The authors – educators and successful entrepreneurs – wrote this textbook with the goal of maximizing your chance of entrepreneurial success. It is designed to encourage those who want to start a business and those who have already begun. It includes guidance, instruction, and practical lessons for the prospective entrepreneur.

The book focuses on early-stage financing of a start-up company, beginning with an emphasis on constructing an effective business plan, including writing techniques to help convey your message, constructing an effective PowerPoint-type presentation, and preparing solid financial statements. This “why and how” of writing a business plan is followed by recommendations on raising outside capital. Important topics include developing a marketing strategy, recruiting and managing creative boards and managers, and retaining effective employees. Legal structures, negotiation strategies, and economic evaluation of opportunities are also discussed. The book concludes with a chapter on project management. The book includes many engineering economy topics, sufficient for those who will be taking the FE Exam.

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THE ENTREPRENEURIAL ENGINEER

How to Create Value from Ideas

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Cornell University

Rhett L. Weiss
Cornell University

Daniel P. Loucks
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John R. Callister
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James E. Timmons
This book effort is dedicated to all those who have tried ... whether they succeeded or failed

[Photo courtesy NASA]
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Preface

Where Are We Going?

If you ask a group of engineers, most of them would probably tell you that they have thought about starting a business. Most did nothing. Some others did some research and preliminary planning. Some of these then invested some personal funds in creating the shell of a company in some legal format. A rare few took their companies forward to the point that they became operational businesses.

Most of us will see opportunities to start a business. This book is for those among us who are contemplating the start of a business and those that may have already taken that big first step. As teachers and successful entrepreneurs, our goal in writing this book is to help you the reader maximize your chances of entrepreneurial success. You will find guidance, instruction, and practical lessons that will assist you, the prospective entrepreneur, with your first steps toward realizing a dream.

The focus of this book is primarily on early-stage financing of a start-up company. Most texts focus on venture capital–type financing, but this is not an option at the beginning. Most companies will be started with personal funds or funds from family and friends. If you can advance to the stage of having a product and some form of sales, then you can attract an angel investor. At this point you’d be looking for hundreds of thousands of dollars, which is still way below the funding level at which a venture capitalist becomes interested. Although the book focuses on the early-stage financing, the lessons and principles presented will be generally applicable as your company advances in maturity and funding needs.

Basis for Content

The book is based in part on the senior author’s real-world experience of having started a technology-driven indoor fish company in upstate New York, an international consulting company, two nonprofit organizations, an indoor shrimp farm in Kentucky in 2007, and three other current ventures involving high-tech fish farms. In writing this book, we have incorporated real examples from our own companies and from other entrepreneurs to motivate and teach.
Our own entrepreneurial experience began with the tilapia fish company, whose objective was to produce food fish for the mass market, using a combination of proprietary and patented technology that we considered disruptive technology at that time and still do. We thought we could revolutionize the aquaculture industry (the jury is still out on that) by providing the means to produce fish in a sustainable and profitable manner. The company was launched in 1997, and became one of the largest indoor fish production facilities in the United States, producing more than 1 million pounds (500 ton) of tilapia for several consecutive years in the mid-2000s.

We first raised capital to fund this venture by self-financing and personal debt, which was then followed by “angel investor” financing, and then venture capital financing. Along the way, we became quite familiar with terms such as preferred stock, cram-down, down round, perfected loan, and disruptive technology – to name just a few. So our writing reflects the belief that there is no substitute for one’s own experience, but that there are large dividends to be had (saving money by reducing your mistakes) by learning what we can from the experiences of others. Hopefully this book will help you minimize costly mistakes.

An important part of this book is the emphasis on constructing an effective business plan and preparing solid financial statements. This “why and how” of writing a business plan is followed by recommendations on how to raise outside capital. Then, we suggest some writing techniques that will be helpful in conveying your message of opportunity to others. After that, we examine methods of developing your marketing strategy, recruiting and managing competent individuals at the creative and managerial levels, and, as the business grows, recruiting and retaining effective employees. Other aspects of starting and running a new business are also addressed, such as selecting a legal structure for your business, negotiating strategies, and performing economic evaluations of opportunities. We conclude with a chapter on project management.

In order to help you get a feel for some of the entrepreneurial concepts, we have included problems that require economic analysis of different opportunities or challenges facing a start-up venture. For example, chapter problems include how to determine internal rates of return (IRR) for a new enterprise or its net present value (NPV), how to evaluate alternative capital investments, and how to calculate basic financial terms such as EBITDA that would include depreciation calculations. The Appendix includes the standard equations used in engineering economic analysis for ready reference plus a collection of financial tables related to depreciation and classifications of real property and the interest factors for discrete compounding calculations.
Preface

Engineering Students and the FE Exam

For the engineering students using this text, at the end of each chapter is a section on engineering economics. After you’ve gone through the first ten chapters, you will have covered all the engineering economics concepts necessary to pass this portion of the Fundamentals of Engineering (FE) test conducted by the NCEES (National Council of Examiners for Engineering and Surveying; see www.ncees.org). The engineering economics material makes up 8% to 10% of the entire FE test, so it will behoove you to master these concepts. This economics text material is not intended to replace a full academic textbook on engineering economics. Please consult other texts on this material if you require more depth, for example, *Fundamentals of Engineering Economics* by Chan S. Park or *Engineering Economic Analysis* by David Newnan, Ted Eschenbach, and Jerome Lavelle.¹

Supplements to the Text

Some chapter topics have been abbreviated by moving this material to the Web support page for the book provided by Cambridge Press; see www.cambridge.org/Timmons. The Web supplementary materials include a primer on dinner etiquette so you won’t embarrass yourself at your first angel investor meeting by using the wrong fork or not knowing what to do with your cloth napkin at the conclusion of a meal. These chapter supplementary materials are noted by chapter number. Several business plans are posted there, most of which were written by students who enrolled in the senior author’s entrepreneurial class at Cornell. We have collected all the engineering economic material from the end of each chapter and placed this on the website as a convenient reference tool to the engineering economics materials. We will also use the book’s website to provide updated information. Additional financial tables are also provided there.

Acknowledgments

This book was made possible by senior author Michael B. Timmons being awarded a Clark Professorship in 2001 from Cornell University (see http://entrepreneurship.cornell.edu/). The Clark Professorships were established in 1992 by J. Thomas Clark (1963, MBA 1964) and Nancy Williams Clark (1962, MEd 1964) to expand and/or enhance the educational opportunities for undergraduate, professional,

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and graduate students in the areas of entrepreneurship, small business, and personal enterprise. These professorships provide funding for a limited term to faculty members selected in a competitive process to develop new courses, integrate entrepreneurship into existing courses, or engage in research in the areas of new business creation, innovation, and/or development. Professors (nineteen total) from eight Cornell schools and colleges have held Clark Professorships. These funds were used to develop this textbook, and we are extremely grateful for this help and sponsorship. Additional thanks go to Mr. John Jaquette, Director of the Cornell University Entrepreneurship and Personal Enterprise (EPE) Program. In addition to financial support for writing the text, the EPE program provides constant moral support and encouragement to each of us to continue to provide and improve the educational experience for Cornell students with an interest in entrepreneurship.

We would also like to specifically thank Professor Deborah H. Streeter, Bruce F. Failing, Sr., Professor of Personal Enterprise in the Department of Applied Economics and Management at Cornell University. Professor Streeter is part of the university-wide Entrepreneurship and Personal Enterprise Program. Dr. Streeter provided valuable guidance and input when we were first constructing the text, and she provided much of the marketing research content in Chapter 3. Also at the end of each chapter are several video clip links that are from her collection of 15,000 in-depth interviews on all aspects of entrepreneurship. That collection was the basis for a start-up company called Prendismo, LLC (see http://www.prendismo.com).

As we developed the new course, BEE 4890 Entrepreneurial Management for Engineers (a four-credit one-semester course), we relied on our personal experiences, class lecture notes, and several texts that we had read at that time as we developed lecture materials and material for the course text. In fact, one of the fish farm’s angel investors had asked us if any of us had read Clayton Christensen’s book on disruptive technology, The Innovator’s Dilemma.² We all said no, but we’d pick up a copy ASAP. The book by Christensen was all about disruptive technology, which we then realized was describing our fish-rearing technology. So, some of the content in Chapter 2 has to recognize that some of the content was based upon Christensen’s writings. The other two books that we found very useful in developing our course were Leading the Revolution by Gary Hamel and Smartups: Lessons from Rob Ryan’s Entrepreneur America Boot Camp by Rob Ryan.³ Both books are very good reads because they discuss the challenges of a start-up venture. Again, we are certain that some of the writing in the text that we’ve written will capture some of the essence of these two books; footnotes where material has been borrowed are presented throughout the text.

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Final Advice

We hope you enjoy this text. A few of our business associates have read some of the chapters and they say it reads like a story. That was our intention. We hope you can benefit from some of our mistakes and our successes. For sure, applying the lessons discussed herein to your own start-up venture will save you time and money. Both are critical to the success we wish you as an entrepreneur.
Dr. Michael B. Timmons, PE. Dr. Timmons has been successful in several entrepreneurial efforts and has led successful fund-raising efforts from both angel investors and venture capitalists. He received his BS from The Ohio State University, his MS from the University of Hawai‘i, and his PhD from Cornell University. In 1997, Dr. Timmons’s first major entrepreneurial experience was launching an indoor fish farm in upstate New York, called Fingerlakes Aquaculture LLC. This venture was a 1-million-pound-per-year tilapia farm. Building this farm required Dr. Timmons to personally guarantee a substantial percentage of the debt equity used to build the farm. It was the lessons learned from this experience that prompted Dr. Timmons to write this textbook. The project was sponsored by J. Thomas Clark, a Cornell alumnus, who endowed Cornell University with funds to support faculty efforts that contributed to the entrepreneurial education of its students. Much appreciation and gratitude is extended to Mr. and Mrs. Clark for their financial help. Dr. Timmons was a J. Thomas Clark Professorship of Entrepreneurship and Personal Enterprise from 2002 to 2008.

Dr. Timmons is one of the recognized authorities on recirculating aquaculture technologies (coauthor of the text Recirculating Aquaculture, with J. M. Ebeling; see www.c-a-v.net). Dr. Timmons has worked in aquacultural engineering for twenty-five years as a researcher and extension specialist. He was one of the founders of the Aquacultural Engineering Society and has served in several officer positions including president. In the spring of 2012 (once again with his wife’s blessings), Dr. Timmons launched Kentucky Natural Organics LLC, a 300,000-pound-per-year tilapia farm and hydroponic producer of leafy greens and tomatoes. These experiences may prompt another textbook! Stay tuned.

Dr. Rhett L. Weiss. Dr. Weiss is the Executive Director of the Entrepreneurship and Innovation Institute at Cornell’s Johnson Graduate School of Management. In addition, he serves on its faculty, teaching or advising graduate students in the entrepreneurship and venture capital areas. Before joining Cornell, Dr. Weiss had more than twenty-five years in successful leadership and management roles.
About the Authors

He has served as a bank COO, directed a consulting practice at a Big-4 accounting firm, practiced law at a major international law firm, and holds a software and business method patent. Throughout his career, he has been involved in transactions worth more than $30 billion and in dozens of entrepreneurial ventures and innovation initiatives. Among them, he is Chairman and CEO of DEALTEK, Ltd., which he founded in 1999. From 2005 to 2010, Dr. Weiss served as Senior Team Leader – Strategic Development for Google Inc. He was chief designer and negotiator of several large strategic acquisition and development projects for Google’s global infrastructure, typically involving its legendary data centers. He headed key initiatives, contracts, and relationships with businesses, utilities, governments, economic development agencies, landowners, and other stakeholders. Dr. Weiss also created and conducted negotiation training workshops in Google’s offices globally. He is a frequent presenter and writer on negotiations, entrepreneurship, and economic development. The transactions that he has led often have received industry recognition, awards, and coverage in business and technology news articles. Dr. Weiss holds a BS in Management with Honors (finance major) from Tulane University, a Doctor of Jurisprudence from the College of William & Mary, and an MBA-level Executive Certificate in International Business from Georgetown University. He also has held board chairman and other leadership positions at professional, educational, and civic organizations.

Daniel P. Loucks. Professor Loucks teaches in the School of Civil and Environmental Engineering and in the Institute of Public Affairs at Cornell. His research focuses on the application of systems analysis, economic theory, ecology, and environmental engineering to problems in regional development and environmental quality management. On leaves from Cornell he has taught at a variety of universities in the United States, Australia, and Europe and has been a consultant to international, governmental, and private organizations dealing with regional development issues here in the United States as well as abroad. He served as an economist at the World Bank and as a research scholar at the International Institute for Applied Systems Analysis in Austria. Loucks was an aviator in the navy and eventually commanded the largest naval air transport squadron in the country, having detachments at Naval Air Facility, Detroit, Michigan; Andrews Air Force Base, Maryland; and Naval Air Station, Willow Grove, Pennsylvania. He was elected to the National Academy of Engineering in 1989.
About the Authors

John R. Callister. Callister is the Harvey Kinzelberg Director of Enterprise Engineering in the Mechanical and Aerospace Engineering Department at Cornell and a lecturer in the Sibley School of Mechanical and Aerospace Engineering and the School of Operations Research and Industrial Engineering. Callister teaches Introduction to Entrepreneurship and Engineering Enterprise, which provides a solid introduction to the entrepreneurial process to freshman students. One objective of the course is to examine and develop skills in the engineering work that occurs in high-growth, high-tech ventures. This course is the first in a program in entrepreneurship and personal enterprise for engineers, but enrollment is not limited to students who elect to enter this program, and students from throughout Cornell University are welcome to enroll, regardless of major. Callister also teaches Entrepreneurship for Engineers, which examines the issues and skills necessary to identify, evaluate, and start new business ventures. Topics include competition, strategy, intellectual property, technology forecasting, product design and development, sources of capital, and manufacturing. Callister also teaches other engineering courses in the M&AE and ORIE departments.

Callister is a cofounder and vice president of Foxdale, Inc., an equipment leasing company in the blown-film polymer industry. He has participated in several entrepreneurship conferences in the past year. He joined the Cornell faculty in 1999.

James E. Timmons. Timmons holds a master’s degree from Central Michigan University in Management and Supervision. His career to date spans more than thirty years, during which time he has managed complex development programs with budgets up to $250 million and other activities with more than 1,100 personnel under his management responsibility. He has experience with both government and private-industry programs and more than twenty-five years of experience in providing and managing the operational and maintenance support requirements and structure for complex mechanical systems. He has developed, produced, maintained, and implemented support plans and programs for a variety of Department of Defense weapons systems and vehicle systems. Most recently, he has been involved with the definition and documentation of the mechanical, electrical, and fluid interface requirements between several of the International Partner modules to the International Space Station.