Peet van Biljon

Innovation for Value and Mission

An Introduction to Innovation Management and Policy

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Advance Praise for *Innovation for Value and Mission: An Introduction to Innovation Management and Policy*

Innovation is essential for organizations to create sustainable success and requires the integration of many different talents and capabilities across the enterprise. This book provides a rich overview of the total landscape all innovators must address, presenting the most important tools and how they connect. It discusses the underlying principles for each, so you can determine how to implement them in your organization, and includes excellent references for additional learning. *Innovation for Value and Mission* is an excellent resource for both teachers and practitioners of innovation and would have made my own leadership in innovation much easier!

–Wayne Delker, Chief Innovation Officer (ret.), The Clorox Company

With all the environmental and social challenges facing us, we literally need innovation to save the world. To do that, we need more practitioners and policymakers who don't only know how to innovate, but also understand innovation in its wider economic and social context. *Innovation for Value and Mission* uniquely connects the world of private-sector innovation with the world of innovation policymaking. It's a rigorous but accessible introduction to innovation for university students. And it’s also a great reference that all innovation practitioners and policymakers should have on their bookshelves.

–Magnus Penker, *Wall Street Journal* & *USA Today* bestselling author; innovation and green-transformation thought leader; CEO, Innovation360

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This book is dedicated to all current and future innovators who want to use innovation to make the world a better place for everyone.

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Preface and Acknowledgments

The purpose of this book is to help you on your innovation journey, whether you are just starting out or taking it to the next stage. It is primarily aimed at postgraduate students who need an accessible, but sufficiently rigorous, introduction to the discipline of innovation within its larger economic, technological, and public-policy context. The book should also find a place on the desks of innovation practitioners who already have deep experience in some areas of the innovation discipline, but would like to expand their horizons to learn about other areas. It is intended as a reference on most innovation topics, presenting prominent methods and frameworks, while citing major sources to further consult on those topics. (I also wrote it with the intention of using it as a handy reference for my personal use!)

Most works on the management and practice of innovation do not cover innovation policy, nor its wider economic context. Most works on innovation policy do not cover how entrepreneurs actually create and innovate, or how innovation is managed at the organization level. I believe that those who desire to make innovation policy need to understand how firms innovate, and that private-sector innovators should be more aware of the potential of their innovations to solve big economic and societal challenges. System-wide transformations, such as we need for sustainability, can hardly be brought about by a single firm. I therefore wrote this book to bridge the gap between the worlds of policy and practice. And at the topic level, the goal is to reveal the interconnections between multiple topic areas, just like any innovation itself is an interconnection of many elements.

Three important threads are pursued and come up repeatedly. These are value, mission, and uncertainty. Innovation should always have a purpose, which is to create *value* – for customers, the organization, and society at large – and, for the public sector, to fulfill a *mission*. However, what makes innovation especially challenging is that it is done under a high degree of *uncertainty*, which necessitates different managing methods and financing models than any other endeavor.

The book starts at a high level with an introduction to innovation, how technological progress works, and how innovation drives economic growth, which together form an essential foundation for the discussion of innovation policy in the latter part of the book. In the middle, the discussion dives deeper into how innovation is conducted in organizations and teams, and how it is managed at different levels. Special attention is given to open innovation, business model innovation, and Lean Startup techniques. Where applicable, references are made to innovation within the context of public-sector organizations.

The private financing of innovation, with a focus on venture capital, is introduced, followed by a discussion of the public financing of innovation. At this point, the discussion ascends again to a higher level, with an introduction to innovation at the national level. The book concludes with an introduction to innovation policy

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tools, a description of major policy inflections over the years, and recent appeals for major directional changes to innovation policy.

No chapter is the last word on any innovation topic. For each topic, I have attempted to provide an entry point to innovation at the firm level and the national level respectfully, as well as to help start or accelerate the reader's innovation journey. For this purpose, the reader is introduced to the relevant terminology, models, and frameworks on innovation management and policy. Once you know what something is called, and where it fits in, it is fairly easy to do further research on your own.

In my experience there is a big divide between the academic treatment of innovation and the popular business writings on innovation. In this work, I have attempted to make the academic writings on innovation – particularly on technology, economic growth, and national innovation and policy – more accessible to practitioners, while at the same time explaining the practice and management of innovation in fairly rigorous terms to students. I have been mindful of the risk that straddling these two worlds might make this book too academic for practitioners and perhaps not academic enough for professors, but this is a risk that I was willing to take for the greater benefit of connecting these two worlds.

The book focuses mostly on the United States, for two main reasons: First, it is necessary to focus and limit the scope. In covering such a breadth of topics, it is not feasible to provide international comparisons as well though several other countries have admirable innovation policies that the United States might learn from. Second is the sheer magnitude of U.S. investment in R&D and innovation over the post-World War II decades, which has been highly consequential and contributed most of the critical technologies that are powering our current era of industrial development.

While I provided brief examples where relevant, I have avoided so-called best-practices cases, even though I am well aware of their popularity. The promise of following others' practices is that we will also enjoy their performance, but that is seldom true. Case studies of how actual companies or agencies perform innovation are highly perishable, as organizations constantly change how they do things and previously successful organizations stumble, invalidating much-vaunted cases.[i] There is also the *halo effect*, a cognitive bias which makes us want to copy everything an admirable organization does, even though those practices may have had nothing to do with its success. Therefore, students and practitioners interested in the latest and greatest examples of how successful organizations perform some aspects of innovation are better off sourcing such cases themselves. (This is best done as and when needed – at least the cases will be fresh then.) The business media is a

i An excellent analysis by McKinsey, "What happened to the world's 'greatest' companies?" (Bradley 2017), of how companies profiled in three best-selling business books fared over the longer run proves this point.

never-ending source of such content, as well as business subscription services specializing in how-to innovation resources and templates.

It is my conviction that the best solution for any given organization and situation is always devised by considering the full context of that organization, its problems and goals, and then applying the innovation principles and best available expertise to the particular innovation challenge to come up with a tailored solution. I have accordingly set out to equip readers by introducing concepts and terms, providing frameworks, and including references on each innovation topic covered. Citations are used throughout the text. None of these is the last word on any of these subjects but should be seen as an entry point instead. Therefore, each chapter provides a pathway for those who want to dive deeper, by listing important references and data sources as applicable. Ample cross-references between chapters are provided, as many topics are interlinked.

The reader does not need to read the book from start to finish but should feel free to move around between subjects. Indeed, one of the hardest parts of writing this book was to determine the order in which to introduce subjects and concepts. With innovation, so many elements are interrelated that it is a great challenge to present them in a linear order. For the most part, each chapter is written as an essay that can mostly stand on its own. An overview of book chapters provided below will help the reader navigate the book.

All the processes, techniques, and frameworks presented here are suitable for direct application to sustainability-oriented innovations, which goals are identified in terms of environmental value, or the completion of a particular sustainability mission. It is indeed important that we channel our innovation abilities to meet the major sustainability challenges of our time. This book was initially going to have one chapter dedicated to sustainability-oriented innovation, but it soon became three, and kept on growing. Eventually, the publisher and I agreed that given the importance and scope of the topic, sustainability-oriented innovation was best kept aside for a later work that could be fully dedicated to it. I am doing ongoing research and advisory work in this new but fast-expanding field, and will have more to contribute on the sustainability challenge when the time is right.

In closing, I firmly believe that one can only ever be a student of innovation, and never a master of this discipline that is too complex and everchanging to ever comprehend fully. We all need to stay curious and keep learning. I am happy to help others on their journey of learning and discovery, even as I continue my own. Teaching innovation at the McCourt School of Public Policy at Georgetown University for the last few years has been a great experience. I would like to thank all my graduate students for the enriching conversations we have had in class, and everything I have learned from them about public-sector innovation all over the world.

I owe much to my fellow innovation travelers and would like to acknowledge all of them here. In particular, I would like to thank my former colleagues at McKinsey for the many learning experiences while serving clients on innovation challenges

and growing the innovation practice there. In particular, I would like to extend my appreciation to Marc de Jong, my mentor in the practice. I learned much about public-sector innovation from Billy Mae and benefited from his experience of how government bureaucracies operate. I would also like to acknowledge a few of my current fellow practitioners: Navin Kunde for sharing his extensive experience with open innovation; Magnus Penker for his inspiring ideas on the transformative power of innovation; George Hemingway for his thoughts on innovation management and strategy; and Geoff Orazem for his insight on the difference in risk tolerance between the private and public sectors. Last, but not least, I am indebted to Mårten Leijon for taking the time to read draft chapters and providing very thoughtful feedback. Of course, any errors of omission or commission in the book are mine alone.

Dear reader, I wish you well on your innovation journey and hope this book will help you see the world in a new way. Bon voyage!

Foreword

I am blessed to have served our great country for 34 years as a naval aviator and to have retired at the rank of Vice Admiral. After graduating from the Naval Academy, I served as an operational strike fighter pilot, a test pilot, a program manager, an engineer, and I commanded four different organizations. My ultimate assignment was as the commander of the Naval Air Systems Command (NAVAIR) where we designed, developed, verified, validated and sustained all things Naval Aviation. While it may sound strange that NAVAIR's $40b annual budget is inadequate to buy all of the capability necessary to protect our national interests, it is true. The key to past and continued success of the US Navy is how well we innovate within the confines of constrained resources and ever-changing threats. I was told by many of my mentors that my success in the Navy was founded in my ability to innovate.

Sadly, the bureaucratic inertia within the U.S. Government and DOD impedes the pace of innovation. When I retired, it was clear that commercial technology development and innovation was outpacing DOD technology development and innovation in many areas. I have dedicated my post-Navy career to finding commercial or hybrid commercial/defense technologies that can be rapidly inserted into the DOD system to speed up the assimilation of state-of-the-art technology. Using commercially developed technology as a fuel to reinvigorate DOD innovation is a clear priority for DOD, as is helping commercial companies navigate the bureaucracy, which by itself requires some innovation. I currently sit on multiple boards and am involved on the ground level or as a co-founder of multiple startups focused on technology and innovation.

In my quest since 2015 to insert innovation into DOD I have run across many incredibly accomplished entrepreneurs and innovators. One of them asked me if I'd be interested in reading a new book on innovation and providing the author feedback on his efforts. Thus my introduction to Peet van Biljon and his book, *Innovation for Value and Mission*. Having read literally hundreds of titles over my life as an executive, I have become quite skeptical of the regurgitated processes, procedures, buzz words, techniques and gimmicks of many improvement books. I was quite pleasantly surprised when I read through Peet's work and found that he was not prescribing a cookbook approach to innovation. On the contrary, he systematically and articulately describes the history of innovation, its successes, failures, implementation techniques, public policy implications, private business implementation and management techniques. Instead of being prescriptive, he describes the toolset along with the pros and cons of those tools so the innovator has a clearer perspective.

My perspective on innovation has evolved over the years and is founded in decades of success and failures. While there are fundamental tenets to successful innovation, every single case is unique and there is never a checklist for innovation. If painting by the numbers created masterpieces, we could all be world-renowned

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artists. In my experience, the fundamentals of innovation require the following characteristics:

- Innovation must elate the customer and create mission success with a viable business strategy and technical competence. The three-legged stool of mission, business, and technology must balance.
- Customers rarely have a vision of innovation but know it when they get there. To that end, closing the loop, failing rapidly, iterating quickly and having the end user closely connected to the process is essential to success.
- For every innovator, there are 10 status-quo advocates who resist the change. Innovators have to be perseverant and managers of innovators need to walk the line between disciplined process and unstructured iteration, while protecting innovators. Unconstrained, innovators can diverge. Too much discipline, and they fail to succeed.
- Bureaucracy is the opposite of innovation. Leaders must create enclaves and protect innovation within bureaucracy.

As I read through Peet's book, I realized he was providing a map to success. His vision resonates precisely with my vision and, in fact, advanced my thinking significantly. His innovation is creating a map and guide for anyone with the curiosity and drive to innovate. From a parent looking to make diaper changing easier to a startup tech CEO in Silicon Valley trying to change the world, this book provides a frame of reference that can be uniquely applied to any situation. In a world where 9 out of 10 individuals hate change, the status quo is viewed as the easiest way, bureaucracies resist change and unconscious bias thwarts good ideas, the innovator needs all the tools and information he or she can find. *Innovation for Mission and Value* is a fantastic reference for those who can always see a better way. Thank you, Peet.

David A. Dunaway
VADM (ret.), USN

Overview of the Book Chapters

Chapter 1 introduces the discipline of innovation and traces its development over recent decades. The special nature of innovation at the intersection of other disciplines is explained. Introductory comments are made on the broader context of innovation with its contribution to economic growth and public welfare, and the respective roles played by the public and private sectors.

Chapters 2 and 3 provide the societal and national context of technological and economic progress, by introducing key innovation and economic concepts. These form a foundation for understanding the objectives and major choices of innovation policy that will follow later in the book:

- Chapter 2 explains the process of technological innovation and how diffusion leads to productivity growth. Key economic concepts needed to understand the linkages between technological innovation, productivity, and economic growth are introduced. The idea of long technological cycles is discussed, with specific reference to industrial revolutions.
- Chapter 3 introduces economic growth theory and explains the main theories that link innovation to economic growth. It aims to provide an understanding of how different schools of thought on economic growth have developed and how each school informs innovation policy choices.

Chapters 4 through 6 explain how innovation is conducted within and beyond organizational borders, along with the typical challenges that need to be met. Specific attention is given to three major extensions of the innovation discipline: open innovation, business model innovation, and the Lean Startup:

- Chapter 4 explains how human creativity works, where insights come from, and how people can best organize to be productive at innovation. Some popular innovation and creativity techniques, as well as the design-thinking approach, are introduced. Common organizational challenges to innovation are discussed, including the constant tension between efficiency and innovation.
- Chapter 5 covers open innovation, in recognition of the reality that no modern organization can effectively innovate entirely within its own boundaries. Different models for open innovation and design considerations are reviewed, as well as open innovation in government.
- Chapter 6 introduces two innovation game changers from the last two decades: business model innovation and its public-sector version, mission-model innovation; as well as the Lean Startup method for innovating under conditions of high uncertainty.

Chapters 7 and 8 are dedicated to the management of innovation, and how it is managed and steered at various levels within an organization. Some important areas of

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innovation management are selected for more in-depth discussion and an explanation of relevant complexities and tradeoffs:

- Chapter 7 offers brief perspectives on key areas of innovation management such as strategic fit, governance, stages, metrics, and the Innovation Management System. The *Innovation Management Map*, which shows how the different layers of innovation management and strategy fit together, is introduced. Particular challenges of managing innovation in government are discussed.
- Chapter 8 continues the discussion of innovation management with an introduction to innovation portfolio management, project selection, and innovation project management. The popular Stage-Gate® model and the major U.S. Department of Defense acquisition phases are introduced.

Chapters 9 and 10 review the roles of the private and public sectors in financing technological progress and innovation and how government agencies and private financiers such as venture capitalists play various roles in funding startups at different stages:

- Chapter 9 begins by explaining the path of scientific progress and how waste and uncertainty are constant companions of the innovation process. The main startup financing stages and the roles played by venture capitalists and other private financiers are explained.
- Chapter 10 explains the linear and alternate models of innovation relevant to the public support of innovation. It contains a brief history of U.S. public support for R&D and innovation in the decades after World War II and outlines current U.S. government investment in R&D, as well as support programs for small business and startup innovation.

Chapters 11 and 12 introduce innovation policy at the national level, starting with the roles played by the main private, public, and academic actors, and culminating with an overview of the public-policy toolkit and the current debates around innovation policy:

- Chapter 11 explains the National Innovation System and related concepts such as the Triple Helix Model, which illustrate the mutually reinforcing roles of the public sector, the private sector, and academia in innovation.
- Chapter 12 introduces major innovation policy tools and instruments, and explains the rationales for government support of technological innovation at particular stages. Recent appeals for more robust innovation policies and calls for mission-oriented policies are reviewed.

Using the Book in a Course

The whole book is intended to support a full two-semester course on *Innovation & Public Policy* with about two weeks spent on the average chapter and the remaining weeks used for group projects, seminars, paper presentations, and so on. When used for a single 14-week semester course, the scope needs to be limited to selections from each, or most, of the 12 chapters with the remaining weeks used as above.

Alternatively, selected chapters (see below) can support semester or block courses more limited in scope, such as *Innovation Management*, *Innovation Policy*, and *Innovation for Industry 4.0*:

Chapter	Innovation Management	Innovation Policy	Innovation for Industry 4.0	Innovation & Public Policy
1. Chapter 1 An Introduction to Innovation	✓	✓	✓	✓
2. Chapter 2 Technological Progress and Industrial Revolutions		✓	✓	✓
3. Chapter 3 Economic Growth and Innovation		✓		✓
0. Chapter 4 People, Creativity, and Organization	✓		✓	✓
5. Chapter 5 Open Innovation and External Collaboration	✓		✓	✓
6. Chapter 6 Game Changers: Business Model Innovation and the Lean Startup	✓		✓	✓
7. Chapter 7 Perspectives on Innovation Management	✓		✓	✓
8. Chapter 8 Portfolio and Project Management	✓			✓
9. Chapter 9 Private Financing of Innovation	✓	✓		✓

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(continued)

Chapter	Innovation Management	Innovation Policy	Innovation for Industry 4.0	Innovation & Public Policy
10. Chapter 10 Public Financing of R&D and Innovation		✓		✓
11. Chapter 11 National Innovation		✓		✓
12. Chapter 12 Innovation Policy Tools and Challenges		✓		✓

Each chapter is concluded by a *Chapter Summary*, *Suggested Exercises and Assignments* (individual and class), and *Recommended for Further Reading* (a short list of important publications for those who want to know more). Where applicable, chapters also contain references to *Recommended Data Sources*.

Further suggestions for course outlines, my current course syllabus, lecture slides, notes, videoclips, and other up-to-date resources can be found on my website: ethicsdriveninnovation.com

Abbreviations and Acronyms

4G	fourth generation broadband mobile
4IR	Fourth Industrial Revolution
5G	fifth generation broadband mobile
ABS	automatic braking system
ACD&P	Advanced Component Development and Prototypes
AI	artificial intelligence
AMA	American Marketing Organization
AMP	Advanced Manufacturing Partnership
ARPA	Advanced Research Project Agency
ARPANET	Advanced Research Projects Agency Network
ATD	Advanced Technology Development
B2B	business-to-business
B2C	business-to-consumer
BAC	budget at completion
BDA	Bayh-Dole Act
BERD	business expenditure on R&D
BM	business model
BMI	business model innovation
BOK	body of knowledge
BU	business unit
CAPM	Capital Asset Pricing Model
CDR	Critical Design Review
CMS	Centers for Medicare & Medicaid Services
CEN	European Committee for Standardization
CEO	chief executive officer
CPG	consumer packaged goods
CPM	critical path method
CRM	customer relationship management
CVC	corporate venture capital
DARPA	Defense Advanced Research Projects Agency
DART	dialogue, access, risk assessment and transparency
DMV	Department of Motor Vehicles
DNA	deoxyribonucleic acid
DOD	Department of Defense
DOE	Department of Energy
DOJ	Department of Justice
DPM	Dynamic Progress Method
DSIP	distribution-sensitive innovation policy
EC	European Commission
EEG	electroencephalography
EFI	equitable growth, finance, and institutions
ES	early finish
ESG	Environmental, Social, and Governance
EU	European Union
EU27	current 27 member countries of the EU
EV	electric vehicle
FFRDC	Federally Funded Research and Development Centers

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FPSP	Flagship Project Support Program
FRED	Federal Reserve Economic Data
FTE	full-time equivalent
FY	financial year
GAO	Government Accountability Office
GDP	gross domestic product
GERD	gross domestic expenditure on R&D
GHG	greenhouse gas
GNI	gross national income
GPS	Global Positioning System
GPT	general-purpose technologies
GS	General Schedule
GSA	General Services Administration
GUI	graphical user interface
H1	Horizon 1 (i.e., the first growth horizon)
H2	Horizon 2 (i.e., the second growth horizon)
H3	Horizon 3 (i.e., the third growth horizon)
HC	healthcare
HHS	Health and Human Services
HR	human resources
HSARPA	Homeland Security Advanced Research Projects Agency
IACS	Institute for Applied Cancer Science
IARPA	Intelligence Advanced Research Projects Agency
ICT	internet, computer, and telecommunications
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IMF	International Monetary Fund
IMS	innovation management system
IP	intellectual property
IPM	innovation portfolio management
IPO	initial public offering
IPPM	innovation project portfolio management
IRR	internal rate of return
ISO	International Organization for Standardization
IT	information technology
ITIF	Information Technology & Innovation Foundation
JCESR	Joint Center for Energy Storage Research
JIT	just in time
JTBD	jobs to be done
JV	joint venture
KPI	key performance indicator
LF	late finish
LS	late start
MEP	Manufacturing Extension Partnership
MFP	multifactor productivity
MIT	Massachusetts Institute of Technology
MITI	Ministry of International Trade and Industry (Japan)
MOU	Memorandum of Understanding
MRI	magnetic resonance imaging

MS	Microsoft
MVP	Minimum Viable Product
NA	not applicable
NASA	National Aeronautics and Space Administration
NBER	National Bureau of Economic Research
NGO	nongovernmental organization
NGT	New Growth Theory
NIH	National Institutes of Health
NIS	National Innovation System
NNMI	National Network for Manufacturing Innovation
NPD	new product development
NPDP	New Product Development Professional
NPM	New Public Management
NPO	Nonprofit Organization
NPV	net present value
NSF	National Science Foundation
NSI	National System of Innovation
NVCA	National Venture Capital Association
ODI	outcome-driven innovation
OEC	Observatory of Economic Complexity
OECD	Organisation for Economic Cooperation and Development
OGD	open government data
OI	open innovation
OMB	Office of Management and Budget
OPSI	Observatory of Public Sector Innovation
OSRD	Office of Scientific Research and Development
OSTP	Office of Science and Technology Policy
PARC	Palo Alto Research Center (Xerox)
PC	personal computer
PDK	process design kit
PDMA	Product Development and Management Association
PE	private equity
PERT	Program Evaluation and Review Technique
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
PMP	Project Management Professional
PPE	personal protective equipment
PPM	project portfolio management
PSI	public-sector innovation
PV	planned value
QFD	Quality Function Deployment
R&D	research and development
RBC	real business cycle
RCT	randomized-control trial
RFP	request for proposal
ROA	return on assets
ROI	return on investment
RP	Research Policy (journal)
SBIR	Small Business Innovation Research

SBM	sustainable business models
SCAMPER	substitute, combine, adapt, modify, put to another use, eliminate and reverse
SDG	Sustainable Development Goals (UN)
SDR	System Design Review
SOP	standard operating procedure
SOW	statement of work
SPAC	Special Purpose Acquisition Vehicle
SPIS	Science Policy and Innovation Studies
SRR	System Requirements Review
STEM	science, technology, engineering, and mathematics
STI	science, technology, and innovation
STIP	science, technology, and innovation policy
STTR	Small Business Technology Transfer
SUV	sports utility vehicle
SWF	sovereign wealth fund
TFP	total factor productivity
THA	Triple Helix Association
TIP	technology and innovation policy
TMT	technology, media, and telecom
TPS	Toyota Production System
UK	United Kingdom
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNIDO	United Nations Industrial Development Organization
US	United Sates
USDA	United States Department of Agriculture
USPTO	United States Patent and Trademark Office
UTT	University Technology Transfer
VC	venture capitalist
VOC	Voice of the Customer
VP	vice president
WBS	work breakdown structure
WEF	World Economic Forum
WIPO	World Intellectual Property Organization
WWII	World War II

Chapter 1
An Introduction to Innovation

This chapter is written in the form of an essay on innovation – what it is and how the discipline has developed, especially over the last few decades. The reader is also introduced to the main innovation topics to be expounded in later chapters, with references to the respective chapters.

The chapter starts with the development of a practical definition of innovation and proceeds with an overview of the different types and categories of innovation found in organizations, both private and public. Schumpeter's famous insight that innovation is the engine of creative destruction will be explained. The evolution of innovation as a concept in management thinking during modern times will be related. The public sector's interest and role in innovation and the interplay between the private and public sectors needed to commercialize innovations based on technological advances will be introduced.

In Search of a Definition

There has been a remarkable rise in interest in innovation over the last two decades, not only in the popular and business media but also in academic publications. The year 2021 alone saw over 33,000 new publications on the topic. At the time of writing, the Web of Science™ lists almost 300,000 publications with innovation as a topic, with over one third of those in the fields of business, management, or economics.[1] Figure 1.1 illustrates the rapid increase in innovation-related academic publications over the last decade, which can be seen as a proxy for rising interest in innovation.

For a word that is used almost too freely, it is remarkably hard to find a good practical definition of "innovation." Merriam-Webster's online dictionary defines innovation as "a new idea, method, or device" or "the introduction of something new."[3] The Cambridge online dictionary similarly defines it as "a new idea or method, or the use of new ideas and methods."[4] However, experienced practitioners know that innovation is about much more than having a new idea. Turning ideas – no matter how good – into successful innovations is exceptionally hard and requires a proper process and execution discipline as well as a supportive ecosystem around it. (Some best-practice processes for how to turn ideas into true innovations will be explained in Chapter 4.)

If we move on from the linguistic definition and look for more rigor in a proper economic definition of innovation, we are initially disappointed. In introductory economics courses, innovation does not usually feature as a major topic or as a driver of economic behavior. This may seem strange, but neoclassical microeconomic theory

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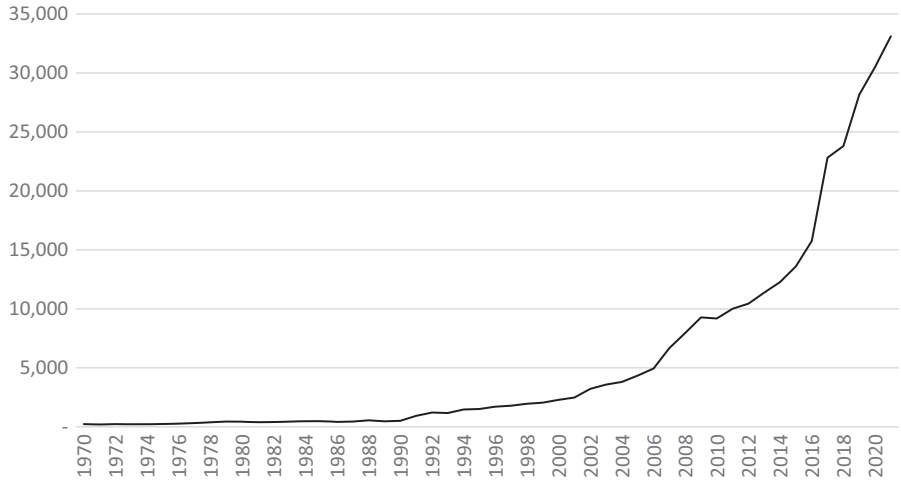

Figure 1.1: Number of Publications per Year (1970–2021) with "Innovation" as a Topic. Source: Clarivate™ Web of Science™ data (2022).[2]

only deals with innovation in passing in the context of a technological change that shifts or modifies the production function (which is explained in Chapter 3), or as a way to explain why products may be differentiated.

Products that are not differentiated at all, are called *commodities*. When commodities or products closely resembling commodities are traded, well-functioning markets will determine the price and quantity sold according to supply and demand in a textbook-like fashion. An ounce of pure gold is the same as another ounce of gold, a barrel of oil is the same as another barrel of oil (with some subtle differences between regional oil markets), and a bushel of wheat is the same as another bushel of wheat. Every time another supplier enters the market, the price is competed down until eventually no economic profits remain to be made. On the opposite end, truly unique products for which there are no easy substitutes are sold to customers by *monopolies*, enabling monopoly profits. According to economic theory, a monopolist supplier can set either the price or the quantity to sell of a product, but not both. In between these two extremes we find *monopolistic competition*, where products are differentiated to some extent but still fairly close substitutes for one another. Most consumer products fall into this intermediate classification. Products with more differentiation – either in terms of real features or perceived superiority – command higher prices.

Firms often pursue innovation because it helps them to differentiate their products from those of their competitors. A breakfast cereal that is crunchier than others, a tasty chocolate bar that has lower calories, or a toothpaste that leaves teeth whiter are all examples of consumer products that can command higher prices and sell more units than their closest competitors' products, at least for a while.

(A price increase of 1 percentage point will generally increase net profits more than a unit sales increase of 1 percentage point.) The same principle applies to higher-priced, more complex products such as automobiles or computer servers. Innovation can be used to add distinct or superior features that differentiate one offering from the other, thereby giving the seller some pricing power and thus excess profits in economic terms. However, competitors will keep imitating any successful innovations in search of profits, making commoditization an ever-present threat.

The only way to make higher profits on commodities is to be a low-cost producer, which is what natural-resource companies that extract commodities have to do. The same is true for most agricultural products. Selling a commodity greatly limits your opportunity to make a profit. Former IBM CEO Sam Palmisano reportedly summed this hard truth up by saying, "Either you innovate or you're in commodity hell. If you do what everybody else does, you have a low-margin business. That's not where we want to be."[5]

However, it should be pointed out that process innovation is applicable to such a situation: Commodity producers such as mining companies or paper mills innovate to lower their process costs, thereby increasing their profits. Furthermore, raw-material commodities can also be transformed into rudimentary products that add value, which customers will be willing to pay a premium for. For example, the mining company Vale converts iron-ore dust into iron pellets, which offer higher efficiency and other processing benefits to steel manufacturers.[6]

Innovation as the Engine of Creative Destruction

Though innovation can indeed increase product differentiation, and yield the price benefits that accompany it, that is too narrow a view for a full definition. It does not offer us a comprehensive explanation of the role that innovation plays in the economy, and it is only one piece of the puzzle.

We have the early 20th century economist Joseph Schumpeter to thank for our understanding of how innovation works in a modern market economy. Austrian by birth, Schumpeter was a colorful character who was briefly the Austrian finance minister in his thirties before going on to make a fortune in banking, which he then lost in the 1929 stock market crash. Penniless, Schumpeter had to use his fame to give paid speeches so that he could afford the transatlantic ship fare to the United States, where he became a professor at Harvard. Schumpeter is perhaps most famous for his coining of the phrase "creative destruction" to describe how in a capitalist system new products and methods displace existing ones. For example, automobiles replaced horse-drawn carriages and streaming video replaced discs. The idea that nothing is ever stable is at the core of Schumpeter's economic philosophy and his understanding of how capitalism works. Schumpeter believed that everything revolves around entrepreneurs, who are the primary agents of innovation

and creative destruction. As such, Schumpeter's explanation of what innovation is and how it works is an important element of his larger explanation of how the capitalist economic system works.

Schumpeter (1943) defined innovation as follows: "Innovation is creative destruction, where entrepreneurs combine existing elements in new ways." He notably defined innovation as the second of three stages in the creative-destruction process: Innovation is preceded by *invention* and followed by *diffusion*.[7]

Schumpeter's distinction between invention and innovation is an insightful and helpful one, which shall be adhered to throughout this book. Invention is the creation of a new technology or new way of doing things. The transistor was a major invention of the last century, but it was not an innovation. Innovation happens when entrepreneurs combine existing elements (including recent and past inventions) to create new products or services for customers. For example, Sony became the first company to commercially exploit the newly available transistor with a mass-market offering, using transistors to make small, affordable radios that filled a real consumer need in post-World War II Japan.

To the innovator goes the spoils, rather than to the inventor: The transistor was invented by scientists at Bell Labs. But while the inventors received the Nobel Prize for this technological breakthrough, it was not they or their employer who created the first blockbuster product that utilized this invention but a previously unknown Japanese company, Sony. Similarly, Kodak can take major credit for the invention of digital-camera technology, but the company failed to turn that new technology into a major innovation, leaving Kodak horribly exposed to other companies who went on to do so. The distinction between invention and innovation helps us to understand many other such puzzling instances where the originator of a breakthrough technology is not the person or organization to profit from it. Profit goes to whomever can create value in the eyes and hands of the paying customer.

The diffusion stage arrives when an innovation has become so ubiquitous that it is no longer the source of any competitive advantage. For example, when it first became available in luxury production cars in the 1980s, ABS (automatic braking system) was a major differentiator for manufacturers, such as BMW, who pioneered it. Nowadays, ABS is standard equipment in all production cars in Europe and North America. More recently, the rearview backup camera made its first appearance in higher-end SUVs, but now it is standard equipment in all such vehicles. Once everyone has copied an innovation, prices decline, and it essentially becomes a commodity. That is why companies have to keep innovating, otherwise they will be overtaken and replaced by entrepreneurs who do. Such is the nature of creative destruction. The government, on the other hand, has a keen interest in seeing beneficial technologies rapidly reach the diffusion stage, where they permeate the economy and their widespread use lifts national productivity. (The process of diffusion is discussed in detail in Chapter 2.)

To escape the relentless discipline of free-market creative destruction, incumbents often petition governments to erect regulatory barriers to keep new competitors out. Thus, the regulatory and legal environment may become an impediment to innovation. Politicians and government agencies have to be vigilant against such *regulatory capture*[ii] by powerful incumbents.

While Schumpeter's explanation of innovation as a force in the capitalist economy is insightful, it does not necessarily help us to understand innovation in all contexts. Non-capitalist countries have produced highly innovative products, too. For example, the AK-47 assault rifle developed in the Soviet Union by Mikael Kalashnikov, and introduced shortly after World War II, gained worldwide popularity (particularly among irregular forces) due to its ease of operation and maintenance and its well-known reliability in the harshest conditions. The AK-47's lack of accuracy was not a drawback in many of the situations it was used, such as in jungle warfare. (The AK-47 was not an invention, because it was based on firearm technology that already existed at the time, demonstrated in a German assault rifle that came into the possession of the Soviets at the end of the war and inspired Kalashnikov.)

This example gives us another important clue as to the true nature of any successful innovation regardless of the economic system in which it is developed: It meets the needs of its user – in this case, affordability and simplicity – and it solves an important and valuable problem for the user – in this case, ease of use and ruggedness. Such user-centric principles are as applicable to the public sector as to the private sector. (How organizations can innovate according to these principles is explained in Chapter 4.)

Definition and Types of Innovation

Peter Drucker, a pioneer of business management thinking who is perhaps not as widely read by today's generation of managers as he should be, further developed our understanding of innovation and entrepreneurship in an eponymous book[8] published in the early 1980s. Drucker (1983) clearly expressed his view of how innovation adds value to society in the hands of entrepreneurs (note the clear alignment with Schumpeter in the first two sentences):

> Entrepreneurs innovate. Innovation is the specific instrument of entrepreneurship. It is the act that endows resources with a new capacity to create wealth. Innovation, indeed, creates a resource. There is no such thing as a 'resource' until man finds a use for something in nature and thus endows it with economic value. Until then every plant is a weed and every mineral is

ii When politicians or regulatory agencies fall under the influence of the industries or companies they are assigned to regulate.

> just another rock . . . Equally whatever changes the wealth-producing potential of already existing resources constitutes innovation.[9] (Drucker 1983, 30–31)

Thus, Drucker (1983) argued for "purposeful" innovation, which means finding a *use* for something that already exists at its core. He also defined what he called *systematic innovation* – emphasizing that innovation is an ongoing organizational practice, not just a single lucky instance – as follows:

> Systematic innovation . . . consists in the purposeful and organized search for changes, and in the systematic analysis of the opportunities such changes might offer for economic or social innovation.[10] (Drucker 1983, 35)

Drucker made the observation that most successful innovations exploit changes that have already occurred, which implies that there is a diagnostic component to innovation as entrepreneurs have to recognize and analyze the relevant changes. Drucker's book, *Innovation and Entrepreneurship* (1983), is organized to discuss the seven major source areas of the changes he identified:

1. The unexpected – success, failure, or outside event
2. The incongruity – between reality as it really is, and as it is assumed that it ought to be
3. Innovation based on process need
4. Changes in industry or market structure that catch everyone unaware
5. Demographics – changes in population
6. Changes in perception, mood, and meaning
7. New knowledge – both scientific and nonscientific[11]

(Drucker 1983, 35)

Like Joseph Schumpeter, Peter Drucker (1909–2005) was born in Austria where he came into direct contact with the ideas of famous free-market philosophers such as Schumpeter, Friedrich von Hayek, and Ludwig von Mises. Schumpeter was a friend of Drucker's father, and Schumpeter's ideas on innovation and entrepreneurship strongly influenced the young Peter Drucker. Like Schumpeter, Drucker emigrated before the Second World War and became a U.S. citizen during the war years. He taught business management at New York University for decades. He later moved to the West Coast and founded a graduate management school (since named in his honor) at Claremont University, where he continued teaching into his nineties. Drucker is widely regarded as the most influential business thinker of the late 20th century and was rightly called the "dean of this country's business and management philosophers" by the *Wall Street Journal*.

As exemplified by the writings of Drucker, who was often at least one step ahead of his contemporaries, by the 1980s innovation had become recognized as a true management discipline, inextricably intertwined with the practice of entrepreneurialism. Drucker emphasized that innovation must be anchored by insights into exploitable *changes*, which requires exploration and analytical rigor on the part of the innovator.

By the early 21st century, an additional aspect of innovation gained prominence, namely *creativity*. Books on creativity and *design thinking* had first started to appear in the 1950s and 1960s, and *human-centered design*, which emphasized

developing engineering solutions from a human perspective, emerged as a new discipline in the 1980s. The 1990s set the stage for an explosion of interest in design thinking. IDEO, perhaps still the world's most well-known design firm, was founded in Palo Alto, California in 1991 when Stanford University professor David Kelley and two British-born designers Bill Moggridge and Mike Nuttall combined their three design companies. David's brother, Tom Kelley, was also active in the firm and helped to manage it for many years.

The design approach that was first developed for consumer products eventually got extended to services. By the early 2000s, several business books on design thinking were evangelizing this approach to innovation. Design thinking is fully expounded in Tom Kelley's book, *The Art of Innovation*.[12] In the book, Kelley (2001) describes innovation, but does not formally define it. However, the innovation process followed by IDEO is explained in detail: It starts with observing the customer trying to do a task or a job, followed by brainstorming on how to help the customer do that better, and creating rapid prototypes of the new product to get feedback from the customer. It is in essence a creative process directly informed by the needs of the customer and frequently subjected to field testing. It also borrows from the scientific-inquiry process by setting up hypotheses in the form of tangible prototypes that are quickly tested, improved, and tested again. This design process shall be covered in more detail in the Chapter 4, but for now it is sufficient to summarize it as both creative and rigorous.

In synthesis of the aforementioned concepts, I offer a broad, practical definition of innovation, which is compatible with Schumpeterian innovation but also accommodates innovation from different sources and for different purposes:

Innovation is a creative and analytically rigorous process for organizations to solve valuable problems for their customers and for themselves.

1. The first part of the definition recognizes the *right-brain-left-brain nature* of the innovation process, because this duality is what makes a true innovation more than the sum of its constituent parts. Do only the analytical part without the creativity and you are back in the pure domains of science, engineering, or business analysis. Do only the creative part without the analytics, and you are in the realm of the arts, without any necessary anchoring in facts or the scientific method. True innovation is thus both an art and a science.
2. The second part of the definition focuses on solving valuable problems, thereby *creating value* for both the customer and the innovator and, most likely, also for society at large. An innovation that does not create value is a curiosity or a mild amusement at most. The problem may be one of creating a better product or service, improving efficiency, lowering costs, or anything else worth solving.
3. The third and last part of the definition puts the focus on *whom* the innovation is supposed to serve. Innovation must always have an *end customer,* whether it is an external customer or an internal customer. Without a customer who benefits, innovation is a self-serving exercise that cannot create value.

Innovation can be applied to virtually any area of human endeavor and is not restricted to things (products). Schumpeter (1943) too pointed this out when he mentioned *methods*. In fact, Schumpeter included all the following manifestations (types) of innovation in his articulation of innovation:[13]

1. Introduction of a new product or service
2. Introduction of a new method of production
3. Development of a new market
4. Exploitation of a new source of supply
5. Reorganization of the methods of operation

To Schumpeter's original list can be added some other modern categories of innovation, which typically are multifaceted or involve a combination of Schumpeter's original categories:

6. Process innovation, in operational areas other than production (similar to 2)
7. Efficiency or cost-saving innovation (related to 2 and 5)
8. Business model innovation (entailing any or most of the above)

Once we understand what innovation is and in what areas it may be applied, we also can recognize that not all innovations are of equal magnitude or equally novel. Some innovations represent major changes to the status quo but others are only minor. There are different degrees of innovation based on the scope of the innovation and the extent to which the innovation results in something a little different or completely new compared to the current situation:

- *Incremental innovation* entails small improvements or variations to existing products, services, or processes
- *Radical innovation* or *breakthrough innovation* entails significant departures from current offerings or processes
- *Next-generation innovation* is an additional term used by some to describe a midway point on a continuum between incremental and radical – going further than incremental innovation and taking the evolution of the offering to the next level, without necessarily changing the nature of it totally, as is the case with radical innovation

An important perspective of how innovation plays out over different time intervals is gained by dividing the future timeline into *three horizons*. Originally proposed by consultants at McKinsey & Company as a growth framework (Coley 2009),[14] the three-horizon approach can be applied to all types of innovation, not only those associated with revenue growth such as new product introductions.

- *Horizon 1 (H1)* represents the core of the business that is most identifiable with the company's identity and which provides the greatest current profits and cash flow.

- *Horizon 2 (H2)* encompasses emerging opportunities likely to generate substantial profits in the future but that require considerable investments.
- *Horizon 3 (H3)* contains ideas for profitable growth much farther into the future and can contain research projects, small exploratory ventures, and minority stakes in emerging new businesses.

The exact time frames for these horizons will depend on the industry and business involved. Most typically H1 is thought of as the 12–18 month short term, H2 as the medium term starting at the end of that 12–18 months and continuing three to four years, and H3 is farther out. Some businesses run on longer cycles (e.g., large infrastructure and heavy industrial equipment) and some on shorter cycles (e.g., mobile phones and CPG), but the above time frame is generally a good starting point. Take an automobile manufacturer as an example across all three horizons: Major new car models released every four to five years would be H2, annual model updates would be H1, and projects to develop new propulsion and energy systems for future cars that depart radically from current cars (e.g., hydrogen) would be H3. From this example, it's clear that H1 is usually associated with incremental innovation, next generation innovation is in H2, and radical innovation is usually H3.

The three horizons will be referenced in the chapters that follow, in particular Chapter 4 due to its organizational implications and Chapter 8, in the context of innovation portfolio management.

Another potential distinction is that between *architectural* and *component innovation*, sometimes also referred to as *systemic* and *modular innovation*. *Component innovation* is when one or more modules nested within a larger system are replaced, while the system itself stays intact. *Architectural innovation* entails changing the overall system design and hence, the way that the parts interact with each other (Henderson and Clark 1990).[15] This distinction is helpful when considering the impact of innovations on large societal systems and particularly in the context of sustainability transformations.

Disruptive innovation is often erroneously conflated with radical innovation. However, its true meaning as defined by its originator, Clayton Christensen, is quite different. Disruptive innovation occurs when large, established companies get outcompeted (i.e., disrupted) by competitors who find ways of meeting the needs of less-sophisticated customers neglected by those large incumbents.[16] For example, Xerox, the erstwhile market leader in enterprise photocopiers, got disrupted by Canon who created a large new market for smaller, cheaper copiers. Thus, disruptive innovation does not fit on the same dimensional axis as incremental through radical innovation. The concept of disruptive innovation was first introduced under the term *disruptive technologies* in Christensen's influential book, *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail* (1997).[17] Disruptive technologies will be further explained in Chapter 2 within the context of technology S-curves.

Market-creating innovation, a more recent contribution by Christensen, Ojomo and Dillon (2019), also does not fit on the incremental-to-radical axis but contains an insight relevant to both private and public sector practitioners of innovation who work in emerging economies. Market-creating innovation is Christensen's answer to the question of how poor, developing countries can create thriving market economies by creating new consumers with spending power: "Market creating innovations transform complex and expensive products and services into simple and more affordable products, making them accessible to a whole new segment of people in a society whom we call 'nonconsumers'."[18]

Organizations typically struggle to get the mix or balance right between the various types of innovation initiatives that they pursue. Frequently they get stuck in a rut such as doing too much incremental innovation, but in other cases they may overinvest in radical innovation. The strategic context determines which mix is right for a particular organization at a particular point in time. Properly aligning the entire portfolio of different innovation projects with organizational goals is an advanced topic that will be covered in Chapter 8.

The Rationales for Innovation in the Private and Public Sectors

In both the private and public sectors, it is fairly easy for advocates of innovation to make a qualitative argument for the need for innovation. In the case of for-profit companies, whether publicly or privately held, innovation is associated primarily with faster revenue growth while cost-savings brought by innovation can also lead to higher profitability. However, the intuitive insight that innovation can increase revenue or lower costs is not always easy to express in quantitative dollar terms, for some very good reasons. This issue shall be further looked at in Chapter 8 where trading off innovation projects against one another is examined in the section on portfolio management.

While private companies may primarily innovate to serve their shareholders, innovation in the private sector can – and should – also serve the interests of a broader set of stakeholders and society at large either by design or at least as a by-product. An example of the former is innovation in the distribution systems of consumer products to enable poor communities to help themselves economically. An example of the latter is higher-efficiency production processes that reduce costs also could reduce environmental pollution.

From a public-policy perspective, the highest societal benefit of innovation is its contribution to national prosperity. Countries that are more innovative outperform those who are not on a number of key public welfare measures. The mechanism through which this happens is covered in Chapter 3, while the policy framework through which this may be promoted is the topic of Chapters 11 and 12.

Innovation is also a way to improve government itself, and a way that agencies can improve their operations to make them more responsive to user needs and more cost-efficient. While the private sector tends to have fairly uniform high-level metrics such as profitability and revenue growth, in the public sector there may be multiple goals that entail either outputs or outcomes, each specific to their part of government and the particular *mission* undertaken by that agency. For example, the U.S. federal government sets annual performance goals by agency, which are published by the Government Accountability Office (GAO 2022).[19] These goals are framed by legislation, typically circumscribed by available budgets, and reflect the priority of the incumbent administration. Performance goals set for the public sector generally come in two types, *outcome-related goals* and *cost-efficiency goals*; the principle being that high-performing agencies create value for citizens by achieving high-value outcomes at high levels of cost-efficiency, thereby serving the interests of both public-sector customers and taxpayers (Cole and Parston 2006).[20]

This complexity and the importance of institutional context is why I advocate for always seeing innovation as *a means to an end*, and never as an end in itself. The question then becomes, "How can innovation help us achieve our organizational goals?" In even blunter terms, the question is simply "What do you want innovation to do for you?" If, for example, you want to grow company revenue by 20 percent year over year, that is something that innovation can contribute to by giving you new products or services to sell or by improving your current products or services. If, for example, you want to increase the accessibility of a particular government service to the public, and you can quantify that goal, innovation can be employed to help you achieve that. For innovation, as for all of life's endeavors, having clarity on the goals you are trying to achieve is always the right place to start.

It is essential that whatever the exact answer to this question is in a particular context, it is always framed in terms of the value that it brings to someone and/or the mission that it fulfills. Tying innovation directly to already established and agreed organizational goals is not only clarifying, but vitally important. You then do not have to justify innovation on its own as a new concept, and it helps you avoid fruitless political debates about the necessity of innovation inside your organization. Goal clarity brings other immediate benefits. Once you can articulate how (and preferably by how much) innovation is expected to contribute to important organizational goals, it becomes much easier to justify an appropriate budget for innovation.

The Multidisciplinary Nature of Innovation

Innovation lies at the intersection of a number of traditional disciplines or corporate functions. The main corporate functions that intersect with innovation are *marketing*, *product development* together with *research and development (R&D)*, and *operations*. Innovation can be beneficial to other functions too, for example, innovation in sales

processes or business development. While any so-called creative accounting should be avoided, there is no reason why the accounting or auditing processes themselves cannot be innovated to make them better. The same is true for human resources and legal processes. However, most organizational activity around innovation in the private sector can be expected to occur in the nexus between marketing, development, and operations. While the scopes of these functions vary depending on the industry sector and the entity, they have certain core responsibilities regardless of industry.

Marketing is defined by the American Marketing Organization (AMA 2017) as "the activity, set of institutions, and processes for creating, communicating, delivering, and exchanging offerings that have value for customers, clients, partners, and society at large."[21]

New product development (NPD) is concerned with the inception, development, and launch of new products. These days, the NPD term is commonly extended to services and solutions.

The term *research and development (R&D)* includes exploratory research and technology development under the research component and the development component typically overlaps with the first stage of NPD. The term R&D is used differently by industry but is generally understood to precede full-scale product development. The earliest stages of research may be seen as falling under the Schumpeterian definition of invention when they result in new technologies, but not in new offerings.

In manufacturing industries, o*perations* comprise the superset of functions around production. It includes manufacturing itself, supply chain management, as well as supporting functions such as quality and logistics. In service industries, the term operations is used to describe all the activities that render the services to the customers. In a restaurant, for instance, both the cooks and the servers are part of operations. In a physical (brick and mortar) bank branch, all activities are part of bank operations, as are the call-center and online banking operation. Bank operations also include so-called back- and middle-office activities, which enable the customer-facing front office to function and that continue, support, and complete processes initiated in the front office.

In many industries, one function traditionally assumes a primary leadership role in innovation. For example, in a highly technological or engineering industry, R&D or product development may be the first among equals. In the consumer-products industry, the marketing function is usually in the driving seat.

In the public sector, as in the private sector, cross-functional collaboration is required in the innovation process. In the public sector, there is no marketing function if the political operation is excluded from the definition, which means that cross-functional collaboration usually entails a partnership between product development or R&D on the one side and operations on the other.

It should be obvious how the process of innovation, and bringing forth an innovative new product or service involves each of these three core functions (NPD/R&D, Operations, and Marketing) to a large extent, or at least to some extent. Innovation is

indeed a multifunctional endeavor, which is why it will quickly expose any existing disfunction in an organization, and suffer from it.

Innovation requires more than alignment between the official functions within an organization. Innovation relies heavily on the free exchange of knowledge and insights between individuals in different groups and departments. That in turn requires high levels of trust and a propensity for collaboration between coworkers. It should therefore be no surprise that there is a strong association between overall organizational health and the general ability of any organization to innovate. The organizational side of innovation is covered in Chapter 4.

No single organization, however large, can command all the expertise and knowledge required to innovate in today's fast-moving global environment. Therefore, over the last two decades there has been an increased emphasis on collaborating with external actors and organizations. Henry Chesbrough (2003) coined the term *open innovation* in his eponymous book to explain these relationships.[22] (Not everyone has embraced Chesbrough's term, which is why the more neutral term, *external collaboration* will also be used.) Of late, there has been further emphasis on the need for not only one-to-one relationships with external actors, but to be part of a network of collaborating external organizations and individuals. Due to its importance for today's innovator, Chapter 5 is devoted to open innovation and external collaboration.

The Management and Strategy of Innovation

Like any organizational endeavor, innovation needs to be managed properly for it to be successful, and particularly if the organization wants to be consistently good at innovation and yield a continuous series of successful innovations. That is what Drucker (1983, 35) had in mind when he argued for *systematic innovation*.[23] Certainly, innovation projects should be properly managed like any other project, with milestones and checkpoints. But given the special nature of innovation as something that has not been done before, it is never routine either. Another way in which innovation is different is that the process of innovation should not be solely optimized for efficiency like a production or other operational process. Some level of waste or inefficiency needs to be accepted as a natural part of the innovation process. The management of innovation is the topic of Chapter 7. Special considerations that apply to bringing innovation into the public services domain are also reviewed.

Senior executives in particular, but also midlevel executives, need to appreciate the larger strategic context in which they manage their innovation efforts as well as their essential technologies. This includes an understanding of what it takes to construct an effective *innovation management system* that can govern and direct innovation initiatives within their organization. A new *Innovation Management Map* that

shows how innovation is managed at different levels in the organization, and how all the components of innovation fit together, is presented in Chapter 7.

Most organizations that are not startups have to manage not only one innovation or innovation project at a time, but dozens or even hundreds of projects. Such a collection of innovation initiatives or projects is called the *innovation portfolio*, and it needs to be balanced and properly managed just like a portfolio of financial holdings. It is also important to incorporate what has been learned from innovation successes or failures in prior projects into best-practices and new directives for later projects. The existence of the portfolio great increases the level of complexity that needs to be managed with important strategic, operational, and organizational implications. For example, the resource needs of projects (including the human resource needs) must be traded off against one another, while any change in the timeline of one project will have knock-on effects on others. Among such complexity, unintended consequences of management decisions must be avoided. Then, there is always the big question of what the optimal set and sequence of projects is to deliver innovation outcomes for the purposes of achieving the maximum value or mission impact possible over a particular number of years, in other words aligning the innovation portfolio with the business objectives or the larger mission. Sound decision-making in the face of this complexity is thus vitally important to any organization engaged in innovation. Fortunately, the modern discipline of behavioral economics sheds much light on the human cognitive biases and distortions to be mitigated in the interest of better decision-making. These topics are further covered in Chapter 8.

The Contribution of Innovation to Public Welfare

In order to truly understand innovation, it is not sufficient to know how it is practiced at a firm or organizational level. The impact of innovation on society and the economy, as well as the societal context within which innovation happens, are equally important.

In a little over two centuries, there has been a remarkable increase in economic growth and prosperity, starting in the Western countries – which were first to industrialize – but since spreading around the world.

The technologies enabling this prosperity were made possible by major advances in scientific understanding and engineering expertise. New ideas are necessary but not sufficient. The water wheel was invented by the ancient Greeks, but it was only when innovation led to large-scale waterwheel designs that they could be used to power mills two thousand years later. Similarly, the ancient Greeks knew the

power of steam[iii] and yet never developed a usable steam engine. They lacked the understanding of thermodynamics that only came after the Scientific Revolution.

The initial Industrial Revolution started with waterwheels powering mills and later, steam engines powering factories of all kinds. Steam-powered trains and ships together with electrical telegraphs connected remote cities, including those an ocean away. Then, in the early 20th century came electrical motors and generators, radio communication, and automobiles and aircraft powered by internal (and external) combustion engines. After World War II came jet engines and nuclear power with innovations continually building on one another – for example, nuclear plants use steam engines to turn electrical generators to generate electricity. Then came computers, the internet, and the digital and mobile revolutions. In the case of each technology, Schumpeter's phases of invention, innovation, and diffusion can be discerned. Inventions do not change the world. It is when the invention is used as a building block of innovation that new technologies become truly transformative. And so, the transformation and accompanying productivity gains were not complete until widespread diffusion of the innovations based on new technologies was achieved. The productivity and income gains made by employing such new technological innovations have been truly remarkable and have lifted hundreds of millions of people out of poverty.

It was not until the 20th century that economists started to think seriously about how innovations based on new technologies increase the national income, also commonly referred to as the gross domestic product. The main growth theories that were developed and refined after the Second World War reach quite different conclusions on the role and importance of innovation to national income and changes in the economy, with quite different implications for public policy. This is the main topic of Chapter 3.

The Interplay Between the Private and Public Sector

A discussion on the broader context of innovation within the economy would not be complete without examining how innovation and invention are financed. Again, Schumpeter's insight that innovation is driven by entrepreneurs, who unlike capitalists have to obtain financing from others, is invaluable. It helps us appreciate that the lifeblood of innovation is the funding needed by innovators before their creations may contribute to the success of their venture and to the greater good.

iii Hero of Alexandria constructed a rudimentary steam engine called the *aeolipile* around 100 BC. It was made from a metal sphere that contained water with two L-shaped tubes on either side emitting jets of steam when the water boiled, thereby rotating the aeolipile.

The story of innovation funding does not start with the innovation stage, but precedes it. While private sector-innovators are celebrated for popular consumer products such as the iPhone and GPS navigation devices, the role of government-conducted or government-sponsored R&D to create the technologies that enable these consumer products to function is too often underestimated. Most of such government contributions may be classified as Schumpeterian invention, but there are also cases that are more properly classified as innovation. For example, the Global Positioning System (GPS), which we all use, is a fully functioning system on its own, making use of many underlying technologies. The internet grew out of a military communication network called ARPANET launched in the 1970s (Abbate 2001).[24]

Basic scientific research that becomes available to anyone to use is what economists call a *public good*. A public good is both *nonexcludable*, which means that once it exists there is no way from preventing everyone from accessing it, and *nonrivalrous*, which means that one person's use of it does not prevent anyone else from using it. (A lighthouse is the classic example of a public good.) The economic reason that governments fund public goods is that, due to their very properties, there is no economic incentive for the private sector to invest in them. That is why there is a longstanding consensus that national defense – clearly a public good – must be provided by the government and funded by taxes. Most economists and policy experts would classify basic science and the inventions that accompany it as public goods too. Once government-funded science exploration has yielded results that can be applied, or even directly be incorporated into inventions, the private sector can exploit the knowledge and inventions further. But there may be a gap when the basic science is complete but not advanced far enough for a private investor to invest in commercializing it. This is commonly called the *Valley of Death*, which creates the need for bridging government finance and policies that support commercialization. (The financing of innovation by the private and public sector is the topic of Chapters 9 and 10, respectively.)

The simple dividing line of the government funding science and the private sector funding innovation is often not followed. Governments may also fund innovation and even commercialization because they place a high priority on the value that these innovations must bring to the nation or the *mission* they are required to fulfill. Examples of such missions are the Apollo program to win the space race, defense systems, and innovations that are considered key to a nation's competitive advantage in certain industries. Another reason for governments to spend money on innovation is where there is a public interest to advance to the diffusion stage faster than the private sector would do on its own; for example, this is the case with new products based on sustainable technologies or in producing vaccines to counter pandemics such as COVID-19.

The interest of the public sector in being an active participant in the innovation process is amplified during times of transformative change exemplified by the major industrial revolutions. Governments may direct public spending and coordinate it

with trade policy to ensure the growth and survival of certain industries seen as critical to future competitiveness. Lastly, the government also has an interest in mitigating the socially disruptive effects of innovations such as job losses due to automation and loss of privacy or data agency due to new consumer information technologies. (Innovation policy is discussed in Chapter 2.)

Chapter Summary

- Having differentiated products is essential for companies to have both pricing power and to outsell their competition. An undifferentiated product is called a commodity, for which the producer has no pricing power but can only reduce costs to increase profits.
- According to Schumpeter, innovation is central to the creative destruction process in a capitalist system. Innovation is when entrepreneurs combine existing elements in new ways. Brand new technologies are inventions; the invention process precedes innovation. The diffusion stage has been reached when everyone has copied an innovation. Companies have to keep innovating to avoid the commoditization that comes with diffusion.
- Successful innovation requires a systemic process in organizations according to Drucker. This process has to constantly scan for changes in the market, technology, and environment that may present opportunities for innovation.
- The design-thinking approach emphasizes observing the needs of the customer or end user, and rapidly trying out prototypes that may help the customer get a job done or solve a problem.
- The practical definition of innovation used in this book is that innovation is an analytically rigorous and creative process for organizations to solve valuable problems for their customers and for themselves.
- Innovation may take many forms, from product to services to process. It can also be placed on a continuous axis running from incremental innovation to radical innovation based on the degree of the change it contains.
- While private-sector companies pursue innovation to drive revenue growth and higher profits, innovation in the public sector has specific goals depending on the priorities of the particular agency at the time. These have to be seen in the context of the mission of the agency.
- At the highest level, innovation in both the private and public sector contributes to national prosperity and public welfare.
- Innovation is a multidisciplinary process involving many organizational functions. In the private sector, these are typically R&D/product development, operations, and marketing; in the public sector, these are typically R&D/product development and operations.

– Governments enable innovation by directly funding research in pure and applied science. Private-sector innovations often depend on the scientific understanding, inventions, and infrastructure created by public-sector investment.

Suggested Exercises and Assignments

– Ask each one in the group to contribute a news article describing a recently launched innovation. In each case, identify what type of innovation it is (from the extended Schumpeter list), and what differentiates that innovation from the existing offerings that it now competes against.
– Discuss recent technological innovations that you admire; identify the prior inventions that made these innovations possible, and estimate how far each innovation is from the point of diffusion.
– Identify key government sponsored research or inventions behind a popular innovation of your choice; debate whether it is fair that all profits made by the private sector on these innovations be kept in the private sector, and whether it is advisable for some share of the profits to go back into a pool that can help fund the next generation of research.

Recommended for Further Reading

Drucker, Peter F. *Innovation and Entrepreneurship*, New York: HarperCollins, 1983.

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McCraw, Thomas K. 2007. *Prophet of Innovation – Joseph Schumpeter and Creative Destruction*. Cambridge, MA: Belknap Press of Harvard University Press.