Finance for Engineers

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Evaluation and Funding of Capital Projects

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For Natascha and Nicholas

Preface

Investment decisions are critical part of a company's success, and capital budgeting is a central topic of financial management. However, in contrast to other strategic decisions in business, decisions on capital projects are decentralized, from corporate to divisions, divisions to operations, from operations to departments. Engineers at various levels within the organization who make a capital proposal are contributing to the strategic success of the organization. This book will assist engineers to contribute strategically to the organization, so that they can contribute to the success of their company and can make a success of their careers.

The purpose of this book is to provide engineers and managers with a working knowledge of the financial evaluation and the funding of capital projects. Four main topics concerning capital investment are covered, namely, the *context* of these decisions, the assessment of their *returns*, the assessment of their *risks*, and their funding and *financing*. Engineers have developed the field of *engineering economics*, and financial managers have developed the discipline of *capital budgeting*, each with its own approach and slightly different terminology. This book borrows from both these disciplines in order to provide engineers with the best possible knowledge about capital projects.

An important aspect of the approach adopted here is to provide context to the techniques, methods and concepts of the economic assessment of engineering decisions. An engineer who knows her subject is able to communicate her ideas to people of different professions and with different training. An essential part of effective communication is to understand the other person's paradigm, to know their basic assumptions. As a result, it is important to understand the basics of decision making, of financial management, and accounting. It is also important to understand the terminology used by different professions. Part I of the book examines these topics, which forms the introduction to the economic assessment of an engineering project.

A project is assessed on its economic merits, its profitability. Part II of the book covers the techniques and methods of capital budgeting and engineering economics. In-depth case studies demonstrate the application of these techniques to practical situations.

The assessment of the economic merits of a project usually refers to the returns expected from the project. The cornerstones of finance are risk and return, and it is essential to address the risk of the project in a discussion of its merits. The risk is the chance of the expected returns not materializing. The types of risk, such as stand-alone risk and portfolio risk, for a capital project are examined in Part III of this book.

It is also important to understand the financing of a project, the sources of finance, and the structure of financial arrangements such as project finance and public-private partnerships. Part IV of the book examines both the internal and external sources of funding and the structuring of the financial and legal relationships that enable the project to be built.

Intended Readers

This book is designed for use both as an undergraduate textbook for engineers and as a reference for practising engineers. The material assumes little prior knowledge of engineering, accounting or financial management. It is intended for use as a text in undergraduate courses on either engineering economics or financial management. It may also be used in an engineering design course where the financial implications of design are under discussion.

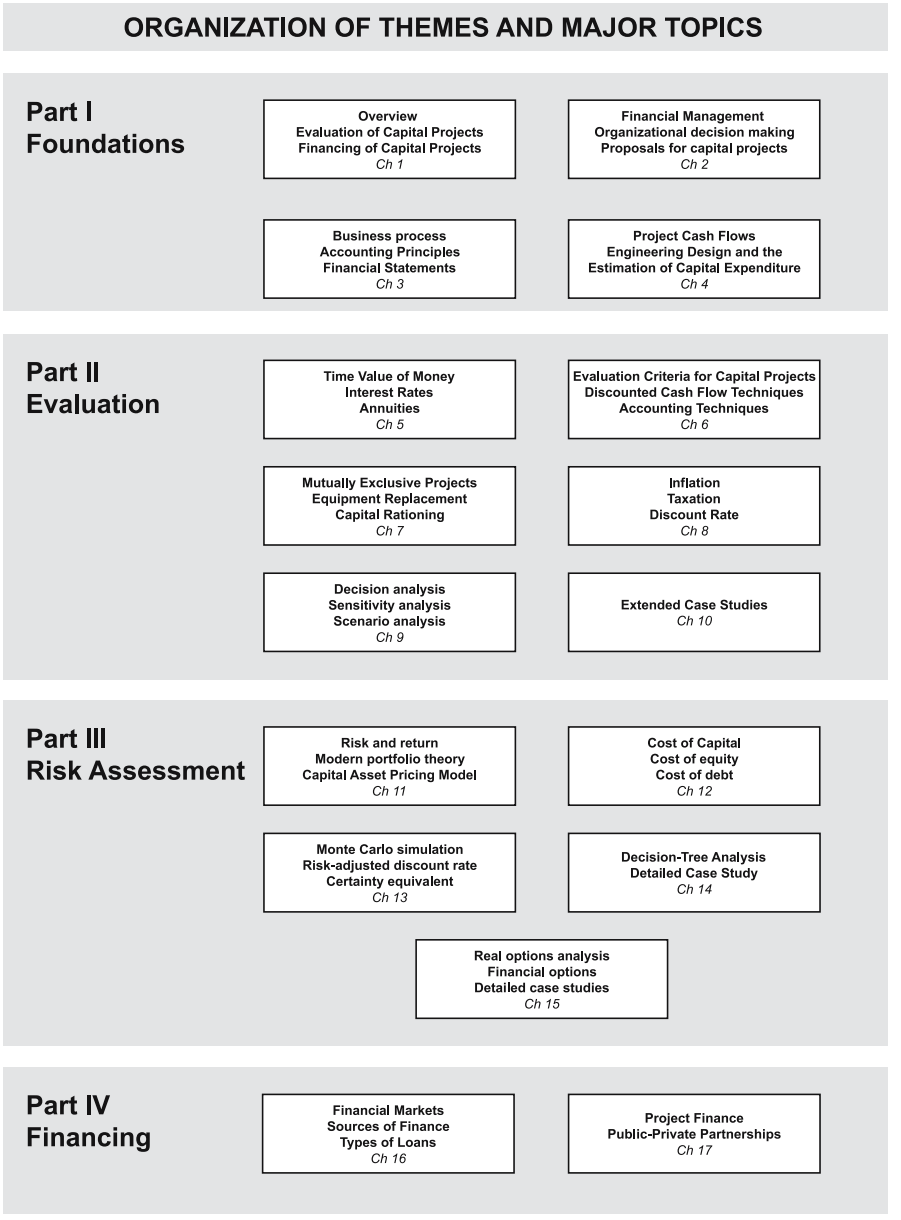
This book has been designed to accommodate all branches of engineering. Examples and case studies have been drawn from as wide a range of the engineering disciplines as possible. For example, there are case studies on, amongst others, hydroelectric power, pumping stations, toll roads, mining, processing technologies, and petroleum production. In addition, these examples cover different geographies, such as the US, the UK, Australia and Brazil, so that this book is relevant to the experience of engineers across the World. Another important example of this is that the difference in the accounting terminology used in the US and the UK for the preparation of financial statements is examined, and a translation table is provided as an Appendix.

Educational Package

The organization of the themes and the major topics of the book is shown in the diagram. A number of different courses can be derived from this book. An Introductory course in Engineering Economics might include a topic from the Part I as an introduction, and then focus on Part II, in which the evaluation of capital projects is discussed in detail. A more advanced course in Engineering Economics could select Chaps. 1 and 4 from Part I, move through Part II and end with Part IV. A course with the title of this book, Finance for Engineers, might cover the material in Part I,

Part II, Chapter 11 from Part III, and then end with Part IV. An advanced course in Financial Management for Engineers might cover all the topics.

Since this book is intended as a textbook and a reference, each chapter includes numerous worked examples and case studies. Each chapter also includes review questions and tutorial exercises. The review questions are designed to emphasize



the concepts that are covered in the chapter, while the exercises allow the reader to practise the application of the techniques discussed in the chapter. Worked solutions to almost all of the exercises are included in an Appendix.

Spreadsheet solutions of all the questions and the case studies presented in the book can be obtained from the website (www.springer.com/978-1-84800-032-2). These solutions provide learners and facilitators with hands-on material to ensure a more thorough understanding of the material. PowerPoint slides for the swift development of course material are also available on the website.

A detailed glossary of the important terms used is also provided as an Appendix.

Acknowledgements

Soon after starting my engineering consulting practice, I happened to meet Dr Wolter te Riele on campus. He suggested that I run a course on finance and economics for engineers. Several hundred delegates with an engineering training have attended my courses, including young professionals starting their careers, company CEOs, and MBA graduates. This book is a culmination of that suggestion of Wolter's and I would like to thank him for it. In addition, a number of people encouraged me to write this book, and pressed me to finish it. Kevan Ford and Natascha were prominent in this regard, and I express my appreciation.

I would like to thank Hazel Moller, Deryn Petty and particularly Natascha Uberbacher for reading and correcting the manuscript.

Frank Crundwell

Contents

List of Abbreviations

AOC	Annual Operating Charge
APR	Annual Percentage Rate
B/C	Benefit Cost Ratio
BOOT	Build, Own, Operate Transfer
BTO	Build, Transfer, Operate
CEV	Certainty Equivalent Value
CF	Cash Flow
CPI	Consumer Price Index
CR	Capital Recovery
DDB	Double Declining Balance
EAC	Equivalent Annual Charge
EPC	Engineering, Procurement and Construction
EPCM	Engineering, Procurement and Construction Management
ESL	Economic Service Life
FV	Future Value
FVA	Future Value of an Annuity
FVIFA	Future Value Interest Factor of an Annuity
GAAP	Generally Accepted Accounting Practices
GDP	Gross Domestic Product
ICO	Initial Capital Outlay
IPO	Initial Public Offering
LIBOR	London Interbank Offer Rate
MACRS	Modified Accelerated Cost Recovery System
MARR	Minimum Attractive Rate of Return
NPV	Net Present Value
OTC	Over The Counter
PV	Present Value
QDB	Quarter Declining Balance
RADR	Risk-Adjusted Discount Rate
ROA	Return On Assets
ROE	Return On Equity
SEC	Securities Exchange Commission
SGA	Sales, General and Administrative
SL	Straight Line Depreciation
SOYD	Sum Of Years Digits Depreciation
TV	Terminal Value
VaR	Value At Risk
WACC	Weighted Average Cost of Capital