

OPERATIONS STRATEGY

Principles and Practice

SECOND EDITION

JAN A. VAN MIEGHEM

Harold L. Stuart Distinguished Professor of Managerial Economics
Professor of Operations Management
Kellogg School of Management
Northwestern University

GAD ALLON

Professor of Operations Management
Kellogg School of Management
Northwestern University

Dynamic Ideas
43 Lantern Road
Belmont, Mass. 02478
U.S.A.
WWW information and orders: <http://www.dynamic-ideas.com>

Cover design: Patrick Ciano

© 2015 Van Mieghem

All rights reserved. No part of this book may be reproduced in any form by any electronic or mechanical means (including photocopying, recording, or information storage and retrieval) without permission in writing from the copyright holder.

Library of Congress Cataloging-In-Publication Data

Van Mieghem, Jan A.

Operations Strategy: Principles and Practice / Jan A. Van Mieghem, Gad Allon.—2nd ed.

p. cm.

Includes bibliographical references and index

ISBN 978-0-9899108-6-6

1. Operations Management. 2. Strategy. 3. Business Logistics. I. Allon, G. (Gad) II. Title.

HD38.5.MI 2015

To Shannon and our future:
Maximiliaan, Katharine, Marcus and Karolien

JVM

To Revital and our future:
Raz, Daya and Naomi

G.A.

ABOUT THE AUTHORS

Jan A. Van Mieghem

Dr. Van Mieghem is the Harold L. Stuart Distinguished Professor of Managerial Economics and Professor of Operations Management at the Kellogg School of Management of Northwestern University. He serves as the Academic Director of the Executive MBA Program. Previously he served as Senior Associate Dean of the Kellogg School and as chairman of the Managerial Economics and Decision Sciences department. He teaches courses in operations management and operations strategy in MBA, Ph.D. and executive programs and advises firms on those topics.

His research focuses on manufacturing, service and supply chain operations. His articles have appeared in leading journals, including *Annals of Applied Probability*, *Journal of Economic Theory*, *Management Science*, *Manufacturing and Service Operations Management* and *Operations Research*. He is past editor of the operations and supply chain area of *Operations Research* and has served on the editorial board of several journals.

Professor Van Mieghem is the co-author of the MBA textbook *Managing Business Process Flows: Principles of Operations Management*. He received his Ph.D. from the Graduate School of Business at Stanford University in 1995. Born in Belgium, he currently lives in Evanston, Illinois, with his wife and four children.

Gad Allon

Dr. Gad Allon is Professor of Managerial Economics, Decision Science, and Operations Management at the Kellogg School of Management at Northwestern University. He received his PhD in Management Science from Columbia Business School in New York and holds a Bachelor and a Master degree from the Israeli Institute of Technology.

His research interests include operations management in general, and service operations and operations strategy in particular. His articles have appeared in leading journals, including *Management Science*, *Manufacturing and Service Operations Management* and *Operations Research*. Professor Allon won the 2011 Wickham Skinner Early-Career Research Award of the Production and Operations Management Society. He is the Operations Management Department Editor of *Management Science* and serves on the editorial board of several journals.

Professor Allon teaches courses in operations management and operations strategy in MBA and executive programs. Professor Allon won the 2009 Outstanding Professor of the Year Award at Kellogg, the 2014 Alumni Professor of the year, and was recently named among the Worlds Top 40 B-School professors under the age of 40. Professor Allon regularly consults firms both on service strategy and operations strategy.

PREFACE

This book explains the principles of operations strategy and describes how companies can apply these principles in practice to increase value. Designing and implementing a successful operations strategy require judgment, experience, creativity, and luck, all of which cannot be taught. What *can* be taught, however, are the concepts, principles, and tools to help you in that process—and therein lies the purpose of this book.

“Principles and practice” is my guiding motto throughout this book. Going beyond telling war-stories, my goal is thus to describe the practice of operations strategy while revealing its driving principles in a structured manner. I am writing under the assumption that *we*—which in this book means you, the reader and I, the writer—seek to build sound intuition for designing, assessing, and improving operations strategies. I believe that sound intuition results from a journey of logical analysis that culminates in a theory. Good theory gives you intuition into the familiar, and beyond.

Each chapter opens with a description of how a real company practices some aspect of operations strategy and then reviews the concepts behind that practice. Tools are provided to analyze the concepts, distill their principles, and suggest guidelines for implementation and improvement. When appropriate, state-of-the-art research findings are integrated in the discussion. Each chapter closes with a mini-case that asks you to explore how you would apply the principles and tools in practice. The last part of the book contains a set of “full-blown” cases to integrate the chapters and emphasize the relevance of our topic to practice.

To increase accessibility, most analysis is described in words and is exhibited with minimal notation and mathematics. For example, equations are stated only if they capture a relationship better than words alone can. To increase usefulness and illustrate implementation, a particular example of each analysis is worked out in a spreadsheet (all spreadsheets can be downloaded from www.vanmieghem.us). More advanced analysis or spreadsheet implementations are relegated to appendices for those who are interested.

Though we are interested in designing *good* operations strategies, strategy evaluation is as much art as it is science. We will adopt a dual perspective that combines qualitative analysis with a financial evaluation of the value created by the operations strategy. Throughout this book, value will thus be our yardstick and our guide to assess and improve operations strategy. Merging the strategic and financial perspective should be natural to the intended reader:

I have written this book with a specific focus on MBA and engineering management students, and on their instructors. I hope that the structured approach

of using analysis to build intuition and reveal improvement levers within a coherent framework facilitates learning and instruction. While the book naturally follows a core course in operations and supply chain management and adopts basic financial evaluation, all concepts are explained “from scratch” to make the book accessible to every business or engineering management student. The book should also be of interest to consultants and practitioners as a reference for concepts, principles, and tools.

According to Francis Bacon, “writing makes an exact man.” While a valiant goal, operations strategy is not an exact science. Nor is there an agreed-upon paradigm for its study, let alone agreement on what exactly “is part” of operations strategy. Given these constraints, this book reflects my best effort to structure concepts and principles in a unified framework for operations strategy. Like any good operation, however, this really is a process of continuous improvement. It never ends, as better ways always exist. If you have any suggestions for improvement, I welcome hearing about them.

Jan Van Mieghem (Jan@VanMieghem.us)
July 13, 2007

CHANGES IN THE SECOND EDITION

This second edition contains changes along various dimensions. First, Professor Allon has joined this ongoing book project as second author. In 2010, Gad started teaching the MBA elective course, *Operations Strategy*, that Jan began designing and teaching in 1998. Second, while the first edition followed a “leading strategy,” in the sense that it contained material that hadn’t been taught yet, this second edition reflects how our MBA elective course has evolved over the last 7 years. It thus contains “class-room tested content.” These two changes led to a new chapter 2; majorly revised chapters 1, 3, 4, 5, 6, and 7 and appendix A; and minor revisions of the remaining chapters.

While we believe significant progress has been made, this book project remains a process of continuous improvement. It never ends, as better ways always exist. If you have any suggestions for improvement, we welcome hearing about them.

Jan Van Mieghem and Gad Allon
July 11, 2014

ACKNOWLEDGMENTS

This book results from the MBA elective course, *Operations Strategy*, that I began designing and teaching in 1998. It reflects the experience and knowledge of the colleagues, teachers, and managers that I have worked with. I have also benefited greatly from the experience, suggestions, and questions of the many MBA and executive students that I have interacted with; while I was teaching, I was learning even more.

Many people have helped me while writing this book. I would especially like to acknowledge the following people:

My students who collaborated with me or shared experiences that are described in this book: Troy Anderson, Mark Bruno, Steven Rudolf Bystriansky, Hsing-Chien (Ken) Chou, Mary Delaney (*Careerbuilder.com*), Hubert Fisher, Devika Gupta, Daisuke Kobayashi, Vikram Malhotra, Kai-Lung (Ron) Nien, Dan Nisser (*Cargill*), Thomas John O'Reilly, Chinmay Pandit, Dhruv Patel, Richard Pérez, Kitikun Prasithrathsint, Mark Price, Chris Recktenwald, Mani Sundaram, Ron Tamir, Brendan F. Tansill, Shaun Usmar, Christian Walters (*Harley-Davidson*), Stacey Watson (*Harley-Davidson*), all my OPNS454 students who provided feedback during Winter 2007 on a early version, and especially my doctoral advisee Lauren Lu (now at *Univ. of North Carolina*) for her research collaboration, careful readings, and suggestions.

All the colleagues who shared their knowledge, especially Gad Allon, Baris Ata, Sunil Chopra, and Marty Lariviere (*Northwestern University's Kellogg*) for all their encouragement during this long project. Sunil's energy and supply chain book have inspired me and Marty has been an incredibly valuable source of information on recent managerial developments. I would also like to thank: Dan Adelman (*University of Chicago*), Costis Maglaras (*Columbia University*), Serguei Netessine (*University of Pennsylvania's Wharton*), and Sharon Novak (*UCLA*) for carefully reviewing chapters and suggesting many improvements; John Birge (*University of Chicago*), Vishal Gaur (*NYU*), Steve Graves (*MIT*), Panos Kouvelis (*University of St. Louis*), Christoph Loch, Ioana Popescu and Nils Rudi (*INSEAD*), Costis Maglaras (*Columbia University*), Scott McKeon (*Northwestern University's Kellogg*), Glen Schmidt (*University of Utah*), and Serguei Netessine (*University of Pennsylvania's Wharton*) for sharing their teaching materials.

All the friends, managers, and professionals for sharing their time, knowledge and experience, especially: Eddy Dumarey (*Cortina*), Maggie and Ken Fleming (for fine culinary and carpentry provisions), Bill Fox (*Eli Lilly*), Cort Jacoby and Ruchir Nanda (*Deloitte Consulting*), Marc van Gelder and Mike Brennan (*Peapod*), Philippe Geyskens (*Digitas*), Luc Kerkhof (*Poppies*), Colin Kessinger (*Vivecon*), Jeff Pharris (*Harley-Davidson*), Martine Van Campenhout (*Procter & Gam-*

ble), and Dirk Wouters (*Dynaco*).

I am especially grateful to Alexandru Rus for compiling the references, glossary, and indexes, as well as for offering many suggestions; to Akhila Kolisetty for final copy-editing the entire manuscript; and to Joshua Miller for all his help during graphic design and typesetting. It is a joy having assistance of that caliber—I could not have finished this project in time without them. (They compressed time during the last week through time-shifting: Josh worked in Evanston, Alex was vacationing in Romania, and Akhila in India!) Meg Stuart and Kate Iberg edited several chapters in early format. Many thanks to Uwe Kern (author of `xcolor.sty`), Frank Mittelbach (author of the `LATEX Companion`), Michael Sofka, Lieven Vandenberghe, and my brother Piet for generously sharing their knowledge of `LATEX`. I am grateful to my editor and colleague, Dimitris Bertsimas, for publishing my book, and to Laura Rose for her careful handling of the production.

I am particularly indebted to the organization that has graced my business card for the last 12 years—after all, this book would have never seen the light of day without the Kellogg School of Management. I am also thankful for the hospitality of the Katholieke Universiteit Leuven during my sabbatical in 2005, when half this book was written.

Finally, and most importantly, I would like to thank my lovely wife, Shannon Cahill, for her unwavering support during this project and so many others. She managed the family with a smile, even during my extensive absence during the last months of this project. It is done at last!

Jan Van Mieghem (Jan@VanMieghem.us)
July 13, 2007

SECOND EDITION: ADDITIONAL ACKNOWLEDGMENTS

We would like to thank our colleagues Pamela K. Armstrong (*University of Maryland*), Robert Boute (*Vlerick - KU Leuven*), Lieven DeMeester (*Singapore Management University*), Lauren X. Lu (*UNC*), Inneke Van Nieuwenhuyse (*KU Leuven*), and Fuqiang Zhang (*Washington University at St. Louis*); our Ph.D. students Kejia Hu, Dennis Jiajun Zhang, Katarina Sonja Eriksson (*Linnaeus University*); and our undergraduate students Anne Xie and Jenny Zhou for carefully reviewing new and revised chapters and suggesting many improvements. Thanks to Brian Tomlin (*Dartmouth University*) and Seenu Sarma (*Deloitte Consulting*) for sharing experiences and several figures. Our ongoing collaboration with Seenu and Deloitte Consulting has resulted in our improved location framework.

We are grateful to Michael Anderson for all his help in graphic design. We thank our editor and colleague, Dimitris Bertsimas, for publishing this second edition, Patrick Ciano for the cover design, and Laura Rose for her careful handling of the production.

Jan Van Mieghem and Gad Allon
July 11, 2014



CONTENTS

Preface	vii
I Operations Strategy: Concept, Value and Capabilities	1
1 Operations Strategy: Concept and VCAP Framework	3
1.1 Operations Strategy	3
1.2 Operating System = Assets + Processes	6
1.3 Operations Strategy Framework: VCAP	6
1.4 Operations Strategy: Relation with Operations Management and Competitive Strategy	10
1.5 The Capabilities View of Operations	13
1.6 Assets: The Resource View of Operations	17
1.7 The Process View of Operations	19
1.8 RoadMap	25
1.9 Applying the VCAP Framework: Zara	27
1.10 Summary of Learning Objectives	29
Discussion Questions	30
Further Reading and References	31
Appendix 1: Three Tools to Tailor Operations	33
Mini-Case 1: The Swiss Watch Industry	38
2 Value Creation and Operations: The Investor View	41
2.1 The External View and Operations Forensics	41
2.2 Quantifying Value Creation from Operations	43
2.3 Identifying and Ranking Operational KPIs	46
2.4 Linking ROIC to operations	47
2.5 Linking Profit and Value to Process Flows	50
2.6 Industrial Applications	55
2.7 Summary of Learning Objectives	55
Further Reading and References	56
Appendix 2: Linking Financials to Detailed Process Flows	59

3	Capabilities, Competition and Operations	61
3.1	Determining Defensibility	61
3.2	Efficient Frontier	63
3.3	The Concept of Operational Trade-off	64
3.4	Operational trade-off curves to analyze a competitive threat . . .	68
3.5	Example: Using Operational Equipment Efficiency (OEE) to Assess Defensibility	70
3.6	Shaping Operational Trade-offs: Examples	73
3.7	Properties of Operational Trade-offs	78
3.8	How to improve Operational Efficiency? Focus!	83
3.9	Operational Efficiency and Productivity	88
3.10	Guidelines for Operations-based Competitive Advantage	91
3.11	Summary of Learning Objectives	93
	Discussion Questions	95
	Challenge Questions	96
	Further Reading and References	96
	Mini-Case 3: FedEx v. UPS	98
	Appendix 3: Data Envelopment Analysis (DEA)	99
II	The Resource View: Tailoring Real Assets	103
4	Strategic Capacity Sizing and Investment	105
4.1	Capacity Strategy: The Concept	105
4.2	Capacity Strategy: Decisions and Trade-offs	109
4.3	Challenges for Capacity Strategy	111
4.4	Forecasting and Modeling Uncertainty	115
4.5	Tools to incorporate uncertainty into capacity analysis	120
4.6	Optimal Capacity Sizing	122
4.7	Capacity Risk and Operational Hedging	124
4.8	Guidelines for Capacity Sizing	131
4.9	Summary of Learning Objectives	133
	Discussion Questions	134
	Challenge Questions	135
	Further Reading and References	136
	Mini-Case 4: Gujarat Apollo Industries Ltd	138
	Appendix 4A: Capacity and Bottleneck OEE and TEEP	139
	Appendix 4B: Capacity-Inventory-Waiting Trade-offs	140
5	Dynamic Capacity Sizing: Timing and Expansion	149
5.1	Dynamic Capacity Strategies	149
5.2	Five Capacity Timing Strategies	153
5.3	Capacity Expansion Cost and Scale Economies	158
5.4	Modeling Dynamic Capacity Strategies: Level 1 (Classic Timing Model)	161
5.5	Modeling Dynamic Capacity Strategies: Level 2 (Real Options)	165
5.6	Modeling Dynamic Capacity Strategies: Level 3 (DCF Simulations)	170
5.7	Tactical Capacity Adjustment: Aggregate Planning	173
5.8	Leadtimes, Irreversibility, and Service Levels	178
5.9	Guidelines for Dynamic Capacity Strategies	182

5.10	Application: Rationalizing Sharp’s Sakai Factory	184
5.11	Summary of Learning Objectives	186
	Discussion Questions	188
	Challenge Questions	188
	Further Reading and References	188
	Mini-Case 5: Timing of IT expansions	190
	Appendix 5: Linear Planning Optimization in Excel	192
6	Asset and Network Flexibility and Consolidation	195
6.1	Different Kinds and Benefits of Flexibility	195
6.2	Obstacles to Achieving Flexibility	202
6.3	Asset Flexibility: Valuation and Consolidation	203
6.4	Network Flexibility	210
6.5	Modeling and Optimizing Network Flexibility	213
6.6	Tailored Network Flexibility	218
6.7	Product Design Strategies for Flexibility	221
6.8	Mass Customization	225
6.9	Guidelines for Capacity Flexibility	228
6.10	Summary of Learning Objectives	229
	Discussion Questions	231
	Analytical Questions	232
	Further Reading and References	232
	Mini-Case 6: Strategic Network Flexibility using FlexCap	234
	Appendix 6: Optimization using Simulation in Excel	237
7	Asset Location, Global Networks and Offshoring	241
7.1	Why firms globalize their operations	241
7.2	Strategic Framework for Location Decisions	247
7.3	Total Landed Cost (TLC) analysis	250
7.4	Integrating Location with operations strategy	253
7.5	Network and Competitive Location Analyses	257
7.6	Network Choices: Centralize or Distribute?	260
7.7	Network Choices: Localize or Standardize?	263
7.8	Global Network Choices: Integrate or Separate?	264
7.9	Global Network Choice: Offshoring and Reshoring	266
7.10	Global Network Valuation: Flexibility and Currency Risk	271
7.11	Guidelines	274
7.12	Summary of Learning Objectives	275
	Discussion Questions	277
	Further Reading and References	277
	Mini-Case 7: Mexico or China? Managing a Global Network	279
III	The Process View: Tailoring Activity Networks	283
8	Strategic Sourcing, Supply Management, and Outsourcing	285
8.1	Strategic Sourcing: Concept and Framework	285
8.2	The Spectrum of Sourcing Relationships	290
8.3	A Framework for the Outsourcing Decision	297
8.4	Total Cost of Ownership	300

8.5	Structured Sourcing Contracts	305
8.6	Multi-sourcing and Tailored Sourcing	310
8.7	Technology, Sourcing, and Value Chain Disintegration	313
8.8	Guidelines for Successful Sourcing	317
8.9	Summary of Learning Objectives	319
	Discussion Questions	320
	Further Reading and References	321
	Mini-Case 8: Bose 301SE: Sourcing and Contracting	323
9	Demand and Revenue Management	325
9.1	Demand and Revenue Management: Concepts	325
9.2	Obstacles to Revenue Management	331
9.3	Customer Segmentation and Product Design	332
9.4	Time Segmentation and Dynamic Pricing	339
9.5	Capacity Reservation and Overbooking	344
9.6	Capacity Segmentation and Allocation	352
9.7	Summary of Learning Objectives	357
	Discussion Questions	359
	Challenge Questions	360
	Further Reading and References	360
	Appendix 9: Price Optimization of Linear Demand	362
10	Risk Management and Operational Hedging	365
10.1	Risk Management: Concept and Process	365
10.2	Identification of Operational Hazards	370
10.3	Risk Assessment and Valuation	373
10.4	Tactical Risk Decisions	379
10.5	Strategic Risk Mitigation	381
10.6	Four Operational Hedging Strategies	384
10.7	Financial Hedging of Operational Risk	387
10.8	Tailored Operational Hedging	391
10.9	Guidelines for Operational Risk Management	396
10.10	Summary of Learning Objectives	397
	Discussion Questions	398
	Analytical Questions	399
	Further Reading and References	399
	Mini-Case 10: Dell Computer	400
11	Improvement and Innovation	401
11.1	Improvement as a Process	401
11.2	Learning and Improvement	407
11.3	The Learning Curve	410
11.4	Innovation and Unforeseeable Uncertainty	416
11.5	Managing Unk Unks and Complexity in Innovation	420
11.6	Innovation, Improvement, and Encroachment	423
11.7	Innovation, Improvement, and Competition	425
11.8	Guidelines for Improvement and Innovation	429
11.9	Summary of Learning Objectives	430
	Discussion Questions	432
	Further Reading and References	432

Mini-Case 11: Quantum-Seagate: Competing on Innovation	434
IV Integrating Case Studies	439
12 Harley-Davidson Motor Company	441
History (1903-1992) and Company Information	441
The 1992 Capacity Decision	447
More Growth in Demand	449
Strategic Choices	451
Discussion Questions	453
13 Seagate Technology	455
Discussion Questions	463
14 Peapod	465
Grocery Industry Overview	465
Peapod	468
Webvan	473
What's Next? Tesco's Entry	474
Discussion Questions	475
Appendix 14: Peapod's Operating Data	478
V Book Appendices	479
A Discounting and Calculating NPV for Operations Strategy	481
B Make-to-Stock Operations (EOQ Model)	489
C Safety Capacity and Inventory (Newsvendor Model)	493
D Make-to-Order and Service Operations (Queuing Model)	499
E Simple Forecasting Techniques	503
Glossary	505
Notation	515
Name Index	517
Subject Index	521

2 Defining Operations Strategy 2.1 What is Operations Management? 2.2 The Role of Services in Operations Management 2.3 What is Strategy? 2.4 What is Operations Strategy? 3 Operations Strategy Formulation 3.1 Hill framework for Operations Strategy Formulation. 4 Lean Operations. 360° . Operations strategies drive a company's operations, the part of the business that produces and distributes goods and services. Operations strategy underlies overall business strategy, and both are critical for a company to compete in an ever-changing market. With an effective ops strategy, operations management professionals can optimize the use of resources, people, processes, and technology. In the book Operations Strategy, authors Nigel Slack and Michael Lewis define the term.