



# COMMERCIALIZATION OF INNOVATIVE TECHNOLOGIES

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## Bringing Good Ideas to the Marketplace

**C. JOSEPH TOUHILL**

Touhill Technology Management Corporation

**GREGORY J. TOUHILL**

United States Air Force

**THOMAS A. O'RIORDAN**

The Raytheon Company

**AIChE<sup>®</sup><sub>100</sub>**

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**Encyclopaedia Britannica, 1771 edition**

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***Library of Congress Cataloging-in-Publication Data:***

Touhill, C. J., 1938–

Commercialization of innovative technologies : bringing good ideas to the marketplace / C. Joseph Touhill, Gregory J. Touhill, Thomas A. O’Riordan.  
p. cm.

ISBN 978-0-470-23007-7 (cloth)

1. Technological innovations. I. Touhill, Gregory J. II. O’Riordan, Thomas A. III. Title.  
T173.8.T68 2008  
658.5’77—dc22

2007030013

Printed in the United States of America

10 9 8 7 6 5 4 3 2

*To our wives and children*

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# FOREWORD

I have known Joe Touhill since we were college classmates in the class of 1960 at Rensselaer Polytechnic Institute. The characteristics that impressed me most about Joe were his eagerness to take on a challenge, his common sense, and his ability to size up an issue and then lay out a logical plan for resolution. Most important, then and now, is his ability to follow through to a conclusion. Joe and coauthors, Greg Touhill and Tom O’Riordan, have produced a book that is focused on one of the most exciting and rewarding challenges of our time: *commercialization of innovative technologies*. Economists pretty much agree that innovation on a commercially attractive basis is one of the key economic drivers of our capitalist system. This means having an atmosphere that promotes innovation, with appropriate rewards and incentives flourishing freely. Our system is based on the premise that incentives really do work!

Entrepreneurship is a popular and growing topic in the business world today. There is a buzz about it. The topic is red hot and is a rapidly emerging course of study on most technology and business school campuses. You cannot pick up a business magazine without finding an article on innovation. Furthermore, it is one of the key metrics that analysts look at in rating an organization. How efficient organizations—research, business, government, military and educational—are in utilizing resources to develop innovation is a crucial question. The authors have educational backgrounds in engineering and the sciences with subsequent business training and experience. They have had genuine exposure and responsibility in the world of development on a results-oriented and profitable basis.

The book hammers on the concept of the *innovation team* and its importance to a consistent and repetitive commercialization process. It identifies the players, their characteristics, how to deal with their idiosyncrasies and what to expect as the commercialization process moves ahead. The book brings all the touchy topics into play: compensation and incentives as well as recognition, rewards, and celebration. The maestro (entrepreneur) inevitably is leading an orchestra of highly strung talented individuals. Embarking on a development process without a realistic understanding of these points is foolishness and costly.

*The Wall Street Journal* suggests that the overwhelming number of innovative ideas since the end of World War II have been commercialized by U.S. citizens. The book suggests that this is changing. Intuitively, we know that creativity is not the sole province of the USA. Because of improvements in global communications, we are seeing global teams put together for the development of ideas. Much of this team building is to take advantage of lower costs in different parts of the world. The innovation team of the future will be looking for the best ideas no matter where they come from. Global teams that we are beginning to see develop is a perfect lead into the topic that this book features uniquely—the innovation team—and understanding how important this concept is.

The book will not turn a poor idea into a profitable one. But it will ensure that attentive readers get a good commonsense strategy in place for identifying, funding, and developing truly good ideas. Of equal if not greater importance, the book will lead you to set up a screening system so that you can quickly identify ideas that do not fit into your strategy and goal profile. If you come away from reading the book with only one idea—the concept that early elimination of time-wasters is crucial to success on a consistent basis—reading it will have been worthwhile. Time really is precious, and things are moving at an ever-accelerating pace. The book takes you through all the steps in sufficient and understandable detail for ease of implementation. It will help you to avoid wasting time and bring discipline to the creative process. Although this may seem like a contradiction in terms, what is business really, if not the application of discipline? The tension between creativity and discipline is discussed candidly. Healthy solutions can only come about with awareness and knowledge. Good things do not happen by accident.

The book does not shy away from difficult questions such as “Can entrepreneurship be taught”? Addressing difficult questions is a hallmark of this book. Anyone who has been through the commercialization process will recognize immediately that the authors have been there. There is considerable benefit to be derived from their experience. The book is

proactive about looking at things that did not go well. How else do we learn if not from our mistakes?

The book is recommended for both students and practitioners (investors, inventors, entrepreneurs, and managers). It will serve as a text for students and as a comprehensive resource for practitioners: those trying to bring innovative ideas to market on a commercially sound basis. The table of contents will serve nicely to direct you to those parts of the process in which you have the most interest.

ROBERT B. SHEH

*Managing Partner  
Alta Group, LLC  
Redondo Beach, CA*

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# ACKNOWLEDGMENTS

Many people and career experiences helped us in writing this book, and it would be a very long acknowledgment indeed if we attempted to identify them all. Thus, at the risk of missing those who truly were influential in guiding our effort, we will thank only a few for their direct intervention and contributions to this endeavor.

Dr. Herbert M. Clark, professor emeritus of physical and nuclear chemistry at Rensselaer Polytechnic Institute, encouraged us in writing this book, challenged us to make it thoughtful and insightful, dispensed considerable wisdom in the process, and as the author of several books, provided us with sound advice on the mechanics of publication.

Dr. Gary F. Bennett, professor emeritus of biochemical engineering at the University of Toledo, wisely guided us to appropriate people at the American Institute of Chemical Engineers (AIChE) who helped us to get the book published.

Dr. Richard D. Siegel, environmental consultant, also a friend and colleague from AIChE, gave us important insights that were valuable in getting ready for publication.

Dr. Kenneth L. Mulholland, president of Kenneth Mulholland & Associates, Inc., and author of *Identification of Cleaner Production Improvement Opportunities*, provided beneficial information related to his favorable experience in publishing his book through the AIChE–Wiley affiliation.

Stephen M. Touhill, vice president of Clearspring Technologies, Inc., was especially helpful in his review of Chapter 3, and in providing insights into the evolution of emerging high-technology startups.

The U.S. Central Command Air Forces (USCENTAF) team, which was awarded the 2006 U.S. Air Force Science and Engineering Achievement

Award for the work cited in Chapter 17, is recognized for its outstanding efforts under very trying conditions. We would like to single out the following officers for their special contributions: Colonel Marty Edmonds, Squadron Leader Patrick Del Guidice, and Major Robert Sylvester.

### **Disclaimers**

The views in this book expressed by coauthor Gregory J. Touhill are his alone and are neither endorsed by nor necessarily reflect those of the U.S. Department of Defense or the U.S. Air Force. Similarly, the views of coauthor Thomas A. O’Riordan are his alone and are neither endorsed by nor necessarily reflect those of the Raytheon Company.

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# 1

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## ESTABLISHING PERSPECTIVE

During the last 100 years, we have created more wealth, reduced poverty more, and increased life expectancy more than in the previous 100,000 years. That happened because of entrepreneurs, thinkers, creators, and innovators. They are the heroes of our world.

Johan Norberg<sup>1</sup>

How many people do you know who when asked “What would you like to be doing five years from now?” answer by saying that they would like to have their own business. In our experience, the percentage is very high. Perhaps this is because the desire to be free, independent, and in control of one’s destiny is innate. However, realization of such a vision is not nearly as frequent as the desire. Key stumbling blocks are that people don’t have the knowledge, resources, energy, or discipline to convert their dream into reality. This book is intended to help provide thoughts on how to bring good ideas to the marketplace. It focuses on and emphasizes technology. Technological innovations can be simple or complex, hardware or software, manufactured products or technology-based services, even systems

<sup>1</sup>Johan Norberg, “Entrepreneurs are the heroes of the world,” *Cato’s Letter*, Winter 2007, Vol. 5, No. 1.

that combine existing technology in a unique and imaginative way, but the pathway to successful commercialization is similar for all good ideas.

In addition to the huge audience of budding entrepreneurs who dream of starting their own businesses (including many who are actively involved in doing so now), there are many others who will find this book useful. Virtually all leading universities now have centers of entrepreneurship and teach courses on the subject to eager management and engineering students.<sup>2</sup> Today's investors are seeking ways to enhance their investment returns because the return earned from current stock, bond, and mutual fund investments is lower than it has been historically, and it appears that investing in real estate has taken on considerable risk. Hence, venture capitalists and consortia of investors<sup>3</sup> continue to look at the potential that innovative technology can have in realizing their target aspirations for significant returns on invested capital.

Another group of significant size that can benefit from this book are those who submit proposals to various federal agencies that award Small Business Innovative Research (SBIR) and Small Business Technology Transfer (STTR) contracts. SBIR is a program that encourages small businesses to explore their technological potential and provides an incentive to profit from its commercialization. STTR is a program that reserves a specific percentage of federal research and development funding for award to small businesses and associated nonprofit research institution partners. Because the risk and expense of conducting research and development can be beyond the means of many small businesses, STTR combines the strengths of small businesses and nonprofit research laboratories by introducing entrepreneurial skills to high-tech research efforts. Its intent is to transfer technologies and products from the laboratory to the commercial marketplace.

The U.S. Small Business Administration, Office of Technology's Web site (<http://www.sba.gov/SBIR/>) provides detailed information on how to become aware of proposal opportunities from agencies that award SBIR and STTR contracts. The Web site answers frequently asked questions and has a master schedule of release dates for solicitation announcements. Additionally, the Web site includes helpful links to agency/department SBIR and STTR program solicitations. Any small business interested in

<sup>2</sup>See Section 1.4 for a discussion of programs and curricula at leading universities that teach entrepreneurship and commercialization.

<sup>3</sup>These consortia, especially those that focus on smaller companies, commonly are referred to as *angel investors*. Interestingly, in 2004, angel investors financed nearly 45,000 startup companies to the tune of \$24 billion. The majority of the startups were high-tech companies. These 225,000 active angel investors outspent venture capitalists, who funded \$22 billion in high-growth startups. Angel investors are described in some detail in Chapter 4.

**TABLE 1.1 Federal Agencies with SBIR/STTR Programs**

Agency	SBIR	STTR
Department of Agriculture	×	
Department of Commerce	×	
Department of Defense	×	×
Department of Education	×	
Department of Energy	×	×
Department of Health and Human Services	×	×
Department of Transportation	×	
Environmental Protection Agency	×	
NASA	×	×
National Science Foundation	×	×

submitting proposals to federal agencies that fund SBIR/STTR programs is strongly encouraged to use this valuable resource for determining what agencies may be interested in their technological innovation, matching that interest with formal solicitations, and learning how to submit proposals.

There are 10 federal agencies that award such contracts (Table 1.1). Contract amounts are significant. For example, during fiscal year 2004, \$2,015,000,000 was awarded for SBIR programs and \$208,700,000 for STTR programs. One of the requirements of both SBIR and STTR is that proposers must demonstrate that their planned effort, if successful, will be commercialized. Thus, we envision that this book can serve as an inventor/innovator manual, a university textbook, an SBIR/STTR reference, or as a technology investment handbook. Additionally, business executives and management students will find it helpful in explaining the life cycle of product innovation and the dynamics of bringing good ideas into practice.

Unfortunately for all of these people, the old truism, “build a better mousetrap and they will beat a path to your door,” doesn’t always work. In fact, our experience shows that unless you know how to commercialize good technological ideas, people won’t take your mousetrap even if you gave it away for nothing. The four key ingredients that make commercialization of good ideas successful are:

- Teamwork
- Planning
- Discipline
- Perseverance

We emphasize the first three ingredients explicitly throughout the book; the perseverance part is implicit, and truthfully, is learned best through experience. Of the key ingredients, we think that teamwork is the most crucial.

This is because we believe that the best chance for commercial success is through the formation of an *innovation team*. Surely there are occasional extraordinary people who alone can bring the germ of an idea to full commercialization, but these geniuses are few. In Section 1.2 we explain our rationale regarding teamwork in more detail and show how teamwork was an essential element in the birth of that great American phenomenon—Silicon Valley. Throughout the book we emphasize that an innovation team cannot succeed without a plan, and we spend time describing how strategy is formulated and how a plan is built. Finally, we stress that it requires discipline to follow a plan and wisdom to know when to amend it.

## 1.1 ORGANIZATION OF THE BOOK

We believe that enhancement of the human condition depends on thoughtful creation and implementation of innovative technologies. In these times of rapid technological expansion and global communications, most people recognize and understand the basic importance of intellectual property. Moreover, they understand the need for the entrepreneurial spirit to launch new enterprises. The winners will be those who know how to exploit good ideas and put them into practice. Our book defines a strategy for doing so and outlines an approach to commercializing innovative technologies successfully.

In the first three chapters we deal with *strategic* issues, answering such questions as:

- What is the audience for this book?
- Why is it so important to form an innovation team?
- Who are members of the innovation team, and what are some of their traits and characteristics?
- What does a strong and flexible commercialization plan look like?
- What are our objectives in developing a strategy for success, and how do we assess, develop, and manage promising technologies?
- How do we develop an endgame?
- What are key elements in executing the strategic plan?

In Chapters 4 through 16 we address *tactical* issues, such as how we find, fund, assess, develop, design, and demonstrate innovative technology. Whereas the first three chapters reflect boardroom decision making, the tactical chapters deal more with on-scene issues and problem solving. In Chapters 17 and 18 we focus on both strategic and tactical decision

making related to how a successful technology can be improved and what happens after our goal of successful commercialization has been achieved.

Some people claim that any worthwhile enterprise rests on a three-legged stool comprised of strategy, tactics, and operations. For our purposes in this book we have chosen not to address detailed operational matters explicitly. We leave this important area to others. Others have recognized the growing strong interest in entrepreneurship and commercialization of innovative technology, and some very good books on the subject have been published recently. Our book is different because we emphasize (1) the importance of the innovation team, (2) the wisdom of building a portfolio that spreads risk, and (3) the strong input required from technologists in the commercialization process.<sup>4</sup>

## 1.2 THE IMPORTANCE OF VIEWPOINT

It is extremely rare that a single person can conceive of an idea and then, alone, carry it through to successful implementation and commercialization. As technology increases in complexity and governmental rules and regulations become more pervasive and onerous, it is difficult to see how one person could bring a good idea to the marketplace without a lot of help. One of our main themes in this book is that successful commercialization is best achieved through teamwork. We believe that building an innovation team is crucial to the process of commercializing good ideas. Our conception of the innovation team that is best equipped to commercialize technology is one comprised of several personalities or roles, each with a different image of the idea or concept that we intend to implement<sup>5</sup>:

- Inventor/innovator
- Investor
- Technologist
- Entrepreneur

<sup>4</sup>Although the two junior authors have been or are associated with the U.S. Air Force, our primary audience is not defense contractors, but rather, people who are highly entrepreneurial and eager to make new ideas grow and go. The book subtitle, "Bringing Good Ideas to the Marketplace," reveals that we are focused on nascent ideas rather than mature technology that characterizes much of the defense community. Not that defense contractors won't find the book useful: To the contrary, many contractors would benefit from reading it, to find and promote new ideas. We see the typical reader as being young in spirit, eager, and bursting with energy and zeal. We hope to provide them with a road map and the benefit of a lot of experience.

<sup>5</sup>Accountants, lawyers, and bankers, among others, are important supporters of the innovation team, but are not regarded as core team members within the context of this book.

It takes all four of these personalities to identify and evaluate good ideas and concepts and then bring them to the marketplace profitably. The best pathway toward successful commercialization requires that the innovation team be flexible and interact well, focusing on the common goal of profitable commercialization. Sometimes people will switch roles as an idea is evaluated, matures, and is developed. Thus, each role, whether undertaken individually or in combination, is vital to successful commercialization.

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### **The Birth of Silicon Valley: The Traitorous Eight**

During 1996, Public Broadcasting aired a television show called, *Caesar's Writers*. It was riotously funny, but more impressive was the story of how a group of very talented writers made it possible for an outstanding comedy ensemble headed by Sid Caesar to capture the relatively new medium of television by storm. *Your Show of Shows*, produced in the early 1950s, remains for many people the gold standard of television comedy. Where Milton Berle's slapstick captured the nation's funny bone, Sid Caesar and his cast taught us the meaning of wit. The truly amazing part of the 1996 reunion of Sid Caesar and his writers was the identity of the writers<sup>6</sup>: Mel Brooks; Larry Gelbart; Gary Belkin; Sheldon Keller; Carl Reiner; Aaron Rubin; the Simon brothers, Danny and Neil; Mel Tolkin; and a very young freelance contributor of jokes—Woody Allen. The show itself was terrific, but to recognize the incredible talent of the comedy writers and what they accomplished collectively over the years was astounding. Just suppose that there is a parallel story in high technology. Well, there is!

In December 1947, two scientists, John Bardeen and Walter Brattain, at Bell Telephone Laboratories in Murray Hill, New Jersey, observed that when electrical signals were applied to contacts on germanium crystals, the output power was greater than the input. Their boss was the magisterial William Shockley. Shockley sought to find an explanation for the phenomenon, and with great insight over a short period, he not only explained the effect on semiconductor materials, but also, and more important, developed a crystal that became known as a junction transistor. By 1951, Shockley and his crew had reduced the transistor to practice. In 1956, Bardeen, Brattain, and Shockley shared a Nobel Prize in Physics for their discovery.

<sup>6</sup>The great Lucille Kallen was not in the program, although she was an essential part of the writing team.

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