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工商管理经典教材·运营管理系列

Administration Classics

运营
供需匹配
Matching
Supply

管理
的视角

(英文版·第2版)

with Demand
(Second Edition)

杰拉德·卡桑 (Gérard Cachon)

著

克里斯蒂安·特维施 (Christian Terwiesch)

任建标 改编

中国人民大学出版社

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Matching Supply with Demand

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· 北京 ·



总 序

随着我国加入 WTO,越来越多的国内企业参与到国际竞争中来,用国际上通用的语言思考、工作、交流的能力也越来越受到重视。这样一种能力也成为我国各类人才参与竞争的一种有效工具。国家教育机构、各类院校以及一些主要的教材出版单位一直在思考,如何顺应这一发展潮流,推动各层次人员通过学习来获取这种能力。双语教学就是这种背景下的一种尝试。

双语教学在我国主要指汉语和国际通用的英语教学。事实上,双语教学在我国教育界已经不是一个陌生的词汇了,以双语教学为主的科研课题也已列入国家“十五”规划的重点课题。但从另一方面来看,双语教学从其诞生的那天起就被包围在人们的赞成与反对声中。如今,依然是有人赞成有人反对,但不论是赞成居多还是反对占上,双语教学的规模 and 影响都在原有的基础上不断扩大,且呈大发展之势。一些率先进行双语教学的院校在实践中积累了经验,不断加以改进;一些待进入者也在模仿中学习,并静待时机成熟时加入这一行列。由于我国长期缺乏讲第二语言(包括英语)的环境,开展双语教学面临特殊的困难,因此,选用合适的教材就成为双语教学成功与否的一个重要问题。我们认为,双语教学从一开始就应该使用原版的各类学科的教材,而不是由本土教师自编的教材,从而可以避免中国式英语问题,保证语言的原汁原味。各院校除应执行国家颁布的教学大纲和课程标准外,还应根据双语教学的特点和需要,适当调整教学课时的设置,合理选择优秀的、合适的双语教材。

顺应这样一种大的教育发展趋势,中国人民大学出版社同众多国际知名的大出版公司,如麦格劳-希尔出版公司、培生教育出版公司等合作,面向大学本科生层次,遴选了一批国外最优秀的管理类原版教材,涉及专业基础课,人力资源管理、市场营销及国际化管理等专业方向课,并广泛听取有着丰富的双语一线教学经验的教师的建议和意见,对原版教材进行了适当的改编,删减了一些不适合我国国情和不适合教学的内容;另一方面,根据教育部对双语教学教材篇幅合理、定价低的要求,我们更是努力区别于目前市场上形形色色的各类英文版、英文影印版的大部头,将目标受众锁定在大学本科生层次。本套教材尤其突出了以下一些特点:

- 保持英文原版教材的特色。本套双语教材根据国内教学实际需要,对原书进行了一定的改编,主要是删减了一些不适合教学以及不符合我国国情的内容,但在体系结构和内容特色方面都保持了原版教材的风貌。专家们的认真改编和审定,使本套教材既保持了学术上的完整性,又贴近中国实际;既方便教师教学,又方便学生理解和掌握。

- 突出管理类专业教材的实用性。本套教材既强调学术的基础性,又兼顾应用的广泛性;既侧重让学生掌握基本的理论知识、专业术语和专业表达方式,又考虑到教材和管理实践的紧密结合,有助于学生形成专业的思维能力,培养实际的管理技能。

● 体系经过精心组织。本套教材在体系架构上充分考虑到当前我国在本科教育阶段推广双语教学的进度安排，首先针对那些课程内容国际化程度较高的学科进行双语教材开发，在其专业模块内精心选择各专业教材。这种安排既有利于我国教师摸索双语教学的经验，使得双语教学贴近现实教学的需要；也有利于我们收集关于双语教学教材的建议，更好地推出后续的双语教材及教辅材料。

● 篇幅合理，价格相对较低。为适应国内双语教学内容和课时上的实际需要，本套教材进行了一定的删减和改编，使总体篇幅更为合理；而采取低定价，则充分考虑到了学生实际的购买能力，从而使本套教材得以真正走近广大读者。

● 提供强大的教学支持。依托国际大出版公司的力量，本套教材为教师提供了配套的教辅材料，如教师手册、PowerPoint 讲义、试题库等，并配有内容极为丰富的网络资源，从而使教学更为便利。

本套教材是在双语教学教材出版方面的一种尝试。我们在选书、改编及出版的过程中得到了国内许多高校的专家、教师的支持和指导，在此深表谢意。同时，为我们后续推出的教材更适于教学，我们也真诚地期待广大读者提出宝贵的意见和建议。需要说明的是，尽管我们在改编的过程中已加以注意，但由于各教材的作者所处的政治、经济和文化背景不同，书中内容仍可能有不妥之处，望读者在阅读时注意比较和甄别。

徐二明
中国人民大学商学院

战略大师迈克尔·波特在《哈佛商业评论》(Harvard Business Review)上发表的经典论文《什么是战略?》(What is Strategy?)一针见血地指出:人们通常将运营效益与战略混为一谈,为了追求生产率、质量和速度,企业发明了许多运营管理工具和手段,虽然运营效率大幅提高,但却无法把这些改进转换成持续的获利能力,不知不觉中管理工具取代了战略,当管理者正在奋力推动管理工具的同时,他们却离成功越来越远。另一方面,好的战略必须以事实和数据为基础,而且要有详细和具体的运营方案。如果缺乏事实基础和具体可行的方案,战略就有可能成为一个宣传口号或是毫无意义的愿景。试想一下我们国家有多少企业整天喊着战略口号、打着战略旗帜,却没有具体可以执行的运营方案。

为了从战略的视角研究企业运营管理中的一些关键决策与管理议题,由全球顶尖的沃顿商学院运营与信息管理系的杰拉德·卡桑和克里斯蒂安·特维施教授合著的《运营管理——供需匹配的视角》是一部从企业供应与需求相匹配的战略视角出发,重视理论介绍与实践应用相结合,结构新颖而又具有实践指导意义的全新的运营管理教材。两位作者在美国商学院的运营管理研究和教学中都非常出色,在运营管理学界享有很高的声誉。他们的教材自2002年首版问世以来已经被美国许多研究型商学院教授采用,足以看出该教材的学术水平和实用价值。

本书具有以下几个特点:

1. 全新的运营管理体系架构。作者以企业运营管理中供给与需求不匹配的现象为主线,结合流程分析、库存管理和供应链管理等内容,详细介绍企业如何应对这一问题。作者把传统的企业内部的生产与运作管理纳入企业供应链管理,从而扩大了运营管理的研究范围、拓宽了运营管理的研究视角、完善了运营管理的体系,并且体现了运营管理研究的发展趋势。作者为了配合各章还特意使用专门的模块详细描述了解决运营管理中的一些具体的决策问题,给出了进行这些决策的方法和工具以支持和完善运营管理的体系架构。

2. 重视运营管理的基础训练。作者认为即使在严格的学术环境下,职业需要的仍是在现实中加以应用的工具和策略。作者通过介绍在现实的运营管理环境中如何运用运营模型,来达到分析问题、解决问题的目的,特别强调对模型的详细介绍,解释如何在现实中获得这些参数,并且开放性地讨论每一个模型/战略在应用中面临的挑战,从而使学生获得运营管理的基础训练,知道如何将理论应用于实践。

3. 大量结合企业实践的案例研究。本书的指导方针就是“真实的运营管理,真正的简单易懂”。“真实的运营管理”指本书的大多数章节都是根据某个具体公司的实际情况编写的。本书案例的选取具有较强的代表性,选择了大量不同类型的公司,小型的和大型的,服务业、制造业以及零售业等,对实际工作具有较强的指导作用。作者为了强调案例在学习中的作用,除在正文中大量使用案例外,在练习中也主要采用案例分析的方法,对提高读者分析运营管理的实际问题的能力有很大的促进作用。

用。我们相信，通过这些案例和习题，可以使读者掌握应对运营管理问题和挑战的方法和工具。

为了使本书更加适合我国高校相关专业“运营管理”课程的教学需求，考虑到我国高校相关专业的课程体系、教学大纲、课程学分与课时及学生对教材价格的要求，改编者根据多年使用该原版教材的课堂教学经验，在保证内容的系统性和特色的前提下，对部分内容进行了必要的改编。改编后由原来的16章缩减为13章。主要改编依据如下：

一是根据学生的反馈认为对有些专题的介绍过于深入，删除第8章和第12章。

二是保持本书始终围绕运营管理的职能主线的阐述框架，删除相对独立的结合定价和能力设置的与营销交叉的内容，即第15章。

三是为了降低定价，缩减篇幅，在不影响全书结构和风格的前提下，删除了一些不必要的附录。

经过改编，本书适合作为我国高等学校相关专业的本科生、研究生、MBA教学尤其是双语教学的教材，也适合作为企业管理人员的培训及自学用书。

本书的改编得到了麦格劳-希尔教育出版公司和中国人民大学出版社的支持，在此表示感谢。由于本人学识和教学经验所限，改编中难免存在疏漏与不妥之处，敬请各位读者批评指正。

任建标

上海交通大学安泰经济与管理学院

Preface*

This book represents our view of the essential body of knowledge for an introductory operations management course. In the years that we have been teaching operations at The Wharton School, our students have repeatedly asked us for recommended readings to go along with the cases and lectures in our courses. Unfortunately, our students found all our suggestions either too remote from the real world (fictitious companies with unrealistic assumptions) or too technical (measured by the number of Greek letters per page).

Given those shortcomings of existing textbooks, our guiding principle in the development of *Matching Supply with Demand* has been “real operations, real solutions.” “Real operations” means that most of the chapters in this book are written from the perspective of a specific company so that the material in this text will come to life by discussing it in a real-world context. Companies and products are simply easier to remember than numbers and equations. We have chosen a wide variety of companies, small and large, representing services, manufacturing, and retailing alike. While obviously not fully representative, we believe that—taken together—these cases provide a realistic picture of operations management problems today.

“Real solutions” means that we do not want equations and models to merely provide students with mathematical gymnastics for the sake of an intellectual exercise. We feel that professional training, even in a rigorous academic setting, requires tools and strategies that students can implement in practice. We achieve this by demonstrating how to apply our models from start to finish in a realistic operational setting. For example, we do not assume the existence of inputs such as a demand forecast or a cost parameter; we actually explain how these inputs can be obtained in practice. Furthermore, we openly address the implementation challenges of each model/strategy we discuss so that students know what to expect when the “rubber hits the pavement.”

To fully deliver on “real operations, real solutions,” we also must adhere to the principle of “real simple.” Do not worry; “real simple” does not mean plenty of “blah-blah” without any analytical rigor. Quite the contrary. To us, “real simple” means hard analysis that is made easy to learn. This is crucial for an operations text. Our objective is to teach business leaders, not tacticians. Thus, we need students to be able to quickly develop a foundation of formal models so that they have the time to explore the big picture, that is, how operations can be transformed to provide an organization with sustainable competitive advantage and/or superior customer service. Students that get bogged down in details, equations, and analysis are not fully capturing the valuable insights they will need in their future career.

So how do we strive for “real simple”? First, we recognize that not every student comes to this material with an engineering/math background. As a result, we tried to use as little mathematical notation as possible, to provide many real-world examples, and to adhere to consistent terminology and phrasing. Second, we provide various levels of detail for each analysis. For example, every little step in an analysis is described in the text via an explicit example; then a summary of the process is provided in a “how to” exhibit, a brief listing of key notation and equations is provided at the end of each chapter, and, finally, solved practice problems are offered to reinforce learning. While we do humbly recognize, given the quantitative sophistication of this text, that “much simpler” might be more accurate than “real simple,” we nevertheless hope that students will be pleasantly surprised to discover that their analytical capabilities are even stronger than they imagined.

The initial version of *Matching Supply with Demand* made its debut in portions of the operations management core course at Wharton in the 2002–2003 academic year. This

* 为保留原书概貌，未对前言做删减。——改编者注

edition incorporates the feedback we have received over the last five years from many students, executives, and colleagues, both at Wharton and abroad.

Although this book has been designed with MBA students in mind (regular and executive), this should not rule out its appeal to an undergraduate curriculum. Moreover, while you will probably not find this book in any airport bookstore (it is not that simple), we firmly believe that professionals in areas such as process analysis, supply chain management, and service operations also will benefit from its content.

We teach the importance of quality in operations, and so we take quality quite seriously with this text. We are proud that we discovered no major defect in the first edition and only a reasonable number of minor defects. (Though, much to our embarrassment, a rather trivial error slipped into the first page of the first edition—a humbling experience in the never-ending quest for zero defects.) We have corrected all known first edition defects and so we hope that the second edition provides even better quality. Nevertheless, as before, we know there must be some defects lurking, so we welcome hearing about them.

Gérard Cachon

Christian Terwiesch

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Introduction

A central premise in economics is that prices adjust to match supply with demand: if there is excess demand, prices rise; if there is excess supply, prices fall. But while an economist may find comfort with this theory, managers in practice often do not. To them excess demand means lost revenue and excess supply means wasted resources. They fully understand that matching supply with demand is extremely difficult and requires more tools than just price adjustments.

Consider the following examples:

- In 2006, Nintendo launched the Wii game console with much success—so much success that the company could not make enough units to keep up with demand. Some entrepreneurs would wait in long lines to purchase scarce units only to turn around and sell them online for several hundred dollars over the retail price.
- In 2007, Dell lost its worldwide market share leadership to HP. Trying to regain momentum, Dell offered laptop computers to consumers in various colors. Unfortunately, problems with dust contamination in the painting process prevented Dell from ramping up production, causing long delays, which in turn caused some customers to cancel their order.
- In January 2004, Vanguard enjoyed the good fortune of a net inflow of \$9.4 billion into its mutual funds. Unfortunately, Vanguard, who is well known for their low cost mutual funds, had a hard time handling the flood of calls to its call center—for the first three weeks in January, the average investor spent nearly seven minutes waiting for her or his call to be answered by a Vanguard representative. Before this surge in activity, Vanguard normally answered calls within 55 seconds. Vanguard began hiring to bolster its staffing but took several months to return service back to an acceptable level.
- In July 2007, a 6.8-magnitude earthquake hit central Japan and seriously damaged the production facility of Riken Corp., maker of piston rings costing about \$1.50 each. Consequently, due to a lack of parts, Toyota was forced to shut down 12 factories and lost an estimated production of 46,000 vehicles.
- In 2005, Airbus announced a production delay for its new 550-passenger jumbo jet, the A380. The company put the blame on production complications with the miles of wiring in the aircraft. In June 2006 the company announced a second production delay, again due to complications with wiring, indicating that the problem had not been solved. As a result, Airbus estimated that it would lose 4 billion euros from its bottom line over the next four years.
- In early 2002, a victim of a car crash in Germany died in a rescue helicopter after the medical team together with their dispatcher had unsuccessfully attempted to find a slot in an operating room at eight different hospitals. In the United States, every day there are thousands of patients requiring emergency care who cannot be transported to the nearest emergency room and/or have to wait considerable time before receiving care.

- There were 95 million doses of the flu vaccine produced for the 2002–2003 flu season in the United States. Unfortunately, 12 million doses were not used and had to be destroyed (a vaccine is good only for one flu season). Only 83 million doses of the flu vaccine were produced for the next season, 2003–2004. (Not coincidentally, $95 - 12 = 83$.) Unfortunately, in that season there were widespread shortages, leading to flu-related deaths, especially in Colorado.

All of these cases have in common that they suffer from a mismatch between demand and supply, with respect either to their timing or to their quantities.

This book is about how firms can design their operations to better match supply with demand. Our motivation is simply stated: By better matching supply with demand, a firm gains a significant competitive advantage over its rivals. A firm can achieve this better match through the implementation of the rigorous models and the operational strategies we outline in this book.

To somewhat soften our challenge to economic theory, we do acknowledge it is possible to mitigate demand–supply mismatches by adjusting prices. For example, the effective market price of the Wii game console did rise due to the strong demand. But this price adjustment was neither under Nintendo’s control, nor did Nintendo (or its retailers) collect the extra surplus. In other words, we view that price adjustment as a symptom of a problem, rather than evidence of a healthy system. Moreover, in many other cases, price adjustments are impossible. The time period between the initiation of demand and the fulfillment through supply is too short or there are too few buyers and sellers in the market. There simply is no market for emergency care in operating rooms, waiting times in call centers, or piston rings immediately after an earthquake.

Why is matching supply with demand difficult? The short answer is that demand can vary, in either predictable or unpredictable ways, and supply is inflexible. On average, an organization might have the correct amount of resources (people, product, and/or equipment), but most organizations find themselves frequently in situations with resources in the wrong place, at the wrong time, and/or in the wrong quantity. Furthermore, shifting resources across locations or time is costly, hence the inflexibility in supply. For example, physicians are not willing to rush back and forth to the hospital as they are needed and retailers cannot afford to immediately move product from one location to another. While it is essentially impossible to always achieve a perfect match between supply and demand, successful firms continually strive for that goal.

Table 1.1 provides a sample of industries that we will discuss in this book and describes their challenge to match supply with demand. Take the airline industry (last column in Table 1.1.). For fiscal year 2007, British Airways achieved a 76.1 percent utilization; that is, a 160-seat aircraft (the average size in their fleet) had, on average, 122 seats occupied with a paying passenger and 38 seats flying empty. If British Airways could have had four more (paying) passengers on each flight, that is, increase its utilization by about 2.5 percent, its corporate profits would have increased by close to £242 million, which is about 44 percent of its operating profit for 2007. This illustrates a critical lesson: Even a seemingly small improvement in operations, for example, a utilization increase of 2.5 percent, can have a significant effect on a firm’s profitability precisely because, for most firms, their profit (if they have a profit) is a relatively small percentage of their revenue. Hence, improving the match between supply and demand is a critically important responsibility for a firm’s management.

The other examples in Table 1.1 are drawn from a wide range of settings: health care delivery and devices, retailing, and heavy industry. Each suffers significant consequences due to demand–supply mismatches, and each requires specialized tools to improve and manage its operations.

To conclude our introduction, we strongly believe that effective operations management is about effectively matching supply with demand. Organizations that take the design of their operations seriously and aggressively implement the tools of operations management

TABLE 1.1 Examples of Supply–Demand Mismatches

	Retailing	Iron Ore Plant	Emergency Room	Pacemakers	Air Travel
Supply	Consumer electronics	Iron ore	Medical service	Medical equipment	Seats on specific flight
Demand	Consumers buying a new video system	Steel mills	Urgent need for medical service	Heart surgeon requiring pacemaker at exact time and location	Travel for specific time and destination
Supply exceeds demand	High inventory costs; few inventory turns	Prices fall	Doctors, nurses, and infrastructure are underutilized	Pacemaker sits in inventory	Empty seat
Demand exceeds supply	Forgone profit opportunity; consumer dissatisfaction	Prices rise	Crowding and delays in the ER; potential diversion of ambulances	Forgone profit (typically not associated with medical risk)	Overbooking; customer has to take different flight (profit loss)
Actions to match supply and demand	Forecasting; quick response	If prices fall too low, production facility is shut down	Staffing to predicted demand; priorities	Distribution system holding pacemakers at various locations	Dynamic pricing; booking policies
Managerial importance	Per-unit inventory costs for consumer electronics retailing all too often exceed net profits	Prices are so competitive that the primary emphasis is on reducing the cost of supply	Delays in treatment or transfer have been linked to death	Most products (valued \$20k) spend 4–5 months waiting in a trunk of a salesperson before being used	About 30% of all seats fly empty; a 1–2% increase in seat utilization makes the difference between profits and losses
Reference	Chapter 2, The Process View of the Organization; Chapter 10, Betting on Uncertain Demand: The Newsvendor Model	Chapter 3, Understanding the Supply Process: Evaluating Process Capacity; Chapter 4, Estimating and Reducing Labor Costs	Chapter 7, Variability and Its Impact on Process Performance: Waiting Time Problems	Chapter 11, Service Levels and Lead Times in Supply Chains: The Order-up-to Inventory Model	

will enjoy a significant performance advantage over their competitors. This lesson is especially relevant for senior management given the razor-thin profit margins firms must deal with in modern competitive industries.

1.1 Learning Objectives and Framework

In this book, we look at organizations as entities that must match the supply of what they produce with the demand for their product. In this process, we will introduce a number of quantitative models and qualitative strategies, which we collectively refer to as the “tools of operations management.” By “quantitative model” we mean some mathematical procedure or equation that takes inputs (such as a demand forecast, a processing rate, etc.) and outputs a number that either instructs a manager on what to do (how much inventory to buy, how many nurses to have on call, etc.) or informs a manager about a relevant performance

measure (e.g., the average time a customer waits for service, the average number of patients in the emergency room, etc.). By “qualitative strategy” we mean a guiding principle: for example, increase the flexibility of your production facilities, decrease the variety of products offered, serve customers in priority order, and so forth. The next section gives a brief description of the key models and strategies we cover. Our learning objective for this book, put as succinctly as we can, is to teach students how and when to implement the tools of operations management.

Just as the tools of operations management come in different forms, they can be applied in different ways:

1. Operations management tools can be applied to ensure that resources are used as efficiently as possible; that is, the most is achieved with what we have.
2. Operations management tools can be used to make desirable trade-offs between competing objectives.
3. Operations management tools can be used to redesign or restructure our operations so that we can improve performance along multiple dimensions simultaneously.

We view our diverse set of tools as complementary to each other. In other words, our focus is neither exclusively on the quantitative models nor exclusively on the qualitative strategies. Without analytical models, it is difficult to move beyond the “blah-blah” of strategies and without strategies, it is easy to get lost in the minutia of tactical models. Put another way, we have designed this book to provide a rigorous operations management education for a strategic, high-level manager or consultant.

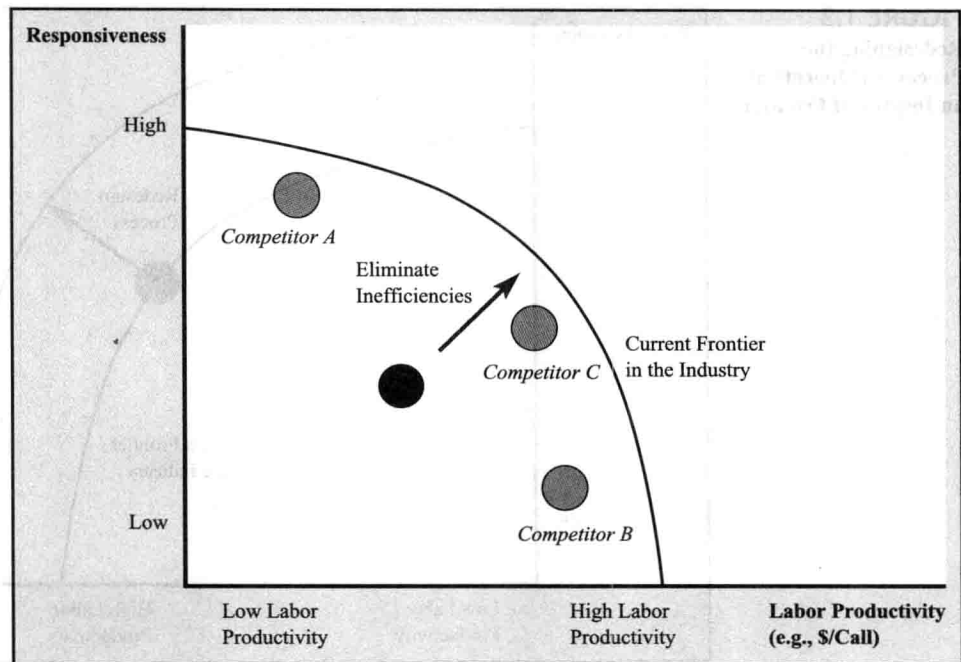
We will apply operations tools to firms that produce services and goods in a variety of environments—from apparel to health care, from call centers to pacemakers, and from kick scooters to iron ore fines. We present many diverse settings precisely because there does not exist a “standard” operational environment. Hence, there does not exist a single tool that applies to all firms. By presenting a variety of tools and explaining their pros and cons, students will gain the capability to apply this knowledge no matter what operational setting they encounter.

Consider how operations tools can be applied to a call center. A common problem in this industry is to find an appropriate number of customer service representatives to answer incoming calls. The more representatives we hire, the less likely incoming calls will have to wait; thus, the higher will be the level of service we provide. However, labor is the single largest driver of costs in a call center, so, obviously, having more representatives on duty also will increase the costs we incur per call.

The first use of operations management tools is to ensure that resources are used as effectively as possible. Assume we engage in a benchmarking initiative with three other call centers and find that the performance of our competitors behaves according to Figure 1.1: Competitor A is providing faster response times but also has higher costs. Competitor B has longer response times but has lower costs. Surprisingly, we find that competitor C outperforms us on both cost and service level. How can this be?

It must be that there is something that competitor C does in the operation of the call center that is smarter than what we do. Or, in other words, there is something that we do in our operations that is inefficient or wasteful. In this setting, we need to use our tools to move the firm toward the frontier illustrated in Figure 1.1. The frontier is the line that includes all benchmarks to the lower left; that is, no firm is outside the current frontier. For example, a premium service might be an important element of our business strategy, so we may choose not to compromise on service. And we could have a target that at least 90 percent of the incoming calls will be served within 10 seconds or less. But given that target, we should use our quantitative tools to ensure that our labor costs are as low as possible, that is, that we are at least on the efficiency frontier.

FIGURE 1.1
Local Improvement
of Operations by
Eliminating
Inefficiencies



The second use of operations management tools is to find the right balance between our competing objectives, high service and low cost. This is similar to what is shown in Figure 1.2. In such a situation, we need to quantify the costs of waiting as well as the costs of labor and then recommend the most profitable compromise between these two objectives.

Moving to the frontier of efficiency and finding the right spot on the frontier are surely important. But outstanding companies do not stop there. The third use for our operations

FIGURE 1.2
Trade-off between
Labor Productivity
and Responsiveness

