the future. Thus at best the past can tell us how the firm will react to specific management inputs. This reflects what might be characterized as the corporate 'culture'.

How Much Information is in a Dataset?

In the mid-1930s, Claude Shannon established the field of information theory, counting among his many contributions some of the more successful early algorithms for casino gambling and computer chess as well as a formalization of the quantity of information in any collection of data (Shannon, 1948).

In a business context, Shannon's view of information can be described in terms of implementing a strategy and observing the consequent outcome.

Assume that a strategy B is chosen with probability P(B), and outcome A occurs with probability P(A). Then the information that management has about the outcome of control strategy B is P(A|B). Conversely, if we observe outcome A, the probability that management had implemented B is P(B|A). According to Shannon, the information $I(A,B)$ about B that is contained in the dataset, message or observation A is

$$I(A,B) \equiv \log_b \frac{P(B \mid A)}{P(B)}$$

The logarithmic base b is arbitrary and serves to define a unit for I. If $b = 2$ is used, the unit for I is the 'bit' (by far the most common unit used). If base 10 is used in definition of information I then the unit for I is the 'hartley' in honour of Ralph Hartley who first proposed a logarithmic measure of information (Hartley, 1928).

Shannon information measures the 'distance' between two probability densities $P(B|A)$ and $P(B)$ – if the two are the same, then the 'distance' is zero, implying that A provides no information about B. There are other measures of the distance between two densities and these are also called 'information' measures; a few examples are Fisher, Wooters, Renyi, Tsallis, Hellinger and Kullback-Leibler.

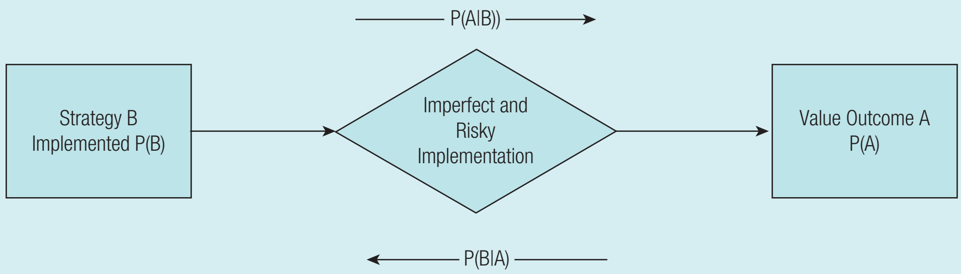

Figure 9.13 Shannon's Model of Information

It is desirable that the behavioural model is as simple as possible, yet predicts as much of the variation in value as possible. The model is also constrained by the data available. For example, published financial data on public firms is quite easy to obtain from databases such as the US Securities and Exchange Commission's EDGAR. It is also constrained by paucity of data. For traditional firms, it is often hard to justify forecasts based on more than 10 years of historical data, because of changes in the business environment and competition. With innovations and firm start-ups, there is often no historical data; one may be lucky enough to find a similar firm that can serve as a benchmark for the start-up or innovation project. But the risk of building models based on someone else's experience is substantially larger than basing the model on historical data.

Strategy Model: Facebook

Arguably one of the major assets of Facebook is its huge base of visitors, and thus we might for financial analysis posit that:

Value generated = f(social networking)

or

Value generated = f(unique visitors, page views)

But these are not directly controllable by managerial decisions, nor are they particularly easy to measure. Instead, we would like to compute value as something that can be controlled by management strategy – a true *strategy model*.

Value generated = f(features for communication; 'image' creation features; picture sharing features)

And we would look for metrics to measure the quantity and quality of features for communication; 'image' creation features; picture sharing features. In addition, we will find out in the next chapter that our model will benefit from a *network effect.* This will give use the 'steady state' strategy model, but will fail to capture all the uncertainty of the start-up.

The Forecast Model

Real Options Some investment decisions give the manager an unprecedented level of 'flexibility' in contracting. This 'flexibility' can take different forms – the ability to change the rate of production, defer development or abandon a project. Traditional project valuation approaches, such as discounted cash flow (DCF), are biased towards binary choice – invest *now*, or forever hold your peace – options contracts will allow that choice to be taken up to some specified time in the future.

An important form of flexibility is the ability to make 'follow-on' investments. For example, start-ups are often required to prove a technology concept and market in stages, funded by multiple rounds of financing. Venture capitalists may use this to encourage value creation and assure good management, and to protect against potential losses. The first right of refusal for a later stage of financing is often written into the investment contract. This is management's equivalent to the securities market 'call option' – a contractual right to purchase a number of shares at a price and time in the future (Porter, 1991).

Real options are both about modelling decisions and uncertainties related to investments. In real options the focus is on options, decisions that are made after some uncertainties have been resolved. The classic example of an option is a call option on a stock that gives its owner the right, but not the obligation, to purchase a stock at some future date at an agreed-upon price. In real options, the options involve 'real' assets as opposed to financial ones. For example, in wildcat oil drilling, an option would allow you to gather information about a prospective oil field before deciding whether to 'exercise your option' and drill the prospect.

Management typically invests in assets that will be used to generate a profit. Sometimes, though, management will invest in an opportunity to do business, without putting money into assets in place. Such opportunities might arise from a one-time opportunity to enter a foreign market, enter into a strategic alliance or acquire a one-of-a-kind asset. Management may have no firm intention of using these opportunities at the time of purchase, but want to retain the option to profit from them in the future. In these situations, discounted cash flow analyses are too simplistic to produce accurate valuations (Faulkner, 1996).

Real options approaches provide a rich vocabulary for the financial analysis of new innovation. These contrast with more direct and simple corporate decision analysis models which tend to consider great detail in the

Consider this example (Figure 9.14) comparing a DCF valuation to a real options valuation of the same project. Say that the investment decision extends over two periods – today (period 1) and a year from today (period 2). Assume a \$1000 investment today will generate cash inflows next year that discounted to today's dollars are either \$800, \$1100 or \$2000 with equal probability. This gives expected return that is shown in Figure 9.15:

$$\$300 = \frac{\$800 + \$1100 + \$2000}{3} - \$1000$$

But what if the manager can delay the investment until next year, and avoid investing if cash inflows turn out to only be \$800? By waiting and gathering information (i.e. what is only being forecast in the DCF model), then expected return is $\$550 = \frac{\$1100 + \$2000}{2} - \$1000$.

This 'real option' to defer the decision until next year is worth \$250 = \$550 – \$300 today.

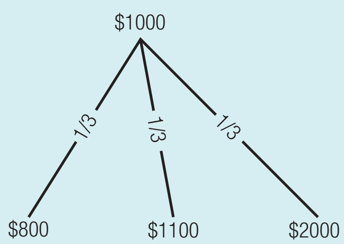

Figure 9.14 Option with Three Possibilities

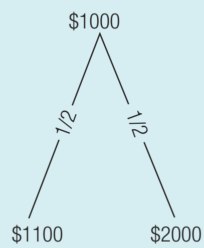

Figure 9.15 Option with Two Possibilities

cash flow models and many uncertainties, but relatively little in the way of dynamic decision making or downstream decisions. Though downstream decisions are something decision analysts know about, they are frequently overlooked or oversimplified in the analyses. Too often, decision models consider only a single decision made up-front – e.g. what strategy should we choose – without considering the opportunities for later adjustments or changes in these strategies.

The real options approach assumes that pivotal managerial decisions are made, and that an uncertain world subsequently unfolds, either rewarding or punishing that decision. The real options decision tree assumes that the manager makes a decision and then finds out what happens. This fails when the manager finds out what happens (or at least guesses what might happen) prior to making a decision. In this case, scenario analysis and decision trees are better suited for the task of dealing with uncertainty. There are a number of easy-to-use programmes that support scenario analysis and decision-tree approaches to valuation.

Where decision trees become especially complex, perhaps growing into involved networks of options and decisions, simple decision-tree software may meet its limits. The mathematics of mixing random variables in any degree approaching the real structure and transaction flows in business is daunting, if not impossible to implement in practice. For this reason, analysts may choose to use Monte Carlo simulations to compute complex forecasts involving the interplay of multiple random variables. Unfortunately, each of these individual components can become a major source of error. Their combined effect can easily swamp the entire simulation.

Forecasts

Physicist Nils Bohr once quipped that 'prediction is very difficult, especially if it's about the future'. Nearly all attempts at valuation need to

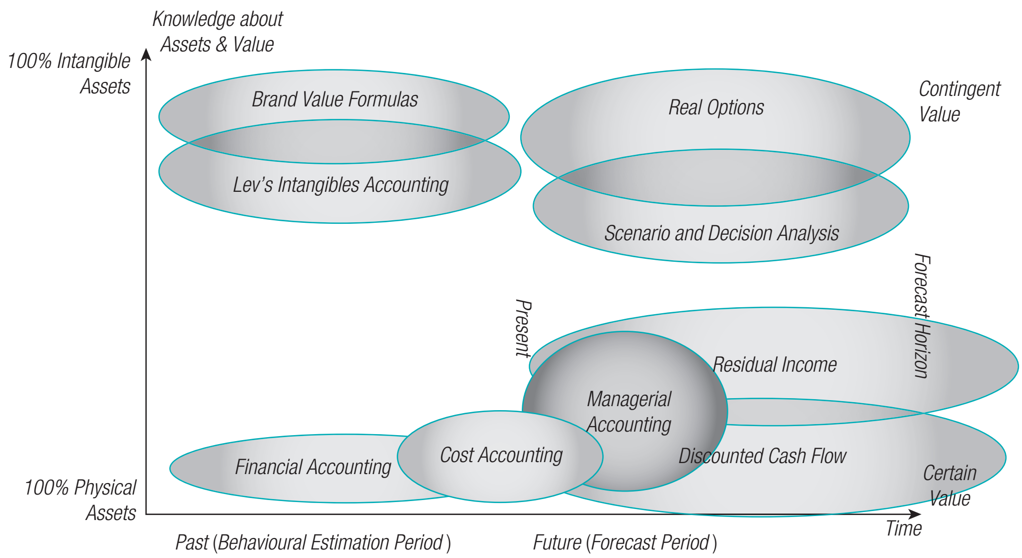

Figure 9.16 Various Methods of Valuation

rely on some guessing about the future – and because of that, it is very difficult (see Figure 9.16 that describes the predictive role of various approaches to valuation). Even financial accounting, which is primarily concerned with tracking historical transactions, needs to make forecasts of the future life of assets in order to compute depreciation. Whether or not a valuation method is or is not a forecast method is one of degree.

Good forecasting involves making *educated* guesses. Good forecasts satisfy four criteria:

1. *Non*-arbitrary: forecasting methodology defines a clear role for data, model drivers, assumptions and hypotheses, which will be applied consistently from analysis to analysis. We can minimize these biases by using a standard formal methodology which encourages four traits of good research: (1) explains observed phenomena, and explains why; (2) is consistent with previously established knowledge; (3) is verifiable by other parties with access to the same data; and (4) stimulates further discussion, investigation and revision as data become available.
2. *Collective:* forecasts should be easily understood by others, and their assumptions stated clearly enough to assure that others can replicate their conclusions.
3. *Reliable:* forecasts can be relied upon to make decisions. Reliability implies not only a *specified degree of accuracy* in financial reporting, but a clear idea of how accurate the reported numbers are through reporting of a *dispersion* statistic – for example, variance or standard deviation – to measure the reliability of the reported value.
4. *Consistent and robust:* forecasts will not change in the absence of fundamental information. Robust methods would limit and assure that different analysts using similar data would produce similar valuations, or, where they were different, could clearly explain the assumptions which account for that difference.

The path through the real options generates value over time, and that value can be graphed. Additionally, recall from the behavioural model that we not only defined the impact of the strategy drivers on value creation, but also the variability. The greater this variability, the more imprecise will be our forecast, and the riskier will be the investment in the business of our innovation. So if we graph the value generated by management's decisions, we would say that, for example, with 95% confidence, we predict that the value generated by the innovation and its business model will lie between the upper

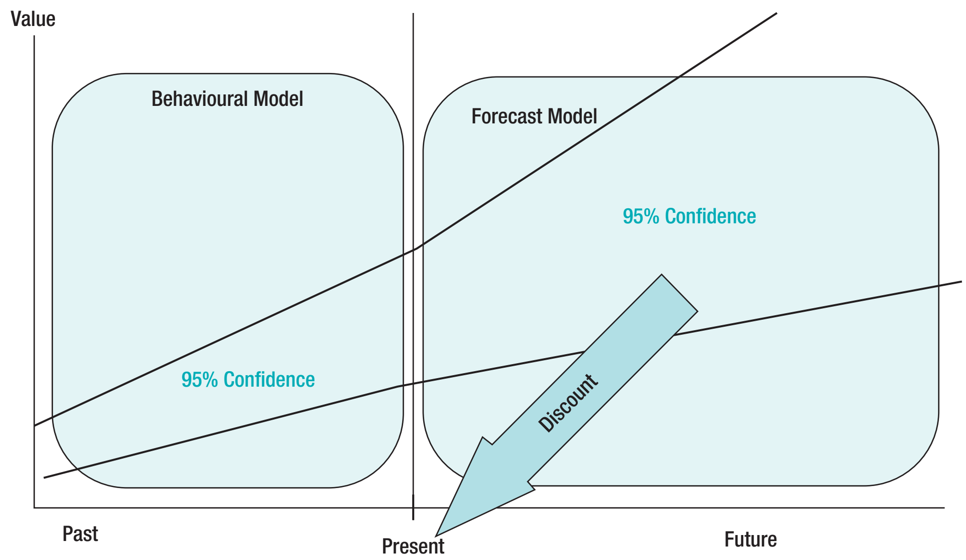

Figure 9.17 Value Cone of the Business Model

and lower bounds on the graph (Figure 9.17). Furthermore, we can discount these future bounds back to the present, and say that the expected present value of the innovation and its business model lies between two numbers. The further apart the numbers, the riskier the project.

Consider two possible outcomes of our real options analysis (Figure 9.18). The first graph shows a business model with modest value generation, but where the confidence bounds are close together, so we have some assurance of what value might be generated. The second

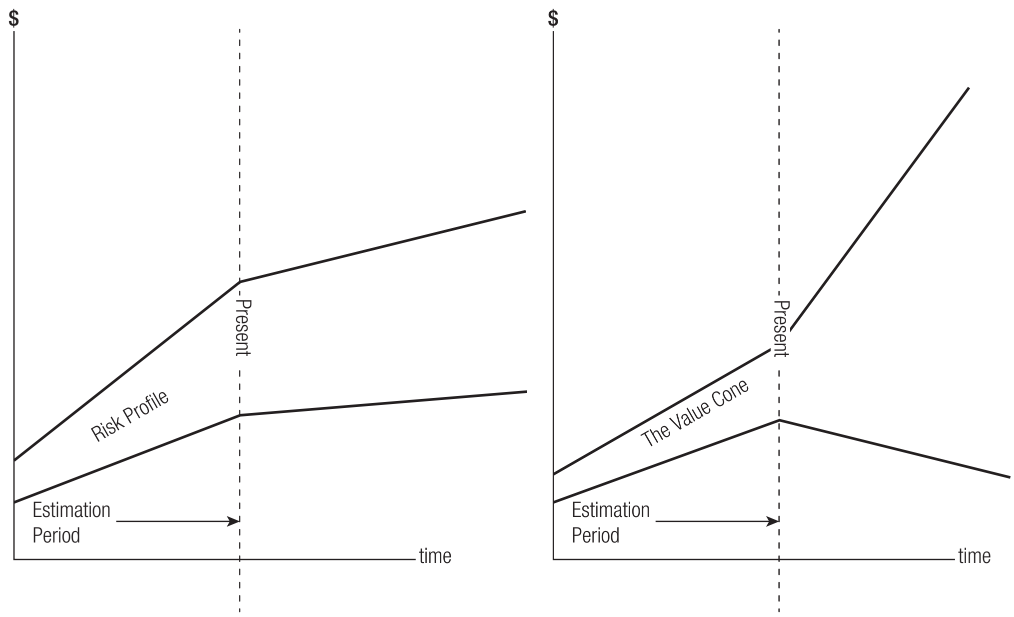

Figure 9.18 A 'Safe' Low-Return Investment vs. a 'Risky' Higher-Return Investment

graph shows a much riskier, but potentially higher-return investment.

The expanding range of possible values between the confidence limits (the two lines extending into the future) is called a 'value cone' and describes the risk profile of the particular business model that management designs to promote the innovation. The value cone reflects the projection of the variability in our behavioural model into the future. It is in general expanding because our forecasting errors compound themselves moving further into the future. Any misestimation of value generation next year will incorrectly forecast the path of development of the business model, and that misforecast will in turn create even greater forecast errors in the subsequent years. Forecast errors result because: (1) we have incomplete control over the drivers of value creation, and (2) we have imperfect knowledge about exogenous events that influence the success of our business (Jensen & Meckling, 1976; Morris et al., 1991; Taylor & Davis, 1994; Fenn et al., 1995).

The Cost of Money

The prior forecast models produce estimates and confidence bounds for value flows that will be generated from the business surrounding the innovation over a series of future time periods. In order to obtain a present value for the business (or more correctly, a pair of confidence limits for the present value) it is necessary to discount the future values back to the current value. This is done by summing all the future values V_t generated in future periods t by a discount factor $1/(1-r)^t$ where r is the discount rate for each period. Discount rate r can be viewed either as (1) a measure of management's impatience – how quickly they want to get their investment back; or (2) as an opportunity cost – a measure of potential return from other investment opportunities which were forgone in order to fund this innovation business. From either perspective, deciding on the appropriate discount rate can be difficult.

Discounted cash flow analysis typically assumes a forecasting horizon – a time after which forecasting is considered to be too error prone or speculative to be useful. So speculation beyond this horizon is halted and replaced with a terminal dividend that reflects not a cash payment as such, rather an estimate of the market value. The terminal dividend was either: (1) the value of an annuity payable into perpetuity, or (2) some price/earnings multiple. However computed, the horizon was typically far enough in the future that the terminal value presented only a small portion of total present value (though this assumption was widely abused during the dot.com boom). The approach was promoted in a popular finance text back in the 1960s, and called the Gordon growth model after the text's author (Gordon, 1962).

Innovation Workout: Scenario Analysis

In the 1970s, US Secretary of State Henry Kissinger suggested to the Shah of Iran that Iran could pay for its expensive US-made military equipment by rationing production and increasing the price of its oil – in short order the world was hit by an oil shortage and a sudden quadrupling of prices. Oil companies were caught by surprise. Except for one: Royal Dutch Shell. It had realized that improbable events can take place without warning, and that such events demand swift and sure management, ideas and decisions. It had prepared several different future scenarios, from 'boom or bust' to 'constrained growth', to address any economic eventuality. A period of constrained growth did, in fact, follow the oil shortage, and its 'constrained growth' scenario positioned Royal Dutch Shell to exploit the shortage. Royal Dutch Shell grew from eighth largest to second largest petroleum company in the world during the 1970s by taking quick advantage of unexpected opportunities.

Royal Dutch Shell had listened to oil consultant – and subsequently Pulitzer Prize-winning author – Daniel Yergin, who suggested they adopt *scenario planning* as a part of their strategy analysis. Yergin, in turn, had adapted scenario analysis to business planning from its original use in US military strategy planning to address thermonuclear war and its aftermath.

Blueprint

The procedures for preparing for the future are:

- *Identify a particular problem in your business.*
- *State a particular decision that has to be made.*
- *Identify the forces (economic, technological, product lines, competition, and so on)* that have an impact on the decision.
- *Build four or five future scenarios based on the principal forces.* Use all the available information and develop scenarios that will give you as many different and plausible possibilities as a pinball in play.
- *Develop the scenarios into stories or narratives* by varying the forces that impact the decision. Change the forces (interest rates escalate, a key performer quits, need for your product or service disappears, etc.) and combine them into different patterns to describe the possible consequences of your decision over the next five years.
- *Search for business opportunities within each scenario.* Then explore the links between opportunities across the range of your scenarios, and actively search for new ideas.

Suppose you are worried about future competitive trends in your business – in particular the pricing of your product. A number of forces have an impact on pricing: profits, return on investment, cash flow, capitalization structure, the competition's pricing, and so on. You can build four or five different, plausible scenarios around the forces you have identified (Figure 9.19).

Scenario 1. Nothing changes. Everything remains the way it is today (*ceteris paribus*).
Scenario 2. Your major competitor reduces prices by 25% (*price war and commoditization*).
Scenario 3. A major technological breakthrough prices out your major product line (*disruptive innovation*).

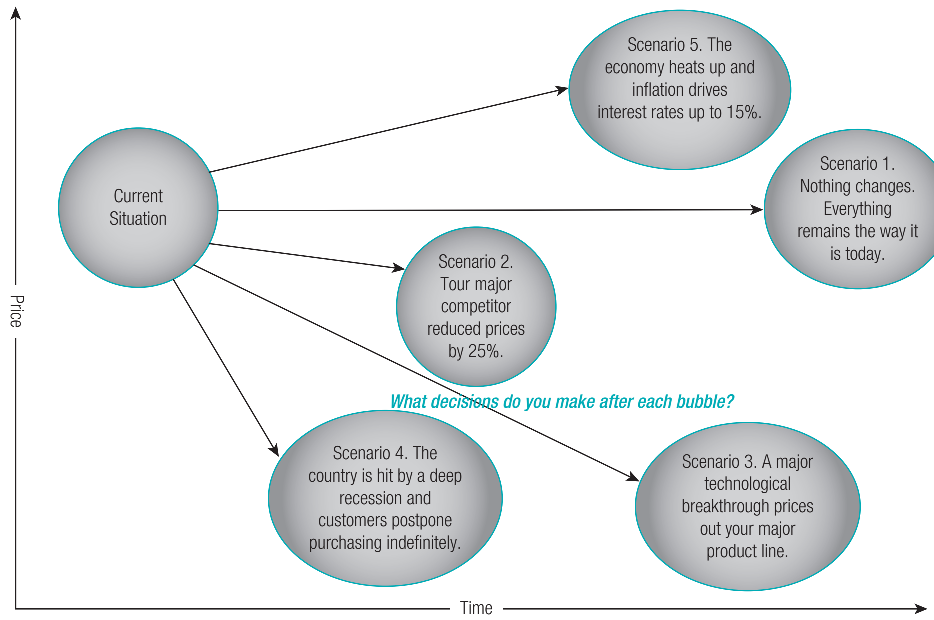

Figure 9.19 Scenarios: Each of These Scenarios Points to Different Actions you Might Take, and Different Business Opportunities

Scenario 4. The country is hit by a deep recession and customers postpone purchasing indefinitely (*economy*-wide deflation).

Scenario 5. The economy heats up and inflation drives interest rates up to 15% (*economy*-wide inflation).

Case Study: Behavioural and Strategy Models in the Early Years of eBay

In its early years, eBay was primarily an auction market. By 2002 it was large enough to consider growth by acquisition, and acquired the operations of iBazar and PayPal during that year. Starting around this time the site also saw an organic transition towards larger and larger numbers of fixed price listings, and away from pure auction business. By 2006 its business model was substantially transformed, with most of its revenues coming from payments (PayPal) and retail (fixed price listings).

Generally the valuation of a business requires an independent analysis of each significant business line. In the early years, eBay had only the auction business line, but this presented a singular challenge to valuation – to price out the effect of the so-called 'network effect' on the value of the market. Markets grow more and more liquid – i.e. traders can transact faster and at better prices – as the number of users of the market increases. Liquidity is a version of network effect, where all communication links flow through the market platform. Assuming we know how to value a network effect, the valuation of the early years of eBay as a business (up to about 2006) is relatively straightforward.

Their value proposition is clear from the company's 2002 annual report: 'Our mission is to build the world's most efficient and abundant marketplace in which anyone, anywhere, can buy or sell practically anything … and through our PayPal service, we enable any business or consumer with email to send and receive online payments securely, conveniently and cost-effectively. Our marketplace exists as an online trading platform that enables a global community of buyers and sellers to interact and trade with one another. Our role is to create, maintain, and expand the technological functionality, safety, ease of use, and reliability of the trading platform while at the same time, supporting the growth and success of our community of users.'

The objectives of eBay are not substantially different from stock markets – to expand the number of traders and their volume of trades by making trading easy, accessible and cheap, and by streamlining payment and clearing.

Figure 9.20 shows how the market value and user base strategy drivers for eBay have influence costs and revenues since eBay's listing in 1997 until its diversification around 2006, and projects revenues and associated costs into the future using a quadratic function (note that both R2 values are above 0.99).

During the same period we can look at listings and active users (Figure 9.21). Again there is a very good fit (R2 ˜ 0.99) to a quadratic growth, which would lead us to two conclusions:

1. Listings, revenues and cost of sales can be represented as linear functions of the number of active users (only about half of registered users are active in any year according to eBay's annual reports).
2. The number of active users grows by the square of the time that the market has been active.

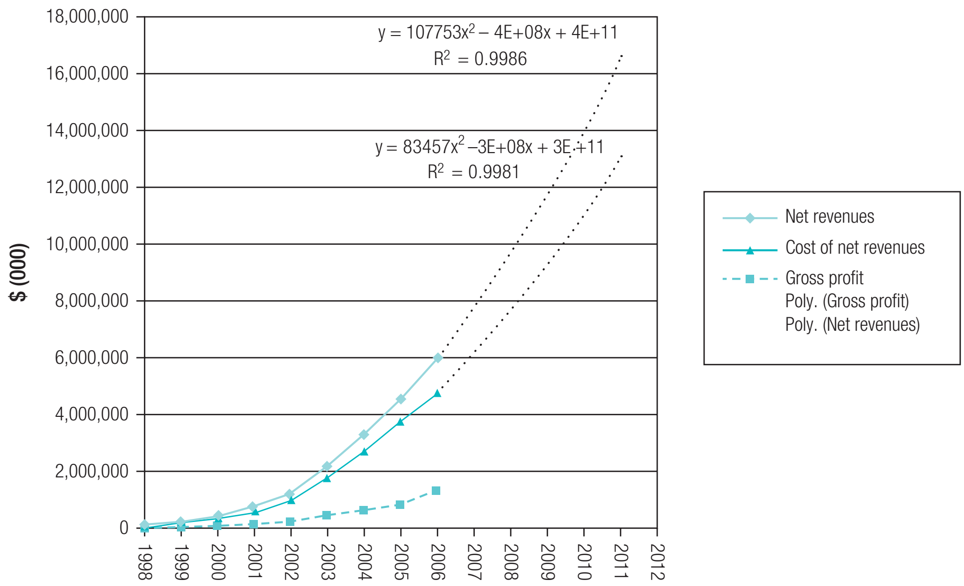

Figure 9.20 Figures of Merit, with Future Projections, for eBay
Source: eBay website, accessed 12 August 2010

The second characteristic is reflective of what Laszlo Barabási (2003) calls a scale-free network in which the number of connections to any individual user (e.g. contacts, transactions, friends) follows a power law. Such networks are 'scale-free' because the appearance and operation of the network for any individual user is independent of their position on the network, or the size of the network – conditions that accurately describe the service that eBay tries to provide its users. Such networks are not static structures, but are the result of particular patterns of growth. Thus *time* implicitly becomes a driver of desirability of being on such a network of traders.

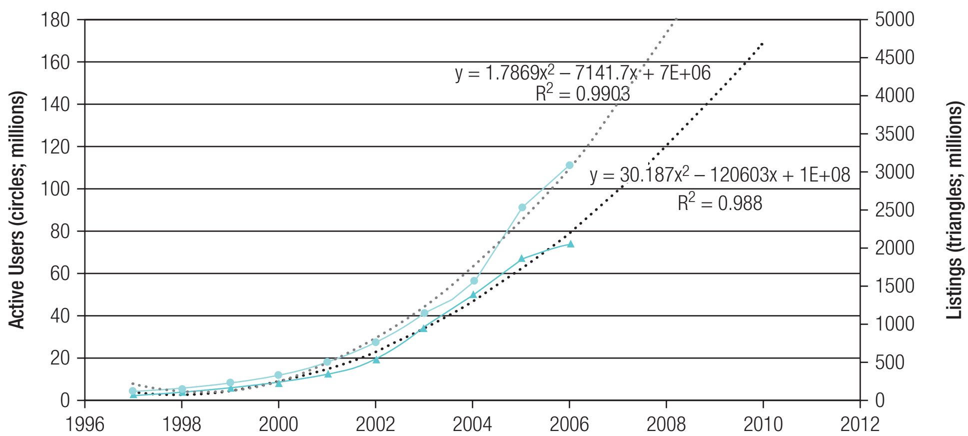

Figure 9.21 eBay Users and Listings Per Year
Source: eBay website

Using this logic, we can build a very simple model of value generation by eBay's business model that is nonetheless quite good at predicting the future.

$$V_t = \beta_0 + \beta_1 t^2$$

If we choose V_t to be net revenue, and t to be the age of eBay (1997, the year it went public, being $t = 0$) then our strategy model is:

$$V_t \cong 74{,}401t^2 - 282{,}290$$

$$\text{i.e. } \beta_0 \cong -282{,}290 \text{ and } \beta_1 \cong 74{,}401 \text{ with an } R^2 \cong .99$$

If we adopt a 40% discount rate to compute present value (ignoring the value cone limits in this example for simplicity) the present value of eBay's revenues is about \$3.2 billion. A closer look at historical results would show that the integration of PayPal into eBay's system after 2002 both pushed up the number of users, and, more importantly, significantly boosted revenue per user. More accurate forecasts become possible when these additional activities are worked into the strategy model for their auction.

Questions: eBay Case Study

1. Where is eBay generating its money? Does free cash flow tell the entire story?
2. How does eBay measure success in its management and operations?
3. eBay clearly is benefiting from network externalities, judging from the growth of both its auctions and revenues. How does this influence the company's cash flow and the future profitability of eBay?
4. eBay is able to increase its revenue per customer by acquiring new complementary businesses (for example, the purchase of PayPal, which substantially increased income per customer transaction from under \$1 to around \$2.15). Could eBay leverage its name to continue adding complementary businesses like PayPal? If your answer is yes, name several new businesses that eBay might add in the next five years.

Chapter 9:Questions for Review

1. During the dot.com boom, there were numerous financial analyses that justified the exceptionally high stock valuations of internet companies (for example, Yahoo traded at a price earnings multiple of over 1000). Were these valuations valid? If they were, why did the stock value drop? If they were not, what were the flaws in their mechanics?
2. How would you incorporate non-linear network effects and technology acceleration into traditional discounted cash flow analyses?
3. How would you incorporate risk into discounted cash flow analyses? Is this the normal method of assessing risk in stock shares?
4. Risk is often characterized as the variance of either stock price or some other metric of firm performance. What are the strengths and weaknesses of a variance 'metric' for risk?

Chapter 9 – Key Points

1. Innovators compete in two markets – product markets and markets for investment.
2. Start-ups and smaller innovators have several relatively new sources of funding:
   a. Crowdsourcing and peer-to-peer;
   b. Seed accelerators;
   c. Angel investors; and
   d. Venture capitalists.
3. Performance of an investment may be measured many ways. The most common approach is return on investment, but any investment should have a clearly defined cash flow performance.
4. Valuation of an innovation or firm requires three separate decision models: the behavioural model, the forecast model and the discounting model.
5. Models are dependent on the amount of information and uncertainty (risk) associated with the available data.
6. Real-options approaches can help value highly uncertain investments.

Further Reading

Abernathy, W. J. and Clark, K. B. (1985). Innovation: Mapping the winds of creative destruction. *Research Policy* 14(1), 3–22.

Aboody, D. and Lev, B. (1998). The value relevance of intangibles: The case of software capitalization. *Journal of Accounting Research* 36, 161–191.

Alexy, O. T., Block, J. H., Sandner, P. and Ter Wal, A. L. (2012). Social capital of venture capitalists and start-up funding. *Small Business Economics* 39(4), 835–851.

Almeida, P. and Kogut, B. (1997). The exploration of technological diversity and geographic localization in innovation: Start-up firms in the semiconductor industry. *Small Business Economics* 9(1), 21–31.

Amit, R. and Zott, C. (2000). Value creation in e-business. INSEAD.

Amit, R. and Zott, C. (2001). Entrepreneurial strategies for wealth creation. *Strategic Management Journal* 22, 493–520.

Amit, R. and Zott, C. (2012). Creating value through business model innovation. *MIT Sloan Management Review*, 53.

Archak, N., Ghose, A. and Ipeirotis, P. G. (2011). Deriving the pricing power of product features by mining consumer reviews. *Management Science* 57(8), 1485–1509.

Barabási, L. (2003) *Linked: How Everything Is Connected to Everything Else and What It Means*. New York: Plume.

Baumol, W. J. (1959). Business behavior, value and growth. *New York*, 32.

Bayus, B. L. (2013). Crowdsourcing new product ideas over time: An analysis of the Dell IdeaStorm community. *Management Science* 59(1), 226–244.

Bonczek, R. H., Holsapple, C. W. and Whinston, A. B. (2014). *Foundations of Decision Support Systems*. Academic Press.

Brabham, D. C. (2013). *Crowdsourcing*. MIT Press.

Burtch, G., Ghose, A. and Wattal, S. (2015). The hidden cost of accommodating crowdfunder privacy preferences: A randomized field experiment. *Management Science* 61(5), 949–962.

Cannone, G. and Ughetto, E. (2014). Funding innovation at regional level: An analysis of a public policy intervention in the piedmont region. *Regional Studies* 48(2), 270–283.

Conner, K. and C. K. Prahalad (1996). A resource-based theory of the firm: Knowledge versus opportunism. *Organizational Science* 7, 477–501.

Cooper, W. W. and Whinston, A. B. (eds) (2012). *New Directions in Computational Economics* (Vol. 4). Springer Science & Business Media.

Czarnitzki, D. and Lopes-Bento, C. (2014). Innovation subsidies: Does the funding source matter for innovation intensity and performance? Empirical evidence from Germany. *Industry and Innovation* 21(5), 380–409.

Diamond, D. W. Monitoring and reputation: The choice between bank loans and directly placed debt. *Journal of Political Economy* 99, 689–721.

Doan, A., Ramakrishnan, R. and Halevy, A. Y. (2011). Crowdsourcing systems on the world-wide web. *Communications of the ACM* 54(4), 86–96.

Doraszelski, U. and Jaumandreu, J. (2013). R&D and productivity: Estimating endogenous productivity. *The Review of Economic Studies* 80(4), 1338–1383.

Economist (1999, 10 June) Measuring intangible assets: A price on the priceless, www.economist.com/node/322532, accessed 22 June 2016.

Elena Pérez, S., Conte, A. and Harrap, N. (2014). Synergies between EU R&I Funding Programmes. *Proceedings from the Launching Event of the Stairway to Excellence Project* (No. JRC92829). Institute for Prospective and Technological Studies, Joint Research Centre.

Ellison, N. B. (2007). Social network sites: Definition, history, and scholarship. *Journal of Computer-Mediated Communication* 13(1), 210–230.

EMC (2014) Managing Storage: Trends, Challenges, and Options (2013–2014), https://sso.emc.com/, accessed 22 June 2016.

European Commission (2005), *Annex to the Proposal for the Council and European Parliament Decisions on the 7th Framework Programme (EC and Euratom)*. European Commission Staff Working Paper.

Everton, S. F., Kang, S. M. and Thornton, P. H. (2013, January). Managing institutional logics: The effects of investors' social capital on venture performance. In *Academy of Management Proceedings* 2013(1), 12407. Academy of Management.

Faulkner, T. W. (1996). Applying 'options thinking' to R&D valuation. *Research Technology Management* 39(3), 50–56.

Fellows, G. K. and Hollis, A. (2013). Funding innovation for treatment for rare diseases: adopting a cost-based yardstick approach. *Orphanet Journal of Rare Diseases* 8, 180.

Fenn, G. W., N. Liang and Prowse, S. (1995, December). The economics of private equity, Board of Governors of the Federal Reserve System, Washington, DC.

Florida, R. (2004). America's looming creativity crisis. *Harvard Business Review* 82(10), 122–136.

Florida, R. and Goodnight, J. (2005). Managing for creativity. *Harvard Business Review* 83(7), 124.

Frontier Economics (2014, June). Rates of Return to Investment in Science and Innovation, www.frontier-economics.com/publications/rates-of-return-to-investment-in-science-and-innovation/, accessed 5 July 2016.

Furman, J. L., Li, J. and Wang, Y. (2015). *Firm Performance and State Innovation Funding: Evidence from China's Innofund Program*. Available at SSRN 2597673.

Gates, Bill. *Business Strategy Review*, London Business School, 99/2, 11–18.

Ghose, A. and Ipeirotis, P. G. (2011). Estimating the helpfulness and economic impact of product reviews: Mining text and reviewer characteristics. *Knowledge and Data Engineering, IEEE Transactions on* 23(10), 1498–1512.

Ghose, A. and Yao, Y. (2011). Using transaction prices to re-examine price dispersion in electronic markets. *Information Systems Research* 22(2), 269–288.

Ghose, A., Goldfarb, A. and Han, S. P. (2012). How is the mobile internet different? Search costs and local activities. *Information Systems Research* 24(3), 613–631.

Gillon, K., Brynjolfsson, E., Mithas, S., Griffin, J. and Gupta, M. (2012). Business Analytics: Radical Shift or Incremental Change? In 33rd International Conference on Information Systems (ICIS 2012), Orlando, Florida.

Gordijn, J., Osterwalder, A. and Pigneur, Y. (2005). Comparing two business model ontologies for designing e-business models and value constellations. *BLED 2005 Proceedings*, 15.

Gordon, M. (1962). *The Investment, Financing and Valuation of the Corporation*. Homewood, IL: Irwin.

Guo, Z., Koehler, G. J. and Whinston, A. B. (2012). A computational analysis of bundle trading markets design for distributed resource allocation. *Information Systems Research* 23, 823–843.

Hall, B. H. (2011). Innovation and productivity. NBER Working Paper No. 17178, National Bureau of Economic Research.

Hall, B. H., Lotti, F. and Mairesse, J. (2009). Innovations and productivity in SMEs: Empirical evidence for Italy. *Small Business Economics* 33(1), 13–33.

Hall, B. H., Mairesse, J. and Mohnen, P. (2009). Measuring the returns to R&D. NBER Working Paper No.15622, National Bureau of Economic Research

Hartley, R. V. (1928). Transmission of information. *Bell System Technical Journal* 7(3), 535–563.

Hellmann, T. and Puri, M. (2002). Venture capital and the professionalization of start-up firms: Empirical evidence. *The Journal of Finance* 57(1), 169–197.

Henderson, R. M., and Clark, K. B. (1990). Architectural innovation: The reconfiguration of existing product technologies and the failure of established firms. *Administrative Science Quarterly*, 9–30.

Hitt, M. A., Ireland, R. D., Camp, S. M. and Sexton, D. L. (2001). Strategic entrepreneurship: Entrepreneurial strategies for wealth creation. *Strategic Management Journal* 22(6–7), 479–491.

Hsu, D. H. (2006). Venture capitalists and cooperative start-up commercialization strategy. *Management Science* 52(2), 204–219.

Huang, E. (2007, 9 March). Nintendo legend discusses Wiis and Miis. GamePro.com

Huang, Y., Singh, P. V. and Ghose, A. (2015). A structural model of employee behavioural dynamics in enterprise social media. *Management Science* 61(12), 2825–2844.

Jensen, M. C. and W. H. Meckling (1976). Theory of the firm: Managerial behavior, agency costs, and ownership structure. *Journal of Financial Economics* 3, 305–360.

Knudsen, B., Florida, R., Stolarick, K., and Gates, G. (2008). Density and creativity in US regions. *Annals of the Association of American Geographers* 98(2), 461–478.

Landier, A. (2003). Start-up financing: From banks to venture capital. Unpublished working paper, Chicago, IL: University of Chicago.

Lee, S. Y., Florida, R. and Acs, Z. (2004). Creativity and entrepreneurship: A regional analysis of new firm formation. *Regional Studies* 38(8), 879–891.

Lenin, Vladimir (1918). *The State and Revolution.*

Lev, B. (2000). *Intangibles: Management, Measurement, and Reporting*. Brookings Institution Press.

Lev, B. (2004). Sharpening the intangibles edge. *Harvard Business Review* 6, 109–116.

Maritan, C. A. and Peteraf, M. A. (eds). (2011). *Competitive Strategy*. Edward Elgar.

Morris, P., Teisberg, E. and Kolbe, A. L. (1991). When choosing R&D projects, go with long shots'. *Research Technology Management* January–February, 3540.

Muller, R. A. (2013). Innovation and scientific funding. *Science*.

Musser, J., and O'Reilly, T. (2006). *Web 2.0. Principles and Best Practices*. O'Reilly Media.

Osterland, Andrew (2001, 1 April). CFO's third annual knowledge capital scorecard, *CFO Magazine*, p. 19.

Osterwalder, A. and Pigneur, Y. (2002). An eBusiness model ontology for modeling eBusiness. *BLED 2002 Proceedings*, 2.

Osterwalder, A. and Pigneur, Y. (2010). *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*. John Wiley & Sons.

Osterwalder, A. and Pigneur, Y. (2013). Designing business models and similar strategic objects: The contribution of IS. *Journal of the Association for Information Systems*, 14(5), 237–244.

Osterwalder, A. Pigneur, Y. and Tucci, C. L. (2005). Clarifying business models: Origins, present, and future of the concept. *Communications of the Association for Information Systems* 16(1), 1.

Poetz, M. K. and Schreier, M. (2012). The value of crowdsourcing: Can users really compete with professionals in generating new product ideas? *Journal of Product Innovation Management* 29(2), 245–256.

Porter, M. E. (1991). Towards a dynamic theory of strategy, *Strategic Management Journal* 12, 95–117.

Powers, J. B. and McDougall, P. P. (2005). University start-up formation and technology licensing with firms that go public: A resource-based view of academic entrepreneurship. *Journal of Business Venturing* 20(3), 291–311.

Puri, M. and Zarutskie, R. (2012). On the life cycle dynamics of venture-capital-and non-venture-capital-financed firms. *The Journal of Finance* 67(6), 2247–2293.

Qiu, L., Rui, H. and Whinston, A. B. (2014). The impact of social network structures on prediction market accuracy in the presence of insider information. *Journal of Management Information Systems* 31(1), 145–172.

Raphael, A. and Zott, C. (2001). Value creation in e-business. *Strategic Management Journal* 22(6/7), 493.

Rosenbusch, N., Brinckmann, J. and Müller, V. (2013). Does acquiring venture capital pay off for the funded firms? A meta-analysis on the relationship between venture capital investment and funded firm financial performance. *Journal of Business Venturing* 28(3), 335–353.

Shannon, C. E. (1949). Communication theory of secrecy systems. *Bell System Technical Journal* 28(4), 656–715.

Shaw, M., Blanning, R., Strader, T. and Whinston, A. (eds). (2012). *Handbook on Electronic Commerce*. Springer Science & Business Media.

Stengel, R. F. (1994). *Optimal Control and Estimation*, New York: Dover Publications.

Stenovec, T. (2011). MySpace History: A timeline of the social network's biggest moments. *The Huffington Post*.

Stolarick, K. and Florida, R. (2006). Creativity, connections and innovation: A study of linkages in the Montréal Region. *Environment and Planning A*,*38*(10), 1799–1817.

Tambe, P., Hitt, L. M. and Brynjolfsson, E. (2012). The extroverted firm: How external information practices affect innovation and productivity. *Management Science* 58(5), 843–859.

Taylor III, A. and Davis, J. E. (1994, 30 May). Iacocca's minivan: How Chrysler succeeded in creating the most profitable products of the decade, *Fortune*.

Zott, C. and Amit, R. (2008). The fit between product market strategy and business model: implications for firm performance. *Strategic Management Journal* 29(1), 1–26.

Zott, C. and Amit, R. (2013). The business model: A theoretically anchored robust construct for strategic analysis. *Strategic Organization* 11(4), 403–411.

Zott, C. and Amit, R. (2015). Business model innovation: Toward a process perspective, in C. Shalley, M. Hitt and J. Zhou, *The Oxford Handbook of Creativity, Innovation, and Entrepreneurship* (pp. 395–406). Oxford: OUP.

Zott, C., Amit, R. and Massa, L. (2011). The business model: Recent developments and future research. *Journal of Management* 37(4), 1019–1042.

3

SOCIAL AND TECHNOLOGICAL ECOSYSTEMS OF INNOVATION

An Introduction to Part 3

Innovation and creativity are inherently human endeavours, and thrive in a diverse, tolerant and educated society. We live in an era in which technology insinuates itself into every aspect of humanity. Technology evolves in three types of context – the individual, community and society – and these increasingly reflect a world in which innovation and creativity are the currencies of the realm. Emerging platforms such as robotics, autonomous vehicles, smart devices and artificial intelligence expand the industrial palette but introduce substantial risks for society.

Part 3 of *Global Innovation Management* addresses the inherently human factors that can be harnessed to create a world in which innovation can thrive and benefit mankind. These final chapters address the social and technological context in which innovations become reality. Chapter 10 surveys emerging platforms such as robotics, autonomous vehicles and artificial intelligence, extending our innovation framework to encompass the most cutting-edge technologies. The most important innovations in the coming decades will derive from these platforms, and this chapter should get you thinking about them. Chapters 11, 12 and 13 address important features of the individual, community and society, respectively, that are moving us towards an economy based on creativity.

The complete set of topics in this book has provided innovators with the tools to manage an innovation cycle from creation through to implementation. Our content and perspective have focused on the *business of innovation*, providing action-oriented tools for commercializing great ideas while keeping in mind the societal factors that make countries appealing, or, conversely, which can undermine their greatest minds. My hope as an author is that I will see these tools successfully applied in the promotion of new generations of ideas which can empower society, consumers and inventors.

CHAPTER 10

EMERGING PLATFORMS FOR INNOVATION

Learning Objectives

After finishing this chapter, you will

Understand the rationale for and features that comprise a technology 'platform'.

Understand, by reviewing patent applications, where the next important technologies will appear.

Understand how the Arduino and Raspberry Pi platforms are the modern IoT counterparts to the 1975 MITS Altair 8800 project computer that inspired the birth of the personal computer.

Understand how the convergence of cloud service computing, cellular phone data technologies, smartphones and battery technology are creating an IoT industry where small, autonomous, mobile devices are endowed with supercomputing power and access to the world's most extensive databases and real-time data feeds.

Understand how the transition from fixed location computers to real-time smart devices requires a change of business model focus from process flow to event-driven dynamic programming.

After doing the *Innovation Workout* you will see some of the issues involved in internet advertising.

After reading the DJI *case study* you will be able to understand how IoT built on emerging smartphone platforms extended into the cinema and film, agriculture, surveillance and package delivery industries.

Emerging Competitive Platforms

The rate of technology acceleration in computers has made them into almost disposable devices that can be dedicated to any task. Increasingly, consumer and industrial products, including cameras, telephones, wristwatches and many other devices, have been replaced with bespoke computer platforms. The modern petrol automobile engine originated from 17th-century research by Christiaan Huygens who conceived the engine as a modified form of military gun. Since Huygens, engine technologies such as silencers, fuel injection and fuel chemistry have developed largely out of weapons research. But now companies such as Tesla are redesigning automobile engines around Nikola Tesla's induction motor managed by bespoke computers. Similar transformations are taking place in many other industries.

The term 'platform' has come into widespread usage in the computer and automotive industries. Its usage is commonly tied to technical standards – established industry or government regulated norms that enforce uniform engineering and technical criteria, methods, processes and practices. As with standards, platforms dramatically reduce the cost and complexity of research and development by sharing technology.

Platforms in computer architecture provide standards in application programming interfaces, operating systems, browsers, embedded systems and hardware. Examples are the Windows, Linux and OS/X operating system platforms; Facebook, Chrome and Safari application programming interface platforms; Internet Protocol data communication standards; and Amazon Web Services cloud computing platform. Platforms in the automotive industry include the underbody, steering, powertrain and frame. The use of a platform strategy provides flexibility between production facilities, cost reduction, higher utilization and reduction in number of components.

Previous innovations have often exploited unique properties of materials and devices, creating distinct technological 'stovepipes' such as biology, genetics, chemistry, electronics and so forth. But we have moved into a world in which new product development is hugely complex and expensive; and one where developments in one scientific realm may directly impact developments in every other realm. The solution to rising expense and complexity has been to develop common technological platforms that can be produced cheaply at massive scale, and which can be customized to do a variety of tasks.

The discussions in this chapter are necessarily limited, as the opportunities to innovate on new platforms are changing rapidly. But I hope by providing material on these new developments that I can offer my own platform for starting classroom discussions on whatever the latest innovation might be.

The Internet of Things

Arguably the most interesting emerging platform today is the so-called Internet of Things (IoT) which uses low-powered, inexpensive computers festooned with sensors and actuators as flexible platforms for many consumer and industrial tasks. As with personal computers in the past, IoT has received its start from hobbyists experimenting with open-source variants of existing technology – in the case of IoT, this is smartphone technology. Otherwise, the Internet of Things is still an imprecise catchphrase that captures the potential for the internet connection of cloud computing and storage services to small, low-power microcomputers, micro-sensors and actuators. The 'things' in the Internet of Things are often called smart objects – embedded microcomputers with many sensors to monitor their surrounding environment, and actuators (e.g. motors, vibrators, lights) to interact with it and the owners of the devices. China in particular is investing heavily in IoT, or as the Chinese government has termed it, 'Internet +', because of its expertise in these technologies. These devices – health sensors, smart watches, home monitors, drones, 3D printers, cars, phones and so forth – could then benefit from data-rich cloud services, supercomputing and real-time global communication while being able to sense and communicate with their local environments.

Our fascination with intelligent artefacts that can keep watch and do our bidding long preceded the internet. Mechanical servants have been a staple of mythology, from the clay golems of Judaism and the clay giants of the Norse to puppets as surrogate children in Disney tales. In the 19th century, H. G. Wells and Jules Verne envisioned fields of steampunk robots engaged to till, reap and complete laborious farm work (in that day representing nearly two-thirds of employment). So compelling was the dream of automatons that unscrupulous entrepreneurs concocted elaborate ruses for financial gain. Wolfgang von Kempelen's 'Mechanical Turk' was one such fraud. Constructed in the 18th century to impress the Empress Maria Theresa of Austria, the Turk played a strong game of chess against a human opponent. It was designed to look like an elaborate artificial intelligence run by pulleys and gears, but in reality board movements were controlled by a clever dwarf ensconced in the belly of the machine. Nonetheless, Amazon has proudly named one of its services after von Kempelen's fraud.

The 20th century brought inventors closer to exploring smart objects, as electronic control systems evolved. Electron tubes (valves), wireless electronics and motors, though crude by modern standards, gave inventors the tools to start recreating the autonomous intelligence they saw in the natural world. Hobbyists experimented with electronic turtles and dogs (though surprisingly, no cats) that would respond to light or sound. Léon Theremin (of the eponymous musical instrument) experimented with proximity sensors for robots in Russia. By the end of World War II there was considerable military interest in this research, and scientists like Grey Walter and Claude Shannon showed off robots with enough intelligence to solve simple mazes or search tasks. IBM, NCR and Singer all built up successful point-of-sale terminal device businesses in the 1970s that embedded sensors (bar-code scanners), actuators (cash drawers, printers etc.) all networked to central corporate databases through communications services like Systems Network Architecture (SNA). All of these efforts were limited to the technologies of the age. As electronics evolved to solid-state devices, then large-scale integration and then micro-fabrication of sensors and actuators, the toolsets for building automatons grew steadily richer.

The 'tipping point' in development of IoT was the commercialization of smartphones, beginning around 2006. The iPhone and Android phones such as Motorola's Droid, initiated a manufacturing boom in cheap, portable, low-powered computers that by default incorporated sensors and actuators (dozens in tablet phones). Because of the widespread availability of this technology, other industries started appropriating it for their own objectives. Hobbyists developed platforms such as the Raspberry Pi and Arduino, that would allow a more general application to specialized projects. Smartphones shifted the emphasis of use from voice calling to data usage – they were more important to their owners as internet data terminals than as voice phones. From the start, smart objects were manufactured with the ability to link to internet cloud services through Wi-Fi and telephone cell towers. The growth of the smartphone app market created a huge community of competent programmers for these smart objects. Combined with exponential price drops, performance improvements and reliability, by 2010 the world saw an explosion of applications for this technology. Home temperature monitors linked directly to energy companies. 3D printers now account for around one-fifth of US manufacturing. Cheap drones have revolutionized photography and movie making, self-driving cars and numerous other applications. The health monitoring industry continued to boom. Pets, and wild and farm animals benefited from biochip transponders. Robots were being built for every conceivable purpose: Mercedes, BMW, Google, Tesla and Ford demonstrated self-driving cars and robots were created for cleaning, firefighting, and search and rescue. Home appliances began to actively monitor safety, fire, carbon monoxide, temperature, food inventory, clothes and other things, ushering in an age of mechanical servants.

Intellectual Property Winners and Losers

Patent applications are a leading indicator of future competitive arenas – they reflect the inventions that will be expanded into innovations and into profitable full-fledged business models. Figure 10.1 provides a table of patents filings by the US Patent and Trademark Office (USPTO) from 1994–2014 categorized by the

Class Title	Total Patent Filings 1994–2014	Average Annual Growth of Filings
Data Processing: Financial, Business Practice, Management	36,077	16%
Digital Processing Systems: Multicomputer Data	49,396	14%
Database and File Management or Data Structures	43,141	13%
Multiplex Communications	86,373	12%
Telecommunications	68,876	12%
Vehicles, Navigation and Relative Location	33,252	11%
Image Analysis	48,611	10%
Computer Graphics Processing	57,146	9%
Pulse or Digital Communications	47,640	9%
Active Solid-State Devices	99,432	8%
Facsimile and Static Presentation Processing	30,898	8%
Digital Processing Systems: Memory	30,735	8%
Television	47,730	8%
Error Detection/Correction	35,723	7%
Illumination	29,710	6%
Incremental Printing of Symbolic Information	37,244	6%
Recording, Communication or Information Retrieval Equipment	49,230	6%
Semiconductor Device Manufacturing: Process	98,054	5%
Electricity: Electrical Systems and Devices	46,339	5%
Communications: Electrical	44,454	5%
Surgery	37,466	5%
Electrophotography	31,947	5%
Static Information Storage and Retrieval	47,754	4%
Surgery	46,082	4%
Radiant Energy	49,114	4%
Power Plants	29,185	4%
Optics: Measuring and Testing	32,937	4%
Transportation	31,195	4%
Optical: Systems and Elements	47,775	3%
Drug, Bio-Affecting and Body Treating Compositions	68,279	3%
Active Electrical Non-Linear Devices, Circuits and Systems	30,397	3%
Electricity: Measuring and Testing	43,065	3%

Figure 10.1 30 Technology Areas with the Most Patent Filings (1994–2014), Ranked by Rate of Growth of Patent Filings

USPTO technology classification. The table provides insight into the most active technology areas. The technologies with the most growth relate to mobile computing and cloud services, followed by health-related biotechnology. It is these two categories of technology that are predicted to offer the most productive platforms for innovation over the coming decade. Biotechnology and the integration of mobile computing with cloud services – better known as the Internet of Things – will be the subject of the remainder of this chapter.

Biotechnology

DNA, the basis for information storage fundamental to life and heredity, was discovered in 1869 by Swiss physician Friedrich Miescher; but its function remained a mystery for the next century. In Miescher's time, genetics was not yet a science, and indeed was incredibly controversial, opposed by most of the religious community. The world would wait another half century before Sewall Wright's rediscovery of Gregor Mendel's experiments proving that hereditary traits were transmitted in small chunks called genes. Shortly thereafter, Russian biologist Nikolai Koltsov suggested that an organism's traits would be inherited via a giant molecule made up of two mirror strands that would replicate in a semi-conservative fashion using each strand as a template. This also met with resistance, as Stalin's henchman Trofim Lysenko denounced Koltsov's theory as 'fascistic nonsense', and orchestrated Koltsov's assassination (Birstein, 2013).

The understanding of genes initiated a revolution in hybrid plants that revolutionized agriculture in the 1930s, created a new category of patents on living things, and in the process avoided a Malthusian starvation crisis. Research accelerated until, in 1953, the chemical basis of genes was discovered by James Watson and Francis Crick – the double-helix DNA molecule.

Once we knew 'how' information was encoded, the race was on to see 'what' was encoded in genes. From that point forward, bioengineering became both a possibility and an area of intense research. The potential to engineer life, use biological processes as chemical factories, eliminate disease and feed the planet make this perhaps the most important technology ever invented by man. Until its automation in the 1990s, sequencing genes was a slow, laborious process. Biologist Craig Venter championed the automation of sequencing as an alternative to the slow pace of progress in the US government's Human Genome Project, ultimately obtaining private sector funds from Celera Genomics to sequence the entire human genome. Completion of human genome sequencing was announced in 2000, giving birth to an entirely new industry. Since that time, thousands of genomes have been published, and the cost of sequencing has been declining exponentially (see Figure 10.2).

Our knowledge of genomes – both human and other in organisms – provides platforms for a dizzying array of new innovations. Indeed, genomics-based disciplines continue to proliferate as scientists find new applications:

1. Whole genome sequencing determines the complete DNA sequence of an organism's genome at a single time. This entails sequencing all of an organism's chromosomal DNA as well as DNA contained in the mitochondria and, for plants, in the chloroplast. It provides a basis for understanding the myriad ways in which health can be affected by genetic variations.
2. DNA profiling is a simpler and more restricted endeavour, but is important in identifying ancestry, diseases, criminals and pets.
3. Genetic variations revealed in single nucleotide polymorphisms – a single base pair mutation at a specific locus – are the basis for the study of health factors and traits, as well as personalized medicine, identification, and the efficacy of drugs in a particular person. This is an area of intense study and huge amounts of funding.
4. SNP microarrays allow detection through molecular beacons making use of a specifically engineered probes that fluoresce when attached to a particular sequence of complementary genomic DNA. The arrays use machinery associated with microchip

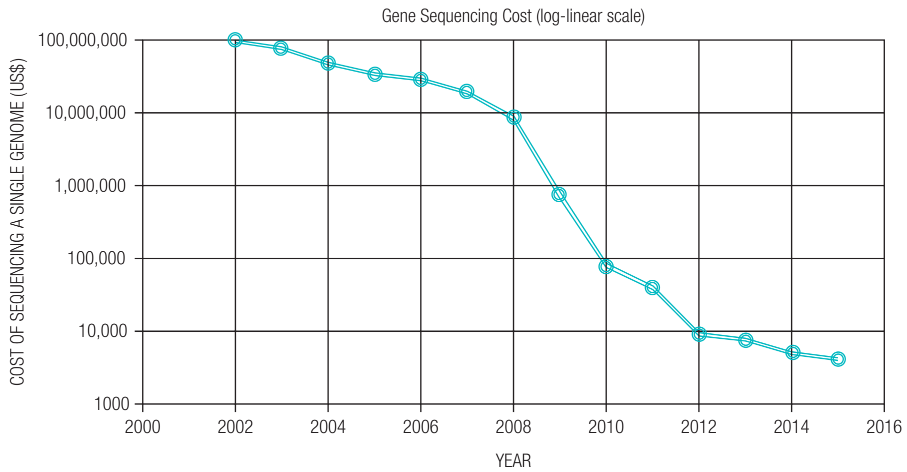

Figure 10.2 The Cost of Sequencing a Genome
Source: National Human Genome Research Institute, www.genome.gov/27541954/dna-sequencing-costs-data

production, repurposing it towards making 'laboratories on a chip'. Companies such as Illumina and Affymetrix have made microarrays with millions of genes available to the wider public for ancestry and personal health via companies such as 23andMe.

5. Biomimetics re-engineers the structures and functions of living organisms for use as models for the design and engineering of materials and machines; it also seeks to better understand the precise operations of complex biological systems.
6. Genetic engineering extends hybridization through direct manipulation of an organism's genome.
7. Biochemical engineering uses biological organisms for chemical engineering. The field involves equipment and processes similar to those used in beer and winemaking for the manufacturing of products like food, pharmaceuticals, chemicals, plastics and paper from genetically engineered organisms.

Craig Venter's project with Celera Genomics was purchasing a significant portion of the output of the PerkinElmer spin-off for automated gene sequencing, Applied Biosystems, Inc., which became a leader in the field. In 2007, Applied Biosystems started selling a new type of sequencer called SOLiD System that allowed users to sequence 60 gigabases per run. The impact of the SOLiD System shows in a sharp decline in sequencing costs from 2007 forward (Figure 10.2).

The Business of Selling a New Technology

New technology brings commercial opportunity, and this in turn tends to usher in a torrent of advice from 'thought leaders' and consulting 'gurus'. The Internet of Things, at the time of this writing, is in just such an awkward initial stage. Thus it is instructive to take a brief look at some of the colourful, specious verbiage generated by writers who are paid to express an opinion, but otherwise haven't a clue. Such advice can be especially entertaining (or irritating, dependent on your perspective) at the very dawn of a new technology offering, when good advice is dearest. But the goal of 'thought leadership' is to prime the capital markets and stimulate the development of new products, and in its own way this approach may indeed work. Let's briefly review some the received wisdom, *c.*2015, about the Internet of Things (IoT). The definition of IoT presented in various white papers by IDC, IBM and Gartner is defined as: 'the interconnection of uniquely identifiable embedded computing devices within the existing internet infrastructure offering advanced connectivity of devices, systems, and services that goes beyond machine-to-machine communications (M2M) and covers a variety of protocols, domains, and applications'. The interconnection of these embedded devices (including 'smart objects') is expected to usher in automation in nearly all fields, while also enabling advanced applications like a 'Smart Grid'. The term 'M2M' begs to be singled out – 'thought leaders' like to present the world in terms of two-by-two charts (and indeed our current text is not averse to this); recently business models have tended to converge on the 'agent' 2 (= 'to') 'agent' cliché to name models of internet-enabled businesses. M2M is essentially one such cliché where the agents are embedded devices (machines).

The point of this little digression is that it is important, when a technology is still in early stages of development and commercialization, to take the words of industry 'thought leaders' and 'gurus' with a grain of salt. Bill Gates, in the early part of 1995, called the internet a 'fad that would pass'. He quickly recognized his mistake and shortly thereafter redeployed about 10% of Microsoft's workforce to internet projects. If a savvy manager like Gates could get an emerging technology so wrong, imagine the opportunities for prediction error in random groups of journalists and self-selected 'gurus'.

Business Models in an Era of Smart Objects

The range of components and services presented under the IoT rubric is so rich and varied that getting your business models right, and understanding potentially successful business models fraught with uncertainty, becomes itself a risky task. Nonetheless, as with other businesses in this book, we can apply our basic consumer-oriented models to IoT components and services to discover important market niches. IoT sits at the juncture of several very distinct component technologies – large-scale computing, micro-fabrication, sensor and motor technology. So expect the performance-to-price point in each of the component technologies to accelerate rapidly, creating a rapidly evolving and complex interplay of product possibilities.

Event-Driven Business Models

Software programming has evolved significantly from its nascence. The computation equipment available in the first half of the 20th century did not strongly differentiate between hardware and software. That distinction formally arose in a computer architecture described in 1945 by the mathematician John von Neumann. Early software merely referenced hardware devices, but

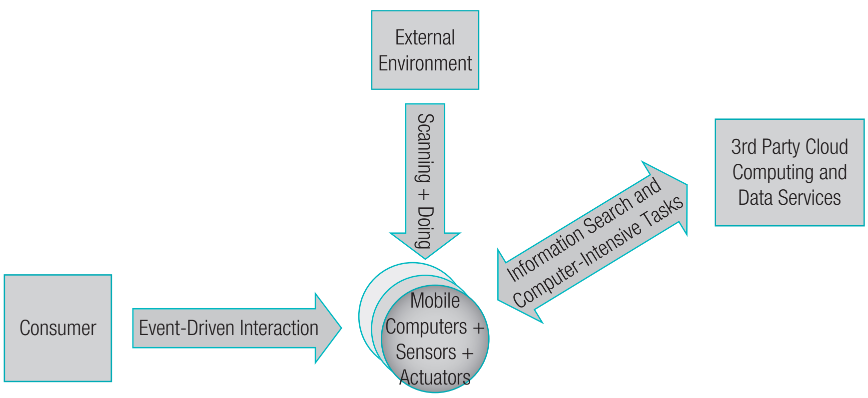

Figure 10.3 Generic Model for Internet of Things (IoT) Applications

invention of compilers and procedural languages by Grace Hopper and others abstracted the design of things that computers could do from the hardware that actually did things. As hardware grew more powerful and expanded the functions possible, more elaborate programming and data storage were needed. Communications protocols, database management systems and object-oriented languages evolved to let humans design the exponentially expanding power of computer technology. Rapid advances in mobile platforms with smartphones, starting about 2006, made it necessary to interact in real time with computer hardware, computing and data resources, and this fomented rapid advance in what is called event-driven computing.

The 'event-driven' paradigm has been a model for real-time interaction and shows up in many modern information systems models. For some time it has been a staple of algorithmic securities trading, and resulted in market anomalies leading up to the 2008 financial crisis. Michael Lewis's book *The Big Short* (2011) provided, for example, a detailed narrative of event-driven trading in the credit default swap (CDS) and collateralized debt obligation (CDO) markets, which some have claimed was responsible for the 2008 financial crash. He chronicles the strategies of Cornwall Capital, which built a $110,000 investment into a $120 million fund using event-driven investment. Cornwall's investment strategy exploited the chaos surrounding unexpected corporate events like earnings calls, mergers, bankruptcies and so forth, incorporating event-driven modelling concepts from computer science that have grown essential to designing products and business models for the Internet of Things.

Cloud Computing, Large Datasets and Cloud Supercomputing

The vendor term 'Big Data' has come to signify an evolution of data storage that is increasingly competent at manipulating non-numeric data modalities – text, images, videos, music and so forth. Information has become a major asset for firms; a fact that is reflected in corporate valuations. The stock market valuation of the S&P 500 companies (which include many traditional industries such as oil and autos) has grown increasingly higher than the accountants' book valuations, which track traditional physical assets. Though not all reflect the growth of information assets, certainly these are a major portion of the 80% of firm value, as reflected in market capitalization, that is not rooted in physical assets.

Since the 1980s, accounting has evolved to focus less on physical things, and more on intangibles and information. Information is increasingly the asset of value in firms, and IT provides the tools to manage, process and deliver information products and services. In 1980, most of firms' value was comprised of physical goods accounted for in the financial statements; today two-thirds of the typical firm's value derives from 'intangible' assets. Much of this 'intangible' value is held in databases, intellectual property, proprietary processes and individual expertise.

Information technology plays a pivotal role in financial control and audit: most if not all financial data is now digitally recorded and dispersed among servers, clouds and networks of computers over which the audited firm has no control. Intellectual property, accounting, finance, IT, and risk data now comprise most of the value of the firm. Financial audits are critical mechanisms ensuring the integrity of information systems and accurate reporting.

The rise of information economies is not limited to just one country, but is a global phenomenon, and one that increasingly integrates business across cultures and political boundaries. Urban planner Richard Florida has quantified this in a number of studies that investigate the role of information creation in the success of economies.

Florida has argued compellingly that economic performance today is heavily tied to 'creativity', and that this linkage is intensifying. Figure 10.4 shows one of Florida's charts linking creativity to economic output of countries around the world, with a coefficient of determination of 70% (Martin Prosperity Institute, 2015).

This growth in digitized information has forced a revolution in the way that data is stored

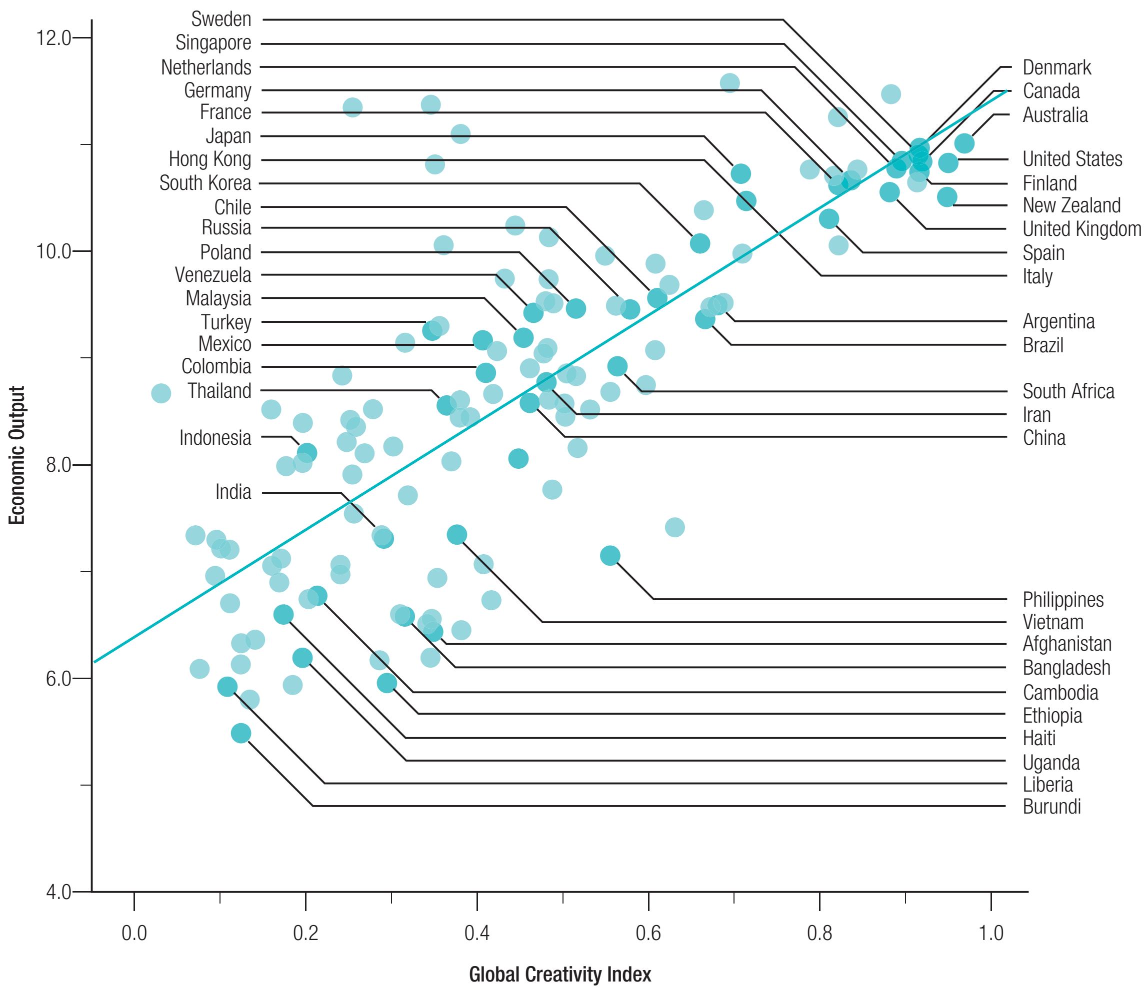

Figure 10.4 Creativity Index and Economic Output (2015)
Source: http://martinprosperity.org/media/Global-Creativity-Index-2015.pdf

and managed. Data organization in cloud computing services today is substantially different from the corporate databases of two decades ago. Global annual data production is now around 10 zettabytes (ZB = 1 trillion GB), and only about 0.5% of this is actually analysed. It is this exponential growth, and the current gargantuan investments in data, to which we are referring when we use the term 'Big Data'. In every stage of information processing – capture, transformation and storage, and interpretation – information technology has become essential.

A growing wealth of data originates from emerging markets, which now comprise about half of new information generated. The majority of data is created and consumed by consumers – watching digital TV, interacting with social media, sending camera phone images and videos between devices and around the internet, and so on. Interestingly, corporations have liability or responsibility for nearly 80% of the information in the digital universe. They deal with issues of copyright, privacy and compliance with regulations even where transient data on their clouds, networks and server farms is created and consumed by consumers.

The mode in which data is presented has changed dramatically over the past century.

Most digitized data was in columnar 'spreadsheet' format still through the 1980s. Increased bandwidth, storage and processing power has allowed richer formats to dominate over the past two decades. Much of the information needed for effective auditing is now encapsulated in these more complex modalities. A great deal of the growth in information has been driven by user creation through social networks and multimedia (videos, pictures, music). There is also a rapid growth in transient data – phone calls that are not recorded, digital TV images that are consumed but not saved, packets temporarily stored in routers, digital surveillance images purged from memory when new images come in, and so forth.

Innovation in digitized information is advancing rapidly in three areas associated with this exponential growth:

1. data types, which are expanding because of the vast number of types of sensors provided by the smart objects in the Internet of Things.
2. organization and accessibility of data in non-numeric modalities – text, video, music, etc.
3. methodologies for summarizing massive amounts of data and making useful decisions from this data. Machine learning, artificial intelligence, pattern recognition and other technologies are opening up many new uses for digitized information.

Tim O'Reilly on the Internet of Things

Tim O'Reilly, the originator of the Web 2.0 concept, has been actively developing his views on the Internet of Things (IoT). O'Reilly observes that contrary to the standard financial and managerial objectives of gaining efficiency from putting various devices online the IoT is really about human augmentation. But useful applications are inherently different when built on sensors, actuators and data. O'Reilly cites the example of Uber, a company built around location awareness. An Uber driver is an augmented taxi driver, with real-time location awareness. An Uber passenger is an augmented passenger, who knows when the cab will show up. Uber is about eliminating slack time and worry. He notes that people would call Uber's technology application 'IoT' if it utilized a driverless car, but in fact Uber's business already utilizes the IoT. You can measure, test and change things dynamically at Uber through the interpolation of computer hardware and software into all parts of the business. It is more than just a single sensor in two-way contact with remote cloud servers, or a driver and a rider with a smartphone. There are many different data sets, and many different feedback loops. The 'Things' themselves have characteristics that are contingent on context (much as we saw methods in object-oriented code being contingent on their specific usage). These 'Things' are on demand; they are load-balanced; and they are aware of other parts of the system. IoT offers a pre-eminently context-oriented world, but with significantly better data and a sophisticated reciprocation between humans, interfaces and machines. The pressing question when you have all of this information and actuation capability is the design of the human interface, where IoT is still developing suitable models. The tendency with new technology is to apply it in exactly the same manner as the technology it replaces. This is inefficient and sometimes silly. Consider the example of electrical motors. When efficient electrical motors became available in the late 19th century, they were typically installed as a direct replacement for hot, bulky, dirty steam engines, with a vast array of pulleys, shafts and gears to spread power over the factory. This was inefficient and hugely dangerous for factory workers. By the 1920s engineers had gotten the installation model right – small motors were placed directly under the machines they powered, and electrical wires were used to distribute power. Power losses dropped from around 50% to close to 0%, and 20th-century factories were much safer, cleaner places to work. In retrospect this is obvious, but it took close to 50 years for industry to figure this out.

(Sources: Kirkpatrick, 2010; Hardy, 2015)

IoT for the Masses: Arduino and Raspberry Pi

In 2016 Arduino and Raspberry Pi were offering $35 Internet of Things computer platforms and software ecosystems originally designed for the classroom. Each device has power that only a decade earlier would have been state of the art. Raspberry Pi's organization is a charity with a customer base of around five million, providing a fully functional computer. Arduino boards and their open-source clones have a customer base of around two million, providing a microcontroller, and thus lacking a full operating system.

The Raspberry Pi was introduced in 2012 from its headquarters in the UK and run by Eben Upton and his colleagues at the University of Cambridge's Computer Laboratory. Upton was frustrated by both the dwindling number of computer science students and their lack of skills. The Raspberry Pi was designed to be a cheap, accessible computer that would attract students to embedded programming – i.e. the programming of 'Things' vs. bespoke computers.

The Arduino, on the other hand, was developed in 2005 at the Interaction Design Institute Ivrea in Italy and named after a local bar. Its inventor Massimo Banzi and his co-founders conceived the device as a simple hardware prototyping tool for his design students. It is fully open-source, so many variants of the device are made with a number of different chip manufacturers.

The Arduino and Raspberry Pi each have their own constituencies arising from their differing capabilities. The Raspberry Pi, with clock speed 40 times that of the Arduino and with 128,000 times more RAM, is a stand-alone computer that runs Linux, multitasks, supports standard ports, outputs HDMI and connects to the internet. It's ideal for complex tasks like media servers and calculators, and indeed comes with a free, fully functional version of Wolfram's Mathematica. In contrast, the Arduino doesn't support a full operating system, and thus uses less power. Arduino boards are microcontrollers, not full computers; they emphasize 'real-time' and 'analogue' capability that the Pi does not, a flexibility that allows them to work with many kinds of sensor or chips. They lack the basic tools an operating system provides, but also avoid the operating system overhead, and you can leave an Arduino plugged in a long time, and just unplug it when you're not using it – ideal for IoT devices. The Arduino has already found widespread application as an open-source flight-controller for drones through the ArduPilot project.

Because of their accessibility, and a growing and active community of hobbyists, both Arduino and Raspberry Pi are the modern-day counterparts to hobbyist computers of the 1970s, most notably the Altair 8800 where Paul Allen and Bill Gates began coding and which inspired them to start Microsoft. The Altair 8800 design was largely copied by Steve Wozniak's in the Apple I in his quest to put his own stamp on the industry. Both devices benefit from large active user communities. In the future we can expect to see a rapid growth in entrepreneurs turning Arduino or Raspberry Pi-based Internet of Things projects into blockbuster products that will transform markets in robotics, home automation and many other personal uses of technology.

Innovation Workout: Advertising with Keywords

20th-century retail innovator John Wanamaker lamented that 'Half the money I spend on advertising is wasted; the trouble is I don't know which half'. This all changed radically in the opening years of the 21st century when search giant Google applied Eugene Garfield's bibliometric tools to advertising. Google takes cues from keywords input to its core search engine, and translates these to deliver relevant ads to consumers. Facebook has extended this model, taking cues from friendship and posting networks, political views, interests, and numerous other measures of a consumer's social life, translating these into relevant ad placements. Together these two internet giants control 40% of the $150 billion internet advertising market, with additional share controlled by internet retailers Alibaba and Amazon. Internet retailers waste very little money, and when they do they know about it quickly.

Massive dollar flows in electronic commerce have ushered in a golden age of consumer research, making available nearly limitless volumes of data on consumer interests, personalities, demographics, intentions and purchase actions all funnelled through our favourite internet browsers. Machine learning, statistical analysis and graph theory have reached an unprecedented level of integration in R, Mathematica and other tools, and can reliably compute demand curves, elasticities, surpluses and other mathematical depictions of consumer behaviour. Google, Facebook, Amazon and other internet firms make it a priority to share marketing data with users and researchers, offering APIs, code bases, and state-of-the-art analysis tools.

The wealth of new data and tools being freely distributed to researchers should have encouraged an explosion of innovation in consumer research. So far, academe has been slow to profit from the abundance. Rensis Likert (1932) created the categorical response questionnaire when few alternatives were available, before the time of computers, data communications and econometrics. It has proved an invaluable tool for researching politics, opinions and demographics as long as strict protocols are applied to assure consistency and validity of responses. In awkward contrast to the 'electronic' in e-commerce, questionnaire research favours pencil and paper methods and abstract perceptions over concrete actions like purchases. Stylistic conventions in questionnaire research often give too little attention to whether data actually reflects underlying sentiment, and there are resulting mismeasurements of vaguely defined 'perceptions' in contrived 'theory' frameworks. These methods were accepted before widespread digitization, and indeed have a current role in special circumstances such as political polling. But in consumer research they cannot compete with more immediate, accurate and reliable methods analysing an unprecedented wealth of tangible real-time data.

This workout invites you to join the ranks of 'Big Data' researchers, fuelled by internet data – purchases, healthcare and medicine, interests, recommendations and so forth – made available through the rise of e-commerce. Search engine marketing jobs alone contribute almost $30 billion a year in salaries in the US. Interest will be spurred by increased market orientation of regulated industries like healthcare. Consumer analysis ecosystems now fund some of our best mathematicians, account and campaign managers, copywriters and research labs that turn consumer ratings into saleable products. Your marketing role models in this workout should be Nate Silver rather than Don Draper; your tools from the Google advertising tool, AdWords.

1. **Quiz**: start by choosing a particular customer demographic that you want to target. Don't choose a product or service yet. Instead, think of the problems that this particular group might need to solve on a recurring basis; or think of opportunities that would motivate them to buy from you. Identify your customer, and their needs, through quizzing and mind maps.
2. **Distil into product features**: once you have determined a particular set of activities, needs, opportunities or whatever that might motivate these customers to buy from you, distil these into the two or three main product or service features that are of most interest to them. Figure out how you would incorporate these into a saleable product, and position the features on a feature map.
3. **Differentiators**: figure out what differentiates your product from competitors' products. At this point, you may want to revisit your customer group to determine if perhaps this should be two groups with different expectations; or whether your market can be expanded for this particular product.
4. **Channels**: draw a consumption chain describing what needs to be done to make customers aware that you exist and to convince them to part with their money for your product. What has to go right for the customer to progress completely through the consumption chain? What will be your conversion rate (number of paying customers divided by number of potential customers)?
5. **Competitors**: who are your competitors and what is your entrance strategy? What will you say to convince customers to choose your product?

6. **Keywords**: take all the information you have collected so far to identify three keywords to acquire at Google's AdWords site that will best identify the customers that would buy your product. These keywords, when searched for on Google, will then display your advertisement to your chosen customer group. How much will these keywords cost, and how much traffic will they bring to your website? (You can access tools at Google's AdWords site that provide estimates of this information.)
7. **Advertisement**: write 25 words of advertising that will entice potential customers to click on your sponsored link.

Case Study: Da-Jiang Innovations

Marketing the Internet of Things

> I was a model enthusiast, but my planes often crashed. So it was my dream to develop this technology. (Frank Wang Tao, Founder, CEO and CTO of DJI)

The Billion-Dollar Drone Company

By the end of 2014, Da-Jiang Innovations, maker of the popular Phantom quadcopter drones, was tracking towards another banner year. The company earned $500 million in revenue in 2014, a figure it would more than double in 2015, solidifying its position as the leading manufacturer of consumer-friendly flying robots. It was moving into the design and marketing of professional and industrial platforms priced in the tens of thousands of dollars. Civil sector applications were proliferating and a wide range of international public service agencies and private corporations were relying on unmanned aerial vehicles (UAVs) for diverse, civil and commercial uses such as inspecting oil pipelines and electrical lines, surveillance, and search and rescue.

But DJI was also looking over its shoulder, and hoping to secure enough venture capital to fend off rivals like 3D Robotics and Parrot. It collectively raised $108 million in 2014, but needed more as the industry heated up. Things were looking up from a regulatory risk standpoint: In February 2015 the Federal Aviation Administration released revised rules for drones that paved the way for broader adoption. Drone enthusiasts, who had been facing increased pressure from local law enforcement, welcomed the new regulatory framework with a sigh of relief.

DJI, one of the nascent industry's market leaders, has carved out one of its most lucrative niches, landing it on Fast Company's 2014 list of the Most Innovative Companies. Its drones are easy to set up and priced for consumer use – the first Phantom, for example, retailed for less than $1000, but was capable of capturing professional-quality images. In contrast, 3D Robotics entered the market by catering to DIY hobbyists, and Parrot built its reputation on introductory models that are more toys than tools.

That positioning has worked to DJI's advantage, freeing it from having to develop custom functionality for specific industries while making it the drone of choice for commercial operations. If archaeologists or firefighters want to modify a DJI drone for a specific use, they can use the company's open platform to develop applications.

Compared to the skittish but acrobatic Parrot AR.Drone, DJI's Phantom is indeed a pleasure to fly. I've found that it remains stable even in high-wind conditions, returning big-screen quality video when a GoPro is attached via a gimbal (camera stabilizer).

'It's a tool that inspires creativity and innovation', Perry says. 'We try to inspire people by showing the breadth of what it can do.'

A Brief History of Drones

The earliest references for vertical take-off and landing (VTOL) devices appeared in China with bamboo flying toys in the 5th century BC. Hydrogen-filled toy blimps were flown around music halls in the late 1800s, radio controlled by electrical spark-gap transmitters. Soviet researchers in the 1920s experimented with twin anti-torque propeller arrangements using small models, as did US VTOL pioneer Igor Sikorsky. Quadcopters with two clockwise and two counterclockwise propellers in an anti-torque arrangement, though promising because of fewer linkages and greater reliability, were tried and discarded. Flying them required pilot reflexes hundreds of times faster than was humanly possible.

Igor Sikorsky ultimately championed the single vertical rotor helicopter format used in his successful R-4 helicopter, which worked at human scale, but became unflyable at 1/10 scale or smaller due to the need for rapid control inputs from the pilot. Arthur Young solved the scale model helicopter problem in the 1940s with the Bell-Hiller flybar mixer, and by the 1990s crude microcontrollers with gyroscope and Venturi sensors further improved model flyability. But quadcopter remote control (RC) remained outside hobbyists' capabilities until the development of affordable and powerful microcontrollers with micro-sensor arrays in the mid-2000s.

The modern drone – also called the unmanned aerial vehicle (UAV) – was invented and transformed into a world-changing technology by a cast of characters no novelist could conjure up – iconoclasts, for the most part, who had vision. It all started, oddly enough, when defence contractor General Dynamics created its General Atomics division in 1955 'for the purpose of harnessing the power of nuclear technologies for the benefit of mankind' (a job that it singularly failed to do). General Atomics was sold off 15 years later, changing hands between oil companies, before two brothers, Neal and Linden Blue, bought it in 1986 for $60 million.

Neal and Linden Blue had grown up in Colorado. The sons of a real estate investor and the state's first female treasurer, the brothers were attracted to aviation from their youth. As teenagers they flew a small plane over the Andes, a feat that earned them the cover of *Life* magazine.

The Blues' inevitable ascent within the aviation industry dovetailed with a developing hatred for communism. Eventually the brothers set up shop in Nicaragua, running a cocoa and banana plantation with the family of former President Anastasio Somoza, the notorious dictator who was overthrown by the Sandinista Liberation Front, the socialist party that prompted the Reagan administration to illegally funnel weapons to the Contras.

So it was an urge to help their friends fend off freedom fighters in Central America that had the Blues first warming up to drones. 'You could launch them from behind the line of sight', said Neal, figuring that light aircraft could be used to destroy Sandinista's oil pipelines. 'You would have total deniability.'

The Blues proceeded to engage a host of colourful characters who shared their (rather perverse) vision – a former Israeli aeronautical engineer, a couple of fighter pilots who saw the potential of planes with no pilots and forced them on the air force, a Pentagon operator named Snake, and so forth. Abraham Karem, the aforementioned Israeli weapons designer and designated leader of the company's small team, constructed a device in his Hacienda Heights California garage that, after some alterations and updates, would become General Atomics' MQ-1 Predator drone.

Initially, General Atomics' MQ-1 Predator drone was regarded as something of a joke. The unmanned craft faltered in the skies over the Balkans, shot down handily by anti-aircraft fire. According to a senior defence department official, 'A good number of them were lost due to operator error. It's hard to land this thing…so we have a lot of losses just from hitting the ground.' Of the 68 Predator drones first sent to the air force, 19 were lost.

Drones, and by extension the Predator, had a public relations problem. In an attempt to scrub away the devices' negative image, the Blue brothers hired Thomas J. Cassidy Jr., a former navy admiral, to convince his old colleagues that drones were the wave of the future. On 6 September 2001, Cassidy gave a presentation detailing the potential attributes of the Predator to an assembly of firefighting officials and scientists. No offers were made. Five days later, with the World Trade Center towers still smouldering, General Atomics' trajectory was radically altered. 'That's when the phone started ringing off the hook', Cassidy told the *Los Angeles Times*.

It didn't take long for the increasingly successful technology to pique the interest of hobbyists, and it was into this environment that Da-Jiang Innovations (DJI) started producing hobbyists drones in China in 2006. The next year, in October 2007, 3D Robotics was founded in the US by British-American author and entrepreneur Chris Anderson, while existing companies like France's Parrot extended their product lines into drones.

Headquartered in Shenzhen, People's Republic of China, DJI was a global leader in developing and manufacturing high-performance, reliable and easy-to-use small unmanned aerial systems – for commercial and recreational use. The company was set up in 2006 by Frank Wang Tao, then a 24-year-old Master's degree student of electronic and computer engineering at the Hong Kong University of Science and Technology. DJI started with a suite of flight-control technologies and helicopter autopilot systems targeted at remote-controlled aircraft hobbyists. Subsequently, Frank shifted the company's focus towards aerial photography by spearheading the development of a number of DJI's technological breakthroughs; from small unmanned multi-rotor autopilot systems to large unmanned modular flying systems for commercial use.

DJI's biggest success came with the launch of its groundbreaking product, Phantom, a 'ready-to-fly' quadcopter aimed at the hobby market, in January 2013. The Phantom proved to be a game changer because of its unique design in terms of its ability to carry a camera, coupled with ease of flying and navigation even for beginners – at an accessible price point. With rave reviews from users, Phantom gained rapid market acceptance and DJI started selling thousands of units per month by mid-2013. Sales volumes grew 79 times in 2013 compared to 2011. Through product innovation, Frank had succeeded in creating a new market space, pulling in an entirely new group of customers who were previously non-customers of this industry, i.e. people who had never flown a RC copter as a hobby or for aerial photography.

By the end of 2013, DJI had an overall market share of approximately 80% for small unmanned aerial systems, earning 60–70% gross margins. DJI achieved annual sales of US$131 million, with a three- to fivefold increase in year-on-year revenue per year. Supported by employee base of 1000 and multiple product lines, DJI's global operations spanned North America, Europe and Asia. But Frank was far from complacent, being fully aware that competitors were striving to secure a slice of this profitable market. He deliberated upon a three-pronged strategy:

1. Maintain DJI's lead position in the hobby market via incremental innovation to develop next generation products integrated with intelligent devices;
2. Penetrate the commercial market for aerial photo/videography; and
3. Develop completely new technologies to create new markets.

The Evolution of Component Technologies

Remote control flyers prior to around 2008 fell into two classes – ready-to-fly toys and build-it-yourself hobbyist kits. Toy airplanes and helicopters were charged with batteries and controlled via remote controllers with joysticks by the pilot on the ground within line of sight. These had been around since the 1970s and typically cost under $50. In contrast, hobbyist radio controlled airplanes and helicopters had grown in popularity through the 1990s.

Until about 2008 this was a hobby for a select group of people who were patient (and wealthy) enough to endure the inevitable crashes and component failures in their bespoke, self-assembled models. Indeed, the technical challenges of building these models were daunting, requiring knowledge of electronics, radio frequency and soldering as well as time and expertise in learning to fly the aircraft. Such hobbyists were supported by fellow flyers and online communities catering to all forms of RC flying. They were, however, limited to flying from their fields and scarcely flew above people, population and property.

The introduction of Apple and Android smartphones in 2007 spurred a whirlwind of development in micro-fabricated sensors. Each smartphone needed about two dozen sensors – accelerometers, gyroscopes, proximity sensors, heat sensors, cameras, sound and so forth – to assure a satisfactory customer experience and keep up with the competition. The subsequent exponential growth in performance to price made available a constellation of cheap sensor and actuator components of use in robotics.

Micro-fabrication and advanced manufacturing technology spurred a growing adaptation of accelerometers, gyroscopes, GPS units, simple-to-use software and interfaces mixed with sophisticated and light hardware for the intelligent devices industry. The multifold demand growth turned these components into commodities with the associated drastic reduction in price. Many start-up companies appeared to sell off-the-shelf, ready-to-use, relatively cheap and affordable components for stabilization systems, autopilots and waypoint navigation. Robotic drones were increasingly easy to design, configure and fly. Online sites started selling frames, motors, electronic speed controllers and a variety of controller board options ranging from cheap manual controllers to expensive GPS-based self-stabilizing navigation systems. Typically, none of these components were commercial or industrial grade. Often, more skill was required to select the right components which could be better matched and assembled for higher performance. All forms of advice flowed across the internet in the form of abundant how-to videos, guides and forums showing the build process, assembly, configuration and set-up, which gave a boost to this hobby.

By 2012 hobbyists' platforms with cameras and 'first person view' (FPV) goggles were becoming commonplace. This involved mounting a camera to the hobby-grade RC airplane or helicopter which, coupled with a technology which allowed the pilot to look into a pair of goggles that displayed the aerial video captured in real-time, made many people consider this set-up as a drone. Users controlled the drone's direction in real time, which felt similar to piloting an aircraft from inside a cockpit. Flying an aircraft with FPV required some knowledge of antennas, video transmitters, receivers and displays (LCD or goggles). Such models typically started at around $500 and could go up into the tens of thousands of dollars.

The Global Positioning System (GPS) guidance was also coming into the mainstream. GPS got its start on Labour Day weekend in 1973, at a Pentagon meeting that created the Defense Navigation Satellite System. Ronald Reagan made the system available for consumer use after the Korean Air Lines Flight 007 disaster in 1983, though the GPS system was not fully completed until 1994 when the 24th satellite was placed in geosynchronous orbit.

The GPS system concept is based on time, comprised of satellites that carry very stable atomic clocks which are synchronized to each other and to ground clocks. A GPS receiver monitors multiple satellites and solves equations to determine the exact position of the receiver and its deviation from true time. At a minimum, four satellites must be in view of the receiver for it to compute four unknown quantities (three position coordinates and clock deviation from satellite time). Relativistic corrections as well as corrections for non-circular orbits are demanded by the technology.

Despite their complexity, platforms with GPS guidance have become the ultimate hobby drone platform – you can place any kind of payload (e.g. a high definition camera) on them, programme the GPS track and send it off on its job. With this level of sophistication, the lines between hobby platforms and surveillance equipment (and hobbyists and professionals) were becoming increasingly blurred. The ability to programme an exact path instead of manual steering makes the technology promising for photography. For example, hobby-class drones could be used for commercial applications such as close-up inspection of structures that were not easily accessible or for creating video fly-throughs of golf courses and environmental areas. Also, the level of interest in multi-rotor aircrafts increased dramatically since early 2010s with enthusiasts, hobbyists, entrepreneurs and aerial photographers embracing the still-young technology as a creative new pursuit. What was once thought of as a 'good idea' but beyond the practical limitations of available technology was becoming commonplace, priced in the range of $500 to $1,500.

Drones are the initial foray into the Internet of Things, and are on target to rival the exponential performance/price improvements of the PC in the early 1980s. But unlike the PC, there are significant privacy and safety concerns connected with drones. These will be resolved, but currently limit some applications of the technology.

Regulations

From 2010 to 2020, the US was predicted to remain the largest producer and operator of UAVs (including military applications), accounting for about 45% of the global market. But legislative and regulatory issues in the country were perceived to have significantly delayed the emergence of the commercial UAV market. The US Federal Aviation Administration (FAA) rules prohibited commercial use of UAVs. Taking video for personal use (including YouTube) was allowed, but such videos could not be sold for business purposes. Rules that applied to drone hobbyists were the ones that had been issued to model aircraft enthusiasts since 1981. Hobbyists flying remote-controlled helicopters or multi-copters were subject to strict guidelines, i.e. that they be kept below 400 feet above ground level; flown a sufficient distance from populated areas and airports; and within the operator's line of sight. Their use was permitted only by universities and public entities, and required a certificate of authorization. For example, researchers at universities could use UAVs for airborne experiments in a wide range of fields from real-time complex PID optimization algorithms to air quality sampling. Federal, state and local agencies could apply for FAA waivers to be able to put drones to work for search-and-rescue operations.

There were 30 states attempting to pass legislation against drones to protect citizens' privacy. In a bid to force a reassessment of the regulations, the US Congress legislated the FAA Modernization and Reform Act of 2012, instructing the FAA to develop a comprehensive plan to safely accelerate the integration of civil unmanned aircraft systems into the national airspace system. The law set a deadline of September 2015 for the FAA to create regulations and technical requirements that would govern the commercial operation of drones.

In December 2013, Jeff Bezos, Founder and CEO of Amazon, announced that the e-commerce giant was testing delivery drones that could someday deliver customers' packages in half an hour or less (Joel, 2013). It was also reported that UPS, the world's largest parcel service, and FedEx were experimenting and evaluating different approaches to drone delivery. The gradual opening of controlled airspace to UAVs envisioned a $5 billion-plus industry of camera drones used for various purposes and industry analysts predicted that the market would double in less than a decade.

Da-Jiang Innovations: The Early Years

Launching a new enterprise – a tech start-up, small business, or an initiative within a large corporation had often been a hit-or-miss proposition. The emergence of transformational technologies, fragmented markets populated by demanding and sophisticated customers, and aggressive competition were the three factors that that pushed new product development to the centre of the playing field. For a small start-up company like DJI, there were limitations in terms of resource bandwidth needed for new product development. Several tough go/no-go decisions had to be made throughout every development stage to ensure that scare resources were allocated appropriately.

Frank Wang Tao had long been enthusiastic about remote controlled helicopters but he did not have the money to buy one. When he achieved outstanding academic results in high school, his mother gifted him with 10,000RMB to buy his first model helicopter. With great anticipation Frank assembled his helicopter but his excitement quickly turned into disappointment when it crashed soon after he flew it. This experience fuelled in him a strong intention to create a RC helicopter which would be easy to control. He salvaged the parts of his broken helicopter and worked towards putting it back together again. As he continued to tinker with it, he was so intrigued that he decided to study electronic engineering at university.

Frank joined the department of electronics and computer engineering at HKUST in 2003. In addition to course projects, he started reading up extensively on open source projects about autonomous helicopters. He applied this learning through active participation in various robotics competitions, leading the university's Robotics Team to take the first place in Hong Kong and third in Asia in the Asia-Pacific Broadcasting Union Robot Contest in 2005. For his Bachelor of Engineering final-year project, he chose to make a functional prototype of a mini-helicopter that could be controlled on the ground. He teamed up with two other students, each with an allocated budget of HK$7,000. Frank put his salvaged helicopter to use and the team set to work in earnest. He felt that this was a good way to begin – with existing components, and then adding on new components using smart software coded by them.

They spent one year making the first prototype. During this period, they researched published papers as well as open source projects on the internet to understand and interpret the multiple technical challenges therein. According to Frank, there were two main software components that were needed for flight control: (1) attitude position and (2) velocity estimation. The basic components required were the flight-controller board which kept the helicopter stable while flying; helicopter frame kit consisting of appropriate motors, electronic speed controllers and propellers; and radio transmitters and receivers.

The principal challenge that Frank struggled with was making the helicopter hover at a position using data from the GPS, i.e. it would remain stationary in the air while there was no input from the remote control. At the time of the final demonstration of the project, Frank could not achieve this. 'We had tried but the experiment failed. I realized it was still 20% unfinished.' Thereafter, he spent 2–3 months at home working day and night until he achieved the target of automatic hovering – a milestone. He had accomplished what he had once dreamt about and gained technological prowess in the process.

Inception (2006)

After graduating in the summer of 2006, Frank immediately joined the postgraduate programme and continued to improve upon his first prototype. He had a strong mentor in his supervisor, Professor Zexiang Li, who gave him freedom and encouraged his efforts. Having successfully achieved the hovering criteria, Frank focused on forward/backward movement, in order to make the helicopter easy for anyone to control without practising for months.

> Professor Li was involved in robotic arm projects; nothing to do with UAVs. Even though I was his postgraduate student, I was not following his research area. I even thought that he may ask me to quit because I was doing my own thing. But that did not happen and after one year he saw potential in my prototype model.

Although he had not started with any business intention, Frank was motivated by the success of his first prototype to convert it into a product that he could sell. He was determined to make the dream of flight accessible to everyone. With technological innovation as the cornerstone, Frank established his own start-up company, DJI, in 2006. He rented an 80 square foot office in Shenzhen and the two teammates from his bachelor's degree project days joined his venture.

Frank's target market comprised users of hobby-grade helicopters who typically purchased individual parts of the helicopter from hobby shops and assembled them for recreational flying purposes. Parts could be replaced (in case of a crash) or even upgraded to get better performance. DJI's initial customers were Chinese hobbyists, a very small niche market which Frank accessed through the internet.

Initially he sold an integrated product – helicopter and controller. He was able to sell one unit every two months. Customers were willing to pay 60,000RMB (around $10,000) per unit, a reasonable price based on prevailing market prices at the time, but they expected extensive product support. At times, Frank even had to fly to Shanghai to help with installation. Being based in the industrial area of Shenzhen, Frank was able to drive his costs down in terms of salaries, rentals and prices of electronic parts. Consequently, his unit cost price was 15,000 RMB and he could sell one unit and could manage to pay the salaries of three people for 3–6 months. DJI had limited capital to invest in in-house fabrication and Frank bought module components such as electronic printed circuit board (PCB) assemblies for controllers from third-party suppliers. Frank sourced for those suppliers who were agreeable to give small quantities at low cost. The quality could be a little lower than he wished but still good enough to begin with.

Second- and Third-Generation Products (2007–2013)

DJI remained small for the next few years. Frank and his team went on to build the second-generation product (helicopter and controller combination) which they were able to price lower at 20,000RMB. At this price point, DJI's sales increased to 20 units per month from a wider customer base including the US. For this model, the unit cost reduced to about 3000RMB. Frank was able to bring down his costs by five times by starting to make in-house electronic modules, as he had developed some of the required technology to do so. Furthermore, he secured discounts on the purchase of more basic components.

Encouraged by this growth, Frank decided to hire some additional people to work on the third-generation product. Prof Li supported Frank by introducing students to join DJI and he also invested in the company. There were many components that still needed to be sourced or made to order from suppliers. At that point, DJI was able to take advantage of market trends whereby the prices of high-quality components such as sensors and GPS units were being pushed down by the booming mobile phone industry and proliferation of handheld devices. Frank coupled low-cost, high-performance electronics with his core competence in developing advanced stabilization and positioning software to automatically pilot the UAV. DJI's third-generation helicopters have been sold in Amazon with prices ranging from US$470 to 1150 with very nice gross margins at better than 70%. Controller came out as a technology-leading product competitively priced at several thousand dollars a unit, which cost about 1000RMB to make with sales standing at 50 units per month. The cost and complexity of operating UAVs had presented barriers to explosive widespread adoption and Frank aimed to address these challenges with his innovation and technology.

Product Promotion

Frank realized the importance of establishing his brand and creating awareness about his products. He believed that within years, China would become a huge market of UAV helicopters for commercial and industrial use. According to him, compared to the market abroad, the bottleneck was not about there being a suitable product or autopilot system, but the limited knowledge that people had about what UAVs were and what they could achieve (Wang Tao, 2013). He decided to create public awareness by participating in relevant exhibitions both in China and globally.

At the 12th China High Tech Fair in 2010, apart from introducing its products, DJI focused on introducing the industry and the idea of future UAV potential to visitors. Again, at the China Aerial and Aviation Exposition, DJI was the only company to perform an on-site flight demonstration. Its UAV helicopter equipped with its own XP3.1 Autopilot system and Ground System Control successfully demonstrated automatic hover, fully autonomous flight in the shape of 8, and beyond visual range flying. Abroad, DJI participated in the National Association of Broadcasters show in Las Vegas which focused on broadcast and television, including related peripheral technology development. The presence of key people from the commercial information industry, news media and telecommunications services gave Frank visibility about the trends of telecom products, technology and services related to communication entertainment and media. In addition, DJI managed to build successful collaborations with several distributors, thereby boosting sales volumes.

Market Shift

While DJI continued lead in developing flight controllers and other components for piloting RC helicopters, some new trends started to emerge. Typically, customers bought the controllers from DJI and gimbals from other suppliers and assembled them together with a camera to shoot aerial photos. In early 2010, one of DJI's clients, a parts supplier who manufactured gimbals, informed Frank that he was selling 200 gimbals per month and 90% of his customers were using multi-rotors. This information caused Frank to pause and he looked around at other companies that also worked with helicopters. He found that most of them were not developing; they either stayed at the same market size as five years ago or had closed down, whereas the market for multi-rotors was growing fast.

Frank took half a year to finally think through all the available information and weigh the pros and cons of multi-rotor models vs. helicopters. The flight time for multi-rotor was low at about 20–30 minutes as it was battery operated, whereas the helicopter could fly for more than two hours (even up to four hours) using gasoline. The helicopter, being bigger, was more resistant to wind and could fly much faster carrying weight of 3kgs easily while the multi-rotor could carry 500 grams. At the same time, the helicopter was mechanically more complex because it had a lot of gearing systems, gear reducers, push rods and several moving parts requiring a lot of mechanical precision. Consequently the cost was high. The propeller was large and stored a lot of energy making safety a key issue; it could destroy property and even hurt people severely. In contrast the multi-rotor was mechanically simple, required less maintenance, and was lightweight and easily portable. Frank, however, was reluctant to change, but as more information came his way he made the decision to make a multi-rotor version. But he was not sure whether this would sell or how much.

Launch of the 'Phantom'

In January 2013, DJI launched the company's most innovative product: 'Phantom', an advanced highly integrated ready-to-fly multi-rotor designed for the mass consumer market. Before the Phantom, building and flying multi-rotor aircraft was a complex task only performed by professionals and extreme hobbyists. This was because similar UAVs on the market were usually in kit form that often required time, patience and mechanical skills for complex building and soldering for assembly. Also flying, navigating and manoeuvring in air required hours of practice to gain sufficient expertise. Announced at the list price of US$679, the Phantom was half the price of competing units. According to Frank, DJI was the first to make publicly available military-grade technology attractive to a broader group of consumer hobbyists than just experienced remote-control pilots.

In addition to having a transmitter, advanced navigation and software control, the distinctive feature of the Phantom was that it came with a mount, designed to carry a small lightweight camera. This allowed customers to mount the camera and gimbal of their choice for video and still photography. For example, third-party cameras such as the popular GoPro Hero or certain models from Sony could be used. Frank envisaged applications for the Phantom for sports, architectural and even event photographers. With 10–15 minutes of flying time, Phantom could be used to record video and photo stills from a thousand feet in the air which used for surveying or advertisements. This was a milestone in terms of creation of a new customer base. Frank explained, 'First you develop a technology and then most of the work is to package the technology in such a way that you can get to the right customers at the right price, with compelling applications'.

The quadcopter's four engines and propellers allowed it to be manoeuvred nimbly to fly on three axes and hover with minimal pilot input. The advanced software used a pre-installed GPS-based autopilot system and a magnetic compass to help interpret the pilot's instructions. Also incorporated were safety parameters, such as a failsafe feature such that the Phantom would elevate to 60 feet and return to its take-off point and land by itself if it lost signal from the remote control unit for any reason. Effectively, DJI had been incorporating features to address the main challenges of piloting and capturing images (much like the automatic modes on a digital camera) which would serve to lower the entry barrier for consumers primarily interested in imaging itself and less in the flying experience.

Phantom became synonymous with the name of DJI and spurred more growth in DJI's business than any other product so far. The company started selling thousands of units every month around the world, with North America being its largest market. Customer base was split between hobbyists who wanted to fly a small vehicle that zipped around and hovered in mid-air, and other buyers who were photography enthusiasts who wanted to use the Phantom to help them shoot aerial photos and videos at special angles. By mid-2013, DJI's portfolio consisted of 15 products in seven different product lines ranging from autopilot systems to ready-to-fly kits, as well as series of products and accessories.

Aerial Filming – Entry into the Service Market

For DJI, a service element had always existed in order to demonstrate to customers the applications of its product. Frank explained that if some client had a piece of land and wanted to check out the conditions then he could approach DJI to provide the aerial photography service. Therefore, the business concept was not to sell the product but to use the product to shoot photos or videos and sell the service. In the early days, Frank himself used to go out and do the filming. He stated that he learnt a lot about product requirements in the process: 'If we are sitting in the office and not flying our own product there will be a huge gap.'

For the service business, with an investment in equipment for 30,000RMB, DJI could earn several times the return on the investment because typically two days of shooting was required to service one customer. The team involved in this job was low skilled, with basic education and minimum training before being employed by DJI. They were trained on the job for one year. They received a commission based on the number of service jobs they completed successfully and sometimes earned more than DJI's highly educated research and development (R&D) talents who earned a fixed salary. This started causing a disparity within the company. Another challenge was that once the service employee had gained experience and client contacts, they were inclined to quit and set up their own business by investing in a RC multi-rotor. Clients also perceived that doing business directly would be more cost-effective for them. Frank sensed that the service business was neither sustainable nor scalable because of these people issues. He was also concerned about the distraction and impact of such issues on DJI's product development efforts.

After deliberation, in a counterintuitive move Frank decided to give up the service business but continued to provide the same service for free as a marketing tool. For example, if movie directors were potential clients, then DJI would demonstrate that their technology could work in the film industry by providing a free aerial filming service. In return, Frank expected that DJI products would receive promotion among peer film makers. At the same time, there was no incentive for staff to leave as the service was being provided by DJI for free. Another factor that helped was that DJI had started lowering the price of its products and was successfully selling larger number of units which meant that customers could buy the product and do their own filming for various needs.

Competitors

While DJI remained at the forefront, with many popular reviews and online sharing of tips, tricks and videos among the user community, there were a variety of RC products which proliferated the market, ranging from DIY models to ready-to-fly multi-copters and fixed-wing UAVs. Some were produced by profitable aerial robotics companies such as Hoverfly Technologies and Draganfly Innovations Inc.; whereas others were venture-backed open source UAV enterprises such as 3D Robotics. In addition, there were several open source communities designing flight-control and autonomous-flight software for UAVs, including OpenPilot, APM:Copter, APM:Plane and DIY Drones. Closer to home in Shenzhen, a small team had created Hex, a completely open source nanocopter kit using digital fabrication via 3D printers, laser cutters and CNC machines for rapid manufacturing and prototyping. Other key players in China – Hubsan and Chenghai UDIRC Toys Co Ltd – offered the palm-sized quads, Hubsan X4 and UDI Micro Quadcopter, respectively. These quads were also gaining popularity. Taiwan-based Tai Shih Hobby Corp (or TSH GUAI) was dedicated to designing, developing and manufacturing innovative RC helicopters and airplanes and the company launched the 330X-S Quad Flyer priced at $399, an entry-level model which was relatively easy to build and pilot. The hobby market was thus exploding, with some products more suitable than others for extreme hobbyists or beginners. And then there were those sophisticated products like the Phantom which straddled recreational and commercial usage as an aerial platform.

The Future

DJI's mission was to become the global leader in developing and manufacturing high-performance aerial photography systems. Frank placed a personal focus on R&D of advanced unmanned aerial technologies to make them easier to use and more reliable for practical uses in the film, advertising, law enforcement and farming industries. As a market leader, DJI had captured 80% market share but it was important to maintain gross margins of 60–70%. In order to continue the growth trajectory, Frank's pondered over a four-pronged strategy:

1. Continue launching superior products to maintain DJI's lead position in the hobby industry: mid- to long-term product R&D efforts would be required to focus on developing superior technology for turnkey systems. Frank estimated that a single technology would require 10 people and three years to develop. Therefore, careful planning in terms of R&D investment (in people, technology and manufacturing abilities) was essential for developing the product pipeline. Another approach was to reduce prices even for the high-end models while keeping cost efficiencies in place to remain profitable.
2. Penetrate the commercial industry with professional filming and aerial photography applications: DJI exhibited its flight-control product range at various forums, for example at the Association for Unmanned Vehicle Systems International's annual show in the US, which attracted the industry's top decision makers, commercial and national defence operators, scientists, researchers and students. DJI demonstrated its UAV total solution Spreading Wings S800 (a hex-rotor unmanned platform) + Zenmuse Z15 (gimbal system) + WooKong-M (autopilot system) + Ruling (for stabilizing and controlling camera equipment). This was its milestone professional platform which combined ease of operation for shooting stable footage (which could lift four times as much weight as the Phantom) with adjusting all necessary gimbal gains from the ground, monitoring the high-quality video in real time on the integrated LCD screen, precision stability and rapid set-up time.
3. Create new markets and customers: regarding his vision for new products, Frank drew an analogy to the car industry in the early 20th century when many companies were building various car components (engines, wheels, transmission systems etc.) which had to be assembled to make a DIY car. He wanted DJI to become the 'Ford' company which would make the 'ready to go' car so that customers would not be required to engage in any DIY component.
4. At all points set the right price vs. volume to capture as much consumer surplus as possible. Frank noted that:

> for example, one model is selling for $100 but technically we are able to sell at $20 as the cost is only around $5. So we have to calculate that if we lower the price from $100 to $20 how many times more can we sell to make up the margin loss. Maybe it is 10 times or 20 times more which immediately justifies our moving in that direction. At the same time we will be restricting the competition as they cannot make money from controllers and they cannot sustain the R&D for three years to get to the next level.

Frank remained conscious of the threat from key competitors as how they moved with their products and pricing would determine the market dynamics and earning potential.

At the same time, he set an ambitious target for DJI to achieve 200% to 300% growth in revenue per year for the next five years.

To achieve this, he has started opening up the Phantom technology through a set of application programming interfaces (APIs) to his core flight-control code. He has also provided a powerful, highly customizable hardware platform for this code, called the Matrice 100, intended for use in agriculture, surveying, package delivery, surveillance, and as many other industries as adopters inject their own ideas into Frank's innovation. Already, DJI's own engineers have marketed a weatherproof crop spraying customization of the Matrice 100 for $15,000. The overall operating cost of this is one-hundredth that of traditional airplane spraying, and it can complete the job more quickly due to reduced down time.

(Sources: Gimbel, 2008; Aria, 2012; Hruby, 2012; Gross, 2013; Joel, 2013, Levine, 2013; Tseng, 2013; Wang Tao, 2013; Wee, 2013; Xu Wei, 2014; Mac, 2015)

Notes

1. More than 8,000 attendees and 500+ exhibitors from more than 40 countries.
2. GoPro, a fast-growing camera company, sold its lightweight Hero3 video camera for $200–400, depending on the model.

Questions: DJI Case study

1.a. Describe the 'Customer Experience' that DJI's Frank Wang Tao wanted DJI's products to deliver in 2009 (when DJI chose to develop quadcopters). What were the key features and problems that Frank faced in delivering this customer experience? What factors needed to be considered in developing the first generation of DJI products in a start-up company? What motivated Frank to shift from helicopter to multirotor? Did this reflect a shift in '*discriminators*' and '*energizers*' driving the company's products?

1.b. The demand curve (i.e. price x volume curve) is a key issue for innovative product acceptance in the market. Based on information given in the case, what would be a reasonable price point (i.e. approximate price for a baseline model) for the Phantom line of products? What would be your projected revenue for the Phantom line of products? Projected cost? Projected volume? Projected profit?

1.c. Given what you know about the '*discriminators*' and '*energizers*' driving DJI's products in 2009, choose three AdWords keywords that will draw significant traffic to the DJI site. Where will you run this campaign and in what languages? Why? Provide detail about estimated impressions, clicks, and the cost per click for these particular keywords. What is the monthly total cost for this campaign?

1.d. Estimate the conversion rates from DJI's online advertising plans as you have defined them. Can you identify ways to improve the conversion rate from their marketing? What is the minimum percentage of clicks you must convert to sales, and what is the minimum required profitability for the average sale to break even (i.e. meaning that your profit per converted click will just cover the estimated click expenses in 1.c. above)?

2.a. In 2013, DJI aerial photography service technology seemed to be a high-margin and profitable business. Did Frank make the right decision to re-focus the product business? How might you justify the rationale behind it? Given the information available in 2013, what were the market risks he took? Did this reflect a shift in '*discriminators*' and '*energizers*' driving the company's products?

2.b. Given what you know about DJI's '*discriminators*' and '*energizers*' defining the company's products in 2013, choose three AdWords keywords that will draw significant traffic to the DJI site. Provide detail about estimated impressions and clicks, and the cost per click for these particular keywords. What is the monthly total cost for this campaign?

2.c. Estimate the conversion rates from DJI's 2013 online advertising plans that you have defined in 2.a. Can you identify ways to improve the conversion rate from their marketing? Provide detail about estimated traffic at all points in your conversion cone. What is the minimum percentage of clicks you must convert to sales, and what is the minimum required profitability for the average sale to break even (i.e. meaning that your profit per converted click will just cover the estimated click expenses in 2.a. above)?

3.a. Describe the marketing channels that are important for DJI quadcopter sales (feel free to search the internet to see where these are sold). Have these changed from pre-2009 to 2009? From 2010 to 2013? From 2013 to the future after 2015?

3.b. What specific new channels can be made available in the future to link drones in the air to the internet (e.g. through mobile phone data services)?

3.c. How can DJI profit from these new marketing channels made available through real-time internet linkages?

4.a. Design an e-marketing business model that most suits the future opportunities that DJI can exploit given the public's expanding interest in the so-called Internet of Things and in hobbyist drones *c*.2015.

4.b. Describe complementary products or additional services that will be necessary to reap the maximum benefit from DJI products.

4.c. Draw DJI's 'value map' and identify where DJI should concentrate its strategy in the future.

Chapter 10 – Key Points

1. The next decade will see an industrial revolution in development of the Internet of Things; it will be one of just many technological revolutions in computers, biotechnology and transportation.
2. The fastest growing areas in terms of patent applications are data processing: financial, business practice, management, digital processing systems: multicomputer data, database and file management or data structures, multiplex communications, telecommunications, vehicles, navigation, and relative location and image analysis.
3. Around 70% of the world's wealth seems to be generated by ideas, based on Richard Florida's analysis.
4. The term 'Big Data' reflects the extent to which growth of information now outpaces computing and telecommunications technologies that are required to distribute and make sense of that information.
5. Hobbyist platforms such as Arduino and Raspberry Pi are ushering in an industrial revolution in IoT in a fashion very similar the way that the MITS Altair 8800 computer initiated the personal computer revolution of the 1980s.
6. The development of DJI's drones are an exemplar of how to construct a successful business in IoT.

Further Reading

Aria, M. (2012, 31 May). How the West was droned: The curious rise of General Atomics (Part 1 & 2). *Motherboard.com*, http://motherboard.vice.com/blog/sandrone, accessed 22 June 2016.

Birstein, V. J. (2013). *The Perversion of Knowledge: The True Story of Soviet Science*. Perseus Books Group.

Castilla-Rubio, J. C. and Willi, S. (2009). Planetary skin: A global platform for a new era of collaboration. Cisco IBSG, March 2009, www.cisco.com/web/about/ac79/docs/pov/Planetary_Skin_POV_vFINAL_spw_jc_2.pdf

Chorost, M. (2008, 20 March). The networked pill. *MIT Technology Review*, ww.technologyreview.com/biomedicine/20434/?a=f, accessed 6 July 2016.

David, P. (1996). *The Dynamo and the Computer*. AER

EMC (2014). Digital universe study, www.emc.com/leadership/digital-universe/2014iview/index.htm, accessed 6 July 2016.

Gimbel, B. (2008, 31 October). The predator. *Fortune*, http://archive.fortune.com/2008/10/28/magazines/fortune/predator_gimbel.fortune/index.htm, accessed 22 June 2016.

Gross, Doug (2013, 2 December). Amazon's drone delivery: How would it work? *CNN News*, http://edition.cnn.com/2013/12/02/tech/innovation/amazon-drones-questions/, accessed 10 January 2014.

Hardy, Q. (2015, 4 February). Tim O'Reilly explains the Internet of Things, *New York Times*, http://bits.blogs.nytimes.com/2015/02/04/tim-oreilly-explains-the-internet-of-things/, accessed 6 July 2016.

Hruby, Patrick (2012, 14 March). Out of 'hobby' class, drones lifting off for personal, commercial use. *The Washington Times*.

Joel, Mitch (2013, 4 January). The booming business of drones. *Harvard Business Review Blog Network*.

Garfield E (1964). Science Citation Index – A new dimension in indexing. *Science* 144 (3619), 649–654.

Kirkpatrick, M. (2010, 18 April). Tim O'Reilly explains the Internet of Things. *Readwrite*, http://readwrite.com/2010/04/18/tim_oreilly_explains_the_internet_of_things/, accessed 22 June 2016.

Lewis, M. (2011). *The Big Short*. New York: W. W. Norton & Company.

Levine, Y (2013). The billionaire blue brothers behind America's predator drones,

www.occupy.com/article/billionaire-blue-brothers-behind-americas-predator-drones, accessed 22 June 2016.

Likert, R. (1932). A technique for the measurement of attitudes. *Archives of Psychology* 140, 1–55.

Mac, R (2015, 6 May). Bow to your billionaire drone overlord. *Forbes*, www.forbes.com/sites/ryanmac/2015/.../dji-drones-frank-wang-china-billionaire, accessed 22 June 2016.

Martin Prosperity Institute (2015). Global Creativity Index 2015, http://martinprosperity.org/media/Global-Creativity-Index-2015.pdf, accessed 22 June 2016.

Tseng, Mitch (2013, 5 July). Interview with Frank Wang Tao, Founder, CEO and CTO, DJI. Shenzhen

Wang Tao, Frank (2013, 5 July). Founder, CEO and CTO, DJI, interview by authors. Shenzhen.

Wee, Darren (2013, 2 December). The apple of the Pearl River Delta? DJI innovations is taking flight. *South China Morning Post*.

Westland J. C. (2015). Structural equation models: From paths to networks. *Studies in Systems, Decision and Control*, vol. 22. New York: Springer.

World Internet Stats. *Usage and Population Statistics*, 30 June 2010.

Xu Wei. (2014, 30 January). Exec foresees 'Silicon Valley' developing in region. *China Daily*.

Zyga, L. (2009, 14 January). Internet growth follows Moore's Law too. *PhysOrg.com*, www.physorg.com/news151162452.html, accessed 18 June 2016.

CHAPTER 11

Understanding and Managing Creative People

Learning Objectives

After finishing this chapter, you will

- Understand current **theory** regarding the **character and measurement of creativity**.
- Understand some of the **personality traits of creative people**.
- Understand the **demographics** and **personal histories** common to creative people.
- Identify **opportunities for leading** creative people to do their best work.
- Learn some specific managerial methods for **motivating and keeping your creative workforce**.

After doing the *Innovation Workout* you will be able to will be able to conduct your own **Innovation Audit**, and generate your product and project's **Innovation Profile**.

After reading the *case study* interview with jazz vibraphonist Gary Burton you will better understand how **leadership, strategy and management of creative endeavours** differ from that of traditional products and services.

Types of Creative People

The topic of creativity invites many differing opinions and perspectives. One reason is that there are many different sorts of individuals, playing different roles, all of whom must communicate and contribute in successful innovation. Creativity requires at least six types of people for success (Afuah, 2003: 37–39) – the invention is just the beginning of the process (and some might say the easiest part). These six types of people are:

1. Idea generators: individuals who can sift through large quantities of technological and market data to identify potentially successful innovations, filling the opportunity register of the firm.
2. Gatekeepers: individuals who stand between two disciplines, translating and interpreting ideas to convey from one department, company or industry to another.
3. Boundary spanners: individuals who identify with two or more disciplines and are essential in communicating ideas from one department, company or industry to another.
4. Champions: entrepreneurs, evangelists and other promoters of new ideas, who see the market value even though they may not have very great technical knowledge.
5. Sponsors: coaches and mentors that can clear the way politically for an idea or invention.
6. Project managers: administrators who can attend to the details required of a high-quality, timely product introduction.

It is important to note that each of these types of people work best if they exhibit a unique personality suited for the role. Gatekeepers and boundary spanners are social and gregarious, whereas idea generators may tend towards introversion. It is probably best that champions are politically savvy and independent from the inventor. Individuals may share roles, but often in practice the various individuals that make a firm creative may not get along with each other all that well. This adds a considerable challenge to management's task of team building.

There is literally a cottage industry in methods for 'team building'. Suffice it to say that methods vary – what may be good for one company or industry is likely to fail elsewhere. Management needs to tailor its approach to team building to individual personalities and corporate culture. There are several caveats that should be heeded:

1. Recognize that team building takes time, occurs through pairwise collaborations, and that each of these pairs will be unstable at times.
2. Teamwork cannot be forced, it has to be encouraged, often with rewards and (used sparingly) threats.
3. Start early with team-building efforts, and with a compelling and well-articulated project description, including milestones and deliverables.
4. Consider using a formal 'team-building' method, but benchmark its performance at other firms to assess whether it is appropriate for your project.
5. Reiterate and reinforce the project description throughout the project.

Peter Drucker's 'Knowledge Workers'

Peter Drucker (1999) observed that 'knowledge workers do not respond to financial incentives, orders or negative sanctions the way blue-collar workers are expected to'. Drucker contended that knowledge workers are best treated as 'de facto volunteers' tied to the firm by commitment to its aims and purposes and often expecting to participate in its administration and its governance. We know from surveys of knowledge workers that not only is Drucker right (and prescient as well, given that he made these comments a quarter of a century ago) but that creative workers value three aspects (in decreasing order of importance) in their jobs (Florida, 2003: 132–137): meritocracy, diversity and individuality.

How Successful Technology Companies Manage Creative Teams

Google (Schmidt & Varian, 2005) believes that successful technology businesses need to follow Peter Drucker's advice and 'strip away everything that gets in their knowledge workers' way'

(Drucker, 2000). Both Google (Vise & Malseed, 2006) and Microsoft (Selby & Cusumano, 1999) have drawn on decades of managerial wisdom, beginning with the seminal work of Drucker, through ongoing studies of how their best technology competitors contend. Here are some of the management lessons that have worked for successful technology firms to help them keep innovating, and which can be applied in many differing industries.

1. Give them challenge and responsibility; but employees expect to have a hand in choosing their challenges.
2. Encourage peer recognition; with peers who they respect, and who are interested in the same challenges.
3. Provide job security: not the old contract for life of the 1950s Organization Man, but one which balances flexibility, reward and security to allow the creative worker to focus first and foremost on the challenge at hand.
4. Salary: money is important, but not as important as the first three items in this list. Because creative workers do not expect a job for life, they want to collect their income now, rather than being rewarded at retirement for a lifetime of loyalty.
5. Hire by committee: virtually every person who interviews at Google talks to at least half-a-dozen interviewers, drawn from both management and potential colleagues. When you hire good people and involve them intensively in the hiring process, you build a positive feedback loop.
6. Hire smart problem solvers: Microsoft gives its applicants problem-solving tests; Google has been known to place difficult problems on highway billboards, not allowing applicants to the next stage of application unless they can solve the problem shown.
7. Cater to their every need: on top of the standard package of fringe benefits, include first-class dining facilities, gyms, laundry rooms, massage rooms, haircuts, car washes, dry cleaning, commuting buses – just about anything a hardworking engineer might want. Programmers want to programme, they don't want to do their laundry. So we make it easy for them to do both. Make the office feel like home: give everyone their own office (even if it is small); don't impose dress codes; make this a place that employees would like to stay.
8. Pack them in: Almost every project at Google is a team project, and teams have to communicate. The best way to make communication easy is to put team members within a few feet of each other.
9. Make coordination easy: Each employee emails a snippet once a week to his work group describing what he has done in the last week. This gives everyone an easy way to track what everyone else is up to, making it much easier to monitor progress and synchronize work flow.
10. Communicate effectively and frequently. Every Friday Google holds an all-hands assembly with announcements, introductions and questions and answers. Google has remarkably broad dissemination of information within the organization and remarkably few serious leaks. It believes that the first fact causes the second: a trusted workforce is a loyal workforce. One challenge for Google is to scale this communication as the company grows internationally.
11. Use your own products and services wherever you can: one of the reasons for the success of Gmail is that it was beta tested within the company for many months. The use of email is critical within the organization, so Gmail had to be tuned to satisfy the needs of some of the most demanding customers – the knowledge workers working at Google. Conversely, avoid the 'not-invented-here' syndrome. A good engineer is always convinced that he or she can build a better system than the existing ones, and he or she may be right, but not necessarily at a competitive cost or delivery time. Manpower spent developing a product internally that already exists on the market is manpower *not* spent on innovations that can give you a competitive advantage.
12. Management focus on consensus: the role of the manager is that of an aggregator of viewpoints, not the dictator of decisions. Building a consensus sometimes takes

longer, but always produces a more committed team and better decisions.

13. Don't be evil: No matter how passionate people are about their views, they need to be presented in an atmosphere of tolerance and respect. Engineers are competitive by nature and they have low tolerance for those who aren't as driven or as knowledgeable as they are. But almost all engineering projects are team projects; having a smart but inflexible person on a team can be deadly. When management sees a recommendation that says 'smartest person I've ever known' combined with 'I wouldn't ever want to work with them again' they decline to make them an offer. One reason for extensive peer interviews is to make sure that teams are enthused about the new team member.
14. Base decisions on empirical analysis: Every decision should be based on quantitative analysis with real data. Google builds systems to manage information, not only on the internet at large, but also internally. Google keeps a multitude of online 'dashboards' that provide up-to-the-minute snapshots of business position.
15. Expect employees to fail: Failure is an essential part of the creative process. Google's CEO, Eric Schmidt, has said 'please fail very quickly, so that you can try again' (Cited in *Economist*, 2007). Make sure that cost of failure is small (by taking small steps) and that the repercussions of failure are not career threatening.
16. Encourage an 'us' vs. 'them' mentality: Constantly remind employees that their competition is other companies, not their colleagues. Product cycles are now so short, and markets so volatile, that failure to stay competitive can quickly put the company at risk.
17. Sustain a start-up mentality: Not just Google and Microsoft, but Dell, Amazon and other successful companies fight complacency by maintaining an ever-present sense of urgency that the business must succeed. Watch costs, keep project teams small, and delivery times short. Keep the office environment comfortable but frugal.
18. Management is responsible for maintaining focus: engineers and programmers love to figure out how to solve problems, but once they've done the hard part, they often get bored and want to move on to something else. It is management's responsibility to insist on deliverables, and to reinforce the idea that the job is not complete until it is satisfied with the deliverable.
19. Recruit for diversity, hire for philosophy; in addition to problem solving, workers should satisfy two other goals. First, their philosophy and character should be aligned with the firm. Cisco actively seeks out firms for acquisition, but the acquisition goes ahead, or is halted, based on whether the two cultures fit. A poor cultural match provides a quick path to disappointment. But a great creative culture allows latitude for diversity – of ideas, backgrounds, knowledge, and so forth. Diversity drives creativity by forcing different ideas together. Part of the creative firm's culture has to be one that embraces a wide range of ideas and people.
20. Recognize their limitations: creative workers can be brilliant at what they do best – and remarkably naïve about the world outside their area of expertise. Because creativity is solitary and mentally intensive, it tends to attract introverts. The more the firm can connect them to the real world, the more they're likely to understand some of the decisions that management, customers and clients make. Firms can benefit from regular applications of inspiration: outside speakers, art and photo exhibits, and social events. But keep it fun (Tischler, 2004).
21. Develop their speaking skills: the same introversion and focus that makes a creative worker brilliant can trip them up when presenting their ideas to others. Engineers and programmers benefit greatly from learning a bit of the language of accountants and financial types, or of the marketing staff. Public speaking and regular presentation of ideas should be encouraged even if individuals are not that good at it, because it will change the way they think about their own work.

22. Allow 10% to 20% of employees' time for their own projects; this is a source of new insights and products for the firm, and a way for knowledge workers to actively recharge their enthusiasm. Disseminate these ideas widely through a mailing list – a company-wide suggestion box where people can post ideas on anything, which are then commented on and rated.
23. Protect creative workers from creativity killers: creative individuals are often more emotionally exposed, and tied to their ideas, than other workers, and consequently more vulnerable to criticism. It is important to explain to them why some ideas don't pass muster, and to keep an open communication channel if they have questions.
24. Add liberal doses of fun: being creative on demand is hard work. It is intellectually taxing and emotionally exhausting. There needs to be latitude for workers to break away from their problem, shift gears, and do something else for a while until they regain their enthusiasm. If you have hired well, creative employees will be too busy solving your problems. Human minds are naturally energized and productive when tasks are enjoyable. Traditional concepts separate work (unenjoyable) from leisure (active enjoyment). But the traditionalist view is bound to make knowledge workers inefficient, and may even motivate them to sabotage work. Neuroscience supports this assertion. When we scrub joy and comfort from the workplace, we distance our employees from effective information processing and long-term memory storage. Instead of taking pleasure from creativity and production, employees grow bored, anxious and anything but engaged. They ultimately learn to feel bad about work and lose any joy they once may have felt.

Creative Minds

Perhaps best known in the field of business are the ideas of Edward de Bono, who has made a high-profile business of 'teaching' creativity. To de Bono, creativity happens through numerous cognitive tricks that one learns to break old habits and preconceptions and visualize a problem from a new angle (Rothenberg & Hausman, 1976; Sternberg, 1998). Even without discussing the merits of de Bono's approach, it is still worthwhile to study whether this indeed is how people who society agrees are truly 'creative' manage to act so creatively.

Creative Paradigm Shifts

Exceptional innovators possess something that sets them apart – exceptional 'creativity'. For example, history since Pythagoras has seen many talented musicians advance the art – but very few, if any, who could match the creative impact of Miles Davis. Miles Davis' 'Kind of Blue' kicked bebop into the modern era, with its expanded modal palette, inventive form and harmony. Extraordinary innovators like Miles Davis can bring about extraordinary cultural impact: innovations, ideas and acts so compelling that they bring about a paradigm shift. Other examples include Sigmund Freud's founding of psychoanalysis and Newton's formulation of the laws of motion. Yet the quality called creativity is elusive, and is perceived differently depending on how it is approached. George Kneller observed that 'creativity consists largely of rearranging what we know in order to find out what we do not know'. Creativity by individuals and teams is a starting point for innovation; it is a necessary but not sufficient condition for innovation (Amabile et al., 1996). Margaret Bodin observed that 'a person needs time, and enormous effort to amass mental structures and to explore their potential. It is not always easy (it was not easy for Beethoven). Even when it is, life has many other attractions. Only a strong commitment to the domain – music, maths, medicine – can prevent someone from dissipating their energies on other things' (Bodin, 1990: 254–255).

Joel Mokyr notes that technological creativity is highly sensitive to culture, and has risen then faded dramatically when social and economic institutions turn rigid and act against it, as was the case in late medieval Islamic and Chinese societies. Both societies had been leaders in mathematics, mechanics, art and many other fields, only to fall far behind the emergent West. He comments:

> technological progress is like a fragile and vulnerable plant, whose flourishing is not only dependent on the appropriate surroundings and climate, but whose life is almost always short. It is highly sensitive to the social and economic environment and can easily be arrested (Mokyr, 1991).

The creative impulse is inherent in a human's mind, and as economist Paul Romer observed, 'an ant will go through its life without ever coming up with even a slightly different idea about how to gather food. But people are almost incapable of this kind of rote adherence to instruction. We are incurable experimenters and problem solvers' (Romer, 1993).

The abode of creativity is the human brain – a still poorly understood collection of function-specific regions. We have yet to identify a physical 'organ of creativity' in the brain (and indeed, there may not be one). Our brain is a very expensive organ in terms of energy consumption, drawing up to 25% of an adult's energy (and 60% of an infant's). Being 70% fat, feeding the brain is one of the primary motivations

Office Cubicles

The 'Action Office' grew out of design exercises at the fine arts department of the University of Colorado in late 1960s. The objective was to create a private yet egalitarian workspace that unleashed the creative potential of its inhabitants. During the apotheosis of the counterculture movement, campus Marxists were keen to end the pervasive corporate 'bull pens' (rows of desks in huge open spaces) where most white-collar employees then lived out their working days under the watchful eyes of managers. The birth of the 'cubicle' offered both privacy and a way to individualize employee workspace. Intel CEO Andy Grove famously foreswore his suite for an 8 by 9 foot cubicle next to his subordinates. Consultants, who are out of the office a notoriously high percentage of their time, carried this one step further, making the cubicle a movable one, where all their personal effects were stored in portable cabinets which they would roll to whichever cubicle was available. Savings accrued to employers from squeezing employees into tiny cubicles in high-rent markets; productivity and creativity gains were more elusive.

The cubicle was object of both praise and ridicule in equal parts – later leaning towards the latter as Scott Adams pilloried cubicle life in his comic strip Dilbert (many characters and situations in Dilbert were drawn from Adams' own experience in the cubicles of Pacific Bell). Adams felt the cubicle culture stifled creativity rather than promoting it, observing that 'creativity is allowing yourself to make mistakes; art is knowing which ones to keep'.

Surveys by Tom Davenport of Babson College have found that three factors determine white-collar performance: *management and organization*, *information technology* and *workplace design*. The open offices typified by bull pens and cubicles can, in fact, lead to more unstructured communication; but can also create problems for employee focus and concentration. Davenport called cubicles 'the attention-deficit office'.

One of the foremost cubicle manufacturers, Herman Miller, is reluctant to abandon a lucrative market, and is rethinking the weaknesses of the cubicle (attention deficits) while trying to keep its benefits (cost and space savings). It has created cubicles with 'busy' lights to deter interruptions, and is experimenting with enhanced sound proofing. Others feel that designing a better cube is putting lipstick on a pig. One size doesn't fit everyone, and the appropriate solution is to customize space to various types of work – give those who need uninterrupted time a quiet place to work and those who need to collaborate a more social space. Square, Inc.'s offices in San Francisco incorporate some of the most innovative solutions to the cubicle's problems, without creating enclosed spaces. Square's space is reminiscent of an Apple store, but with comfortable seats surrounded by sound-proof glass that allow for privacy, conversations or reflective thought in a more or less open area. The majority of space is modernized bull pen, but with the option for software engineers to grab their laptops and retire to private spaces. In the war for talent, office space is part of that work contract, and if you are not engaging employees, you may be prompting them to find their next employer.

behind the modern addiction to fatty foods (and perhaps the 'geek' proclivity for that sugar- and fat-laden junk food rush). As a percentage of body weight, the human brain is 15–20 times larger than those of other mammals – by inference, much of that added tissue weight is not dedicated to mammalian tasks such as muscle coordination and autonomic control of metabolism. Rather it arose, as economist Paul Seabright (2004: 110–115) details it, to deal with a society of 'murder, reciprocity, trust, hoarding and stealing' that arose when early man was forced out into the more brutal environment of the savannahs.

Industry Standards and the Invention of the Light Bulb

The cartoon light bulb is the quintessential symbol of inspiration and innovation. But who actually invented the light bulb? Most Americans would respond with their own national hero Thomas Alva Edison. But it was actually British chemist Humphry Davy that proved the concept in 1809 and British physicist Joseph Wilson Swan that built a practical light bulb in 1878, offering much brighter lighting than the existing gas and arc lighting. Edison was also interested in lighting buildings and streets, but was more systematic in patenting his devices. He attempted to prosecute Swan for patent infringement, eventually merging Swan's company into his in 1883. Edison not only had patents, but he had developed a 'system', noting that:

> 'all parts of the system must be constructed with reference to all other parts, since in one sense, all these form one machine part' (Thomas Alva Edison, referring to an electrical grid in his article on the phonograph in the North American Review, 1878).

Edison and his team of engineers in Menlo Park, New Jersey, spent years building the entire electric system, from light sockets and safety fuses to generating facilities and the wiring network; and of course, advertising and promoting the whole system.

Edison built his entire system around direct current (DC). Unfortunately, DC line losses were so great that generators could not practically be more than about one mile away from the lightbulbs and motors they powered. This system was challenged by George Westinghouse, whose alternating current (AC) generators' operation at 133 cycles per second (Hz, or Hertz) could distribute electricity over hundreds of miles, making for much greater economies of scale. Westinghouse and Edison fought a brutal battle in the marketplace, with Edison electrocuting stray dogs to demonstrate the dangers of AC, and coining the term 'Westinghousing' for the electrocution of criminals.

Westinghouse's system had one weakness: it lacked a motor, which was becoming a major deal-breaker for industrial electrification. Factories wanted motors that could substitute for steam engines. In an attempt to satisfy this demand, Westinghouse subcontracted the building of motor designs to the eccentric genius Nikola Tesla. After an enormous amount of experimentation and calculation, Tesla came to the correct conclusion that motors operated most efficiently at 60 Hz and 240 volts. Westinghouse adopted Tesla's designs (after futilely trying to make them work at 133 Hz). And Edison ultimately was forced to admit the superiority of AC, and built his own systems, running the lines at 110 volts, adopting the same voltage used in his DC systems.

When the German company AEG built the first European generating facility, its engineers decided to fix the frequency at 50 Hz, because the number 60 didn't fit the metric standard unit sequence (1, 2, 5). At that time, AEG had a virtual monopoly and its standard spread to the rest of the continent. But the order imposed by the metric system was at odds with physics. Not only is 50 Hz 20% less effective in generation, it is 10–15% less efficient in transmission and it requires up to 30% larger windings and magnetic core materials in transformer construction. Electric motors are much less efficient at the lower frequency, and must also be made more robust to handle the electrical losses and the extra heat generated. Originally Europe had followed Edison's lead, and run its lines at 110 volts. But it decided to generate at 220 volts after World War II to try to overcome the inefficiency of 50 Hz by increasing the voltage to get more power with less losses and voltage drop from the same copper wire diameter. At the time the US also wanted to change but because of the cost involved to replace all electric appliances it decided not to. In the 1950s the average US household (but not its European counterparts) already had a refrigerator, a washing machine, etc. For this reason, today only a handful of countries (Antigua, Guyana, Peru, the Philippines, South Korea and the Leeward Islands) follow Tesla's advice and use the 60 Hz frequency together with a voltage of 220–240.

Edison may have gotten his voltage wrong (a mistake that plagues us to this day) but his other experiments with electrical lighting systems generated their own unsung successes. In 1883 Edison observed that a current flowed between the filament of an incandescent lamp and a plate in the vacuum near it when the plate was connected to the positive end of the filament, but not when the plate was connected to the negative side. In 1899, J. J. Thomson showed that this Edison Effect was due to a stream of negatively charged particles, electrons, that could be guided by electric and magnetic fields. Fleming patented the diode in 1904 and in 1907, Lee de Forest patented the triode (which he called the Audion; the term 'triode' was not used until much later, after it threatened to become a trade name). For more than a half century until the commercialization of the transistor, electron tubes were the preferred choice for amplifying music.

(Source: Energy.gov, 2003)

Our brains evolved to handle specific challenges in our evolutionary environment. Most of the distinctly human aspects of our bearing evolved early in our lineage – our large brains did not. Our *australopithecines afarensis* forbears living 3–4 million years ago had brains about 450–500 cm^3 in volume, not much larger than that of a chimpanzee. There appear to have been two bursts in absolute brain size – one 1.8 million years ago when our brains jumped to about 850cm^3 in volume and another about 150,000 years ago when our brains reached the modern 1400cm^3 in volume. The bursts appear to have been associated with climate changes in Africa which pushed man out of the forests and onto the more exposed and competitive savannahs.

Creativity is just one aspect of humans' unique capability for abstract thought. But creativity underlies the process of invention; indeed, a useful definition is that inventions are the end product of the creative process. As innovations are commercialized inventions, the whole process of innovation is more or less predicated on the activities of creative individuals (Brockman, 1993; Bloom, 2002; Florida, 2003).

Einstein's Brain

Albert Einstein was considered by many to possess the smartest brain on the planet. But for more than two decades after his death in 1955, no one, not even Einstein's family, knew the whereabouts of that famous brain. Only in 1978, did reporter Steven Levy track Einstein's brain to one Thomas Harvey, the pathologist who performed the autopsy, removed the brain, dissected it into 240 pieces, and embedded the pieces in a plastic-like substance called celoidin. Levy tracked Harvey to his home in Wichita, Kansas, and after a long conversation, Harvey admitted that he had the brain. Out of a box labelled 'Costa Cider' he pulled the two Mason jars that contained the brain that had brought about a revolution in science (Witelson et al., 1999).

Since then, Harvey has allowed three teams to examine parts of the brain. The findings indicate that the ratio of neurons to glial cells (the cells that support and protect neurons) in one part of Einstein's brain was smaller than the ratios in 11 normal brains, and the authors concluded that the larger number of glial cells per neuron might indicate that Einstein's neurons possibly worked harder. Furthermore, though Einstein's brain weighed less than the average (2 pounds 11.4 ounces compared to 3 pounds 1.4 ounces for the average; 1230 grams compared to 1400 grams) it packed more neurons in a given area (Diamond et al., 1995). Also, the inferior parietal region that is thought to be used for mathematical reasoning was found in Einstein to be 15% wider than normal. Finally, a groove (sulcus) was found to be partially missing in that area. The researchers argued that the absence of that fissure could have resulted in more effective communication among neurons (Anderson & Harvey, 1996).

The remaining pieces of Einstein's brain were eventually brought by Harvey to their final resting place – the Pathology Department at Princeton Hospital. When asked why he took the brain in the first place (Einstein's body was cremated), Harvey explained that he felt obligated to salvage the precious grey matter for posterity.

(Source: Abraham, 2002)

Creativity is not just something that happens inside someone's head. To be able to declare something as 'creative,' it has to be compared to a standard. For instance, we could say that Einstein's general relativity is truly creative when compared with previous theories of the operation of mechanics and the cosmos. Creativity involves relations between three domains: (1) the creative person; (2) the domain in which the creative act occurs (e.g. mathematics, music, literature); and (3) the field of practitioners that set the 'standard' (e.g. other mathematicians, museum curators, literature readers and critics) (Csikszentmihalyi, 1996).

The story of discoverers could be told in simple chronological order, since the latest science replaces what went before. But the arts are another story – a story of infinite addition…creators in all the arts have enlarged, embellished, fantasized and filigreed our experience…in the random flexings of the imagination.

Daniel Boorstin, The Creators, Vintage, 1993

Traits of Creative People

Metrics

Many attempts have been made to develop a *creativity quotient* of an individual; however, these have been unsuccessful, as the measure of creativity is too personal and subjective to submit to standardized measure. One of the earliest formal attempts arose from work by mathematician George David Birkhoff (best known for his contributions in ergodic theory and geometry) who developed his *Aesthetic Index* to measure the quality of creative output. The best known of recent measures is J. P. Guilford's *Torrance Tests of Creative Thinking* (1967). These present subjects with a bank of tests which measure:

1. *Fluency*. The total number of interpretable, meaningful and relevant ideas generated in response to the stimulus.
2. *Flexibility*. The number of different categories of relevant responses.
3. *Originality*. The statistical rarity of the responses among the test subjects.
4. *Elaboration*. The amount of detail in the responses.

But psychometric measures of creativity have always been controversial; many researchers recommend measures that are more qualitative and situational (see, for example, citations in Sternberg and O'Hara, 1999). Bringing about a paradigm shift in a field of invention does not necessarily require genius. Studies have shown that beyond a certain level of IQ, around 120, there is no clear correlation between intelligence and creativity. True creativity probably requires some degree of intelligence, but there is absolutely no guarantee that a person with an IQ of 170 will be any more creative than one with an IQ of 120. This is possibly due to the fact that the field of practitioners and consumers of innovation sets a de facto standard for creativity. In the 1930s, Lewis Terman's tests of gifted children discovered a cognitive disconnect between individuals with more than 30 points' IQ differential. If consumer intelligence tends to hover around an 'average' IQ of 100, then perhaps a slightly above average intelligence, but below 130 IQ, may yield the best innovations simply because innovators can communicate them to practitioners and consumers.

3M

Recall from Chapter 3 that Minnesota Mining and Manufacturing (3M) began life in 1904 as a failure, but managed to turn this failure to its advantage. Among ideas that were core to McKnight's management:

1. Give it a try – and quick! When in doubt, vary, change, solve the problem, seize the opportunity, experiment, try something new. Listen to anyone with an original idea, no matter how absurd it might sound at first. Do. Adjust. Move. Act. No matter what, don't sit still.
2. Accept that mistakes will be made. Since you can't tell ahead of time which variations will prove to be favourable, you have to accept mistakes and failures as an integral part of the evolutionary process. The concept is Darwinian: try many experiments (multiply) of different types (vary), keep the ones that work (let the strongest live), and discard the ones that don't (let the weakest die).
3. Take small steps. It's easier to tolerate failed experiments when they are just that –experiments, not massive corporate failures. We have seen in Chapter 6 that this is the basis for the 'stepping-stone' entrance strategy that has worked for many successful innovators.
4. Give employees the room they need. Visionary companies hire and promote the best people, decentralize more, provide greater operational autonomy and allow people to be persistent. Hire good people, and leave them alone.
5. Leadership tone is just the start. You need to translate intentions into tangible mechanisms. Good intentions or setting the right 'leadership tone' by themselves simply won't succeed. Encourage; don't nitpick. Let people run with an idea; if you put fences around people, you get sheep.

Contrast this with 3M's arch-rival Norton, founded in 1885 around grinding wheels for the machine tools industry. The company was always successful, multiplying its capital 15 times in the first 15 years of its existence; by 1990 it was and has remained the largest abrasives company in the world. Norton's success grew from its good management through classical planning and control approaches. It determined what it did well (its competences); grew its asset base around those competences, and dominated a market that is in many ways not that much changed from a century ago.

Both companies were successful, but took different paths from different bases. Norton's conservative stance caused it to miss out on substantial new markets as they arose. Norton's failures were essentially 'opportunity costs' – the cost of not gaining the markets and accompanying profits that might have been.

(Source: Collins, 2001)

Creative Qualities

Psychologist Ellen Winner (1997a) has noted about gifted children:

> for those who do make it into the roster of creators, a certain set of personality traits proves far more important than having a high general IQ, or a high domain-specific ability, even one at the level of prodigy. Creators are hard-driving, focused, dominant, independent risk-takers.

While researchers have not been able to discern with any certainty whether personal characteristics can indeed be the direct causes of creativity, there is little doubt that some qualities are intimately involved in the creative process. So what are these traits?

Psychologists John Dacey and Kathleen Lennon (1998) emphasize tolerance of ambiguity – the ability to think, operate and remain open-minded in situations where the rules are unclear, where there are no guidelines, or where the usual support systems (e.g. family, school, society) have collapsed. Indeed, without the competence to function where there are no rules, painter Pablo Picasso would have never invented cubism and mathematician Evariste Galois would not have come up with group theory. Tolerance of ambiguity is a necessary condition for creativity.

Complexity, another qualitative measure, reflects an individual's ability to harbour tendencies that normally appear to be at opposite extremes (Csikszentmihalyi, 1996). For instance, most people are somewhere in the middle of the continuum between being rebellious or highly disciplined. Very creative individuals can alternate between the two extremes almost at the drop of a hat. Michael Csikszentmihalyi interviewed many dozens of creative people from a wide range of domains, stretching from the arts, humanities and sciences to business and politics. Based on these interviews, he compiled a list of *ten dimensions of complexity* – 10 pairs of apparently antithetical characteristics that are often both present in creative minds:

1. Bursts of impulsiveness that punctuate periods of quiet and rest.
2. Being smart yet extremely naïve.
3. Large amplitude swings between extreme responsibility and irresponsibility.
4. A rooted sense of reality together with a hefty dose of fantasy and imagination.
5. Alternating periods of introversion and extroversion.
6. Being simultaneously humble and proud.
7. Psychological androgyny – no clear adherence to gender role stereotyping.
8. Being rebellious and iconoclastic yet respectful to the domain of expertise and its history.
9. Being on one hand passionate but on the other objective about one's own work.
10. Experiencing suffering and pain mingled with exhilaration and enjoyment. (Csikszentmihalyi, 1996)

Interestingly, psychologist Ellen Winner (1997b) finds that child prodigies usually exhibit only one extreme of the spectrum of characteristics – they tend to be intense, driven and introverted. We should remember, however, that gifted children are still in the soaking-up knowledge mode, rather than in the creative mode. The reality that most prodigies do not become particularly creative in their adult life may reflect, among other things, the fact that only a small fraction of gifted children actually possess the capacity for complexity.

Being smart but naïve, realistic yet imaginative, simultaneously rebellious and respectful are combinations of creative traits. Psychological androgyny – being on one hand very sensitive and more 'feminine' and on the other aggressive and offensive – was another creative trait.

Unitech Networks, Hong Kong

Alex Chan, the CEO of Unitech Networks in Hong Kong, encourages his 150 consulting and network engineering employees to constantly seek new business opportunities. In his market, opportunities arise only if demand exists for a product or service, and if his people have the necessary technical expertise. Because an employee's education in a particular piece of software or hardware may require a lead time of several months, Alex likes to anticipate markets for new switches, routers, software such as WAP 2.0 for phones and so forth by buying the software or hardware and making it freely available to all of his engineers (often by sticking it in the centre of his office space or making it available from the company's network). Employees are allowed 10%–20% of their time to 'play around' with new equipment or software that Alex feels might ultimately become a future business. In addition, employees are encouraged to bring their toys in from home (often robots and remote-controlled cars, planes and helicopters) and play with them during off-hours in the workplace. The idea is to (1) keep his employees' minds active, but not chain them to a rigid set of problems, and (2) keep employees around the workplace at all hours, so it becomes a second home and social club. The approach has proven very successful for Unitech which has experienced low turnover and a profitable, expanding business throughout its 15 years of existence.

(Source: Personal interview with the author)

Dacey and Lennon identify a few additional traits that in their opinion contribute to tolerance of ambiguity and to its role in promoting creativity. One of these – stimulus freedom – is what we might call the ability to think outside the box. To a large extent, the very essence of creativity is the capacity to break out of common assumptions and to escape any pre-existing mindsets.

From an administrative standpoint, one can see how the sum of these traits can quickly place a huge burden on managers – leadership of creative types is not easy.

There are in addition to these abstract qualities behind creative minds three tangible traits commonly associated with them – (1) loss of a father; (2) youth; and (3) psychosis. We will look at each of these in turn.

Loss of a Father A particular characteristic that appears to be shared by many creative individuals is the loss of a father early in life. Among nearly a hundred creative interviewees, Csikszentmihalyi (1996) actually found that no fewer than three out of 10 men and two out of 10 women were orphaned by the time they reached their teens. Orphans avoid the huge psychological burden of having to live up to the perceived expectations of their missing father, while gaining opportunities to reinvent themselves. The French philosopher Jean-Paul Sartre observed that 'the death of [Sartre's father] Jean Baptiste was the big event of my life: it sent my mother back to her chains and gave me freedom.... Had my father lived, he would have lain on me full length and would have crushed me. As luck had it, he died young' (cited in Livio, 2005).

40 Lives in Bebop

Psychiatrist Geoffrey Wills (2003) studied the lives of 40 of the great innovators in the period 1945–1960 (six trumpeters, three trombonists, four alto saxophonists, one alto doubling tenor saxophonist, five tenor saxophonists, three baritone saxophonists, five pianists, five bassists, four drummers, one guitarist, one vibraphonist and two arrangers). Some of the jazz musicians suffered from self-medication; for example Miles Davis developed sickle-cell anaemia and used excessive amounts of cocaine and barbiturates to control the arthritic pain. As a result, he developed paranoid delusions and auditory hallucinations, searching in his house for imaginary people whose voices he thought he heard. Among Wills' sample there was a high rate (52.5%) of addiction to heroin at some time during the musicians' lives. This usage was very likely anomalous, as heroin use was widespread and in fashion among jazz musicians after World War II, but as jazz gradually became more accepted, and as younger musicians saw the harm caused to their older colleagues, usage began to fall off. In other psychological parameters, jazz musicians fared similarly to their classical brethren:

- 28.5% of jazz musicians suffered mood disorders compared with 41% and 34.6% for classical composers in prior studies.
- 7.5% of jazz musicians suffered psychotic illness compared with 10% and 1% of classical composers in prior studies.
- 27.5% of jazz musicians had alcohol problems, compared to 40% and 21.2% of classical composers.

Youth Some of the most creative mathematicians, lyric poets and composers of music were extraordinarily young when they produced their best work. Most painters, novelists and philosophers, on the other hand, continue to create and are often at their peak well into old age. Disciplines that are intense and analytic tend to require youth; reflective and artistic disciplines may be pursued well into old age. At the extreme is polymath Thomas Young, exhibited one of the most creative minds of the 18th century. By his mid-30s he had estimated the size of the atom within an order of magnitude, introduced the term Indo-European language after comparing some 400 different languages, posited the tri-colour theory of human light perception, figured how to translate the hieroglyphics of the Rosetta stone, and provided numerous other insights in physics and medicine (Gardner, 1993).

It is important to note here a decisive difference between the arts and social science on the one hand; and natural sciences and mathematics on the other. Individuals in these latter areas begin to be productive at an early age and may make numerous innovations during their early years. But the speed of change in the sciences tends to favour the energies of youth. In either case, Howard Gardner has proposed a 'ten-year' rule that suggests that creative individuals contribute their most important work only after 10 years of effort in their domain.

Psychosis The most enduring (and perverse) speculations about creativity involve its correlation with madness. Such prejudices are fuelled by popular films such as *A Beautiful Mind* which chronicles the madness of Nobel laureate John Nash, or the film *Proof* in which Gwyneth Paltrow is the brilliant and troubled daughter of a mathematician (Anthony Hopkins) whose descent from mathematical ingenuity into insanity keeps the audience guessing whether Paltrow will follow in her father's footsteps. *Proof* itself plays on three recurring themes, each with a basis in reality: (1) creativity and the loss of a father; (2) creativity and youth; and (3) creativity and madness.

Prejudices about psychosis and creativity has ancient roots, dating at least to the speculations of Roman philosopher Seneca. The 19th-century psychiatrist W. L. Babcock published an article entitled 'On the Morbid Heredity and Predisposition to Insanity of the Man of Genius' in which he claimed that like proneness to early death, creativity and genius was a characteristic of inferior genetic make-up (Lombroso, 1895; Post, 1994; Ludwig, 1995). On a more solid footing is recent research which supports the general association of creativity with psychopathology, at least in some creative domains. One study of creative individuals found that 28% of prominent scientists experienced at least some sort of mental disturbance; the fraction increased to 87% among outstanding poets (Ludwig, 1995). Psychometric evaluation of many creative mathematicians, architects and writers has revealed that creative individuals consistently scored higher on dimensions that are indicative of various affective disorders such as schizophrenia, depression and paranoia (MacKinnon, 1975), thus providing evidence for associating creativity with psychosis (Simonton, 1999). Creative individuals tend to exhibit 'complexity' – i.e. very creative individuals can alternate between the two extremes of being rebellious or highly disciplined – which is consistent with the sorts of psychoses associated with creativity.

Traits of Creative Societies

Some societies have a reputation for creativity, and this has led some political scientists and economists to look for characteristic indicators of governance of other societal creativity. For example, Italy has a well-deserved reputation for cutting-edge innovation in cars, motorcycles, furniture, and fashion and Japan is known for innovation in products and industrial processes. What is it about the social or governmental systems of these countries that inspires innovation? Can it be duplicated at the country, firm or group level?

Economist Paul Seabright (2004: 110–115) argues that the major social stimuli for creativity are: (1) enough wealth to give those with ideas some hope of finding patrons or jobs; (2) a substantial immigrant population eager to challenge the established order, and (3) a total population large enough to contain a critical mass of talent, but with enough focus in its geography to allow for effective networking. Historian David Landes (1998: chs 27–29) provides evidence that creativity has thrived in societies which:

- operate, manage and build instruments of production
- create, adapt and master new technologies
- impart expertise and knowledge to the young
- choose people for jobs by competence and relative merit
- promote and demote on basis of performance
- encourage initiative, competition and emulation
- let people enjoy and employ the fruits of their labour, enterprise and creativity.

Landes describes the government's role in promoting creativity, arguing that innovation has flourished in the past when governments do the following:

- encourage saving and investment
- enforce rights of contract
- secure rights of personal liberty against tyranny and crime
- provide stable government, though not necessarily democratic
- provide responsive government
- provide no rents nor favours for government position
- have governments that are moderate, efficient and non-greedy.

Landes also argues against government behaviour which is likely to squelch creativity. For example, he says that direct government involvement in innovation tends to favour the creation and maintenance of powerful, conservative, expensive scientific bureaucracies which rob would-be innovators of scarce talent. Landes' lists effectively explain why we see huge populations of creative people centred in clusters of innovative companies around Silicon Valley and Santa Monica, despite the high cost of living in California. Where governments have tried to build such environments, they have often failed. The most obvious examples are the 50-odd 'science parks' constructed around the world since the 1990s, which, with only a few exceptions, either lay dormant or provide low-rent homes for government-favoured national champions.

Open Source Software

Open source software such as Linux operating system or the Apache netserver provides guides to how the alignment of objectives, an open horizontal structure and voluntary membership can develop innovative, high-quality commercial products. Open source software is based on the voluntary cooperation of developers in many different locations, with a shared 'culture' across a diffuse community of practice. There are minimal reporting relationships, assignments and clear lines of responsibility. But underneath there is a society based on performance, capability and peer review. There is a distinct division of labour; the software itself is modular, and programmers tend to specialize on particular functional modules. In addition there are diffuse organizations that impose order, like the Apache Software Foundation which manages the Apache netserver, a meritocracy where membership is granted only to core volunteers who have actively contributed to Apache projects. Though there are over 13,000 open source developers contributing to Linux, Apache and other codes, less than 0.1% contributes around three-quarters of the code to these projects. Within this diverse community, subtle codes of conduct arise that in many ways fill the same roles as corporate management, policy and procedure. Members exert strong peer pressure against noncompliance with rules or standards through flaming, spamming and refusal to acknowledge contributions. This is reminiscent of a tribal society where active monitoring of community members' behaviour (Lerner & Triole, 2000) fosters order and productivity.

Innovation Workout: The Innovation Audit

Until this point in the text we have covered a diverse array of topics that are needed for effective innovation. In most actual operations, some of these 'best practices' will have been implemented and are functioning well; others may still be deficient or completely ignored. The purpose of an Innovation Audit is to survey your own corporate landscape to determine where management attention is needed. The Innovation Audit has two primary objectives:

1. to assure that you have completely defined the target customer groups and the specific innovations to the product and the channels that will motivate potential customers to buy your product; and
2. to assure that you have accurately defined the future sources of revenue and costs required to deliver your product and operate your channels to a sufficient extent that investors are comfortable with your business model and valuation.

This Innovation Audit will assess the strengths, weaknesses, opportunities and threats in your business model. These should ultimately be summarized in an Innovation Profile for the project and product. One method for summarization using radial graphs is presented in this workout, but you are invited to innovate on the best way to take a complex product and distil its characteristics down to a few key statistics that will be meaningful to investors and potential employees and managers.

Audit Task	Strengths	Weaknesses	Opportunities	Threats
Technical Factors in the Application of the Innovation Analysis Toolkit (innovations and target customer groups)				
Is each one of your innovations defined by a few key features that are well positioned in your supply- and demand-side feature maps?				
Did you use quizzing and mind maps to assess the anticipated experience provided to your target customer by each of these key features?				
Have you defined consumption chains for each product × target customer group?				
Have you defined how each step on each consumption chain will be managed to assure the customer buys and is satisfied with your innovation?				
Have you determined that you can cost-effectively deliver this product to your customers, either directly or by hiring third parties? (supply-side feature map)				
Alignment of Competitive Strategy & Innovation (for individual innovations and target customer groups)				
Have you predicted where the market for your product will be in 6 months? 1 year? 2 years? 5 years? Will capabilities be adequate to compete?				
What is the role that this product plays in your portfolio (cash cow, growth, star performer, loss leader or complementary product)?				
What complementary products not controlled by you are needed for this product's success?				
Are you a first mover or follower in your product's competitive space?				
What is your prediction of market penetration in 6 months? 1 year? 2 years? 5 years?				
Market Entrance and Innovation Portfolio Management				
Do you know who will be your first three customers? How will you assure that they will promote your product?				
Have you positioned each of your products by the degree of innovation (market or technological)? Are your entrance strategy and tactics based on this positioning (i.e. direct launches, stepping-stone options, positioning options or scouting options)?				
Who are your lead-steer customers? How are you managing them for maximum benefit to your product launch?				
Have you defined an entrance strategy and set of detailed tactics?				

Audit Task	Strengths	Weaknesses	Opportunities	Threats
Business Models and New Product Development				
Can you expand your demand-side feature maps into a prediction of revenues in the next 6 months? 1 year? 2 years? 5 years?				
Can you incorporate your supply-side feature map into a production and channel management budget for the next 6 months? 1 year? 2 years? 5 years?				
Have you used the 'Morphological Boxes' approach to determine the optimal feature set?				
Can you consolidate your supply- and demand-side feature maps into a flowchart of costs and revenues? Can you interpret this into pro forma budgets for the next 6 months? 1 year? 2 years? 5 years?				
Infrastructure Assessment: Investment, Competences and Assets				
Do you have the human resources (competences) need to produce a competitive innovation and business model for your target customer group? If not, how will you acquire the needed competences? Will outside investment be needed?				
Do you have the assets needed to build a competitive innovation and business model for your target customer group? If not, how will you acquire the needed assets? Will outside investment be needed?				
What is the net present value of your innovation? What percentage of company ownership do you wish to sell in order to acquire needed resources?				
Alignment with Market and Technology Trends				
Have you assessed the rate at which performance to price point is doubling for each technology in your innovation?				
How is the third-party market for components of your innovation changing? Assets such as factories for electronics fabrication? Competences such as logistics, design and so forth? Are you planning on outsourcing any or all of your design, production and innovation?				
Do your plans to redesign and re-engineer existing product lines take into account the rate of change in component technologies?				
What is the probability that this product market will be eliminated through the Innovator's Dilemma? How are you prepared to restructure your business to avoid loss of revenues?				

Audit Task	Strengths	Weaknesses	Opportunities	Threats
How will you manage and secure your intellectual property? Do you have an IP strategy for your innovations?				
Innovation Culture and Creativity Assessment (how do we measure up in this list of objectives for creative firms)				
Challenge and responsibility				
Peer recognition				
Job security				
Salary				
Hire by committee				
Hire smart problem solvers				
Cater to their every need				
Pack them in				
Communicate effectively and frequently				
Use your own products and services wherever you can				
Management focus on consensus				
Are ideas presented in an atmosphere of tolerance and respect?				
Base decisions on empirical analysis				
Sustain a start-up mentality				
Recruit for diversity, hire for philosophy				
Recognize the limitations of creative workers				
Keep it fun				
Speaking skills				
Allow 10% to 20% of employees time for their own projects				
Protect creative workers from creativity killers				
General Questions				
How many new products and services did we launch last year and how does this compare to the ideal?				
How long does it take an idea to go from initial approval to full implementation?				
What proportion of our revenues comes from products or services launched in the last two years?				
How effective is our idea generation programme? How many ideas are we generating?				

Audit Task	Strengths	Weaknesses	Opportunities	Threats
How healthy is our new product pipeline? What is the forecast value of developments in the pipeline?				
How many ideas per employee are submitted and how many are approved?				
What resources in terms of people, time and money are we allocating to innovation?				
To what extent are people empowered to try out new ideas?				
Do we recognize and reward risk taking?				
Do we blame people for failure when initiatives do not succeed?				
Can people challenge company policy or managerial decisions?				
Are we complacent or entrepreneurial?				
Do we deliberately look outside for ideas?				
Do departments openly collaborate on projects?				
What is stopping us from implementing more ideas quickly?				

The audit lays out the particular components of successful innovation presented in *Global Innovation Management* in a checklist fashion. Checklists alone do not lead to comprehensive strategies; but they can clearly map firms' strengths and weaknesses in the context of commercial innovations – either services or products – and point where management needs improvement.

The Innovation Audit examines seven areas of firm performance.

- Technical Factors in the Application of the Innovation Analysis Toolkit
- Alignment of Competitive Strategy & Innovation
- Market Entrance and Innovation Portfolio Management
- Business Models and New Product Development
- Alignment with Market and Technology Trends
- Infrastructure Assessment: Competences and Assets
- Innovation Culture and Creativity Assessment

The Innovation Audit Scorecard

The following checklist provides the promised Innovation Audit Scorecard.

The Innovation Audit Report

The Innovation Audit Scorecard is intended to be descriptive, each cell suggesting actions to be taken to keep a firm's product innovation in top form. But the cells could also receive performance grades (e.g., 5, 4, 3, 2, 1 corresponding to A, B, C, D, E) and these consolidated over a particular category. This allows a very detailed assessment of the firm's strengths and weaknesses to be presented in a consolidated, quick-to-interpret dashboard such as the radar chart shown in Figure 11.1. Note that all four of the SWOT assessments are included, but the strengths and weakness assessments (being the most important in a report card) are drawn with heavy lines. In Figure 11.1, entrance strategy, the business model, infrastructure of capabilities and

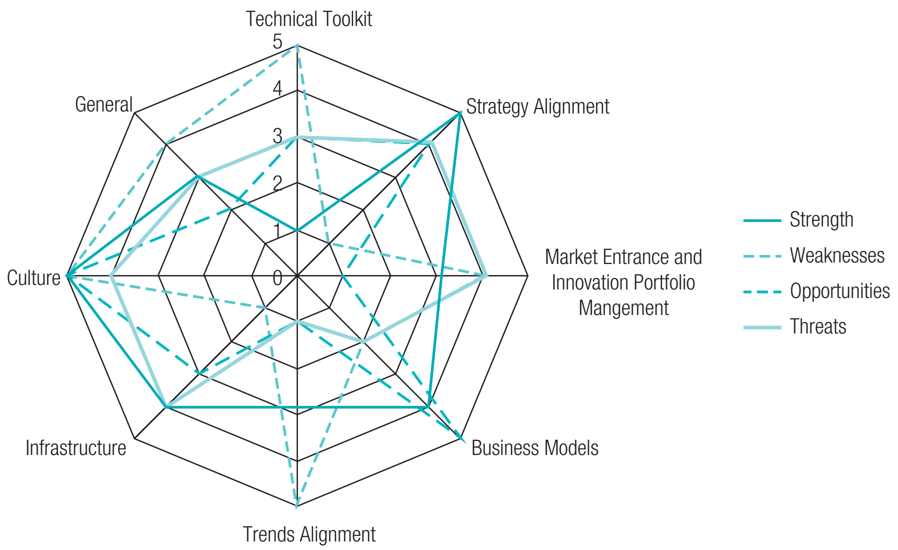

Figure 11.1 A Report Card of the Firm's Innovation Performance for a Particular Product

innovation culture all appear to be working well for this particular product's development. On the other hand, the report clearly shows some deficiencies in the application of the technical toolkit (quizzing, feature maps and consumption chain) and these deficiencies may increase the odds of encountering unexpected pitfalls for the company as it brings its ideas to market.

Case Study: Q&A – Jazz Vibraphonist Gary Burton Talks about Managing Creative People

Vibraphonist Gary Burton is well known in jazz circles. He was *Down Beat* magazine's 1968 Jazzman of the Year, is a member of the Percussion Hall of Fame, and is currently Dean of Curriculum of the Berklee College of Music in Boston. Burton is known worldwide as a musical innovator and master improviser. In a career that has spanned three decades, he has recorded with jazz legends like Chick Corea, Stan Getz, George Shearing and Quincy Jones, pop and rock stars like k.d. Lang and Eric Clapton, and has led the Burton Quartet.

Conventional wisdom says that jazz combos are free and spontaneous, and symphony orchestras are dominated by autocratic conductor/CEOs. Do those images correspond to reality?

Unless you've been inside a jazz combo or an orchestra you can't know how they really work. For example, there's a very strong leader in the jazz group. For all the talk of openness and spontaneity, a jazz group can't adopt a communistic attitude: 'We're all equals here'. There's a need for vision and concept, and only one person can effectively establish and define a vision. Once you have this vision, your job as leader is to bring out the best in the people who're working with you. I want my piano player to have as much input as I can stand – as long as it doesn't bump into the vision. I need to communicate to him what my vision is, so the stuff he contributes fits it.

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Just how collaborative are jazz combos really?

If it's my group my judgement is ultimate. I'll talk with my musicians about how I see the song. Each song is like a little play that we've been given. Usually it's about 30 seconds of information – a chord sequence, a tempo, a mood and a concept. We're going to take that and spin it into a story for the next eight or nine minutes.

I'll say to the group, 'Here's the script. It's set in Argentina, and it's got a melancholy feel to it, and this is what I see happening'. I describe this to the group in two ways: I play it for them myself and say, 'I hear it at this tempo, and I hear a crescendo in this section, and then it tapers off in this section'. So I'm showing them how I feel the tune should be played, and I'm also describing it in words as much as possible.

Within the context of that vision, individual players start to contribute their ideas. Occasionally, I have to say, 'What you're doing there doesn't really work. Could you try something else?'. Everybody makes suggestions, we discuss them, eventually we work it out. If we have a stand-off, the leader makes the decision and everyone goes along with it.

The jazz leader I most admired was Miles Davis. That may come as a surprise, because he had a reputation as an eccentric. The way he looked was absolutely intimidating, and he was mesmerizing to watch and hear in action. But he was also the most creative and daring musician. The best jazz musicians wanted to play with Miles because they knew that he could get them to go places musically that otherwise they wouldn't be able to go. He would sign up the biggest stars to play with him, encourage them to do their best work, and be strong enough himself to bring them all together and meld them into a cohesive group. As demanding and intimidating as he was, it was worth it.

That's more like what you hear about conductors of symphony orchestras. Is a conductor more like a CEO who defines a vision and then makes sure everybody executes it appropriately?

That's certainly the general image. But there's a dark side of orchestras that most people don't know about – a strange political battle between orchestra members and conductors. The members of the orchestra are constantly harassing and challenging the conductor, doing anything they can to try to mess him up, including very childish things. It's almost like they defy the conductor to make them toe the line. It's very common.

Is that the musical equivalent of corporate alienation?

One of my classical friends, a violin soloist, experienced this when she was guesting at Lincoln Center, with the New York Philharmonic.

She went to rehearsal and there was Zubin Mehta conducting and the players were being incredibly disrespectful. They weren't paying attention, they were talking to each other, listening to the ballgame on the radio. She turned to one of her friends and said, 'I had no idea things were this bad.' He said, 'We're all on good behaviour tonight because you're here.'

Gamesmanship like that is fairly familiar in corporations. What accounts for it in orchestras?

I guess it's a psychological thing: because the conductor literally has all the control, the players then abdicate. They've been disempowered, as they say in the business world. I know it sounds exactly like the corporate environment: 'I just type whatever they give me. It's none of my business whether it's all wrong or not, or whether I could make a suggestion. Every time I make a suggestion, nobody cares anyway, so let them stew in their own juice.' It turns out the same thing applies to a large corporate structure or a symphony orchestra.

Businesses say they want their traditional management teams to become as spontaneous and improvisational as a good jazz combo. How hard is it to teach a classical musician to feel comfortable improvising?

It's a very difficult transition for someone who has been a typical classical musician for decades. A lot of my classical music friends say to me, 'I'd love to be able to improvise. Tell me how to do it. You're a teacher – help me out'.

It's not out of the question. But I have to tell them, 'You'll learn a process, you'll understand it, but you'll have to unlearn or replace a lot of ingrained habits'.

It turns out that classically trained musicians are the toughest ones to teach. It's easier to teach somebody who's a beginning musician. Performing music – or managing in a company, for that matter – is all about developing habits and ways of doing things that your unconscious mind controls. A very modest example of this would be the way people learn to play the piano. You don't start out for the first year saying, 'This year we're going to start using just these two fingers and get good at that, and then next year go to four fingers'. You don't work your way up to 10 because that would mean relearning your concept of how to function on the instrument all over again. You learn one way of doing it and that becomes your natural, spontaneous physical connection to the process.

One of the paradoxes of improvisation is that it's a mixture of two opposites – tremendous discipline and regimen balanced by spontaneity, listening, and playing in the moment. We spend countless hours going over and over things, trying to learn parts, trying to get our playing perfected. We practise exercises, we play the passage repeatedly until we can get it right, and then as soon as we get that one right we move on to another one and start doing it over and over again. Every musician puts in anywhere from an hour to several hours a day for years just to get their basic craft organized. Now that kind of experience is highly regimented – it's totally lacking in spontaneity.

At the same time, musicians have a highly developed instinct to be spontaneous. When something in us says, 'Do it!' we're able to just go ahead and do it. As a musician you have to be able to live by those spontaneous instincts or you simply become nonfunctional. One of the things I suspect about the colourful behaviour of musicians, whether classical, jazz or rock, is that it's a way to shake off all that regimen and get back in touch with the raw emotion of music.

Are there techniques you use with students to try to teach them to be spontaneous?

I tell them to use their ears instead of their brains. If I'm working with a student, I'll play something and tell them to play something back to me. Respond to it. React to it. Don't stop and study it. Answer it. Make musical conversation happen.

Gradually what happens is that you let your unconscious mind make the decisions. This is the essential element for the jazz musician. When I'm playing, my mind has to make thousands of little decisions incredibly quickly. I couldn't possibly think about each one, consider each one, and make the decision. My unconscious mind can weigh all these alternative possibilities, pick the right one, time it exactly, Coordinate the muscles, and make it happen.

As I start to play a song, in those first few moments of playing I step back from the process mentally, and the playing starts going on its own. I start watching it as if I'm an observer. The unconscious mind is now doing it. It's very natural for me now, after doing it for years. It wasn't so natural in my early days when I was much more conscious about my playing. But you learn to trust your unconscious mind.

(Source: Schrage, 2006: 6, 110)

Gary Burton Interview: Questions for Review

- What are the distinctive characteristics of the most creative people that you know?
- What habits or behavioural traits do you like about these people?
- What habits or behavioural traits do you dislike about these people? How would you ask them to change? What impact might this have on their creativity?
- What sort of business environment can you envision that would maximize the amount of innovation contributed by these creative individuals?

Chapter 11 – Key Points

Understanding Creative People

1. No one knows exactly what triggered the increase in brain size, and presumably the concurrent rise in human creativity. But can you, in a Darwinian context of random genetic mutations, and aggressive natural selection, outline a scenario in which creativity becomes as much of a human necessity as hunger or sex?
2. Beyond a certain level of IQ, probably around 120, there is no clear correlation between intelligence and creativity.
3. Creators are hard-driving, focused, dominant, independent risk-takers.
4. Complexity is the ability to harbour tendencies that normally appear to be at opposite extremes. Very creative individuals can alternate between the two extremes of being rebellious or highly disciplined almost at the drop of a hat.
5. Psychological androgyny – being on one hand very sensitive and more 'feminine' and on the other aggressive and offensive – is another creative trait.
6. Child prodigies usually exhibit only one extreme of the spectrum of characteristics – they tend to be intense, driven and introverted.
7. Creative people exhibit stimulus freedom – what we might call the ability to think outside the box.

Managing Creative People

1. Recruit for diversity, hire for philosophy.
2. Redesign your officespace.
3. Within limits, let them make the rules.
4. Keep their eyes on the prize.
5. Feed their heads.
6. Teach them a new language.
7. Allow time for blue-sky thinking.
8. Protect your team from creativity killers.
9. Add liberal doses of fun.

Further Reading

Abraham, C. (2002) *Possessing Genius: The Bizarre Odyssey of Einstein*'s Brain. New York: St. Martin's Press.

Afuah, A. (2003). *Innovation Management*. Oxford.

Aijmer, K. (2014). *Conversational Routines in English: Convention and Creativity*. Routledge.

Amabile, T. M. (1996). *Creativity in Context*. Boulder, CO: Westview Press.

Amabile, T. M., Collins, M. A., Conti, R., Phillips, E., Picariello, M., Ruscio, J. and Whitney, D. (1996). *Creativity in Context: Update to the Psychology of Creativity*. Boulder, CO: Westview Press.

Anderson, B. and Harvey, T. (1996). Alterations in cortical thickness and neuronal density in the frontal cortex of Albert Einstein. *Neuroscience Letters* 210, 161.

Andreasen, N. C., O'Leary, D. S., Paradiso, S., Cizaldo, T., Arndt, S., Watkins, G. L., et al. (1999). The cerebellum plays a role in conscious episodic memory retrieval. *Human Brain Mapping* 8(4), 226–234.

Baer, J. (2014). *Creativity and Divergent Thinking: A Task-specific Approach*. Psychology Press.

Bloom, H. (2002). *Genius*. New York: Warner Books.

Bodin, M. (1990) *The Creative Mind: Myths and Mechanisms*. New York: Basic Books.

Brockman, J. (ed.) (1993) *Creativity*. New York: Touchstone.

Christianson, S. A. (1992). Emotional stress and eyewitness memory: A critical review. *Psychological Bulletin* 112(2), 284–309.

Chugani, H. T. (1998). Biological basis of emotions: Brain systems and brain development. *Pediatrics* 102, 1225–1229.

Collins, J. (2001). *Good to Great: Why Some Companies Make the Leap...And Others Don't* (pp. 65–73). HarperBusiness.

Collins J. C. and Porras J. I. (2005). *Built to Last: Successful Habits of Visionary Companies*. Random House.

Csikszentmihalyi, M. (1996). *Creativity*. New York: Harper Collins.

Csikszentmihalyi, M. (2014). *Society, Culture, and Person: A Systems View of Creativity* (pp. 47–61). Springer Netherlands.

Dacey, J. S. and Lennon, K. H. (1998). *Understanding Creativity*. San Francisco: Jossey-Bass.

Davenport, T. (2011) Why office design matters. *HBS Working Knowledge*, http://hbswk.hbs.edu/archive/4991.html, accessed 22 June 2016.

Diamond, M. C., Scheibel, S, Murphy, G. J. M. Jr. and Harvey, T. (1985). On the brain of a scientist: Albert Einstein. *Experimental Neurology* 88, 198.

Drucker, Peter F. (1999). *Management Challenges of the 21st Century*. New York: Harper Business.

Drucker, Peter F. (2000) Managing knowledge means managing oneself, *Leader to Leader* 16 (Spring).

Dulay, H. and Burt, M. (1977). Remarks on creativity in language acquisition, in M. Burt, H. Dulay and M. Finocchiaro (eds), *Viewpoints on English as a Second Language*. New York: Regents.

Duxbury, T. (2012). Creativity: Linking theory and practice for entrepreneurs. *Technology Innovation Management Review* 2(8).

Economist (2007, 3 March). The rise and fall of corporate R&D, pp. 69–71.

Elsbach, K. D. and Hargadon, A. B. (2006). Enhancing creativity through 'mindless' work: A framework of workday design. *Organization Science* 17, 470–483.

Energy.gov (2013, 22 November). The history of the light-bulb, www.energy.gov/articles/history-light-bulb, accessed 27 June 2016.

Florida, R. (2003). *The Rise of the Creative Class*. New York: Basic Books.

Gardner, H. (1993). *Creating Minds*. New York: Basic Books.

Gero, J. S. and Maher, M. L. (eds) (2013). *Modeling Creativity and Knowledge*-based Creative Design. Psychology Press.

Glover, J. A., Ronning, R. R., and Reynolds, C. (eds) (2013). *Handbook of Creativity*. Springer Science & Business Media.

Grant, A. M. (2008). The significance of task significance: Job performance effects, relational mechanisms, and boundary conditions. *Journal of Applied Psychology*, 93, 108–124.

Guilford, J. P. (1967). *The Nature of Human Intelligence*. New York: McGraw-Hill.

Hanks, K. (2012) Building a fun and creative team, www.indiana.edu/~bobweb/Samples/Motivating_Your_Team_part_1.doc, accessed 22 June 2016.

Kohn, A. (2004). Feel-bad education. *Education Week* 24(3), 44–45.

Krashen, S. (1982). Theory versus practice in language training, in R. W. Blair (ed.) *Innovative Approaches to Language Teaching* (pp. 25–27). Rowley, MA: Newbury House.

Landes, David S. (1998). *The Wealth and Poverty of Nations: Why Some Are So Rich and Some So Poor*. New York: W. W. Norton & Company.

Lerner, J and Triole, J (2000, December) The simple economics of open source software, NBER Working Paper No. 7600.

Lieberman, J. N. (2014). *Playfulness: Its Relationship to Imagination and Creativity*. Academic Press.

Lombroso, C. (1895). *The Man of Genius*. London: Charles Scribner.

Livio, M. (2005) *The Equation that Couldn't Be Solved*, Google Books, https://books.google.com/books?isbn=0743274628, accessed 22 June 2016.

Ludwig, A. M. (1995). *The Price of Greatness: Resolving the Creativity and Madness Controversy*. New York: Guilford Press.

MacKinnon, D. W. (1975). IPAR's contribution to the conceptualization and study of creativity, in I. Taylor and J. W. Getxels (eds) *Perspectives on Creativity*. Chicago: Aldine Publishing.

Mauzy, J. H. (2006). Managing personal creativity. *Design Management Review* 17(3), 64–72.

Mayo, Elton (1945). *Social Problems of an Industrial Civilization*. Boston: Division of Research, Graduate School of Business Administration, Harvard University.

Mokyr, J. (1991). *The Leaver of Riches*. Oxford: Oxford University Press.

Norman, Warren T. (1963). Toward an adequate taxonomy of personality attributes: Replicated factor structure in peer nomination personality ratings. *The Journal of Abnormal and Social Psychology* 66(6), 574–583.

Patterson, Ch., *Individual and Organizational Creativity*. Halifax, Nova Scotia, Canada.

Perry-Smith, J. E. and Shalley, C. E. (2014). A social composition view of team creativity: The role of member nationality-heterogeneous ties outside of the team. *Organization Science* 25(5), 1434–1452.

Perry-Smith, J. and Mannucci, P. V. (2015). 12 social networks, creativity, and entrepreneurship, in C. Shalley, M. Hitt and J. Zhou, *The Oxford Handbook of Creativity, Innovation, and Entrepreneurship* (p. 205). Oxford: OUP.

Post, F. (1994) Creativity and psychopathology: A study of 291 world-famous men. *British Journal of Psychiatry* 165, 225.

Romer, P. (1993, 11 September) Ideas and things. *The Economist*, p. 21.

Rothenberg, A. and Hausman, C. R. K (eds) (1976). *The Creativity Question*. Durham: Duke University Press.

Runco, M. A. (2014). *Creativity: Theories and themes: Research, Development, and Practice*. Elsevier.

Sartre, Jean-Paul (1964). *The Words*. Trans. Bernard Frechtman. New York: George Braziller.

Sawyer, R. K. (2011). *Explaining Creativity: The Science of Human Innovation*. Oxford University Press.

Sawyer, R. K. (2014). *Group Creativity: Music, Theater, Collaboration*. Psychology Press.

Shadmehr, R. and Holcomb, H. H. (1997). Neural correlates of motor memory consolidation. *Science* 277, 821–825.

Schmidt, Eric and Varian, Hal (2005, 2 December). Google: Ten Golden Rules, *Newsweek*.

Simonton, D. K. (1999). *Origins of Genius*. Oxford: Oxford University Press.

Shalley, C. E., Zhou, J. and Oldham, G. R. (2004). The effects of personal and contextual characteristics on creativity: Where should we go from here? *Journal of Management* 30, 933–958.

Schrage, M. (2006). *The Gary Burton Trio: Lessons on Business from a Jazz Legend*. Fast Company.

Seabright, P. (2004). *The Company of Strangers.* Princeton: Princeton University Press

Selby, R. and Cusumano, M. (1999). *Microsoft Secrets*. New York: The Free Press.

Sowell, E. R., Peterson, B. S., Thompson, P. M., Welcome, S. E., Henkenius, A. L. and Toga, A. W. (2003). Mapping cortical change across the human life span. *Nature Neuroscience* 6, 309–315.

Spencer, E., Lucas, B., and Claxton, G. (2012). Progression in creativity: Developing new forms of assessment: A literature review. *Creativity, Culture and Education*.

Stein, M. I. (2014). *Stimulating Creativity: Individual Procedures* (Vol. 1). Academic Press.

Sternberg, R. J. (ed.) (1998). *Handbook of Creativity*. Cambridge: Cambridge University Press.

Sternberg, R. J. and O'Hara, L. (1999). Creativity and intelligence, in R. J. Sternberg (ed.), *Handbook of Creativity* (pp. 251–272). New York: Cambridge University Press.

Tischler, L. (2004, December). The Care and Feeding of the Creative Class. *FastCompany*, Issue 89, 93.

Tischler, L. (2005, June). The cubicle. *FastCompany*, 95, 29.

Vise, D. and Malseed, M. (2006). *The Google Story*. New York: Delta.

Wills, G. I. (2003). Forty lives in the bebop business: Mental health in a group of eminent jazz musicians. *The British Journal of Psychiatry* 183: 255–259.

Winner, E. (1997a). Exceptionally high intelligence and schooling. *American Psychologist* 52(10), 1070.

Winner, E. (1997b).*Gifted Children: Myths and Realities*. New York, Basic Books

Witelson, S. F., Kigal, D. L. and Harvey, T. (1999). The exceptional brain of Albert Einstein. *The Lancet* 353, 2149.

CHAPTER

12 Communities, Networks and Reputation

Learning Objectives

After finishing this chapter, you will

- Understand the action of network effects and industry standards.
- Understand how brands and reputation signal the market concerning minimum quality standards.
- Understand branding as a contracting vehicle for mutual trust and community responsibility, however the community and contract are defined.

After doing the *Innovation Workout* you will be able to apply inductive reasoning based on existing successes to your brand development.

After reading the Craigslist *case study* you will be challenged to define future roles for community, the creative commons, principles and moral compass that guide a company, and the mutual effect of reputation and viral network growth of services such as Craigslist.

Network Effects

Networks have long been a progenitor of radical change in business. Networks of canals, rails and highways fomented a huge economic shift over a century ago – the shift from an agricultural to industrial economy at the end of the 19th century. Railways accounted for almost 15% of US gross domestic product (GDP) at the end of the 19th century – similar to IT around the year 2000. With railways, farmers were no longer tethered to the farmers' markets of their local village. They began growing large surpluses of grains for distribution throughout the US. Railways had made distance irrelevant (or perhaps less relevant). Universal access was important, especially to farmers. For example, the state of Iowa enacted legislation that required railways to provide service to within six miles (one day's buggy ride) of any farm in the state. Trustbusters worried about unhealthy synergies between network industries – such as electricity, oil pipelines, telephone and telegraph – which could benefit from the railways' long, uninterrupted rights of way. The Texas Railroad Commissioner grew to be one of that state's power brokers when oil was discovered at Spindletop at the turn of the century – he controlled the flow of oil along the pipelines that followed the rails.

Network industries play a crucial role in modern life. The modern economy would be very much diminished without the transportation, communications, information and railway networks. Most of the major information industries are also either network industries or share many essential economic features with network industries.

The First Network Bubble

On Black Thursday, 18 September 1873, the New York banking house of Jay Cooke and Company, the financier of the Northern Pacific Railway, collapsed. The enormous cost of the Civil War, excessive railway building, inflated credit, speculation, overexpansion and capital outlays for new farmland provoked a crisis. In a domino effect, railway bankruptcies and bank failures followed. Over 18% of the country's railway mileage was in the hands of receivers, iron and steel works were devastated, and business failures led to massive layoffs. Wages plunged by 25%. Over the next four years, business failures reached $775 million ($155 billion in 2002 dollars) and the number of unemployed rose to nearly three million (in a country of 45 million).

It didn't end there. Railways burned money on a colossal scale. Textile mills, the country's largest manufacturers, rarely cost more than $1 million ($18 million in 2002) whereas the capitalization of the four big east-west trunk lines – Pennsylvania, Erie and Northern Pacific, New York Central and Baltimore & Ohio – reached $140 million (over $25 billion today). E. H. Harriman, the boldest proponents of the spend-money-to-make-money strategy, poured a rousing $240 million ($4.8 billion today) into expanding and modernizing the Southern Pacific Railroad. Three months after President Grover Cleveland began his second Democratic term in 1893, railway overexpansion provoked a cascading collapse of the economy that, until the 1929 Wall Street Crash, was known as the Great Depression. The 1893 slump brought down the Erie, other debt-ridden railways and 600 banks. It embittered the already discontented farming regions and exhausted the silver-mining states.

Conceptually, anything called a network can be described using 'links' that connect 'nodes' in radial tree diagrams.

A phone call from A to B is composed of the access to the switch of customer A, the access to the switch of customer B, and switching services provided by the carrier. Networks where services AB and BA are distinct are named 'two-way' networks. Two-way networks include railway, road and many telecommunications networks. When one of AB or BA is unfeasible, or does not make economic sense, then the network is called a one-way network – for example radio or television broadcasting networks (Tushman, 1978; Tushman & Moore, 1988).

The crucial relationship in both one-way and two-way networks is the *complementarity* between the pieces of the network. *Standards* assure that various links and nodes on the network can be mixed and matched at zero marginal cost to produce demanded (and thus valuable) goods.

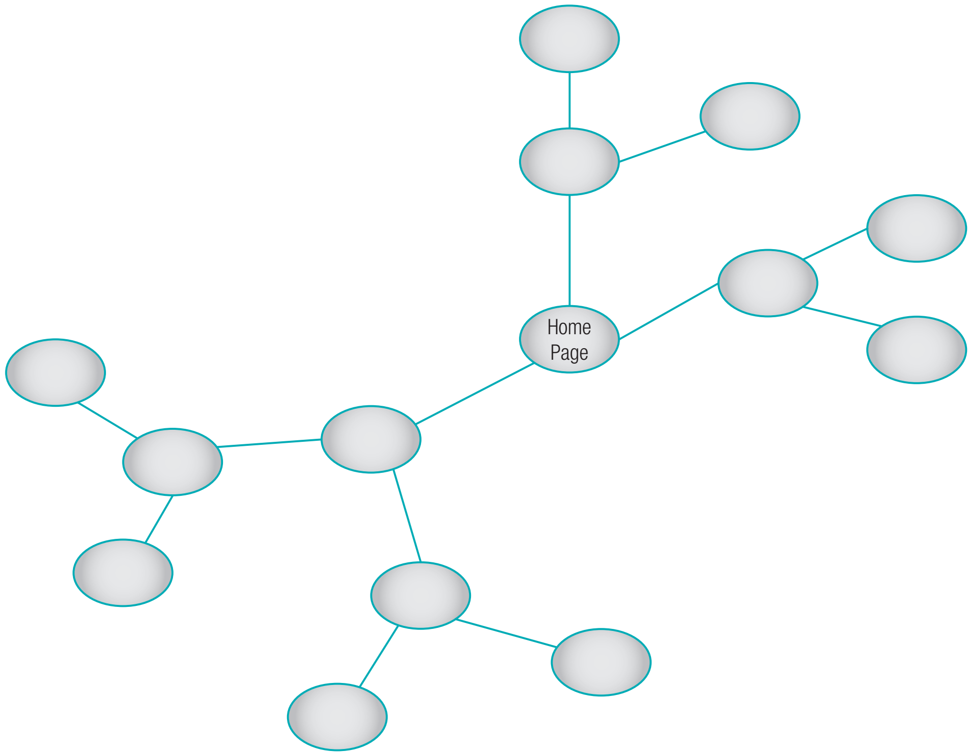

Figure 12.1 Radial Tree Diagram of a Network

Electrical Standards

Standards are critical, yet often set haphazardly. Nicola Tesla's experiments in the 1860s determined that electric motors ran most efficiently with alternating current at 220 volts and 60 cycles per second. George Westinghouse, the original champion of alternating current, developed his system of generators and transformers to run at 133 cycles, but depended on Tesla for motors. For all their efforts, Westinghouse's engineers were unable to adapt it to 133 cycles, and were instead forced to switch all of their generators to 220 volts at 60 cycles per second. And that would have been the end of it except that his competitor, Thomas Edison, had been running his direct current generators on Pearl Street in New York at 110 volts. When Edison switched to generating alternating current, he ran it through the same cables and substations, so kept the voltage at 110 volts but adopted 60 cycles per second.

As we saw in Chapter 11, when German company AEG built the first European generating facility, its engineers fixed the frequency at 50 Hz, because the number 60 didn't fit the metric standard unit sequence. It adopted Tesla's suggestions for 220 volts, but running at 50 cycles per second.

The system cost of these decisions is enormous. A motor run on current at 50 cycles per second is on average 17% less efficient than one run at 60 cycles per second – this forces Europe to generate perhaps 10% more energy than if it was running at 60 cycles per second. In the US, Edison's decision to run his system at 110 volts (which ultimately became the US standard) creates problems for the power line going into a house or business. The drop from one end of a typical American house to the other may be as much as 20 volts, forcing distributors of electricity to send 120 volts to the house just to assure that the voltage will not drop below 100 volts (which would cause a noticeable dimming in incandescent light bulbs).

Network effects often arise where technologies are used by many people at once, such as those which help establish direct or indirect personal communications – e.g. word processors, programming languages, email, telephones, database standards and so forth. It usually takes some time to enable this communication through innovation or standards. Individuals can realize economies of scale when they all adopt the same standard technology in their interactions. The economies of scale are larger where more people adhere to the same standards – they are said to benefit from network effects with which they can improve the efficiency of their work.

Natural Monopolies

Theodore Vail, a former director of the US Postal Service, who had taken great advantage of network innovations such as the railway and the telegraph to make the US Post Office the most efficient and profitable in the world, took control of Bell Telephone (renamed AT&T after J.P. Morgan gained control of the company in 1907). Bell's patents on the telephone had run out in 1894, and since that time the company had faced intense competition from nearly 6000 other phone companies across the US. Vail believed that Bell Telephone's future would be secure if it could build a national network and function as a national utility before its exclusivity ran out. This was an expensive proposition, but it would be even more expensive for a viable competitor to build out a network to challenge Bell Telephone. In AT&T's 1908 annual report Vail argued that:

> A telephone without a connection at the other end of the line is … one of the most useless things in the world. Its value depends on the connection with other telephones – and increases with the number of connections.

Vail's ideas about the power of network effects were central to arguments he used to justify AT&T's acquisition of smaller competitors throughout the 1920s and 1930s, and to justify its defence of 'universal service' and 'natural monopoly,' similar to the post office or railways, up until Bell's breakup in 1982.

Network effects can play an important role in the efficient allocation of resources. In a free-market economy, individuals tend to focus on their own particular welfare, and there may not be proper incentives to build up networks large enough to benefit them with network effects. This may be cited as justification for 'natural monopolies' (see box) in network industries like power, transportation and telephones, which ostensibly can allow individuals to realize these network benefits.

The Networking Family

The Vail family played a big part in many of the early network industries in the US. The grandfather of Theodore Vail (see the preceding 'Natural Monopolies' box), Lewis Vail, was a civil engineer who moved to Ohio and made his name building networks of canals and highways, relatively new infrastructures at that point in American history. Theodore's uncle, Stephen Vail, was founder of the Speedwell Iron Works that built much of the mechanical technology that went into the early steamships that crossed the Atlantic Ocean. Stephen, together with his sons George and Alfred Vail, funded inventor Samuel F. B. Morse with the money for his wireless transmitter. Cousin Alfred Vail invented the dot-and-dash alphabet utilized by Morse's telegraph. Theodore Vail's one adopted daughter, Katherine, became one of the founders of Bennington College, and Theodore himself joined the US Post Office, inventing its 'Fast Mail' service, the first mail-only train service, which in 1875 began operations between New York City and Chicago. In 1878 Vail left the Postal Office to become general manager of the recently established American Bell Telephone Company, which was started on 9 July 1877 and spent many of the subsequent years fending off court challenges from telegraph giant Western Union. Theodore left the company after a decade, but came out of 'retirement' to lead the company in its post-patent days.

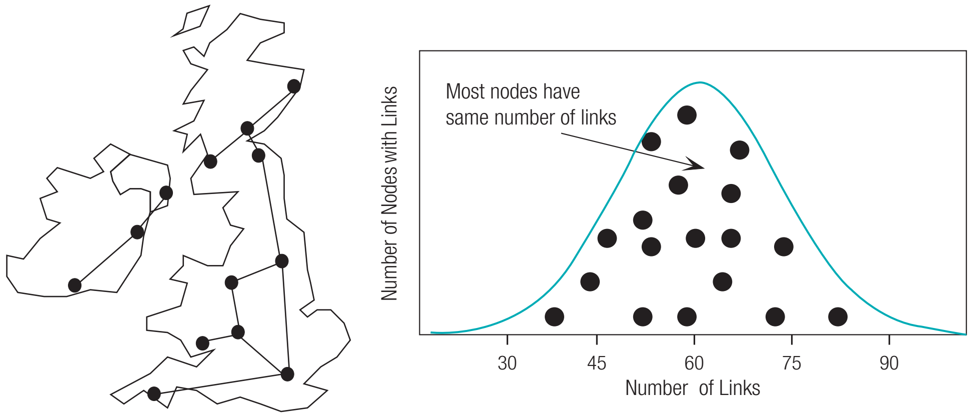

Figure 12.2 Random Networks (UK Highways)
Source: Barabási, 2014.

Bob Metcalfe (2000: 97), inventor of Ethernet and former CEO of 3Com, developed a characterization of network effects for an Ethernet network in 1980 that suggested that the cost of a computer network increases linearly with the number of nodes, while the value increases by the square of the number of nodes. Metcalfe's idea had great influence during the dot.com boom, where it was used to justify telecommunications investments and standards wars with the idea that network business models have a 'critical mass' beyond which profits and value to adopters grow rapidly, and where higher switching costs tend to lock in adopters. More recently, Andrew Odlyzko has suggested that Metcalfe overestimated value and that network value increases logarithmically (Briscoe, Odlyzko & Tilly, 2006). In contrast, David Reed suggested that value scales exponentially, and that Metcalfe underestimates value. Though widely cited, neither theorist has conducted the empirical work needed to support his claims (neither has Bob Metcalfe).

The most extensive empirical work on network structure has been conducted by physicist Lazlo Barabási (2014) and his colleagues around the world. They have identified three topologies for common networks – random, small-world, and scale-free. This is not the only way to describe network topologies, nor is there even universal agreement about how network topologies should be differentiated. But these three topologies serve to differentiate some of the more commonly encountered networks.

Random networks (Erdös-Rényi networks) Random networks provide a benchmark model used in assessing networks. Though not widely found in the real world, they were the first to be modelled and investigated intensely by Paul Erdös and Alfréd Rényi in the 1950s. Many important properties of random graphs appear quite suddenly – a phenomenon that corresponds to the 'critical mass' in economics of networks, and the 'percolation threshold' in many physical phenomena. Random networks are like highway networks, where most cities are served by around the same number of highways (Figure 12.2) and thus the number of links on the average node tends to cluster around the mean of a normal distribution.

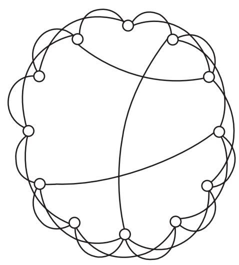

Figure 12.3 Small-World Networks Tend to Have a Few Close Contacts, and a Few Nodes that Stretch Their Contacts Across the Whole Network (In Social Networks, These will be the Most Widely 'Networked' People in a Crowd)
Source: Barabási, 2014

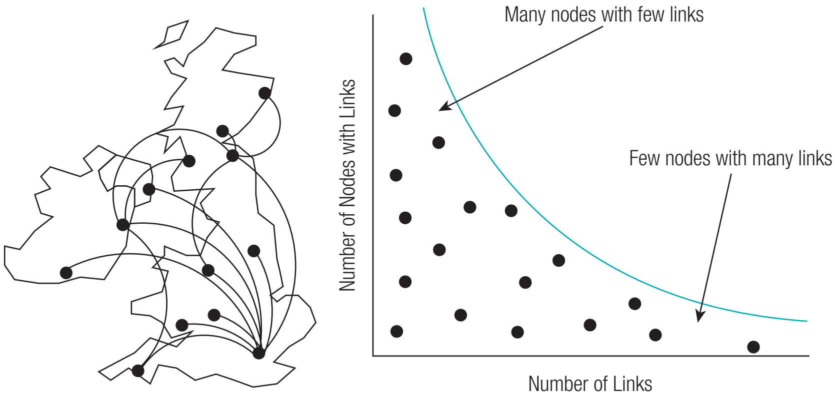

Figure 12.4 UK Air Traffic (Scale-Free Network With a Power Law Distribution of Links)
Source: Barabási, 2014

Small-world networks Many real-world networks have relatively short path lengths between nodes – for example, the six degrees of separation between individuals in the world studied by Stanley Milgram and Manfred Kochen in the 1960s. Duncan Watts and Steven Strogatz have studied such networks, which were inspired by the structures that Milgram found in his studies (summarized in Watt's book *Six Degrees*, 2004). Small-world networks add a few extra long-range links to what is otherwise the limited networking of a small local social community. These long-range links drastically shorten the average separation between all nodes, similar to the real-world social links that Milgram discovered.

Scale-free networks The WWW is a 'scale-free network'. The number of links attached to an arbitrary node tends to follow a power law – i.e. the frequency with which we encounter a node with k links will be k^{-x} where x is some fixed number that characterizes the way the scale-free network is connected. Linkages follow a Zipfian distribution (also called Paretian or Yule distribution), a distribution that has been widely studied, and for which several competing models of generation exist. In many real-world networks $x \cong 2$, possibly giving credence to Metcalfe's law if we assume that value is somehow tied to the number of links to certain nodes. Scale-free networks are like air traffic networks, where a few 'hub' cities have a large amount of the total traffic (Figure 12.4).

In addition to the topology of linkages of a network, one has to consider that all links may not be equally strong. This seems to be especially important in social networks (e.g. networks of friends, business associates and so forth) because maintaining strong links (e.g. close friendships) can become prohibitively costly for more than a very few links. Mark Granovetter (1973) suggested that most social networks consist of small clusters of tightly connected individuals, with a few individuals maintaining weak ties with a much larger community (Figure 12.5). This is similar to Watt's small-world network, but with varying strengths of ties. Recent work has reinforced Granovetter's contention that *weak ties* are more

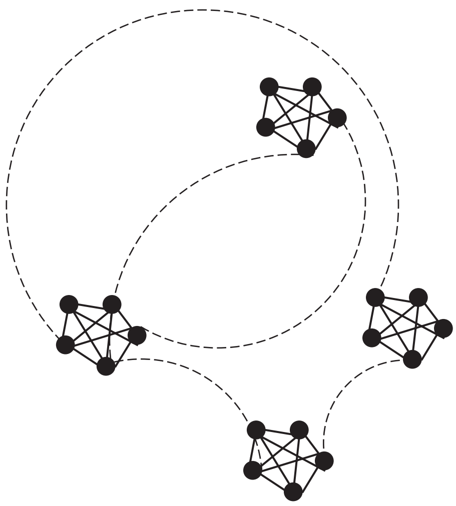

Figure 12.5 Strong and Weak Social Links

important for the effectiveness and reach of a network (and thus, presumably, its value to those who use the network) than strong ties.

Value Drivers in Network Economics

If you have some idea of the topology of a particular network which lies at the core of a strategy model (for example, eBay's community of traders is a network that generates all of the value from their business model) then Barabási's research (2014) finds that there are three robust measures of network topology, and thus strategy drivers that may be controlled as well as called upon to forecast value generation. These measures are:

1. ***Average path length:*** the distance between any two nodes;
2. ***Clustering coefficient:*** (a measure of tendencies of cliques in social and communications networks) which is measured with a standard metric developed by Watts and Strogatz, 1998, who were the first to report that clustering in real-world networks tended to significantly exceed that of random networks; and
3. ***Degree distribution:*** i.e. the probability distribution giving the probability that there are k links attached to an arbitrary node.

Barabási and his colleagues have also shown how these characteristics are generated from particular initial conditions and patterns of growth (adding new links to nodes). There is a dynamic behind the structure, and *time* implicitly becomes a fundamental value driver in network effects.

Standards, Lock-in and Critical Mass

No discussion of network effects would be complete without mentioning three topics that regularly surface in competitive strategy – critical mass, customer switching costs and lock-in, and competition to set interface, interoperability and other linkage standards. These concepts grew in popularity during the dot.com boom, when many business models made internet networking their centrepiece. The idea is that networks grow, then reach a 'critical mass' of users, after which network effects are so overpowering that network growth explodes (much like critical mass in a nuclear weapon). Once network effects are this large, customers are locked in to the network, and high switching costs will prevent them leaving for a competitor. Networks may be real, like the internet, or virtual, like Microsoft's operating systems. Virtual networks depend on 'standards' for interfaces, interoperability and so forth.

So embedded is the received industrial wisdom that it has been supported with its very own supporting mythology (see box: 'Myths About Public Goods, Externalities and Lock-in'). Intellectual property rights may indeed accrue to firms that set a standard – for example, Microsoft in operating systems and word processors. And perhaps these are inferior to competitors that do not have the luxury of lock-in and a critical mass of users. But a number of examples cited in support of lock-in and critical mass – especially to an inferior standard – have been questioned and found wanting. Thus the verdict is still out on just how important standards, lock-in and critical mass are to competitive strategy.

Myths About Public Goods, Externalities and Lock-in

Lighthouses are commonly cited as a natural monopoly that is provided as a pure public good, in order to improve shipping network efficiencies by preventing wrecks. But nearly three decades ago, economist Ronald Coase showed that when lighthouses were first built in Britain they were provided by private enterprise; tolls were collected when ships reached port. Another common example of bees providing a beneficial 'externality' by pollinating flowers for free was challenged by economist Steven Cheung who examined beekeeping and apple growing in the state of Washington. He found that apple growers paid beekeepers for their bees' pollinating endeavours; those services were not, in fact, an unpriced 'externality' (Buchanan & Stubblebine, 1962).

But perhaps the most enduring myth was that of the superiority of the Dvorak typewriter keyboard. The myth goes that early typewriters adopted the QWERTY key arrangement on typewriters (so called because of the top row of keys) to slow down typists who would tend to jam their primitive keyboard mechanisms. By the 1930s, QWERTY standard lock-in was so strong that consumers were unwilling to bear the high switching costs to convert to the vastly superior Dvorak keyboard layout, even though the initial anti-jamming justification for the QWERTY layout was no longer valid. The received wisdom: users of the QWERTY keyboard were so numerous that they had long since reached critical mass and locked themselves into a vastly inferior standard.

Economists Stan Liebowitz and Stephen Margolis (1990) dug deeper into the history of the typewriter to show that the first evidence supporting claims of Dvorak's superiority was extremely thin. The main study was carried out by the US navy in 1944 (a time when every second counted in the typing pools). The speed of 14 typists retrained on the Dvorak layout was compared with the speed of 18 given supplementary training on QWERTY. The Dvorak typists did better. But it is impossible to say from the official report whether the experiment was properly controlled, as they suffered a variety of oddities – not to mention the curious fact that the experiments were all conducted by one Lieutenant-Commander August Dvorak, the navy's top time-and-motion man, and holder of the patent on the Dvorak layout.

Somewhat later, in 1956, a carefully designed study by the General Services Administration found that QWERTY typists were about as fast as Dvorak typists, and sometimes faster. Ergonomists point out that QWERTY's bad points (such as unbalanced loads on left and right hand; or excess loading on the top row) are outweighed by other benefits (notably, that alternating hand sequences make for speedier typing). Interesting, but the point is this: if you have learned to type on a QWERTY keyboard, the pain of retraining for Dvorak, however modest, is not worth suffering – the QWERTY standard is already just as efficient.

Social Networks in the City

Humanity crossed a significant landmark towards the end of year 2007, when more than half of the world's population were living in cities. In developed economies, over 70% live in cities; the average percentage living in cities in less developed economies is around 40% (Crane & Kinzig, 2005; South China Morning Post, 2007). Cities impose a much smaller environmental footprint than farming, occupying a mere 0.3% of total land area (and around 3% of the world's total arable land) (Henderson, 1977).

Cities provide rich backdrops for numerous sorts of social networking by bringing people close together where it is easy – in fact unavoidable – to bump into one another in the process of going about one's daily chores. Physicist Felix Auerbach published a study of the distribution of city sizes in 1913, showing an exponential distribution consistent with a scale-free network. Since that time, other studies, by Herbert Simon (1955), Xaviar Gabaix (1999) and Paul Krugman (1991) have confirmed and expanded our understanding of the way that various factors – including the growth of ideas – scale within cities.

Today's cities are larger and more complex than at any time in history, which makes continual demand on the energy and creativity of their inhabitants. Figure 12.6 shows how innovation (as measured by patents, inventors, research and development (R&D) and so forth) grows faster than cities (Coser, 1956; Cheung, 1973).

City growth is constrained by the availability of resources (which are used both for maintenance and growth) and their rates of consumption. Different social activities exhibit substantially different long-term behaviour depending on whether the exponent β is larger than one. When exponent β is less than one, growth ceases at some time in the future as the population of the city reaches some limit in carrying capacity. But where exponent β is larger than one, growth is faster than exponential and quickly grows unbounded. Since this cannot happen in practice – where resources, energy and wealth are limited – major qualitative changes must occur which effectively reset the city's

Measure of Social Activity	β	95% Confidence Interval	Adjusted R^2	Obs	Country/Year of Study
New patents	1.27	[1.25,1.29]	0.72	331	US 2001
Inventors	1.25	[1.22,1.27]	0.76	331	US 2001
Private R&D employment	1.34	[1.29,1.39]	0.92	266	US 2002
Supercreative employment	1.15	[1.11,1.18]	0.89	287	US 2003
R&D establishments	1.19	[1.14,1.22]	0.77	287	US 1997
R&D employment	1.26	[1.18,1.431	0.93	295	China 2002
Total wages	1.12	[1.09,1.13]	0.96	361	US 2002
Total bank deposits	1.08	[1.03,1.11]	0.91	267	US 1996
GDP	1.15	[1.06,1.23]	0.96	295	China 2002
GDP	1.26	[1.09,1.46]	0.64	196	EU 1999–2003
GDP	1.13	[1.03,1.23]	0.94	37	Germany 2003
Total electrical consumption	1.07	[1.03,1.11]	0.88	392	Germany 2002
New AIDS cases	1.23	[1.18,1.29]	0.76	93	US 2002–2003
Serious crimes	1.16	[1.11, 1.18]	0.89	287	US 2003
Total housing	1	[0.99,1.01]	0.99	316	US 1990
Total employment	1.01	[0.99,1.02]	0.98	331	US 2001
Home electrical consumption	1	[0.94,1.06]	0.88	377	Germany 2002
Home electrical consumption	1.05	[0.89,1.22]	0.91	295	China 2002
Home water consumption	1.01	[0.89,1.11]	0.96	295	China 2002
Gasoline stations	0.77	[0.74,0.81]	0.93	318	US 2001
Gasoline sales	0.79	[0.73,0.80]	0.94	318	US 2001
Length of electrical cables	0.87	[0.82,0.92]	0.75	380	Germany 2002
Road surface	0.83	[0.74,0.92]	0.87	29	Germany 2002
Walking Speed (meters / sec)	0.80	[0.74,0.92]	0.80	19	US 2006

Figure 12.6 Social Activities as an Exponential Function $[N(t)]^{\beta}$ of City Size $N(t)$
Source: Bettencourt et al., 2007

dynamics. It is at these points of collapse in one set of city activities, and the initiation of a new set, that government must proactively manage the direction of with innovative responses that assure that the next stage of growth continues to create knowledge and wealth. These successive cycles of superlinear innovation must occur at shorter and shorter intervals as the city grows. Not only does the pace of life increase with city size, but so also must the rate at which new major adaptations and innovations need to be introduced to sustain the city (Watts, 2004). These predicted successive accelerating cycles of faster than exponential growth are consistent with observations for the population of cities, waves of technological change (Westland & See-To, 2007), and the world population (Kremer, 1993; Cohen, 1995). We will revisit the scaling of ideas, inventions and innovation in cities, and scaling's economic importance for the future, when we discuss cities in the last chapter of this text.

Brands and Reputation

How much is a brand worth? This is a question that regularly crops up – especially in mergers and acquisitions when negotiating price, to assist with brand management and strategy, and in litigation when one firm accuses another of damaging its brand. Yet there is no pat answer to this question. The problem has less to do with future value than the fact that a brand is a name or a symbol, along with its associated tangible and emotional attributes. A brands identifies – in the minds of consumers – the goods or services of one seller in order to differentiate them from competitors' products.

Patagonia's 'Green' Credentials

Yvon Chouinard, Patagonia's founder, got his start as a 14-year-old climber in 1953. Not being satisfied with the soft pitons available at the time, he purchased his own coal-fired forge and anvil and began making his pitons out of hard steel. By 1970 he had become the largest supplier of climbing hardware in the US and also one of its chief environmental villains because his gear was damaging the rock. Climbing had become more popular, and fragile cracks in stone faces had to endure repeated hammering of pitons during both placement and removal – the disfiguring was severe.

Fortunately, there was an alternative: aluminium chocks that could be wedged by hand rather than hammered in and out of cracks, which Chouinard introduced in 1972. Influential Sierra climber Doug Robinson was effusive:

> There is a word for it, and the word is clean. Climbing with only nuts and runners for protection is clean climbing. Clean because the rock is left unaltered by the passing climber. Clean because nothing is hammered into the rock and then hammered back out, leaving the rock scarred and the next climber's experience less natural. Clean because the climber's protection leaves little trace of his ascension. Clean is climbing the rock without changing it; a step closer to organic climbing for the natural man (cited on www.patagonia.com).

This was the first of many environmentally motivated decisions by Patagonia (named after a region of vast steppe-like plains in South Argentina which Chouinard claims is pronounceable in any language). The company today is a member of several environmental movements and is a major contributor to environmental groups. Patagonia commits 1% of their total sales or 10% of their profit, whichever is more, to environmental groups. Since 1985, when the programme was first started, Patagonia has donated $25 million to over 1000 organizations. Patagonia co-founded 1% For the Planet. This is an alliance of businesses who, like Patagonia, commit at least 1% of their total sales to the environment.

In 1996, Patagonia converted its entire sportswear line to 100% organically grown cotton, promising never to go back to conventional cotton, regardless of the outcome. Since then Patagonia has become the largest purchaser of organic cotton in the world. Patagonia is a member of the Fair Labor Association. Inspections conducted by the Fair Labor Association rarely finds violations at factories producing Patagonia clothing.

Patagonia's commitment to 'green' causes has made excellent business sense – largely in response to its clientele who are apt to be much more sensitive to the environment, as they are in direct contact with it on their camping, hiking and other outdoor activities. Though the company is privately held and does not publish financial statistics, the industry press observes that it is one of the fastest growing clothing retailers, and one whose management and product quality set standards for the competition.

(Source: Chouinard, 2006)

The large number of brand acquisitions in the late 1980s alerted investors to the hidden value in highly branded companies and propagated the practice of brand valuation. Some of these acquisitions included Nestlé buying Rowntree, United Biscuits buying and later selling Keebler, Grand Metropolitan buying Pillsbury and Danone buying Nabisco's European businesses. All these acquisitions commanded high price earnings multiples which were directly attributed to their brand equity by investors.

Interbrand's study of acquisitions in the 1980s showed that, whereas in 1981 net tangible assets represented 82% (on average) of the amount bid for companies, by 1988 this had fallen to just 56%, and companies were being acquired less for their tangible assets and more for their intangible assets (De Chernatony & McDonald, 1998). This expansion in the value of intangible assets is also reflected in the ratio of accounting book value of firms to their market value. The average book-to-market value of the S&P 500 firms dropped from approximately 100% in 1980 to around 50% by 1990.

Procter and Gamble's Brand Equity

Harley Procter and James Gamble began business in Cincinnati in the 1870s selling candles and soap from a wheelbarrow. James Gamble, an inveterate chemist and tinker, perfected his formula for 'P&G White Soap' in 1878. Unsatisfied with this appellation, Harley Procter decided to give the soap a name that people could remember – he named the soap 'Ivory' after the verse in Psalm 45: 'All thy garments smell of myrrh and aloes and cassia, out of the ivory palaces whereby they have made me glad.'

Gamble's floating soap was invented when one of the P&G factory workmen left to go to lunch while the machinery was still running, letting air work its way into the mixture. The product was popular because Cincinnatians often bathed in the Ohio River in those days and the floating soap would never get lost in the Ohio River's murky waters.

A chemical analysis of Ivory soap found that 0.56% of the ingredients did not fall in the 'pure soap' category so Gamble – being obsessed with truth in advertising – adopted the slogan '99 and 44/100% Pure.'

This was notable because – by accident or not – it was one of the first deliberate exercises in branding and P&G became one of the first corporations whose main investment was in brand equity.

(Sources: P&G: Our History – How it Began, www.pg.com/en_US/downloads/media/Fact_Sheets_CompanyHistory.pdf, accessed 22 June 2016; P&G: History of Innovation, http://us.pg.com/who-we-are/heritage/history-of-innovation, accessed 22 June 2016)

Successful brands signal to consumers that this firm's product or service is different from those of its competitors. It is the associations which consumers make with the brand that establish an emotional and an implied contract between the supplier and the consumer – one that is dynamic and ongoing. Consider widely disseminated brands such as McDonald's or Starbucks. The premium that consumers are willing to pay for these brands exists because the brands mitigate risk by assuring minimum quality. The brand is maintained and defended by their owners simply because this assures security of demand in the future.

The Politics of Innovation

In the 1970s, British historian Donald Cardwell surveyed two thousand years of developments in science and technology including the most important discoveries and inventions in human history, from the medieval horse stirrup to nuclear power. Cardwell concluded that "...no nation has been very creative for more than an historically short period" and that over the long run, nationality is not an important factor in advancing science and technology. Cardwell was unable to explain what political and social inputs were essential for successful science and technology.

In the twenty-first century, national borders and distances have declined in importance to scientific knowledge and technical information, and inventors anywhere can readily tap into global stores of knowledge, capital, equipment, and talent. In a twenty-first century environment, the American academic Mark Zachary Taylor argues that policy-makers can grow a vibrant, productive science community, creating the patents, inventions and jobs that can drive a high-tech economy by promoting a state of "creative insecurity." Some countries are better at innovation than others because they are prepared to pay a price – deferring comforts and investing in research. Their circumstances naturally or artificially promote a state of creative insecurity which requires them to view external threats as more pressing and important than internal politics. Creative insecurity may be fostered by military threats, economic hardship or individual competitiveness, and to some extent these motivations can be manufactured.

According to Taylor, politics is a vital consideration in the way that innovation is funded, assessed and implemented, with ample room for confusion and false signaling between parties. Sadly, when couched in terms of creative insecurity, innovation easily becomes a minefield of potential triggers for racism, triumphalism, imperialism, misguided cultural relativism and abuse by demagogues and bigots. At worst, politicians may conclude that an effective science and technology may be to scare citizens into believing their country faces threats from "evil foreigners" – indeed there are ample examples today of despotic regimes doing just that. But an informed population will soon see through a manufactured bogeyman; and an uninformed population is unlikely to excel in science and technology.

Taylor's research is extensive and finds no evidence of systematic national, geographical or racial influences on research, though he does acknowledge the political focus provided by military funding. Success requires perseverance to overcome elements of randomness, unclear objectives and unpredictable returns. Taylor paints a persuasive picture of successful innovators that embrace the hardship of creative insecurity and individual competitiveness to reap quantifiable rewards.

(Source: Taylor, The Politics of Innovation)

Assessment of the 'brand premium' lies at the heart of brand formularies such as those practised by consulting firms like Interbrand. Interbrand began valuing brands in the mid-1990s with a valuation of Rank Hovis McDougal, which was used in their opposition to a hostile takeover bid. With the brand value information, the Rank Hovis McDougal board was able to go back to investors and argue that the bid was too low, and eventually repel it (Stobart & Perrier, 1997).

Most brand formularies compute brand equity (i.e. the market value attributable solely to the brand) based on an 'excess profit' figure by comparing benchmark firms in the same industry without brand recognition to that of the target firm. Future excess profits are forecast, and then discounted to the present using an industry-specific discount rate.

Asia's Diploma Mills

How would you rate a degree from Britain's Canterbury University, Winchester University or Belford University; Kingston University or Lansbridge University in British Columbia, Canada; or Pacific Western University in the US? In fact, none of them are recognized as providers of degrees in their home countries: these are 'diploma mills' whose degrees have popped up all over the world alongside degrees from hundreds of other suspect colleges.

Britain's National Recognition Centre (NARIC), which vets qualifications for universities in Britain and Australia, and for large companies such as HSBC looking to hire an international workforce, has noticed a steady rise in fake degrees around Asia – especially from Thailand, Malaysia and Singapore. 'We've seen diploma mills in Asia before, but not on the scale we have now', said Allen Ezell, a former FBI agent and author of a book on diploma mills. 'When the job market requires higher levels of education, then credentials become important. With globalization, more and more people are applying for jobs in other countries, it's a problem that knows no boundaries', said Ezell who has 10 bachelor's degrees, 19 master's degrees; four doctorates and two medical degrees awarded by US 'universities' from his time as a special agent for the FBI's operation DipScam (Diploma Scam) which ran for 11 years in the 1980s and 1990s.

Diploma mills award degrees without requiring students to meet educational standards for such degrees. They may offer degrees on the basis of 'life experience'. St. Regis University in Britain netted revenues of more than US$10 million before it was shut down in 2005. Fake degrees can be picked up on Bangkok's Khao San Road (an estimated 30% of foreign teachers in Thailand have fake qualifications). In one bizarre case in 2006, 120 South Korean musicians were exposed as having bogus music degrees from a Russian 'university' to qualify to play in orchestras or teach music.

Shenzhen is the centre of China's fake degree industry. Operators hand out leaflets or post them on lamp posts. Diplomas are sold over the internet for as little as US$100. Shenzhen's best-known printer, backalleypress.com, advertises 'novelty degrees', claiming to print over 1,500 documents in a year. The bulk of the orders come from China, despite the steep cost of US$235 for a bachelor's degree and $475 for a master's.

The Shenzhen operations pale beside the organized providers of unrecognized degrees in Malaysia, Singapore and Cambodia:

> Many degree mills operate as private colleges and are very well known in Malaysia and Singapore. Private agencies can apply to the Malaysian Quality Assurance Agency for recognition. In Singapore they can set up as private companies operating under the radar of the authorities. They operate openly and do big shows and presentations.

Irish International University (IIU) has a high-profile presence in Malaysia even though in 2005 the Dublin government asked the Malaysian authorities to shut it down because it was 'neither Irish nor a university'. In 2007, IIU expanded into Cambodia where it formed an alliance with the privately run Build Bright University, which is officially accredited to issue degrees in Cambodia. 'IIU claims to be accredited by QAC', located at the address of unmanned office in North London', said Hamshere. 'IIU is now an external examiner for St. Clements University, operating out of the Turks and Caicos Islands and Niue, an atoll in the South Pacific. St Clements' actual address in London is the back of a tailor's shop.' IIU has apparently set its sights on becoming an 'accreditation mill' to accredit the phoney diplomas of new diploma mills.

The big diploma mills expanding in Asia tend to be from Britain or the US. Often they have slick websites with 'alumni' statements, graduation pictures, photographs of their vice-chancellors in full regalia; and there are even photo shoots of college sporting victories.

(Source: South China Morning Post, 2007)

Brand equity calculations can be undermined by unexpected events – and rather quickly. Two brands in recent history have seen an abrupt reversal of fortune – Firestone and Arthur Andersen. After several Ford SUV rollovers were reported in the press – all due to blowouts in Firestone tyres – the Firestone brand, owned by Bridgestone, went from being an asset to a distinct liability almost overnight. Similarly the Enron debacle brought down Arthur Andersen, once considered the top accounting firm in the world.

Another oddity of brand valuation occurs when good and bad products are mixed in such a way that consumers grow confused. Adverse selection occurs in a competitive market where buyer and seller have different information about the quality of a product. The classic example is the 'market for lemons', referring to George Akerlof's 1970 example of the used car market. In his example, the demand for used cars vanishes as soon as average quality drops even though there are many good-quality cars. Obviously, the example is extreme. It is meant to make the point that the presence of unidentifiable 'lemons' makes it difficult to sell cars of better quality at a good price, with the implication that the average quality of traded used cars is lower than that of non-traded used cars.

Innovation Workout

Inductive Reasoning in Brand Development

Your business has a brand whether you manage it or not. One way or another, your customers will form an impression of you. Branding is the proactive creation and management of this impression. Implicit in the management of a brand are seven strategic goals:

1. To install your brand in the minds of customers and prospective customers.
2. To identify and enrich customers' perceptions of your business.
3. To safeguard your product against competing ones.
4. To appeal to the emotional wants and needs of your customers.
5. To develop the powerful intangibles that define who you are to your audience.
6. To create essential elements such as your brand promise, brand logo and brand position.
7. To maintain these impressions throughout the lifecycle through warranties, quality control and advertising.

Of all the tasks involved in commercializing a new idea, the brand is probably least amenable to creation by checklist. Cookbook formulas for branding are unlikely to capture the creative DNA of a new idea, or to effectively broadcast the promise of your innovation. Every successful brand has been preceded by an overriding element of discovery – of learning from past mistakes.

Instead of formulaic approaches, consider developing a brand by asking what you believe are good brand names and then attempting to determine what commonalties they possess. Unfortunately, this method tends to be quite time consuming – to some extent depending on your ability to recall brand names and the images these conjure up.

Consider the task facing the US military in early 2003. Under direction from the US President and his Cabinet, the US military initiated a highly unpopular offensive against Iraq. To attempt to make this expensive operation more palatable to a sceptical nation, the government searched around for a compelling handle, a 'brand' that would help to sell the war. Initially, the protracted US military build-up in the Persian Gulf had no handle of its own. Instead, the Pentagon referred to it as simply an extension of 'Operation Enduring Freedom', the name of America's war against terror in Afghanistan and elsewhere. There was a calculated reason for that. From September of 2002 – when the Bush administration began trying to compel Iraq to eliminate its alleged stocks of 'weapons of mass destruction' – the White House had tried to cast the secular dictator Saddam Hussein as an Islamic fundamentalist in the employ of the al-Qaida terrorist network. 'Operation Enduring Freedom' helped to simplify the war in the minds of American citizens by casting all of the complex sets of players and relationships opposing US forces as members of a single, monolithic army intent on global domination.

Choosing operation names is serious business to military leaders. The top brass views them as an important part of the public relations battle, where an evocative name can serve as a symbol or 'brand' for the underlying purpose of the military action. The selection of 'Iraqi Freedom' reflects that. The runner-up name – 'Operation Desert Freedom' – was rejected because it didn't send the message that America's intent was to liberate the Iraqi people. Reportedly, the military leadership preferred 'Desert Freedom' because it continued the 'desert' theme that had begun with 1991's 'Operation Desert Shield', the six-month build-up to the Persian Gulf War, and 'Operation Desert Storm', the air and ground assault that followed. But the President's Office and Cabinet (which has the final word) opted for 'Iraqi Freedom' because it was more explicit.

Even the names of minor items can receive attention. For example, the 'Al-Hussain' missile used in Iraq (a variant of the German V-2 rocket that Iraqi scientists named after Saddam Hussein himself) was invariably referred to in Western press releases by the unflattering 'Scud' moniker, a name used internally by US intelligence agencies for Russian versions of the V-2. Such negative branding helped belittle the enemy.

The current era of military operation nomenclature began with the 1989 US incursion into Panama to capture Manuel Noriega. Until that invasion was imminent, it was being called 'Operation Blue Spoon', a nonsense combination generated with a computer's help. At the last minute, however, 'Blue Spoon' was replaced with 'Operation Just Cause', after top officials answered the rhetorical question posed by one general: 'Do you want your grandchildren to say you served in "Blue Spoon?"'

A compromise inductive reasoning approach to choosing a brand name – and for brainstorming elements such as your brand promise, brand logo, and brand position – is to provide a list of actual brands. To get you started, examples are provided in the list below of Interbrand's 2014 list of the 25 most valuable brands in the world, the value of their brand, and the increase or decrease in value from the prior year.

Split into discussion break-out groups of between three and four individuals for approximately 15 minutes of brainstorming. The task for each group is to identify any rules or guidelines that it believes are at work in the branding decisions made by these companies. Do the brand names suggest what is being sold; a particular lifestyle choice; an industry or technology sector? See if you can figure out what makes the most valuable brands tick.

Going from the specific cases – an inductive approach – helps to develop your inductive reasoning skills while the group aspect fosters teamwork and friendly competition among groups.

Rank 2014	*Brand*	*Brand Value $US Billion*	*% Value Increase from* 2013
1	Apple	118.9	21%
2	Google	107.4	15%
3	Coca-Cola	81.6	3%
4	IBM	72.2	–8%
5	Microsoft	61.2	3%
6	GE	45.5	–3%
7	Samsung	45.5	15%
8	Toyota	42.4	20%
9	McDonald's	42.3	1%
10	Mercedes-Benz	34.3	8%
11	BMW	34.2	7%
12	Intel	34.2	–8%
13	Disney	32.2	14%
14	Cisco	30.9	6%
15	Amazon	29.4	25%
16	Oracle	26.0	8%
17	HP	23.8	–8%
18	Gillette	22.8	–9%
19	Louis Vuitton	22.6	–9%
20	Honda	21.6	17%
21	H&M	21.1	16%
22	Nike	19.8	16%
23	American Express	19.5	11%
24	Pepsi	19.1	7%
25	SAP	17.3	4%

Figure 12.7 Brand Value
Source: Interbrand

Case Study: The Craigslist Network

Having observed people on other sites helping one another in a friendly, social and trusting community way, and feeling a bit isolated as a relative newcomer to San Francisco (SF), Craig Newmark decided in 1995 to create something similar for local events – he called it Craigslist. The soul of the site is expressed by the simple populist formulation that Craig Newmark states over and over again when he is asked about his purpose: 'We are just trying to give people a break.' Users throng the site not only because it is free, fast, and stripped-down but because of the communitarian values flowing from the founder. Newmark started with an email distribution list marketed solely through word of mouth, to tell friends about upcoming tech or art events in SF. Once the number of people on the list grew too large, Craigslist became a formal website, which friends encouraged him to call 'Craig's list' since that was how recipients had referred to the email list. The content expanded from events to classifieds, to the full range of categories offered on the site today. Craigslist will add a new city to Craigslist when there are enough requests from users to add that particular city. Craigslist did not specifically target 'social influencers' or conduct any pre-launch marketing in a new market that it entered. Even in 1998, Newmark still viewed his career as being that of a software engineer – Craigslist was a cool hobby that was getting him invited to the best parties for geeks and nerds.

Ultimately, that changed. Craigslist incorporated in 1999, and in 2007 is operating with a staff of 24 people serving 450 cities around the world. Its sole source of revenue is paid job ads in select cities ($75 per ad for the San Francisco Bay Area; $25 per ad for New York; Los Angeles; San Diego; Boston; Seattle; Washington DC), and paid broker apartment listings in New York City ($10 per ad). Although the company does not disclose financial information, journalists have speculated that its annual revenue approached $10 million in 2004. It serves over five billion page views per month, to 10 million unique visitors. With over 10 million new classified ads each month, Craigslist is the leading classifieds service in any medium. The site receives over 500,000 new job listings each month, making it one of the top job boards in the world. It is the number seven ranked site in the US (and 25th globally) (Source: Wikipedia).

Craigslist offers a centralized network of online urban communities – a network of community networks. It offers free classified advertisements (with jobs, internships, housing, personals, for sale/barter/wanted, services, community, gigs and resumes categories) and forums sorted by various topics. Newmark says that Craigslist works because it gives people a voice, a sense of community trust and even intimacy. Other factors he cites are consistency of down-to-earth values, customer service and simplicity. After first being approached about running banner ads, Newmark decided to keep Craigslist non-commercial.

Yet the commercial impact of Craigslist is huge; a business study in the Bay Area showed that local newspapers were losing as much as $50 million a year in revenue to Craigslist. The awareness of the trend has since avalanched. Classifieds make up as much as 50% of big-city newspaper ad revenues; at a time when the newspaper industry is in crisis with circulations going down by as much as 2.6% a year as readers die off and the young go elsewhere for their information, Craigslist has acquired a reputation as the newspaper killer.

CEO Jim Buckmaster has told investment analysts, much to their dismay, that Craigslist has little interest in maximizing profit from the website but instead prefers only to help users find cars, apartments, jobs and dates. Craigslist fashions itself more of a public service than a for-profit entity, ignoring the numerous opportunities to monetize its user base. However, Craigslist has clearly established itself as one of the leading online brands and the dominant presence in the US online classifieds market (Gabbay, n.d.).

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Craigslist is unusual in that it develops products and strategy by following particular guiding principles. At the core of these principles are three objectives:

1. *Create a culture of trust:* Craig and the Craigslist staff actively respond to user emails, and does not make any major changes to the site without first announcing and testing response from users. Its lack of banner advertising and pop-ups contributes to the perception that Craigslist is 'not in it for the money'.
2. *Social contributions from site take precedence over commercial aspects:* free classifieds under the rubrics 'Casual Encounters', 'Rants and Raves', and 'Missed Connections' generate no revenue, but clearly arouse considerable interest in readers and posters. They provide forums for visitors to air their thoughts, giving users a voice in their community. This creates a pattern of usage that is more frequent than buying or selling an item. Newmark argues that the ability to make such posts fosters the sense of community and trust that gives consumers greater confidence in the commercial-oriented classifieds.
3. *Site ease of use:* The site is clean, almost clinical in its sparseness, and does not require user registration, thereby allowing anonymous posting and browsing. The user self-service site publishing tools are also intuitive and core to the site.

Much of Craigslist's growth has to be attributed to an amazing amount of positive mainstream PR and word of mouth. Newmark is happy to make a good living for the employees of Craigslist without the need to make an extravagant profit. He has turned down many acquisition offers for Craigslist that would by any measure make him a very rich man. Craigslist's CEO Jim Buckmaster has stated that Craigslist could probably make 10 times the revenue it makes today if it tried. So what is Craigslist worth? Assuming it could make $200 million in revenue at a 40% net margin, and applying an eBay-type earnings before income tax, depreciation and amortization (EBITDA) multiple, that would place the value of the company at around two-and-a-half billion US dollars. Auction giant eBay would be the most logical acquirer, given that it already owns a 25% stake through a rather dubious stock sale by a former trusted employee of Craigslist.

(Sources: Gabbay, n. d.; San Francisco Chronicle, 2004; Weiss, 2005; http://en.wikipedia.org/wiki/Craigslist, archived 18 June 2007)

Questions: Craigslist Case Study

1. Everyone from the big boys (eBay, Google, MSN) to start-ups (LiveDeal, Edgeio, Oodle) has an online classifieds offering. Many of these new offerings are employing Web 2.0 technologies and strategies, while Craigslist has continued to maintain its relatively spare text-based web page. Should Craigslist be afraid of this competition? How should it respond (what strategies, changes to their website and new offerings should it consider)?
2. Craigslist doesn't advertise; yet it has posed the greatest threat to classified advertising that newspapers have ever seen, threatening to bankrupt many of them. Is advertising dead? If you answered 'No' then what is Craigslist's success secret? If you answered 'Yes' then what will replace advertising?
3. Discuss the concept of 'viral marketing' in the context of the case study. Viral marketing is clearly cheap (free), but is it as effective as paid advertising? Is it as controllable?
4. What are the advantages of the spare, text-based user interface of Craigslist compared to the more complex Web 2.0 interfaces of competitors?
5. Craigslist might be rightly called an 'information commons' or 'commune' (recall the Paris Commune that challenged the rights of French royalty and clergy). The theme of social revolution pervades Craig Newmark's offerings. Is this a new business model, or is it just hype?

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6. Discuss the benefits and costs (including opportunity costs) of the community element that lies at the core of Craigslist's strategy. This community will be hard for competitors to replicate. It is not just a more robust classified post or search feature that makes for a more compelling user experience. The consumer loyalty that Craigslist has developed over the last 10 years is highly defensible.
7. If you were a competitor seeking to enter into Craigslist's market, which of the following four strategies to differentiate your site from Craigslist would be most likely to succeed; which would be least likely to succeed?
   a. incorporate user reputation and feedback into the classifieds,
   b. make it easier for users to submit classified listings (especially power users),
   c. adjust the business model away from a straight listing fee per classified, or
   d. offer a larger selection of items/postings.
8. Do you think that the incorporation of user reputation into a classifieds site might be a possible winning strategy (just as the authorship of a book may be more important than topic and content)?
9. Is reputation/feedback of higher value than user anonymity? For which categories?

Chapter 12: Questions for Review

1. Think about the relationship between networks, communities and reputation. What role does each play in a successful business? Start by considering the role of 'trust' enabled by a good reputation, and how this can enable (or the lack of it can disable) communication or contracting between any two individuals. Communities are predicated on trust; networks are more active and less costly with trust, because there doesn't have to be as much policing and security.
2. How might network businesses differ if the network is random, small-world or scale-free? What differences would you expect in business models; cost structures; and profitability with scale?
3. Are network businesses inherently unstable, like the railways in the 19th century or the dot.coms in the 20th century? Explain why or why not.
4. Many of the important network cost and revenue relationships follow power law rather than linear models. How should business models be constructed to take advantage of this?
5. How large a problem is presented by fake diplomas? What sorts of problems might fake diplomas create? How would you feel if your next surgeon held a degree from Pacific Western University? What is the appropriate legal action against diploma mills?

Chapter 12 – Key Points

1. Network effects are central to modern economies and are tightly linked with standards.
2. Network effects are the basis for value added in public goods, externalities, vendor lock-in and standards.
3. Traditionally networks have been categorized as random networks, small-world networks and scale-free networks, though more recent empirical research indicates that many real-world networks don't precisely fit into these categories.
4. Brands and reputation management are vehicles for the company to control – albeit imperfectly – their network effects.
5. Brand equity is a measure of the value of a company's network.

Further Reading

Akerlof, G. A. (1970). The market for 'lemons': Quality uncertainty and the market mechanism. *Quarterly Journal of Economics* 84, 488–500.

Aral, S., Brynjolfsson, E. and Van Alstyne, M. (2012). Information, technology, and information worker productivity. *Information Systems Research* 23, 849–867.

Aral, S., Brynjolfsson, E. and Wu, L. (2012). Three-way complementarities: Performance pay, human resource analytics, and information technology. *Management Science*, 58(5), 913–931.

Auerbach, F. (1913). The distribution of population concentrations, *Peterman's Letters* 59, 74–76.

Barabási, A-l (2014). *Linked: How Everything Is Connected to Everything Else and What It Means for Business, Science, and Everyday Life*. Basic Books.

Bettencourt, L. M., Lobo, J., Helbing, D., Kühnert, C. and West, G. B. (2007, 24 April). Growth, innovation, scaling, and the pace of life in cities. *Proceedings of the National Academy of Sciences*,104(17), 7301–7306.

Borah, A. and Tellis, G. J. (2015). Halo (spillover) effects in social media: Do product recalls of one brand hurt or help rival brands? *Journal of Marketing Research* 53(2), 143–160.

Brahm, L. J. (2001). *China's Century*. Wiley.

Briscoe B., A. Odlyzko and Tilly, B. (2006, July). Metcalfe's Law is wrong, *IEEE Spectrum*.

Brynjolfsson, E. and McAfee, A. (2012). *Race Against the Machine: How the Digital Revolution is Accelerating Innovation, Driving Productivity, and Irreversibly Transforming Employment and the Economy*. Self-published.

Brynjolfsson, E. and McAfee, A. (2014). *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*. WW Norton & Company.

Brynjolfsson, E., Hu, Y. J. and Rahman, M. S. (2013). Competing in the age of omnichannel retailing. *MIT Sloan Management Review* 54(4), 23–29.

Brynjolfsson, E., Hu, Y. and Simester, D. (2011). Goodbye pareto principle, hello long tail: The effect of search costs on the concentration of product sales. *Management Science* 57(8), 1373–1386.

Brynjolfsson, E., Renshaw, A. and Van Alstyne, M. (2012). The matrix of change. *Sloan Management Review* (Winter 1997), 38(2).

Buchanan, J. and Stubblebine, W. (1962). Externality. *Economica* November, 371–384.

Cheung, Steven N. S. (1973). The fable of the bees: An economic investigation. *Journal of Law and Economics* 16, 11–33.

Chouinard, Y. (2006). *Let My People go Surfing: The Education of a Reluctant Businessman*. Penguin.

Cohen, J. E. (1995) Population growth and earth's human carrying capacity. *Science* 269, 341–346.

Coser, L. A. (1956). *The Functions of Social Conflict*. New York: Free Press.

Crane, P. and Kinzig, A. (2005). Nature in the metropolis. *Science* 308(5726), 1225.

De Chernatony, L. and McDonald, Malcolm H. B. (1998). *Creating Powerful Brands in Consumer, Service and Industrial Markets*, 2nd edition. New York: Butterworth-Heinemann.

Gabaix, X. (1999) Zipf's Law and the growth of cities. *American Economic Review* 89, 129–132.

Gabbay, Nisan, www.startup-review.com/blog/authors/, archived 18 June 2007.

Gillon, K., Brynjolfsson, E., Mithas, S., Griffin, J. and Gupta, M. (2012). Business Analytics: Radical Shift or Incremental Change? In 33rd International Conference on Information Systems (ICIS 2012), Orlando, Florida.

Granovetter, Mark (1973). The strength of weak ties. *American Journal of Sociology* 78 (May), 1360–1380.

Henderson, J. Vernon (1977). *Economic Theory and the Cities*. New York: Academic Press.

Kremer, M. (1993). Population growth and technological change: One million B.C. to 1990. *Quarterly Journal of Economics* 108, 681–716.

Krugman, P. (1991). Increasing returns and economic geography. *Journal of Political Economy* 99, 483–499.

Liebowitz, S. J. and Margolis, S. E. (1990). The fable of the keys. *The Journal of Law & Economics* 33(1), 1–25.

Luo, A., Lehmann, D. R. and Neslin, S. A. (2015). Co-managing brand equity and customer equity. *Handbook of Research on Customer Equity in Marketing*, 363.

MacCrory, F., Westerman, G., Alhammadi, Y. and Brynjolfsson, E. (2014). Racing with and against the machine: Changes in occupational skill composition in an era of rapid technological advance. *Proceedings of ICIS 2014*, AIS.

McAfee, A., Brynjolfsson, E., Davenport, T. H., Patil, D. J. and Barton, D. (2012). Big data. The management revolution. *Harvard Business Review* 90(10), 61–67.

Metcalfe, Bob (2000, 21 February). Interview. *Forbes ASAP*, 97.

Reed, David (2001). The Law of the Pack. *Harvard Business Review* February 2001, 23–24.

San Francisco Chronicle (2004, 15 August). On the record: Craig Newmark, http://sfgate.com/cgi-bin/article.cgi?file=/c/a/2004/08/15/NEWMARK.TMP, archived 18 June 2007.

Sethuraman, R., Tellis, G. J. and Briesch, R. A. (2011). How well does advertising work? Generalizations from meta-analysis of brand advertising elasticities. *Journal of Marketing Research* 48(3), 457–471.

Simon, H. (1955). On a class of skew distribution functions. *Biometrika*, 42(3/4), 425–440.

South China Morning Post (2007, 14 June). Making the grade, A16.

Spann, M., Fischer, M., and Tellis, G. J. (2015). Skimming or penetration? Strategic dynamic pricing for new products. *Marketing Science* 34(2), 235–249.

Spence, J. D. (1988). *Emperor of China: Self-Portrait of K'ang-Hsi*. Vintage; Reissue edition.

Stobart, P. and Perrier, R. (1997). *Brand Valuation*. New York: Premier Books.

Tambe, P., Hitt, L. M. and Brynjolfsson, E. (2012). The extroverted firm: How external information practices affect innovation and productivity. *Management Science* 58(5), 843–859.

Taylor, M. Z. (2016) The Politics of Innovation: Why Some Countries Are Better Than Others at Science and Technology, Oxford: Oxford University Press.

Tirunillai, S. and Tellis, G. J. (2014). Mining marketing meaning from online chatter: Strategic brand analysis of big data using latent Dirichlet allocation. *Journal of Marketing Research* 51(4), 463–479.

Tushman, M. L. (1978). Task characteristics and technical communication in research and development. *Academy of Management Review* 21, 624–645.

Tushman, M. L. and Moore, W. L. (eds) (1988). *Readings in the Management of Innovation*. New York: HarperCollins.

Vomberg, A., Homburg, C. and Bornemann, T. (2014). Talented people and strong brands: The contribution of human capital and brand equity to firm value. *Strategic Management Journal* 36(13), 2122–2131.

Watts, D. (2004). *Six Degrees: The Science of a Connected Age*. W. W. Norton & Company.

Watts, D. J. and Strogatz, S. H. (1998). Collective dynamics of 'small-world' networks. *Nature* 393(6684), 440–442.

Weiss, P. (2005). A guy named Craig. *New York Times Online*, http://nymag.com/nymetro/news/media/internet/15500/, archived 18 June 2007.

Westland, J. C. and See-To, E. (2007). The short-run price-performance dynamics of microcomputer technologies. *Research Policy* 36, 591–604.

CHAPTER 13

Society, Government and Innovation

Learning Objectives

After finishing this chapter, you will

- Understand the changes being impelled by rapid innovation in economies and societies around the world.
- Understand the role of tolerance, diversity and creativity in economic wealth.
- Understand what governments can and cannot do to promote an innovation-based economy.

After doing the *Innovation Workout* you will be challenged to put together everything you have learned about innovating in the prior chapters.

After reading the Meade Instruments *case study* you will understand why creative passion is important in technology industries.

The Innovation Society

Why are some societies more innovative than others? The answer to this question matters greatly, because the world – though flat from a manufacturing and services perspective – has increasingly clustered around creative centres. And at these centres are cultures and lifestyles that foster innovation. These centres are also where most of the world's wealth is being created.

The Rise of the Innovators

Figure 13.1 shows graphically how innovation and the creative labour force responsible for continuing innovation have risen to become the most important generator of both jobs and wealth in the US. Agriculture was revolutionized by the hybrid seed technology in the first half of the 20th century, and has steadily consolidated and automated. Meanwhile, automation and global outsourcing have flattened the demand and income from industrial jobs.[1] All of the growth since the 1960s has involved information-intensive jobs for innovators, and the low-paid service jobs through which new innovations are implemented.

Amabile and colleagues observe that 'creativity by individuals and teams is a starting point for innovation; the first is a necessary but not sufficient condition for the second' (Amabile et al., 1996). There is widespread agreement on this – you can't innovate if you don't first fill your opportunity register with new ideas. And the corollary to this observation is that a critical mass of creative people will not guarantee successful innovation, but lack of creative people will assure that there will *not* be innovation.

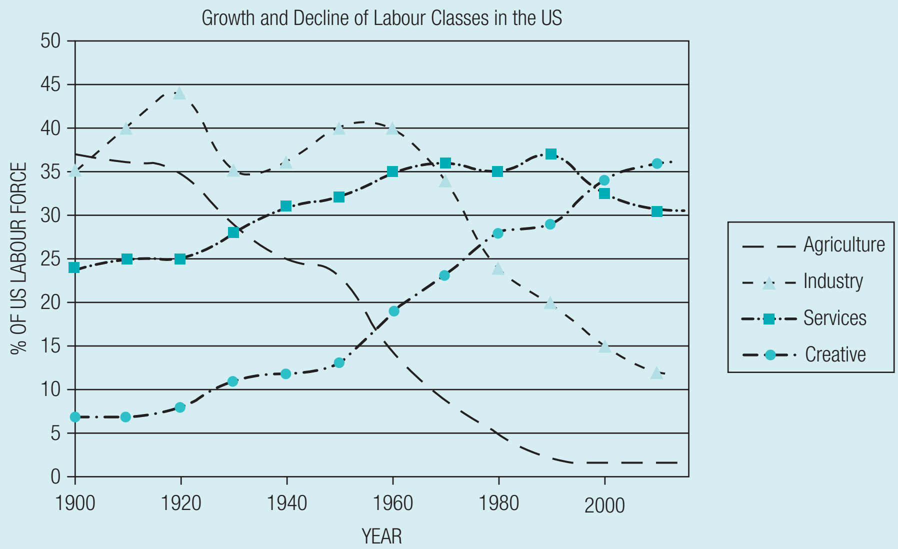

Figure 13.1 Historical Structure of US Job Market
Source: US Bureau of Labor Statistics

Innovation's Role in Economics

Adam Smith incorporated the political constituencies of land, labour and capital into his distinct world view. Smith wrote *An Inquiry into the Nature and Causes of the Wealth of Nations* with a view to explaining England's rise to global prominence and wealth in the 18th century. In England's case it was not the climate and soil, nor the extent of its territory, nor industriousness (many people in England didn't work at all) that made it wealthy. Smith concluded that it was *specialization* (the division of labour) that made England uniquely productive.

Specialization created the opportunity for increasing returns to scale. But increasing returns could only be realized through innovations – the division of the job into ever more specialized categories, and that simplified production and deskilled jobs so that even the simplest of workers could perform them well. Adam Smith could easily have been describing the process by which modern jobs are deskilled and outsourced today.

Other observers of the Industrial Revolution were more strongly influenced by France's class struggles. David Ricardo (1891) was less concerned with operations, and more with class conflict between land, labour and capital; he argued for equitable *distribution* of wealth among the classes. Karl Marx took this further, incorporating the social impact of rapid innovation and the marriage of machine and man. Marx referred to the *ratio of labour to machines* as the '*organic composition of capital*' (my emphasis). In Marx's mind, machinery could not produce value itself, but was necessary in order to gain a temporary price advantage over competitors. His reasoning: machines are a tool of man, and essentially an amplifier of their labour. Both men presaged the rising conflict between scientists, designers and innovators that created machines and defined the character of work, and the industrial and service workers at the business end of these designs (Freeman, 1982; Galbraith, 1982).

Marx saw how the Industrial Revolution was altering the landscape of power in the early 19th century. Materials, labour and capital were the new powers in Europe – materials from mines and farms of the landowning nobles (~3% of the population); capital from the savings and investment of bankers, merchants and entrepreneurs (~10% of the population); and labour from the working classes, often poor, displaced serfs or sharecroppers (the remainder). The particular claims and contributions of these political groups were legitimized in the account classifications which to this day provide much of the basis for financial reporting and economic analysis.[2]

Adam Smith's Pin Factory

(Extracted from *An Inquiry into the Nature and Causes of the Wealth of Nations*)

> To take an example, therefore, from a very trifling manufacture; but one in which the division of labor has been very often taken notice of, the trade of the pin-maker; a workman not educated to this business (which the division of labor has rendered a distinct trade), nor acquainted with the use of the machinery employed in it (to the invention of which the same division of labor has probably given occasion), could scarce, perhaps, with his utmost industry, make one pin in a day, and certainly could not make twenty. But in the way in which this business is now carried on, not only the whole work is a peculiar trade, but it is divided into a number of branches, of which the greater part are likewise peculiar trades. One man draws out the wire, another straights it, a third cuts it, a fourth points it, a fifth grinds it at the top for receiving the head… I have seen a small manufactory of this kind where ten men only were employed…make among them about twelve pounds of pins in a day…in consequence of a proper division and combination of their different operations.

(Source: Smith & Nicholson, 1887)

The increasing returns of Adam Smith's Pin Factory tended to be less influential in economics in the subsequent two centuries, where there was an implicit assumption that any production would be subject to the same decreasing returns to investment that had always been true for traditional extractive or agricultural businesses. For example, the more you mine a vein of gold, the less return you can expect from each man-hour of effort; the first few barrels of fertilizer spurs greater crop production, but more will burn the crops.

Economists saw increasing returns, where costs fall and profits increase with more output, associated mainly with machine output, which allocated the fixed cost of machinery over longer and longer production runs. In the 19th century, another source of increasing returns was found to come from the growth of networks – e.g. rail, telegraph, telephone, petroleum. Theodore Vale, the first president of Bell Telephone after Bell's patents ran out, argued persuasively that increasing-returns industries like the telephone were 'natural monopolies' that should be regulated by government, rather than be let free to dominate their industries, a view that prevailed throughout much of the 20th century.

Virtual Economies

Economic sociologist Vili Lehdonvirta of the Oxford Internet Institute suggests that the virtual economy today includes tens of billions of game-based intellectual assets such as spells, game weapons, game currency and so forth. Virtual currency, like its real counterpart, is convertible, albeit imperfectly, to real cash through exchanges and sales platforms, and forms a basis for virtual economies. Virtual economies are real enough that large game economies like Blizzard's World of Warcraft even hire their own economists to regulate money supply. Connecting virtual economies with their real-world counterparts through real money transactions (RMT) has grown explosively. Transactions take place on public auction sites; but virtual items residing only on game servers are increasingly getting their own search auction sites, providing virtual economy-specific search and sales for real money. In addition, game developers have created their own foreign exchange markets for virtual currency.

(Sources: Lehdonvirta, 2005, 2009, 2010; Hamari & Lehdonvirta, 2010)

By the turn of the 20th century, many industries with increasing returns to scale populated the economic landscape. Alfred Marshall characterized these as benefiting from 'external increasing returns' economies, a term which was quickly shortened to 'externality'. Marshall went on to put economics on a firm algebraic footing with his marginal productivity theory (ironically, economist Francis Edgeworth complained that Marshall's system left no room for innovation and entrepreneurs) and the view that technological innovations were somehow external to the functioning of the economy prevailed through most of the 20th century.

Marshall suggested that there are two kinds of 'increasing returns'. The first were due to allocating fixed costs over larger and larger production runs; the second were external and the result of general development in the industry (like greater connectivity offered as rail or telephone networks expand). In his analyses, Marshall recognized the importance of innovation, technology and knowledge as both factors and engines of production, but characterized it under his second type of externality. Innovation was characterized as a 'gift' somehow uncontrollable by human decisions or activity.

The Economics of Alternate Realities

Entertainment – consisting of motion pictures, music, television, video games and so forth – is globally around a $200 billion annual business. Traditionally, motion pictures and music provided the most profitable sectors. But as the 1990s wore on, internet technologies made it difficult to control property rights on music, and the industry dwindled. By 2006 the motion picture industry generated around a $30 billion annually; video games were estimated to generate 150% to 200% of that amount.[3] The two genres were linked by the tendency to release blockbuster movies as video games, and vice versa. The youth market comprises the largest share of the motion picture market, and PG or PG-13 films comprised 85% of the top 20 films (Motion Picture Association of America, www.mpaa.org/index.asp).

The fanciful realities of children's entertainment constitute a huge industry – an industry with some of the most innovative and forward-thinking artists in the world. The advent of ever more powerful computers has steadily increased the 'animation' content of films, though these may be called something else, like special effects or post-production work. But Hollywood sees a day not far off when photorealistic animation will completely replace expensive, capricious actors, complex sets and location visits, providing a far greater range of artistic control than is possible with physical sets and actors.

Such whimsy always been the domain of some. In the early days of American film, cartoonists such as Walt Disney, Paul Terry and Max Fleischer created imaginary characters and worlds with simple pen and ink tools. The medium steadily evolved, becoming technically more sophisticated, as well as providing ideas and technologies for motion pictures and games.

Some modern giants of animation still opt for the creative control and low costs of pen and ink. Foremost is Hayao Miyazaki of Studio Ghibli in Tokyo. Miyazaki's film's *Princess Mononoke* and *Spirited Away* were the highest-grossing films of all time in Japan, displaying his recurring themes of humanity's relationship to nature and technology.

Sustainability

The overarching goal of sustainability is to enable the Earth in the future to continue supporting human and animal life and society roughly as we know it today. A major part of that objective involves maintaining a diverse animal and plant population in a time that more and more arable land is dedicated to mega-farming or industrial use. Sustainability requires the global and holistic involvement of ecology, economics, politics and culture in order to be successful. Collectively, sustainable technologies and processes are called 'green', reflecting the central role of carbon sequestration and oxygen creation that chlorophyll-based photosynthesis provides; or they may be called 'renewable', reflecting the role played by the full cycle of production, use and disposal, and the importance of recycling waste in the production of new products.

Expansion of production and consumption create waste and raw material extraction that pose a threat to the ecological status quo. Consumption is not in itself bad, but disrupts existing ecosystems in ways that can be toxic and from which it may be difficult to recover. Accurate analysis of production, consumption, waste and extraction of resources is a necessary predicate for effective sustainability programmes. Today, sustainability analysis focuses on *four key resource* categories: *energy*, *food*, *water* and *industrial materials*. Sustainability analysis focuses on four main threats to the ecosystem status quo: *disease*, *resource depletion*, *greenhouse gases* and *monoculture* in agriculture and fisheries which reduces diversity. This section briefly discusses challenges in the four key resource categories.

Energy

Daniel Yergin's Pulitzer Prize-winning history of the oil-industry, *The Prize* (2011), describes a modern world populated by 'hydrocarbon men', reflecting the fact that 90% of today's energy use derives from coal or petroleum. The ecological consequences of this massive resource use, as well as the creation of greenhouse gases, is unsustainable and immensely damaging.

Oil: The 19th-Century 'Green' Technology

Yet, not so long ago, hydrocarbon fuels represented a sustainable alternative to other ongoing environmental disasters. An 18th-century home had two options for lighting at night – dim, foul-smelling, smoky tallow candles, or expensive beeswax candles. By the turn of the 19th century, both technologies were supplanted by sperm oil, which burned more brightly and cleanly. By the 1830s the US was importing nearly five million gallons each year; by the 1850s the sperm whale had been hunted nearly to extinction. The discovery of oil in Pennsylvania made possible the growth of the petroleum industry whose main product was kerosene – an alternative to sperm oil. As we saw in Chapter 5, John Rockefeller consolidated and expanded this industry around lighting; he had retired from Standard Oil before the first automobile hit the road.

The devastation of the whale population created a scarcity of sperm whale teeth to produce inked carvings known as scrimshaw. Similar bone and ivory products served the same purpose as plastics do today. In particular, the elephant populations of Africa were rapidly depleted in the 1870s to create billiard balls. In the 1950s, the plastic by-products of petroleum refining would provide alternatives to whale and elephant parts which would save these endangered animals. The devastation of whale populations had a complex knock-on effect in greenhouse gases. Whales excrete iron-rich faeces, which cause phytoplankton to take up carbon from the atmosphere and deposit it on the ocean floor. It is estimated that whaling annually placed an additional two million tons of carbon in the atmosphere.

Our dependence on hydrocarbons today affect the ecology in five areas. Crude oil is a mixture of many different kinds of organic compounds, many of which are highly toxic and carcinogenic.

1. The burning of hydrocarbon releases water, carbon dioxide, carbon monoxide, methane, methanol and fine particulates of soot, and may acidify rain and snow. These are currently huge problems in populous East Asia where smog can shut down major cities and causes illness.
2. A significant amount of oil extraction and distribution happens near or under water; additionally, fracking requires the use of water from aquifers and other resources. This can create oil spills that are damaging to aquatic ecosystems and difficult to clean up.
3. The lighter refined hydrocarbons are typically volatile organic compounds which are easily vaporized and which have short- and long-term adverse effects on health and the ecosystem.
4. Lubricants are a huge petroleum industry in their own right. Lubricants tend to have relatively short useful lives, and thus need to be thrown away. Waste oils can be especially toxic and can spoil soil and water for decades.
5. The quest for agricultural alternatives to petroleum products has created additional environmental problems. Most of the corn grown in the US is used in manufacture of ethanol for cars, or sweeteners. Palm oil is primarily used as a lubricant. Both are products of environmentally damaging monoculture mega-farms.

The ecological problems caused by hydrocarbons make it imperative to move to a post-hydrocarbon future. A range of technologies have the potential to replace hydrocarbons: solar, wind, geothermal, biofuels, tidal and nuclear. The safety and renewability of each of these is hotly debated. As technologies advance, though, mankind will have more and more choices.

Greenhouse Gases

Greenhouse gases are the by-products of hydrocarbon energy production with the potential to change our atmosphere. They derive their effect from a phenomenon where carbon dioxide, methane and so forth in the atmosphere trap infrared light, heating up the Earth's surface like a greenhouse. The term is loosely applied, and may include fluorocarbons which affect the ozone layer at the Earth's poles. The world has moved from denying the existence of these effects two decades ago to global cooperation to control them through technology and transport systems that don't depend on hydrocarbons. Nick Lane in his book *Oxygen* (2002) describes periods in prehistory where nitrogen, oxygen and carbon dioxide existed in substantially different ratios than they do today, and indicate that life thrived, just not the same life we have today. This is of little comfort for humans.

Stabilizing the world's climate will require developed economies to reduce their emissions by 80% over current levels by 2050; this would be expected to hold CO_2 levels to around 600 parts per million to avoid catastrophic climate change which would make large tracts of the Earth's surface unliveable. These goals are considered unreachable by some, and climate engineering has been mooted as a remedial action in case greenhouse gases cannot quickly be reduced. It involves a deliberate intervention in the Earth's climatic system with the aim of limiting adverse climate change. Two areas are being intensely researched: carbon dioxide capture and sequestration; and solar radiation management. Technologies cover a wide range: solar power generation and batteries; space mirrors; filtration and scrubbing systems; bioengineering of oceans, crops and forests; and so forth.

Water

Fred Pearce's book *When the Rivers Run Dry* describes a world rapidly going to war over scarce water resources. The world now uses around half of the globally available freshwater: two-thirds for agriculture, one-fifth for industry and the rest domestically. Five of Asia's seven major rivers start their journey in China's Tibetan province – the Indus, Yangtze, Irrawaddy, Salween and Mekong rivers. Tibet's neighbours compete intensely for their water resources, and they are the cause of much of the pressure for independence movements in the province. Elsewhere, the longest running wars in the 20th century have centred around the Tigris and Euphrates rivers where civilization arose. Agriculture and industry both depend on ample sources of fresh water – where they are absent, people move elsewhere. As the scale of both have expanded in the 21st century, water has grown polluted as well as scarce. Most key rivers have legislated allocations of their water flows. Since rain and snow melt vary significantly from year to year, it is common to run out of water before many groups receive their allocations, putting huge stress on societies. These stresses and their management were documented in numerous 'hydraulic civilizations' by the historian Karl Wittfogel.

Food

Another book by Fred Pearce, *The Land Grabbers*, chronicles the growth of mega-farms – country-sized tracts of land dedicated to monocultures of industrially important products. Money for these projects increasingly comes from Chinese and Middle Eastern investors interested in securing food supplies, or from US funds that see this as a growth market. They buy land in countries like Tanzania, Kenya, and Indonesia. The products are not always foodstuffs. Ethanol from corn in the US, or from cane in Brazil; palm oil in Indonesia and soy in Brazil are industrially farmed, disrupting local ecosystems and contributing to global warming through their inefficient use of resources. There are now substantial movements at the global level to address the negative impact of mega-farms through programmes of sustainable agriculture, organic farming and alternatives to resource-intensive meat production. Agriculture and land reform have often in world history been at the centre of revolutions. The structure of agriculture around the world is likely to change substantially in the near future as a consequence of new technologies, especially from bioengineering, economics of mega-farming and distribution, and changes in political sentiments.

Industrial Materials

As global population and affluence have increased, so has the use of various materials increased in volume, diversity and distance transported. Included here are raw materials, minerals, synthetic chemicals, manufactured products, food, living organisms and waste. Analysis and management of the impact of extraction and disposal of industrial products on society and health are enormously complex problems, but have grown increasingly important as our technology advances.

National Innovation Systems

Friedrich List and Karl Marx were arguably the most influential economists of the 19th century, setting agendas in political economics for the next two centuries. List promoted ideas of national economics and science policy, with a theory of 'national economics' that contrasted with the individualism of Adam Smith and J. B. Say in defining a unique role for the State for setting priorities and funding projects. List's ideas became extremely influential after the unification of Germany into a politically and administratively integrated nation state in 1871 under Otto von Bismarck and later Wilhelm II.

Elsewhere, the move towards implementation of national innovation policies was promoted in the early 20th century by Vladimir Lenin, a disciple of Marx and List. Lenin claimed in 1916 that World War I had transformed laissez-faire capitalism into monopoly capitalism. Government officials were supposed to provide the social and legal framework within which giant corporations can operate most effectively. After the October Revolution, Lenin sent the best Soviet scientists on tours to tout Soviet technology. Thinkers such as Léon Theremin, in sensor and surveillance technology, and Nikolai Kondratiev, who constructed the Soviet New Economic Plan, were important figures in the Soviet innovation system.

Léon Theremin

Léon Theremin led a rich and interesting life. A brilliant scientist and darling of Lenin and the Soviet State, he defected to the US in 1927 on a Soviet technology tour; became a New York and Hollywood music celebrity; married a young African-American ballerina, Lavinia Williams – scandalous in those days; and was later kidnapped by KGB agents in New York and spirited back to the Soviet Union. His most famous invention was the 'theremin', the first electronic musical instrument; his second most famous invention was a listening device, 'the Thing', that hung for seven years in plain view in the US Ambassador's Moscow office and enabled Soviet agents to eavesdrop on secret conversations. His American admirer, Bob Moog, brought Theremin back to the US to much acclaim in 1991 when he was 95 years old.

Lenin's science policy and New Economic Plan had enormous influence on Statist policy after World War I. Fascism in Italy, the Meiji Restoration in Japan and National Socialism in Germany made science and technology pillars of their systems. This allowed Germany in particular to make significant advances in weapons technology; its guided ballistic missile programmes in the 1940s cost several times the amount spent on the US Manhattan Project; at the time it was the largest science project in the world. German World War II rocket technology was the basis for US Redstone rockets, Soviet A-4 rockets, and most of the rockets called 'Scuds' in North Korea, Iraq, Iran, and other countries.

After World War II, General Curtis LeMay and head of the US Office of Scientific Research and Development, Vannevar Bush, pushed for an extension and expansion of US wartime national innovation policy. Bush devised the current US system of national funding for science, where:

1. *universities* would conduct basic science funded by the National Science Foundation and to impart the fruits of this research to future business, research and government leaders;
2. *corporations* would conduct applied research funded by contracts – largely weapons contracts in what Eisenhower called the military-industrial complex; and
3. *centres* for research important to public welfare, for example that conducted by the National Institutes of Health and Centers for Disease Control.

Vannevar Bush's perspective on innovation was strongly influenced by his memex project in the 1930s – basically Wikipedia c. 2016 using a microfilm-based device in which an individual stores all his books, records and communications, mechanized for quick, flexible retrieval. Bush was concerned that information overload might inhibit the research efforts of scientists and set out his thoughts in an extremely influential article 'As We May Think,' predicting that 'wholly new forms of encyclopedias will appear, ready made with a mesh of associative trails running through them, ready to be dropped into the memex and there amplified'. Bush's influence led to Eugene Garfield's 'Web of Knowledge' project in the 1950s, which is the basis for the PageRank algorithm used by Google and for the Impact Factor in scientific research. It inspired Hypertext and Internet Protocol projects that became central to the modern internet.

The modern term 'National System of Innovation' arose in the writings of Christopher Freeman and Bengt-Åke Lundvall in the 1980s, essentially restating the political economy of Friedrich List and influenced by the success of Japan's Meiji Restoration as well as its post-World War II reconstruction.

Hong Kong's Cyberport: A Cautionary Tale about Economic Clusters and National Innovation Systems

East Asia has an obsession with innovation, often feeling that its workforce lags behind the West in innovating. Whether this is true or not, and there is substantial evidence that it is not, East Asian governments have funded more 'science parks' than any other region in the world. The science park has been seen as a way to jump-start innovation clusters analogous to California's Silicon Valley and North Carolina's Research Triangle Park within their own countries.

Innovation clusters were popularized by Michael Porter in the late 1980s, while during the same time the importance of geographical economics was emphasized by Paul Krugman. Clusters have the potential to affect competition in three ways: by increasing the productivity of the companies in the cluster, by driving innovation in the field, and by stimulating new businesses in the field. Innovation clusters in a particular geographical location allow the accumulation of human, research and production resources and competences that can drive, in Porter's vernacular, a decisive sustainable competitive advantage.

Innovation clusters attracted the interest of the post-handover government in Hong Kong in late 1997. Hong Kong had grown rich over the prior two decades through unique strengths in correspondence banking and re-export, and wanted to ensure a sustainable competitive advantage for the long run. This period saw a frenetic investment by its government in science parks supporting a set of six clusters:

1. Biomedical technology
2. Electronics
3. Green technology
4. Information and communications technology (ICT)
5. Material and precision engineering
6. Internet and media

The internet and media science park proved most controversial, yet this is the cluster into which the government committed the greatest amount of capital for jump-starting innovation. Heavily influenced by Hong Kong's richest tycoon Li Ka-shing, the Hong Kong government allocated one of the last available tracts of ocean front property on Hong Kong Island to build Cyberport under the management of Li's son, Richard Li. Cyberport was sold as a creative digital community that would be a 'hub' for the world's internet traffic and innovation, and that would jump-start the creation of Hong Kong internet media content, built on the existing Hong Kong film industry platform.

The reality was somewhat different.

Activist investor David Webb argued:

> Cyberport … represented unnecessary government intervention in the property sector and, most importantly, that the 24-hectare waterfront project was awarded to a developer without tender …the Government's claim that 'two-thirds of the site will be for Cyberport development' obscured the fact that only 17% of the floor area was for offices, while 76% was residential, a 2,900-unit project now known as Residence Bel-Air… Their TV ad campaign featured a woman flouncing around a stunning villa which in fact was not in [Hong Kong's] Pokfulam but was the Villa Ephrusi de Rothschild in the South of France. The illusion even extends to page 11 of the annual report of Pacific Century Premium Developments Ltd (0432) where you will find a picture of the gardens of the French Villa opposite a description of the Cyberport.

Webb continued, explaining that:

> [G]overnment-owned Hong Kong Cyberport Development Holdings Ltd and its subsidiaries were incorporated in December 1999, but refuse to publish any of their accounts… by 2004… the government is the outright owner of all portions of the project except the residential part, where it will receive a share of the profit (if any) on the development, net

> of Cyberport construction costs, to reflect the land input. The profit-sharing ratio has never been disclosed, but was based on the peak cash outlay from PCCW (however fleeting) relative to the value of land contributed by the Government.

Webb described a complex ownership and profit-sharing structure of Cyberport which obscures actual cash flows and ownership rights:

> Cyberport is managed by a Government-owned company called Hong Kong Cyberport Management Co Ltd (HKCM) which was incorporated in Dec-99. In fact, although HKCM is the public face of the Cyberport, with a board which includes outside directors, there are three companies involved – Hong Kong Cyberport Development Holdings Ltd (HKCDH) and its two subsidiaries, HKCM and Hong Kong Cyberport (Ancillary Development) Co Ltd (HKCAD). HKCDH holds the master title to the land and granted sub-leases over the Cyberport portion to HKCDH and over the residential portion to HKCAD.

Despite the complexity Cyberport did not choose to enlighten its investors with an annual report until 2012, nearly 13 years after the project was initiated. The overall rationale of the project has been questioned: details that have emerged about the planning and budgeting for the project indicate that 75% of the area developed is residential, and office space allocated for the technology companies would only be around 17% of the total. Also the 'shared facilities' make up part of a small 18,000-square-metre (190,000 sq. ft) block which includes houses and apartments.

More telling, Cyberport has the reputation of being a 'ghost town', and suffers from low occupancy despite its opulent setting on Telegraph Bay. Fifteen companies signed letters of intent with the developer, including Hewlett-Packard, IBM, Microsoft and Yahoo, but only three moved their Hong Kong sales offices into the complex at its initial opening. Richard Li's Pacific Century Group later hived off the residential property interests into a shell company separate from the telecoms operation so that the shell company would receive the residential housing sales revenues.

One could argue that Hong Kong doesn't really need to invest in technology hubs, since they live next door to one of the world's great biotechnology, electronics and computer manufacturing innovation clusters in Shenzhen, China. Most of Hong Kong's technology work force is actually employed around Shenzhen. Hong Kong's heavy investment in local science parks derives more from its intense rivalry with the mainland than with any desire to be a tech hub. Hong Kong's property tycoons have always recognized the incongruity of science parks and East Asian research and industrial culture. With Cyberport, they responded in their own way – they appropriated those government investments for themselves, erecting a Potemkin village around their property to project a superficial display of technological prowess.

East Asians say 'It is better to be the head of a small chicken than the tail of a large ox' – it is better to run your own show than be a part of someone else's. Confucian values play a part in this attitude, where loyalty to family and village come first. Compare this to the West's Enlightenment and humanist emphasis on the individual and society at large. East Asian businesses tend to be small and family run. East Asian governments have enforced scale businesses on their cultures, such as Chinese State enterprises, Japanese zaibatsu and Korean Chaebol. But the real Asian dynamism and wealth are in the East Asian 'mittelstand' firms – mid-sized family companies dominating market niches.

The Japanese mittelstand define the lengths to which East Asian companies will go to abide by Confucian filial piety. The six oldest businesses in the world are Japanese – Kongō Gumi (578 AD), Nishiyama Onsen Keiunkan (705 AD), Koman (717 AD), Hoshi Ryokan (718 AD), Tech Kaihatsu (760 AD) and Genda Shigyo (771 AD) – and these businesses have stayed relevant through the uniquely Japanese custom of adult adoption. Around 98% of adult adoptions in Japan today are by families who bring in talented outsiders to run the operations of the family firm. Rather than consign their family's assets to outside management and board of directors, they welcome the talent into their family. This allows a Confucian family business to survive as a dynamic, innovative and efficient firm for lengths of time that would be unimaginable in the West.

(Sources: https://webb-site.com/dbpub/orgdata.asp?p=17936; https://webb-site.com/dbpub/artlinks.asp?s=81; https://webb-site.com/dbpub/artlinks.asp?s=4368; https://webb-site.com/articles/cybervillas.asp; https://webb-site.com/dbpub/articles.asp?p=17936; https://webb-site.com/articles/kroll.asp; https://webb-site.com/articles/cybersecrets.asp; https://www.cyberport.hk/en)

National Innovation Systems focus on controlling the flow of technology and information among people, enterprises and institutions to direct and promote progress in key technologies and research, similar to the manner in which these were emphasized in Vannevar Bush's memex project. These systems dictate funding and relationships between corporations, universities and government research institutes.

In the 1970s, economists started giving more thought to identifying the distinguishing feature of an innovation – either as an input or output of production. Innovations are special sorts of goods; they are neither a conventional good, nor a pure public good (one shared by all, and owned by none). Rather an innovation is a nonrival good (i.e. you and I can both enjoy the good at the same time without influencing the other's consumption or enjoyment of the good) and a partially excludable good (i.e. 'owners' may limit access to the good). Rival goods are objects; nonrival goods are ideas – atoms vs. bits. Such features of innovation show up in a variety of packages: the pattern for a pair of Calvin Klein jeans, a personal computer operating system, an operatic performance, a logic chip design, an encrypted message, a map of the E. coli genome, the formula for a new drug, a genetically modified rice seed, and the process that created it, a Calder sculpture, the text on this page. All of these are nonrival goods because they can be copied or shared and used by many people at the same time. Most are partially excludable as well. Access to them can be controlled to some degree, in the manner of access by members of a club.

Differences in the structures and strategies of National Innovation Systems among developed countries suggest that there is no universal best practice recipe, and that the best systems take culture, national assets and existing industrial base into consideration. The complexity of these relationships and their strategic importance have been studied extensively by César Hidalgo and are highlighted in the book *The Atlas of Economic Complexity* (Hausmann & Hidalgo, 2014) and at the interactive website *The Observatory of Economic Complexity* (http://atlas.media.mit.edu/en/)

In the 1990s, David Stokes started to distinguish between the motivation for particular innovations and scientific pursuits in terms of practical applicability and utility vs. fundamental understanding of the character of nature (Abernathy & Utterback, 1978).

Stokes divided research expenditures into three categories – *basic, use-inspired basic* and *applied* (Figure 13.2). In many countries, including the US, these three categories mainly occur in their own unique institutional structures. Universities tend to focus on basic research; industrial laboratories concentrate on products, and thus pure applied research; government laboratories such as the US Center for Disease Control concentrate on use-inspired basic research such as vaccines and cures for cancer. Figure 13.3 shows the level of spending in the US on these three classes of research.

		Considerations of Use?	
		No	Yes
Quest for Fundamental Understanding?	Yes	**Pure Basic (Bohr)**	**Use-Inspired Basic (Pasteur)**
	No		**Pure Applied (Edison)**

Figure 13.2 David Stokes' Taxonomy of Research
(Source: Stokes, 1997)

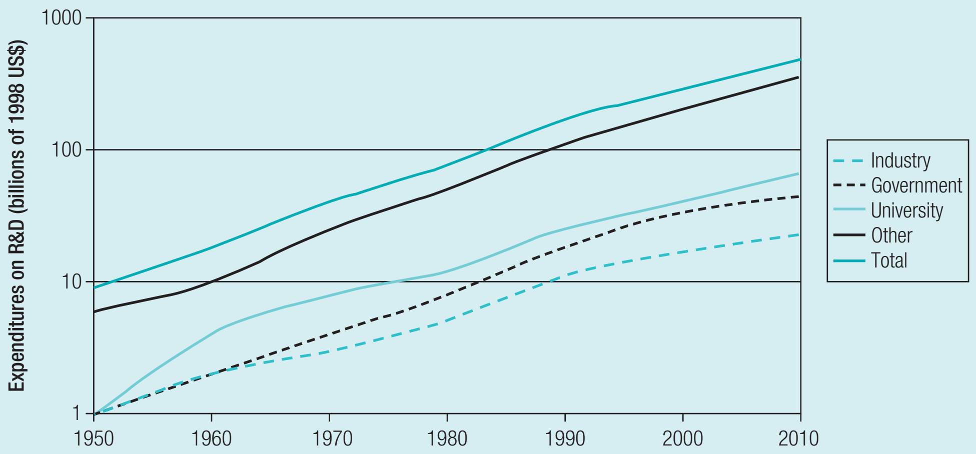

Figure 13.3 R&D Spending in the US (1950–2010 est.)
(Source: National Science Foundation, Division of Science Resource Studies)

Technology, Talent and Tolerance

Economists can be seen to approach the role of innovation in economics and business from theory to data, while sociologists approach the question from data to theory. In the latter class are the detailed case studies and demographic data evaluations by Richard Florida, presented beginning with his book *The Rise of the Creative Class* (2003), followed by several more influential works. Florida crunched demographic data from around the world in search of the correct recipe for cities to generate future wealth – a question similar to that asked by Adam Smith two centuries earlier. The key institution, found Florida, was the university.

The Most Creative Nations

Richard Florida has been generating listings of creativity in competitive economies for two decades. The basis for these evaluations rely on a balance of *technology, talent* and *tolerance* that is postulated to provide the foundation for a social community that is good at continuously generating new and useful ideas.

Technology has been recognized as a key driver of wealth and progress since Karl Marx, and later Joseph Schumpeter and Robert Solow argued that advances in technology enable capitalism to generate new industries and foster economic growth. Technology is spurred by university, government and corporate research laboratories, and reflected in patents and research papers among other measures.

Talent and knowledge capital is the dynamic force behind the creation and implementation of new technologies. Peter Drucker and Fritz Malchup have argued that knowledge workers are pivotal to economic development, and substantial research has demonstrated the tight connection between talent and growth. Talent is fostered by strong universities and environments that welcome foreign talent to live and work.

Tolerance of diverse views and lifestyles is the hallmark of an enlightened and intelligent mind, and establishes a social context where individuals and teams can create without friction. Tolerance is a fundamental requirement to attract talent in a global market.

Countries that open to different views, lifestyles and backgrounds gain an edge for creative employees in in a competitive global talent pool.

Taken together, these three factors comprise a creativity measure that is strongly correlated to economic performance. The 2015 ranking suggests that countries that are high on the creativity index are not necessarily those with large economies. Rather they create an environment that knowledge workers find both accessible and comfortable, but which gives them ample opportunity to create and profit from their ideas.

Creative nations are diverse, with a high tolerance for divergent life styles, new immigrants and artistic inclinations. Growing a creative ecosystem is an organic process. Each place has unique assets to do this, and there is no cookie-cutter strategy which can be re-enacted anywhere. Science parks are a non-starter, and the idea that 'creative' types can be lured to relocate like a sports franchise is deeply misguided. Jane Jacobs (1992b) liked to say that the 'key to attracting creative citizens is to "squelch the squelchers" – the controlling leaders, micromanagers, and broader structures of social control and vertical power – that quash and derail creative energy' (p. 132).

(Sources: Florida, Martin Prosperity Institute, 2015)

Rank	*Country*	*Technology*	*Talent*	*Tolerance*	*Creativity Index*
1	Australia	7	1	4	0.97
2	United States	4	3	11	0.95
3	New Zealand	7	8	3	0.949
4	Canada	13	14	1	0.92
5	Denmark	10	6	13	0.917
5	Finland	5	3	20	0.917
7	Sweden	11	8	10	0.915
8	Iceland	26	2	2	0.913
9	Singapore	7	5	23	0.896
10	Netherlands	20	11	6	0.889
11	Norway	18	12	9	0.883
12	United Kingdom	15	20	5	0.881
13	Ireland	23	21	7	0.845
14	Germany	7	28	18	0.837
16	Switzerland	19	22	17	0.822
16	France	16	26	16	0.822
16	Slovenia	17	8	35	0.822
18	Belgium	28	18	14	0.817
19	Spain	31	19	12	0.811
20	Austria	12	26	32	0.788
21	Hong Kong	32	32	30	0.715
21	Italy	25	31	38	0.715
23	Portugal	35	36	22	0.71
24	Japan	2	58	39	0.708
25	Luxembourg	20	48	32	0.696

Figure 13.4 The Most Creative Countries in the World
(Source: Martin Prosperity Institute (2015) Global Creativity Index)

The university plays three roles in the modern economy – contributing *technology, talent* and *tolerance*. The best and most influential academics are employed in universities – and this attracts both technology and talent. Their students are likely to be corporate leaders, and particularly the fresh graduates are going to be doing the most cutting-edge work with new ideas. As a result, technology centres around the world tend to be associated geographically and demographically with world-class universities.

The university's role in engendering tolerance is perhaps a bit more difficult to articulate. In part, tolerance is required because the high energy level, mental intensity, unique backgrounds, and the deep insights that are the domain of the most talented academics also tend to emphasize any social or personal eccentricities that these individuals may hold. And these may be on display to classrooms of impressionable students or other audiences. But also because universities house not only the natural and applied sciences – e.g. engineering, physics, biology, but also the social science faculties – philosophy, sociology, political science. These latter faculties may build their academic careers around challenging existing cultural and political norms. They generate ideas, solve problems and enrich a culture of creativity – but they cannot survive in a climate of intolerance.

Innovations and the steady rise in complexity of products and services have shifted value away from purely physical assets in more recent years. Various authors have used different names to described society's shift away from productivity and wealth based on 'things', and towards 'idea'-based wealth. Daniel Bell, in his book *The Coming of Post-Industrial Society* marked the year 1971 as the start of the 'post-industrial society', following two years that saw a fourfold increase in world oil prices. Peter Drucker used several terms to describe the restructuring of work, starting with the 'post-capitalist society', but which he eventually ended up calling the 'knowledge economy'. Richard Florida is more specific – calling it the creative economy. Like Ricardo and Marx, Florida predicts a new class struggle in the creative economy altering the landscape of power throughout the 21st century. His studies focus on the US, but are likely to accurately depict the new divisions in Europe, Japan, and other OECD countries. Florida sees three groups comprising the new landscape: (1) the Creative Class (currently around ~30% of the US of which ~12% is what Florida calls the Creative Core); (2) the Industrial Class (~25% of the US); and (3) the Service Class (~45% of the US). Florida dismisses farmers as no longer a power; much of US farming is done by corporations, and less than one-tenth of 1% of employees make their living as full-time farmers (Lapowsky, 2012; Forbes, 2015).

Dublin: Building the High-Tech Mecca

The rapid growth of the computer industry throughout the 1980s, as well as the Thatcher-Reagan era restructuring of many traditional industries, forced many nations firmly into post-industrial economies.

By the end of the 1980s, many countries were searching for ways to keep their industries and workforces relevant in a world that valued information industries over steel, concrete, mining and other asset-heavy sectors. Ireland was no exception, having suffered from double-digit unemployment, stagnant incomes and a steady exodus of talent for a decade.

Ireland's challenge by 1990 was building a post-industrial workforce – one with college degrees, technical savvy and entrepreneurial spirit. This workforce might come about by retraining blue-collar workers to work in information industries. Or it might be possible to ramp up colleges and universities to produce more science, technology, engineering and mechanics (STEM) graduates. Or it could be built by simultaneously attracting foreign talent while retaining domestic talent.

Ireland chose the last option as being most realistic, and throughout the 1990s pursued a quest to make Ireland an attractive home for tech workers and information firms. Ireland's Industrial Development Authority actively started recruited US technology companies through financial and tax-related incentives. IBM, Lotus, Intel, Microsoft, Dell, Gateway and Oracle had already been attracted by the many talented graduates emerging from the country's world-class universities. The idea was to bring these companies closer so that citizens could see how successful companies worked. It also helped that Irish spoke English, and the multinationals investing were American (a similar linguistic tie has helped India, where most college graduates speak excellent English).

The country wanted to make sure that exposure to multinationals spurred local entrepreneurship, and subsequently set up Enterprise Ireland to support entrepreneurship and venture capital and foster an indigenous high-tech industry. Today the Irish software industry is made up of some 900 firms, employing over 30,000 people. Many of these employees boasted an apprenticeship with one of the multinationals.

Part of the draw for multinationals was talent. Ireland's educational system both generates and attracts world-class talent. Since the 1960s, the Irish government has heavily funded technical skills in electronics and computer-related disciplines through a system of regional technical colleges. Today, 60% of Ireland's university students major in engineering, science or business studies.

The final ingredient in Dublin's recipe for success was tolerance and diversity; this is what has set Dublin apart is its attempt to refashion itself as a lifestyle community. Ireland has a legacy of culture, art and music that resonates with English speakers around the world. The distinguishing feature of communities of writers, musicians, artists and other bohemians is a sense of diversity – of ideas, of cultures and of lifestyles – and a sense that new ideas will be tolerated. It was easy to build on this, as well as on Dublin's picturesque downtown, to create a trendy, vibrant, interesting lifestyle centre attractive to dynamic creative people and those who want to be around such amenities. The 30- and 40-something professional crowd are less influenced by alcohol-centric pubs and instead seek art houses, music venues, coffee shops, bookstores and boutique shopping. Because they may work odd hours, they like these to be available from the morning into the evening. Up into the 1990s, downtown Dublin still tended to close up at 5 pm. Since then the city has been obsessive in building on its history by restoring its Temple Bar district, restoring the same pubs where James Joyce, Bram Stoker and Samuel Beckett might have once downed a Guinness. Dublin spent $25 million in European Union tourism funds to emphasize Temple Bar's rich history, trying 'not to turn the neighbourhood into a Euro-Disney of faux-Georgian architecture, but to encourage innovative design.'

(Source: Williams, 2000)

Some of the trends that Florida finds are reminiscent of earlier revolutions in power. Creative workers and service workers are entwined in the same manner as were capitalists (bankers and entrepreneurs) and labourers were in the 19th century. Creative workers define as well as streamline, outsource, and modify the jobs that are held by service workers; Service workers are their new proletariat. Today's industrial workers are faced with a bleak future similar to that which vexed landed nobility in the 19th century. Comfortable factory positions protected by union contracts will be whittled away over time as the Creative Class figures out new ways to outsource and automate, just as the bankers and entrepreneurs whittled away the privilege of nobility in the 19th century.

Asia Innovates

Singapore has long been considered one of the economic successes of Asia. But it has had difficulty spurring a competitive technology sector. Despite being home to the Asian operations of a large number of multinationals, its investments in technologies such as consumer electronics have not kept pace with Japan, Korea or China, and until recently biotechnology investments have generated losses. This has worried Singapore's leaders, who can boast good universities, an educated populace, great infrastructure and continued investment in science parks and other property projects intended to spur technology entrepreneurship.

In short, Singapore was a country with technology and talent, but historically without tolerance. In fact, it touted just the opposite – a reputation distinguished by brutal intolerance for even the small indiscretion of chewing gum, administered by an oppressive no-nonsense bureaucracy. After decades of trying to jump-start high-tech entrepreneurial business through science parks and handouts, around 2005 senior government officials realized that they would an easier time attracting talent if they just became more tolerant of diverse ideas. The Singapore government changed direction quickly, tackling one of the most controversial topics. The government committed itself to make Singaporeans more sensitive to aesthetics by having art programmes in schools, encouraging art festivals and building cultural infrastructure. It dedicated money towards remaking Chinatown and Clarke Quay, a pretty nightlife district on the river, into trendy areas like Temple Bar. Singapore is now one of Asia's most successful economies and provides a model to other nations in attracting tech talent and fostering entrepreneurship in computers and biotechnology.

(Sources: Hobday, 1995; Wong et al., 2003; Wong & Singh, 2004; Luke et al., 2005; Wan et al., 2005)

Innovation Workout: Putting it All Together (with a Digression on 'The Blues')

The 6th-century BC mathematician Pythagoras is known best for his theorem relating the length of sides and hypotenuse of a right triangle. But he also invented the blues scale. Pythagoras and his followers built a religion full of rituals, and believed in immortality and transmigration of souls, at the heart of which was a universe based on numbers. Every aspect of life was expressible in number. Marriage, for example, was the number 5 as the union of a man (= 3) and a woman (= 2). Musical harmony was similarly expressible in numbers – the length of string determined the note produced, and that note was then related exactly to other notes by fixed ratios of string length. The heavens were ruled by pentatonic harmony, with each of the five known planets of Pythagoras's day occupying a sphere whose radius allowed it to vibrate harmonically with the others – what came to be known as 'the music of the spheres'. Pythagoras's pentatonic harmonies of planetary motion have their modern scientific restatement in Bode's Law.

Pythagorean tuning is based on geometric note relationships; the pentatonic scale was devised with the use of only the octave, fifth and fourth (i.e. a fifth down). It produces three intervals with ratio 9/8 and two larger intervals. Think of this as a minor blues scale (sans 5b) on the piano – in C this would be C, Eb, F, G, Bb (this is also called the 'rock' scale). Think of building a scale only with fifths and octaves, from C you go up a 5th for the G, down a fifth for the F, down another fifth for the Bb, and down another fifth for the Eb. These are 'just' intonations (there are no beats or dissonances in the notes in the scale) so that scale is, from a human hearing standpoint, an ideal scale. Unfortunately, this neat Pythagorean number system breaks down for intervals other than the octave, fourth and fifth (Pythagorian thirds just don't cut it) which was the reason that other tunings were invented. Modern equal temperament, for example, keeps the fourths and fifths within five cents of the Pythagorean tuning, and spreads the dissonance across all the notes of a diatonic or chromatic scale.

The intervals of the pentatonic scale are integral to the psychology of music and to human hearing; they somehow resonate with us at a very fundamental level; they are found in the tuning of the Ethiopian krar and the Indonesian gamelan, the melodies of Chinese folk music, African-American spirituals, Celtic folk music, Polish highlanders from the Tatra Mountains and the music of French composer Claude Debussy. They are the musical counterpart to Noam Chomsky's 'deep structures': universal grammar underlying all languages and corresponding to an innate capacity of the human brain.

In the Middle Ages, the church outlawed the secular pentatonic melodies along with major-minor (Ionian, Aeolian modes) and substituted the church modal systems for religious music.

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The medieval church wanted people to pull away from the sensual and secular; to get people to stop dancing and tapping feet. Later the church introduced the pipe organ into its services to accompany the choir, and along with it the first incarnations of the modern keyboard. Originally these keys were large levers which were operated by a whole hand; keyboards until the 15th century had seven naturals to each octave – i.e., only 'white keys' playing in the key of C. Church modes would simply start on a note higher or lower than C. As there were no accidentals (i.e., 'black keys') it was impossible to play a pentatonic scale, even if one dared to do so in a church.

The pentatonic came back into use in the Renaissance with the spread of secular music. Instruments such as the clavichord were small, designed for private dwellings, and added 'black keys' to their distinctly smaller keyboards in order to play in other keys and accompany other instruments.

The modern jazz blues scale grew out of impromptu pentatonic harmonies in the folk music of the rural South. At the turn of the 20th century, W. C. ('Father of the Blues') Handy composed a campaign song for E. H. Crump, the candidate for mayor of Memphis Tennessee, using harmonies that he first heard from a banjo player while waiting at a train station in Mississippi. The song, 'Mr. Crump', was later retitled 'Memphis Blues' and became very popular, to be followed by 'St. Louis Blues', and so forth. Handy's 'blues scale' added the flat fifth (in C this is C, Eb, F, Gb, G, Bb) which arose from the country music technique that took a flat five 'bent' note and would slide it into the dominant.[4] On the piano for which Handy's music was published, with its tempered, enharmonic tunings, the blues scale became something else; a scale that could fit with a diverse array of harmonies.

Figure 13.5 Blues Scale

Which brings us to the following list of *problems with the modern piano keyboard*:

1. Tuning: The organ keyboard (which preceded the stringed keyboard instruments by several centuries) dates before any agreement on the best way to tune the instrument. It was designed to simplify the execution of one scale (C major) and a number of other church modes which are not common today; in so doing, it complicated the remaining scales. Tuning in the early days of the keyboard was a topic of heated debate. Johann Sebastian Bach, in particular, was a proponent of equal temperament (though one that is different than we use today). The major builders of pianos and organs, such as Bach's contemporary and colleague Gottfried Silbermann, preferred simpler tunings, given that they had to tune on organs with thousands of pipes. Bach disagreed with Silbermann's organ tuning so vehemently that he called one-third of it 'barbaric' and once launched into a piece in A-flat major on purpose – the worst key in Silbermann's tuning – just to pique Silbermann in public. Silbermann, it is said, retaliated by grabbing Bach's wig and throwing it off the choir loft.
2. Ergonomics of the keyboard's physical configuration: the correct division of function between the thumbs (which need to tuck under the other fingers) and the remaining fingers necessitates a high level of training to master. Interestingly, it was J.S. Bach who originated the widespread use of the thumb undertuck. Prior to Bach, pianists were even more hobbled by technique that considered the thumb to be an ungainly stub, and didn't use it at all.
3. Ergonomics of chord and scale shapes: the keyboard was designed originally to play in one key – C. But today, most music is played in any key but C, and typically shifts keys at least once per song. Chord and scale shapes are different in all 12 keys because of the configuration of raised black keys. This requires substantially more memorization of shapes than is required for other instruments.

4. Ergonomics of the physical interface: Physical interface problems arise from weighting, relative keyboard and hand dimensions, and responsiveness of the mechanism. Because the keys are elongated rectangles, the hand attacks the very high or low notes at substantially different angles from the keys in the centre of the keyboard.

Thinking About the Problem: A Potential Innovation

Although there are many competing ways to tune modern stringed instruments such as violins, guitars and harps, the 'oriental tuning' (i.e. tuning in fourths E-A-D-G) which is standard for bass guitar offers some distinct advantages. It removes the irregularity of the interval of a third between the second and third strings. With oriental tuning, chords can simply be moved down or across the fretboard, dramatically reducing the number of different finger positions that need to be memorized. Could this structure be carried over to the piano keyboard without creating other problems?

Fleshing out the Innovation

Here is one potential solution to the prior problems. A keyboard with round (typewriter-style) keys in a tiered arrangement of four rows (Figure 13.6).

Consider how this eases the process of transposing chords and key centres (Figure 13.7). On the tiered keyboard, the shape of the C, C# and F# scales (and corresponding chords) are all the same; on a traditional keyboard, they change, increasing complexity, memorization problems and ergonomic problems.

Where would we look for markets? Essentially, anywhere these problems repeatedly assert themselves, and where there may not be much resistance to learning a new technique. Traditional classical performers probably will be unwilling to adopt. But adopters might be found in:

1. Vocal accompaniment, where the ability to learn in one scale and transpose without problem is a valuable asset.

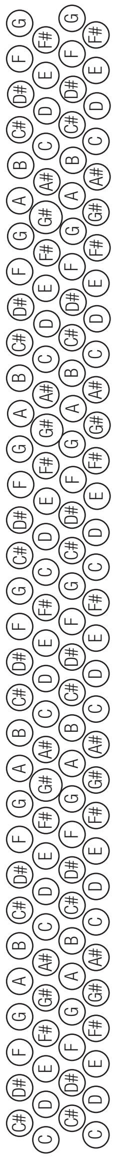

Figure 13.6 Redesign of Piano Keyboard for Easy Transposition and Greater Reach (5½ Octaves)

2. Rock and jazz keyboardists, where innovation is embraced and transposition is central to the music.
3. Improvisatory music, orchestral transcriptions (where large intervals need to be spanned), and where other complex, flashy music not specifically designed for the traditional piano is to be played.

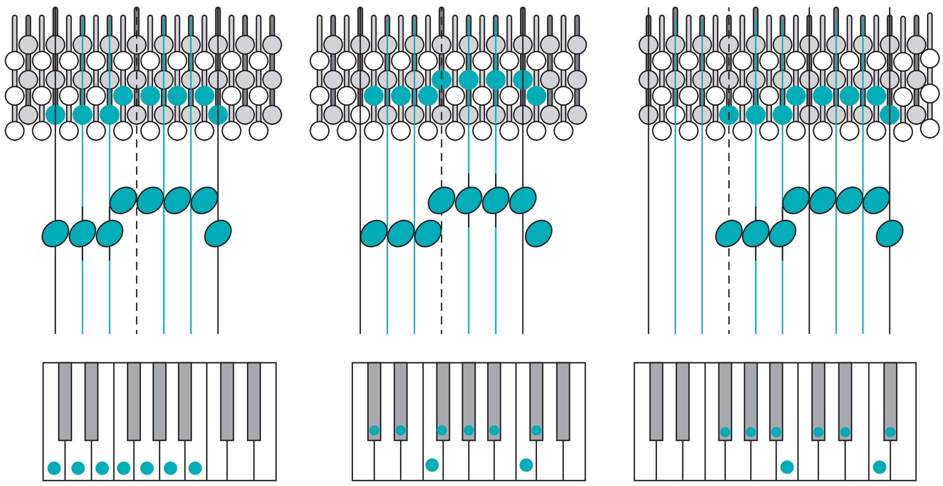

Figure 13.7 C, C# & F# Major Scales on a Standard Piano Keyboard and on the Tiered Keyboard of Figure 13.6

Innovation Workout: To Do

(1) (*Vision*) What will this company look like in:
   a. 2 years?
   b. 5 years?
   c. 10 years?

(2) (*Business Model*) Draw a value map for a business model for selling this keyboard innovation:
   a. Identify where it should concentrate its strategy in the future.
   b. Identify where it incurs costs, and estimate how much these might be, given what you know about the price of computer chips.
   c. Identify where it will earn revenues, and estimate how much these might be, given what you know about the price and volume of sales of computer chips.
   d. Describe how and where *network effects* appear.

(3) (*Industry Dynamics*) Describe how exponential growth in technology performance over time manifests itself in this business:
   a. Predict past and future times of disruptive technology innovation.
   b. Describe how and when the Innovator's Dilemma will manifest itself in the future decades.

(4) (*R&D-CRM*) How would your company link its product R&D and its customer relationship management (CRM)? R&D needs to design products that customers will want to buy in the future, and CRM serves several functions: making sure that customers are satisfied with existing products; making sure that they know about new and upcoming products; asking them questions to find out what they want in new products; making them aware of new features that they didn't know they wanted.

(5) (*Investment*) How can your company invest to compete with 'traditional' keyboard instruments? Your answer to this question is important, because outside investors will provide the money for these investments, and in answering this question, you will need to let them know 'where they will make *their* money'.

(6) (*People*) What sort of people should your firm hire to develop a commercially successful product, and what will you have these people doing in your company?
   a. Idea generators (i.e. those who can sift through large quantities of technological and market data to identify 'innovations')
   b. Gatekeepers and boundary spanners (who bring ideas from one department, company or industry, to another)

d. Champions (entrepreneurs, evangelists and other promoters of new ideas, even though they may not have very great technical knowledge)
e. Sponsors (coaches and mentors that can clear the way politically for an innovation)
g. Project managers?

(7) (*Milestones*) How will you translate your innovation development and market entry strategy into specific milestones (i.e., deliverables)?
Define three milestones for the business. Each milestone must trigger a test of one of your underlying assumptions about the business and product. Specify an assumption test for each milestone you list.

(8) (*First Customers*) Identify your best choice for your first three customers, *and explain why*. These should be specific company or individual names, or at least defined precisely enough that I can identify the three specific customers.

(9) (*Combatants*) Identify your major combatants (size and commitment), sleeping dogs (size only), bystanders (neither size nor commitment) and skirmishers (commitment but insufficient size). You may make references to generic categories of products or generic names of industries.

(10) (*Entry Tactic*) Choose and elaborate upon a single 'best' entry tactic that is based on your answers to the questions above. Your objective should be to avoid debilitating competitive interaction by using speed, skill and surprise, rather than your scarce start-up resources. Explain in detail how your choice of entrance strategy achieves these objectives better than any other possible entrance tactic. You want to use your imagination, innovation and creativity to outmanoeuvre your competitors … not your resources.

Case Study: Meade Reaches for the Stars

'I was miserable. I'd never held a job before, and I hated working for someone else' recalls John Diebel about his first job as an engineer at Hughes Aircraft Company in Los Angeles. Shortly after starting at Hughes, he began browsing the periodicals at the Los Angeles Public Library for other business opportunities, and sent out letters to companies that interested him. After several months of no responses, Diebel was finally contacted by Japan's Towa Optical Manufacturing Company to distribute their optical products in the US (Levy, 2000).

In 1972, armed with his agreement with Towa, the 29-year-old entrepreneur started with a loan of $2500 from the Hughes Aircraft credit union (after other banks had flatly refused him any credit). He ordered $2000 worth of Towa telescopes, got a post office box, and set up business in the kitchen of his small apartment. Following a vacation trip to Lake Mead in Nevada, he decided to call his company Meade Instruments, adding the 'e' because he thought it looked nice. He took out an advertisement in the July 1972 issue of *Sky & Telescope* (at that time the only mass magazine targeted at amateur astronomers) offering Towa's line of refracting telescopes. By the end of his first year in business, he had netted $8000 in sales, had quit Hughes, had moved the company to a warehouse in Costa Mesa, California, and hired his father, a retired furniture store owner, to help with the rapidly expanding sales. 'I didn't know anything about running a business. My father taught me everything, from preparing financial statements to talking to the bank'. Business expanded rapidly and Diebel realized that he had accidentally tapped into a potentially huge market.

The Meade-Towa products were attractive to amateur astronomers in the 1970s because of Towa's unheralded innovations that were not offered by US competitors – e.g., spring-loaded gearboxes for smooth focusing and viewfinder eyepieces with wider fields. By 1975, the firm had net income of $55,000 on $259,000 sales.

In those days, Japanese firms were still struggling to enter US markets and gain recognition for their rapidly improving quality. Towa's managers were thrilled with John Diebel's success, and their corporate and personal relationships grew close. In the late 1970s, Diebel married the daughter of Towa's founder.

By 1976 demand for tube assemblies for reflecting telescopes exploded and Diebel began manufacturing the assemblies in Costa Mesa to meet demand. The first telescopes of its own production (the model 628 and 826 six-inch and eight-inch reflecting telescopes) were so good that Meade quickly gained a large share of the market. By 1978, its sales had topped $2 million.

By the late 1970s, amateur astronomy was a rising fad. Another Southern California telescope maker named Tom Johnson – founder of Meade's perennial rival Celestron – had pioneered the amateur (read affordable) Schmidt-Cassegrain telescope (SCT). Johnson's design utilized two mirrors and a corrector plate (see Figure 13.8) to produce wide-field, high-resolution images. Ready to take on the challenge, Meade directed all of its resources into the development of a Schmidt-Cassegrain to compete with Celestron's, which had been on sale since the 1960s. By September 1980, Meade was ready to sell its first Schmidt-Cassegrain model, the eight-inch 2080.

The company continued to release new models and new accessories, and by 1985 it had surpassed competitor Celestron as the largest telescope manufacturer in the world. The news came the same year that the famous Halley's Comet was about to return, an event which unleashed an unprecedented wave of interest in amateur astronomy among the general public and boosted sales substantially (Berkman, 1990).

By 1986 Meade employed a staff of about 100 people, generating $13 million in sales. Still, profits were small, and Diebel was forced to personally guarantee all of the company's loans. Seeking more personal security he sold Meade for $6.5 million to the Harbor Group, a holding company based in St. Louis Missouri (Los Angeles Times, 1987), while remaining on as the company president (Orange County Register, 1987).

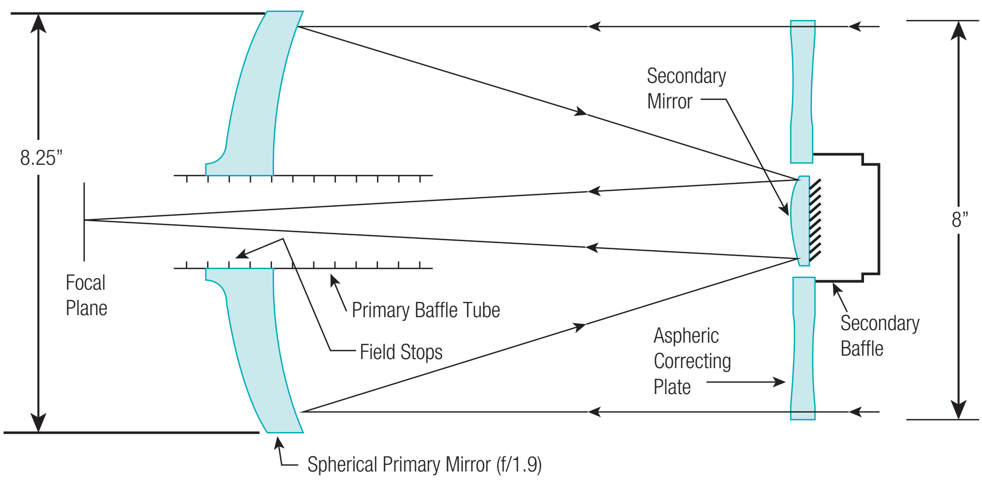

Figure 13.8 Meade's 2080 Schmidt-Cassegrain

This, however, was not a happy marriage. Harbor Group was the archetypal finance MBA-driven venture capital firm, interested primarily in pumping up the financial statements of its acquisitions in pursuit of an initial public stock offering. While Diebel was customer and product driven, Harbor was focused on profits and (ultimately) the potential to take the firm public. Meade's R&D suffered under Harbor's bureaucratic management style; Diebel found himself saddled with paperwork, meetings and marketing studies; and any new product development soon ceased almost entirely.

After two years, Diebel had had enough. He quit, moved to Hawaii, played golf, consulted for a diminished Meade one day a week, and watched as Meade's sales plummeted (*Los Angeles Times*, 1990). Harbor Group tried to resolve this problem the only way it knew how – not by improving the product, but by looking for a merger or acquisition target. In July 1990, it announced that Meade would merge with its main competitor Celestron International to create (on paper at least) a firm with $21 million in annual sales. The US Federal Trade Commission, though, blocked the merger. By the end of 1990, Meade was nearly bankrupt, running a loss of $2 million on $10 million annual sales (Dow Jones News, 1990).

By February 1991, Harbor Group's 'value-building' had driven Meade's net worth to a negative $2 million, and Meade's creditors called in their loans. Diebel quickly returned from Hawaii to loan Meade $65,000 of his own money to meet the weekly payroll while he negotiated a buyout of the company with three partners. In the end, Harbor sold all of Meade's stock along with all its assets and liabilities to the group of partners for a nominal $1000 – $510 of that came from John Diebel's own pocket, and Diebel once again regained majority ownership of Meade.

Accepting an annual salary of only one dollar, Diebel put up $1.8 million of his proceeds from the earlier sale to Harbor. His three partners, all Meade employees, mortgaged their homes and came up with $250,000 in cash (Levy, 2000). That money was put towards revitalizing Meade's R&D programme, beginning with the ETX, a small (90mm–125mm) telescope modelled on Questar's 3.5-inch Maksutov-Cassegrain telescopes. Questar's founder, Lawrence Braymer, had been a commercial artist by trade, and his artistic talents had rendered an expensive but visually stunning telescope with intuitive controls. The ETX combined all this at one-quarter the price of the Questar (Stevens, 2001).

Meade's other blockbuster product – the LX200 – relied on John Diebel's background in electrical engineering (Diebel had an undergraduate electrical engineering degree from Caltech, and a PhD from the University of Southern California). It was to be a $2000 SCT and mount equipped with computer controls to automatically slew the scope to 64,000 celestial objects (Yu, 1998). Diebel put over $1 million into R&D for the LX200, but even so, by 1993 Meade was profitable, and by 1995 Meade telescopes were outselling all competitors combined throughout the world. In 1996, Meade's sales rose to $29.8 million. Sales would again double by 1998, and yet again by the end of the 2000 fiscal year (Lindquist, 1998). By the end of 1999, Meade boasted a 70% share of the high-end telescope market (Berry, 1999) and 40% share of the low-end market (Hirsch, 1997; Johnson, 1997).

Meade became peripherally involved in some of the dot.com madness when it was engaged by TeraBeam to manufacture optical components for TeraBeam's fibre optic networks (Dow Jones Business News, 2000; *Los Angeles Times*, 2000). Meade, which had gone public, saw its stock rise on the association (because fibre optics are a key component of the internet) and in early May of 2000 made public a two-for-one stock split (Fields, 2000).

Subsequent financial news was disappointing, as the retail chain of 'Natural Wonder' stores merged with 'World of Science' stores, and then stopped carrying Meade's products.

The 2000 Christmas season saw retail sales plummet, and by the end of the first quarter of 2001 the company had reported a loss of $4.7 million. The dot.com fuelled stockmarket crash claimed Meade's rival, Celestron, which went bankrupt when its owner Tasco Worldwide began the process of liquidating after failing to service debts to its secured lenders (Grover, 2000). The US Federal Trade Commission once again prevented Meade from purchasing Celestron's assets, and to this day Celestron remains a separate enterprise (Orange County Register, 2000).

Diebel commented to astronomer David Levy:

> I love my job; I wouldn't trade it for any other – when I wake up each morning I can't wait to get to work. I am still an amateur astronomer at heart. Whenever we think of a new product, I imagine myself using it and try to put myself in the customer's position. We never forget who our customers are; the amateur astronomer is the ultimate arbiter of our performance as a company (Levy, 2000:80).

(Sources: Levy, 2000; Meade Instruments Corporation History, www.fundinguniverse.com/company-histories/meade-instruments-corporation-history)

Questions: Meade Case Study

1. Why did Harbor Group's 'value-building' drive Meade's net worth to a negative $2 million?
2. Why was Diebel able to successfully turn Meade's business around after his group repurchased it from Harbor Group?
3. Why did Diebel choose to come back to a very troubled business, one that was consuming huge amounts of his personal wealth, when he could have stayed in Hawaii and played golf?
4. What single characteristic of Meade's business model was most responsible for its success?

Chapter 13: Questions for Review

1. What countries will be the wealthiest economically in 2020?
2. Which countries will decline in wealth over the next decade?
3. What can a city do to ensure a healthy economy in the next decade?
4. What shouldn't a city do if it is to survive?
5. Many countries espouse nationalistic objectives, and make it very difficult for immigrants to obtain visas or citizenship. Will these countries have an economic role to play in the future? What kind of role? Why would it be beneficial to limit immigration into a country?
6. Do you believe that we are moving into a non-egalitarian world where social classes are differentiated by learning and creativity? Explain what news events or insights contribute to your view.
7. From a personal perspective, how do you go about assuring that you can be a part of the Creative Class, as opposed to the lower-paid working or service classes?

Chapter 13 – Key Points

1. Innovators are now the key contributors to a nation's economic health.
2. The manner in which innovation contributes to the economy was first described by Adam Smith in his parable of the pin factory (in *The Wealth of Nations,* which is generally considered the first modern work of economics).
3. An increasing amount of innovation is now taking place in virtual worlds with virtual economies.
4. Successful innovation requires a workforce with technology, talent and tolerance.
5. National innovation initiatives and science parks have a mixed record of success – there is no checklist for becoming an innovative nation.

Notes

[1] The rise of innovation was commented on repeatedly throughout the 20th century, notably in Chandler, 1962, which provides insight into how some aspects of competition and innovation are much the same as they were even in the first part of the 20th century.

[2] These influences come less from Marx than his contemporary Physiocrats, who strongly influenced early accounting. The perspective of the Physiocrats is still promulgated in the stewardship orientation of accounting that dominates thinking at the US Financial Accounting Standards Board.

[3] These two genres have protected themselves against piracy by locking their content into particular platforms. Video games are tied to game consoles by unique identifiers in both machine and program which can be verified through the internet. Motion pictures have resisted the transition to digital film (essentially high-resolution digital television) by distributing on film.

[4] The 'blues' scale is more formally called a hemitonic relative minor pentatonic scale in classical theory, but anyone using the term should rightly be considered an insufferable pedant.

Further Reading

Abernathy, W. J. and Utterback, J. (1978) Patterns of industrial innovation, in M. L. Tushman and W. L. Moore, *Readings in the Management of Innovation* (pp. 97–108). New York: HarperCollins.

Amabile, T. M., Conti. R., Coon, H. et al. (1996). Assessing the work environment for creativity. *Academy of Management Review* 39 (5), 1154–1184.

Bakari, Mohamed El-Kamel. (2014). Sustainability's inner conflicts: From 'ecologism' to 'ecological modernization'. *Journal of Sustainable Development Studies* 6(1), 1–28.

Barnosky A. D., Hadly, E. A. et al. (2012). Approaching a state shift in Earth's biosphere. *Nature Review* 486, 52–58. doi:10.1038/nature11018

Basile, A. (2011). Networking system and innovation outputs: the role of science and technology parks. *International Journal of Business and Management* 6(5), 3.

Bell, D. (1999). *The Coming of the Post-Industrial Society*. New York: Basic Books Reissue edition.

Berkman, Leslie (1990, 10 October). FTC has eyes on telescope firm merger monopoly. *Los Angeles Times*.

Berry, Kate (1999, 17 October) Meade's telescope sales make it an industry star. *Orange County Register*.

Blewitt, J. (2008). *Understanding Sustainable Development*. London: Earthscan.

Botkin, D. B. (1990). *Discordant Harmonies, A New Ecology for the 21st Century*. New York: Oxford University Press.

Bournay, E. et al. (2006). Vital waste graphics 2. The Basel Convention. UNEP, GRID-Arendal.

Business Wire (1999, 30 December). Meade Instruments CEO Says R & D investment paying off.

Business Wire (2000, 29 March). Meade Instruments posts earnings well below analysts' reduced estimates. *Dow Jones Business News*.

Campanella, F., Rosaria Della Peruta, M. and Del Giudice, M. (2014). Creating conditions for innovative performance of science parks in Europe. How manage the intellectual capital for converting knowledge into organizational action. *Journal of Intellectual Capital* 15(4), 576–596.

Caperna, A. and Tracada, E. (2013). A new paradigm for deep sustainability: Biourbanism. In *Application of Efficient & Renewable Energy Technologies in Low Cost Buildings and Construction Conference Proceedings*, International Conference & Exhibition, 16–18 September 2013, Ankara-Turkey (pp. 367–381). Gazi University & University of South Wales.

Caradonna, Jeremy L. (2014). *Sustainability: A History*. Oxford University Press.

Castronova, Edward (2001). Virtual worlds: A first-hand account of market and society on the cyberian frontier, CESifo Working Paper No. 618, December.

Castronova, Edward (2005a) Real products in imaginary worlds. *Harvard Business Review* May, 19–20.

Castronova, Edward (2005b) *Synthetic Worlds: The Business and Culture of Online Games*. University of Chicago Press.

Chandler, A. D. (1962). *Strategy and Structure: Chapters in the History of American Industrial Enterprise*. MIT Press: Cambridge, MA.

Cheng, F., van Oort, F., Geertman, S. and Hooimeijer, P. (2013). Science parks and the co-location of high-tech small- and medium-sized firms in China's Shenzhen. *Urban Studies* 51(5), 1073–1089.

Coffey A. (2005, 5 November). Cyberport tech park still has doubters. *The Age*.

Communications and Technology Branch (1999, 3 March). $13 billion Cyberport project announced. *Commerce and Economic Development Bureau*.

Cooke, P., Uranga, M. G. and Etxebarria, G. (1997). Regional innovation systems: Institutional and organisational dimensions. *Research Policy* 26(4), 475–491.

De la Mothe, J. and Paquet, G. (eds) (2012). *Local and Regional Systems of Innovation* (Vol. 14). Springer Science & Business Media.

Diamond, Jared (2005). *Collapse: How Societies Choose to Fail or Succeed*. New York: Viking Penguin.

Díez-Vial, I. and Fernández-Olmos, M. (2014). Knowledge spillovers in science and technology parks: How can firms benefit most?. *The Journal of Technology Transfer* 40(1), 70–84.

Dow Jones Business News (2000, 15 March). Meade Instruments shares soar on word of alliance with TeraBeam.

Dow Jones News (1990, 9 October). Federal Trade Commission moves to block telescope venture. *Dow Jones News Service-Ticker*.

Eurasia Review (2012, 16 July) Hong Kong: Revelations in SHK bribery case; Collusion between politicians and property tycoons.

Fields, Robin (2000, 16 March). Meade shares soar 77% on Terabeam deal. *Los Angeles Times*, C8.

Florida, R. (2003). *The Rise of the Creative Class*. New York: Basic Books.

Florida, R. (2005a). *Cities and the Creative Class*. Routledge.

Florida, R. (2005b). *The Flight of the Creative Class. The New Global Competition for Talent*, HarperCollins.

Florida, R. (2009). *Who's Your City?* Basic Books.

Florida, R. (2014). *The Rise of the Creative Class – Revisited: Revised and Expanded*. Basic Books.

Forbes (2015). Startup Mecca rises from abandoned Guinness storehouse. *Forbes*, www.forbes.com/startup-mecca-rises-from-abandoned-guinness-storehouse/, accessed 22 June 2016.

Freeman, C. (1982). *The Economics of Industrial Innovation*, 2nd edn, Frances Pinter, London.

Freeman, C. (1995). The 'national system of innovation' in historical perspective. *Cambridge Journal of Economics* 19(1), 5–24.

Freeman, C. (2001). A hard landing for the 'new economy'? Information technology and the United States national system of innovation. *Structural Change and Economic Dynamics* 12(2), 115–139.

Galbraith, J. R. (1982). Designing the innovative organization. *Organizational Dynamics* Winter, 3–24.

Grover, Ronald (2000, 29 May). Back from a black hole. *Business Week*.

Hamari, J. and Lehdonvirta, V. (2010). Game design as marketing: How game mechanics create demand for virtual goods. *International Journal of Business Science & Applied Management* 5(1), 14–29.

Hausmann, R and Hidalgo, C. A. (2014). *The Atlas of Economic Complexity: Mapping Paths to Prosperity*. MIT Press.

Hirsch, Jerry (1997, 14 September) Irvine Telescope builder proved to be farsighted. *Orange County Register*.

Hobday, M. (1995). *Innovation in East Asia*. New York: Basic Books.

Huesemann, M. H. and Huesemann, J. A. (2011). Chapter 5: In search of solutions II: Efficiency improvements, in *Technofix: Why Technology Won't Save Us or the Environment*, Gabriola Island, Canada: New Society Publishers.

Jacobs, J. (1992a) *The Death and Life of Great American Cities*, Vintage.

Jacobs, J. (1992b). *Systems of Survival: A Dialogue on the Moral Foundations of Commerce and Politics*. New York: Random House.

Johnson, Greg (1997, 6 February) Irvine Telescope manufacturer Meade plans IPO, *Los Angeles Times*, D5.

Kafka, Peter (1999, 15 November) In focus. *Forbes*, 210.

Kelleher, James B. (2000, 13 March). Meade Instruments is soaring. *Orange County Register*.

Klein, N. (2011, 28 November). Capitalism vs. the Climate; What the right gets – and the left doesn't – about the revolutionary power of climate change. *The Nation*, 11–21.

Kondratieff, N. D. (1935/51) The long waves in economic life. *Review of Economic Statistics* XVII, 6–105 (1935), reprinted in *Readings in Business Cycle Theory*, Homewood, IL: Richard D Irwin (1951).

Krugman, P. R. (1991). *Geography and Trade*. MIT Press.

Lane, N. (2002). *Oxygen: The Molecule That Made the World*. Oxford: OUP.

Lapowsky, I. (2012) Why Dublin's tech scene is booming, *Inc.com*, www.inc.com/issie-lapowsky/start-up-boom-in-dublin.html, accessed 22 June 2016.

Lehdonvirta, V. (2005). Real-money trade of virtual assets: Ten different user perceptions. *Proceedings of Digital Arts and Culture (DAC 2005)* (pp. 52–58). IT University of Copenhagen, Denmark.

Lehdonvirta, V. (2009). Virtual item sales as a revenue model: Identifying attributes that drive purchase decisions. *Electronic Commerce Research* 9(1–2), 97–113.

Lehdonvirta, V. (2010). Virtual worlds don't exist: Questioning the dichotomous approach in MMO studies. *Game Studies* 10(1), 1–14.

Lehdonvirta, V. and E. Castronova (2014) *Virtual Economies: Design and Analysis*, Boston: The MIT Press.

Levy, David H. (2000). The man behind Meade. *Sky & Telescope* July, p. 80.

Lindquist, Diane (1998, 28 November). Irvine Telescope firm looks to Tijuana. *San Diego Union-Tribune*, C1.

Los Angeles Times (1987, 9 January). Missouri holding company acquires Meade Instruments, D3.

Los Angeles Times (1990, 9 October). FTC opposes telescope merger, P3.

Los Angeles Times (2000, 6 May). Meade stock will split 2-for-1, C2.

Luke, A., Freebody, P., Shun, L. and Gopinathan, S. (2005). Towards research-based innovation and reform: Singapore schooling in transition. *Asia Pacific Journal of Education* 25(1), 5–28.

Lundvall, B. A. (2009). Innovation as an interactive process: user-producer interaction to the national system of innovation: Research paper. *African Journal of Science, Technology, Innovation and Development* 1(2 & 3), 10–34.

Manning, S., Boons, F., Von Hagen, O. and Reinecke, J. (2011). National contexts matter: The co-evolution of sustainability standards in global value chains. *Ecological Economics.*

Martin Prosperity Institute (2015) The Global Creativity Index, http://martinprosperity.org/media/Global-Creativity-Index-2015.pdf, accessed 22 June 2016.

Mehrotra, V., Morck, R., Shim, J. and Wiwattanakantang, Y. (2015) *Adoptive Expectations: Rising Sons in Japanese Family Firms*, www.insead.edu/facultyresearch/areas/finance/activities/documents/AdoptiveExpectations.pdf, accessed 5 July 2016.

Montoro-Sánchez, A., Ortiz-de-Urbina-Criado, M. and Mora-Valentín, E. M. (2011). Effects of knowledge spillovers on innovation and collaboration in science and technology parks. *Journal of Knowledge Management* 15(6), 948–970.

O'Dell, J. (1996, 20 July). Workers acquire a stake in Meade. *Los Angeles Times*, D4.

Orange County Register (1997, 6 February). Telescope firm focuses on stock sale.

Orange County Register (2000, 17 March). Meade shares fall back a bit.

Patel, P. and Pavitt, K. (2000). How technological competencies help define the core (not the boundaries) of the firm, in G. Dosi, R. Nelson and S. G. Winter (eds) *The Nature and Dynamics of Organisational Capabilities* (pp. 313–333). Oxford: Oxford University Press.

Pearce, F. (2007). *When the Rivers Run Dry: Water – The Defining Crisis of the Twenty-first Century*. Beacon Press.

Pearce, F. (2013). *The Land Grabbers: The New Fight over Who Owns the Earth*. Beacon Press.

Pearce, F. (2015). *The New Wild: Why Invasive Species Will Be Nature's Salvation*. Beacon Press.

Pearce, J. M. (2012). The case for open source appropriate technology. *Environment, Development and Sustainability* 14, 425–431.

Pearson, R. J., Eisaman, M. D. et al. (2012). Energy storage via carbon-neutral fuels made from CO2, water and renewable energy (pdf). *Proceedings of the IEEE* 100 (2), 440–460. doi:10.1109/JPROC.2011.2168369. Accessed 7 September 2012. (Review.)

Phan, P. H., Siegel, D. S. and Wright, M. (2005). Science parks and incubators: Observations, synthesis and future research. *Journal of Business Venturing* 20(2), 165–182.

Porter, M. E. (2008). *Competitive Advantage: Creating and Sustaining Superior Performance*. Simon and Schuster.

Reinecke, J., Manning, S. and Von Hagen, O. (2012). The emergence of a standards market: Multiplicity of sustainability standards in the global coffee industry, *Organization Studies* 33(5–6), 791–814.

Ricardo, D. (1891). *Principles of Political Economy and Taxation*. G. Bell and Sons.

Salvador, E. (2011). Are science parks and incubators good 'brand names' for spin-offs? The case study of Turin. *The Journal of Technology Transfer* 36(2), 203–232.

Salvador, E. and Rolfo, S. (2011). Are incubators and science parks effective for research spin-offs? Evidence from Italy. *Science and Public Policy* 38(3), 170–184.

Smith, A. and Nicholson, J. S. (1887). *An Inquiry Into the Nature and Causes of the Wealth of Nations.* T. Nelson and Sons.

Stevens, Tim (2001, 15 January). Master of his universe. *Industry Week*, 76.

Stokes, D. E. (1997). *Pasteur's Quadrant: Basic Science and Technological Innovation*. Washington DC: Brookings Institution Press.

Taipei Times (2005, 5 April). Multinationals back away from Hong Kong's IT park, 17.

United Nations Environment Programme (2010). Assessing the environmental impacts of consumption and production: Priority products and materials 2010. *International Resource Panel*.

Vedovello, C. (1997). Science parks and university-industry interaction: Geographical proximity between the agents as a driving force. *Technovation* 17(9), 491–531.

Wan, D., Ong, C. H. and Lee, F. (2005). Determinants of firm innovation in Singapore. *Technovation* 25(3), 261–268.

Webb, D. (2004, 24 October). Cyberport secrets, https://webb-site.com/articles/cybersecrets.asp, accessed 22 June 2016.

Williams, F. (2000, 12 October) Dublin: Now fair and worldly. *New York Times*.

Wong, P. K., Kiese, M., Singh, A. and Wong, F. (2003). The pattern of innovation in Singapore's manufacturing sector. *Singapore Management Review* 25(1), 1.

Wong, P. K. and Singh, A. (2004). The pattern of innovation in the knowledge-intensive business services sector of Singapore. *Singapore Management Review* 26(1), 21.

Yergin, D. (2011). *The Prize: The Epic Quest for Oil, Money & Power*. Simon and Schuster.

Yu, Roger (1998, 4 May) Telescope maker seeks to expand its small universe. *Orange County Business Journal*.

Zhou, Y., Xu, L. and Manyike, R. (2013). University science parks and promoting knowledge transfer in emerging economies: A study on required attributes with evidences from South Africa and China. In *Innovation Conference (SIIC)*, 2013 Suzhou-Silicon Valley-Beijing International (pp. 159–165). IEEE.