PART 1 ESSENTIALS

CHAPTER 1

Introduction to Operations Management

Before I speak, I have something important to say.
—Groucho Marx

MAJOR SECTIONS

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IN THIS CHAPTER, LOOK FOR...

- Operations management as the creation of value, making it the heart of any organization.
- The balance of productivity, sustainability, and responsibility in successful operation.
- Types of decision making and product, and degree of uncertainty and control.
- Operations within an organization, as well as supporting professional and academic societies.

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INTRODUCTION

At the heart of any organization are its operations—the activities that define it. This description holds true whether the organization is a global brand manufacturer such as Apple or Toyota, a major retailer like Home Depot, a nonprofit organization such as the International Red Cross, or a local gas station or health care clinic. Purchasing, assembly, shipping, settling accounts, stocking, and even communicating are but a few examples of many different actions unfolding within these organizations, united by a single purpose: to create value for a customer.

Operations management may be the oldest of all the business disciplines. Some of the earliest examples of written language are 5,000 year-old Egyptian and Sumerian inventory records, a vital tool of operations still in action today. In fact, one of the oldest known textbooks of any type, *De Re Metallica*, teaches operations in the context of mining and metallurgy. Written by Georgius Agricola in 1556, this textbook described organized, high-volume manufacturing some 350 years before Henry Ford is credited with introducing the world to modern manufacturing practices.

Simultaneously, operations management is one of the youngest of all business disciplines, based on formal recognition. Subjects such as marketing and finance were formally taught in business curricula decades before operations first appeared as "production management" or "factory management" in the 1950s. As a subject, operations has evolved rapidly since the days of factory management, recognizing the need to create value in individual projects, service settings, nonprofit organizations, and multiorganizational global supply chains. Operations management also includes valuable action in disorganized settings, its modern-day frontier of agility, incident management, and creative activity.

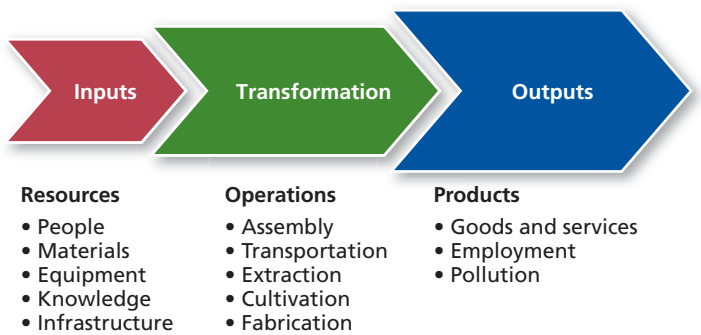
Operations management is present in some form anywhere a person or a group moves forward toward a goal. Regardless of what name it is given at that moment, the widespread nature of operations makes it both exciting and perhaps a bit puzzling at first. So we begin our study of operations management by examining several frameworks to organize and clarify its wonderful diversity.

ESSENTIAL OPERATIONS MANAGEMENT

operations
A set of activities dedicated to the transformation of inputs into outputs of greater value.

One of the simplest and most enduring descriptions of operations is *transformation*. Any undertaking transforming some set of resources into some result can be thought of as an operation. Figure 1.1 illustrates this as the classic input/output model of operations management. While simplified, this model helps clarify what operations such as manufacturing, health care, agriculture, and education have in common. Like all other operations,

FIGURE 1.1 A Model of Any Operation



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each is an example of a particular set of inputs being transformed into a particular set of outputs, with most but not necessarily all of those outputs being intentional or beneficial. The transformation sector in the center of Figure 1.1 most closely represents the operation itself. While the inputs and outputs of any given operation are identifiable entities such as people, knowledge, and goods, the associated operation consists of processes, or actions taken to create the outputs. Thus, *operations management* is the planning and facilitating of those actions.

processes
Activities that transform inputs into outputs.

Describing operations management as transformation focuses on the actions themselves, but another way to understand operations is to consider the purpose of those activities, or what they achieve. Returning to Figure 1.1, the fundamental purpose of any operation is to produce outputs more valuable than inputs consumed. Thus, the purpose of operations management is to create value, and the literal difference in value between outputs and inputs is a performance measure known as value-added or value creation. Successful value creation ultimately depends on a balance of related achievements, some of which are easy to evaluate and others less so. Figure 1.2 introduces these three interdependent elements: productivity, sustainability, and responsibility.

value-added
The difference between the total value of the outputs and the total value of the inputs associated with an operation.

value creation
Achieving positive value-added.

Productivity

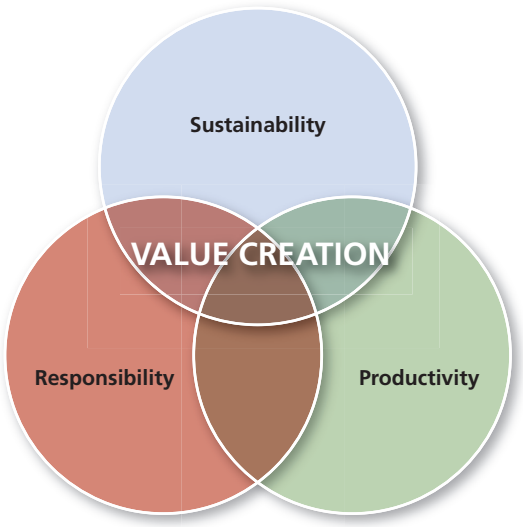
Productivity measures the success of the operation by comparing its inputs to its outputs, and is generally the most visible and measurable of the three issues linked in Figure 1.2. While value-added refers to the difference between the value of inputs and outputs, productivity compares the same values as a ratio, such as cars per shift or miles per gallon. Historically, technological innovation increases the productivity of most, although not all, transformation processes. Inappropriately low productivity indicates lost opportunity to create additional value from the same set of inputs, a wastefulness that highlights the fused area between productivity, sustainability, and responsibility.

productivity
A measurement of value creation, calculated as a ratio of the values of output to input.

Sustainability

While productivity is a familiar measure of performance, high productivity does not necessarily indicate a well-managed operation. As Figure 1.2 suggests, successful value

Elements of Value Creation **FIGURE 1.2**



Productivity in Road Construction

Paving roads illustrates both the input/output transformation model and the concept of productivity. Grouped together on the right of this picture are three major inputs of road construction: raw materials, specialized equipment, and skilled labor. Visible to the left is their combined output, the new road. Modern road construction illustrates how technology usually advances productivity; this operation requires less labor than would have been needed several decades ago. This increase in productivity is achieved through the use of more sophisticated equipment, the increased expense of which must be fairly reflected in any productivity study when comparing this operation to older paving practices.

sustainability
The degree to which activity with immediate benefit does not incur greater costs in the long term.

creation also depends on the sustainability of that operation, the extent to which operating at a particular time does not create greater costs to be paid in the future. Lack of attention to sustainability can occur at any of the three stages in Figure 1.1, although problems with inputs are particularly familiar throughout history. Consider these examples:

- Archeological findings suggest many early cities suffered a pattern of overshoot-and-collapse in the use of nearby resources, including those of the Mesopotamians, the Mayans, and the Anasazi. Each of these groups used available technology to concentrate population, build ~~increasing~~ sophisticated structures, and advance knowledge in areas such as astronomy, mathematics, and management. However, little remains of these achievements because each community exhausted a necessary resource, often available forest, triggering extinction of the city and often loss of its innovative advances.
- Sixty million buffalo roamed North America prior to the 1870s, when buffalo hunters began killing the animals for their hides, which were transformed into clothing, machinery drive belts, rugs, and other products. As buffalo were harvested at a much higher rate than their population could regenerate, these herds were destroyed within 20 years, and the buffalo hide industry died with them.
- Concern for the unsustainable consumption of resources such as fossil fuels, forest, and fresh water continue to present day. More recently, rare earth minerals used in the creation of high-performance electric motors, LEDs, and computer tablets have been added to this list of concerns. This dilemma in sustainability brings with it an irony that dependence on these resources is currently necessary to lessen dependency on other nonrenewable resources, as rare earth minerals are vital to the production of wind turbines, energy-efficient lighting, and electric vehicles.

Although human history supplies many sad examples of failure to focus on the sustainability of inputs, an operation can fail just as readily if the practices used in transformation do not likewise conform to the principles of sustainability. From history, two particular patterns of bad practice have nicknames of their own:

- *Boomtowns.* Boomtowns are communities that grow rapidly around the development of a single resource. Some boomtowns like the Australian gold-rush center of Ballarat do survive to become broader economies long after the original resource is depleted. Most, however, become ghost towns, abandoned when their original operations fail. The resulting loss and wasted infrastructure of a ghost town echoes the overshoot-and-collapse cycle of ancient communities.

Energy as an Input

Electrical energy is an input of almost any modern operation. However, this input often raises troubling questions of sustainability. Pictured here are the cooling towers of a nuclear power plant, releasing harmless water vapor into the atmosphere. While this plant generates electricity without air pollution, it also creates highly radioactive waste as an output, which must then be stored for hundreds of years. Note the railroad tracks and hopper cars visible at the bottom of this picture, indicating that this electrical generation facility does not rely exclusively on nuclear power. These rail cars are evidence of nearby use of large amounts of a dry commodity such as coal. Coal supplies half of all electrical generation in the United States and is responsible for much of its air pollution. While coal-fired generation does not possess the higher construction costs or the risk of catastrophic failure associated with nuclear power, it is a nonrenewable resource, raising further questions about its sustainability.

- *Bubbles*. Bubbles are the economic equivalent of boomtowns, in which investors and organizations trace an overshoot-and-collapse pattern through unsustainable activity, drawn in by some immediate benefit and disregarding longer-term reality. This often takes the form of investing in an operation far beyond its intrinsic value, leading to a meltdown at some future time. As an example, the global financial crisis of 2007–10 was triggered largely by the collapse of housing prices around the world, a bubble formed from historically low interest rates and the unsustainable activity of housing buyers, banks, and construction companies alike.

Finally, but by no means less important, sustainability concerns the outputs of an operation as well. Sustainability addresses the intended products of an operation as well as any other consequences, creating two major areas of output concern:

- *Pollution.* Polluting of air, soil, and water brings long-term consequences potentially greater than the short-term value creation releasing the pollution. Although societies have struggled with control of pollution for centuries, the recent accumulation of carbon emissions in the atmosphere has raised new alarm. Linked to global climate change, these emissions result from fossil-fuel-burning operations that power much of the world's transportation and energy infrastructure.
- *Disposal.* Disposal of intended products after use can be problematic if this last phase of their life cycle is not carried out in a manner consistent with long-term sustainability. Unfortunately, ample evidence of neglect for this issue exists, apparent in the example of used clothing, the fastest-growing source of trash in American landfills today. In the United States, 12.8 million tons of textiles were disposed of in 2008, up from 1.8 million tons in 1960, or an increase of over 600% during a time in which the population discarding that clothing grew by only 73%. This not only suggests a distinct waste of value, it also stresses the finite resource of safe landfill area.

Sometimes fixing unsustainable practices in disposal can simultaneously solve problems with input availability. This type of problem solving is inspired by biomimicry, or the imitation of natural systems. Natural systems form continuous cycles of consumption, production, reclamation, and regeneration, whereas the traditional view of an operation in Figure 1.1 is linear, starting and stopping at discrete points. Newer approaches

biomimicry
The imitation of natural processes and systems.

Landfills as Processes

A landfill accepts and buries discarded waste, and many landfills are complex logistical operations. A well-managed landfill builds barriers to protect its surrounding environment, monitors incoming materials to prevent burial of hazardous substances, and covers allowable garbage daily to further minimize exposure. Landfills also attempt to use as little space as possible, by crushing and compacting waste before burial. Modern landfill operations do not stop there, recognizing that reducing the amount of waste is far more effective than simply compacting it for burial. As a result, modern facilities feature preprocessing areas like the one pictured here, where reusable materials such as metal are recovered from the arriving discards, for removal and recycling elsewhere.

green
Assures sustainability.

to production are said to be green if they are sustainable, and these approaches are also better described as cycles that loop the straight-line system of Figure 1.1 back upon itself. In many cases, green practices avoiding the wasteful disposal of some product or by-product do not create an input for that same green process, but do create a valuable input for some other process, such as the recycling of discarded tires into durable landscaping material.

We can think of sustainability as broken into three general levels. Achieving the first level means "getting the basics right" with the system as it is, such as recycling whenever possible and turning off lights when not needed. The second level is "learning to think sustainably," and it is at this level that operations management is often the most active and effective. This thinking requires assessing the impact of decisions across both an operation and its broader supply chain partners, with a view to incorporating new lean (reducing waste in all forms) and sustainable practices wherever possible. As an example, a sawmill producing lumber might achieve the first level of sustainability by optimizing its cutting patterns to extract the maximum lumber product from incoming trees, and minimizing use of electricity and fossil fuels by careful selection and maintenance of its equipment. To climb to the second level, however, the same mill may seek useful

lean
Operating without waste.

Recycling as Transformation

The internationally recognized symbol for recycling consists of three block arrows folded into a Mobius loop, as shown on this collection bin. Created by a college student in the early 1970s, this symbol suggests an unending use of outputs as inputs, which is a circular reformatting of the traditional model of operations in Figure 1.1. This is also a good example of biomimicry, because recycling is an effort to mirror nature's theme of repeating cycles of transformation.

applications for its current waste products, such as preparing its wood bark and scrap for use in paper products, and/or resolve to purchase inputs exclusively from sustainable sources (timber companies that replant trees after harvest). The third and top level of sustainability involves benchmarking, auditing, and governance to bring clarity to the environmental impact of the organization's practices, which may require the sawmill to reorganize its habitual operation completely.

Assessing sustainability is more tricky than calculating productivity because it requires calculating the future cost of a present action, and some degree of uncertainty concerning the future always exists. Here, management is key in determining whether all foreseeable future consequences have been acknowledged and explored to the best of the organization's ability.

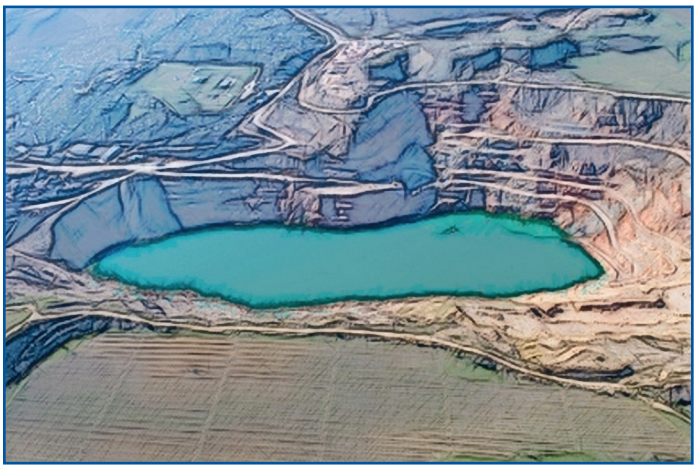
Responsibility

Responsibility has multiple dimensions. Corporate social responsibility concerns the quality of interaction between a business and surrounding society, whereas employees of a corporation also have direct responsibilities to perform for their employer. Corporate social responsibility is at its most visible when a business publicly assumes responsibility for damage inflicted by its operation, such as accident response and voluntary recalls. However, corporate social responsibility is defined largely by an obligation to pursue sustainability. Some corporations such as Campbell Soup and Dow Chemical have vice presidents of social responsibility and sustainability, but these issues are not limited to job titles for particular managers. Some argue that decision making in any organization is driven by the incentives offered to the decision makers, and little progress toward long-term sustainability will be made if performance measurement and rewards emphasize short-term results. Not surprisingly, many companies recognized for corporate social responsibility have invested considerable effort in developing "green" scorecards and other new managerial tools to naturally motivate responsible decision making, seeking that highest level of achievement in sustainability.

responsibility
An obligation to perform.

Responsible decision making guides ethical behavior. Ethics are simply rules that identify good versus bad behavior, and these rules vary between cultures and even between large organizations. Ethics are not tangible and specific like legal code. And, as Thomas Paine so aptly stated, "A long habit of not thinking a thing is wrong gives it a superficial appearance of being right." Technology and rapid innovation can create operational practices that do not appear wrong only because they have yet to offend during their relatively brief history, but that does not necessarily mean these new practices are appropriate or advisable. Blindly accepting an operation as ethical until such time

ethics
Principles governing conduct, delineating good from bad.



Mining as Transformation

Virtually every product begins with the processes of mining, logging, and/or farming. Each of these processes transforms the natural landscape, but none more dramatically than surface mining, pictured here. Surface mining requires removal of large amounts of earth to expose the substance of value to the operation, such as coal, metal ore, or limestone. In a few cases, the resulting tiered pit is large enough to be seen from outer space. Responsible surface mining includes a reclamation phase, in which the pit is rehabilitated into a stable ecological landscape as the last stage of activity at that mining site. However, this responsibility is not always met. Active mining has ended in this picture, evident from the flooded pit floor and lack of logistical activity, yet efforts to reclaim this site are likewise missing.

as it violates some standard of sustainability often comes at great cost. As an example, deep-water oil extraction had been a generally acceptable practice despite the fact that little was known about how to fight ruptures at those depths. A lack of accidents at such depths created little concern for this issue until April 20, 2010, when an explosion aboard the oil platform DeepWater Horizon resulted in an oil leak 1 mile below the ocean's surface. British Petroleum then struggled for 3 months to stop this leak, which produced the largest oil spill in history. ~~By concentrating on productivity, at the considered exclusion of sustainability, BP was judged to have shirked its ethical responsibility.~~

CLASSIFYING OPERATIONS

Because operations management is embedded in all organized activity, we categorize different operations according to common traits, to clarify similarities among organizations. Figure 1.3 illustrates four common frameworks for organizing various operations into useful groupings, each one providing insight into some aspect of successful management within the groups.

Tangibility

tangibility
The degree of perceivable, physical essence of a product.

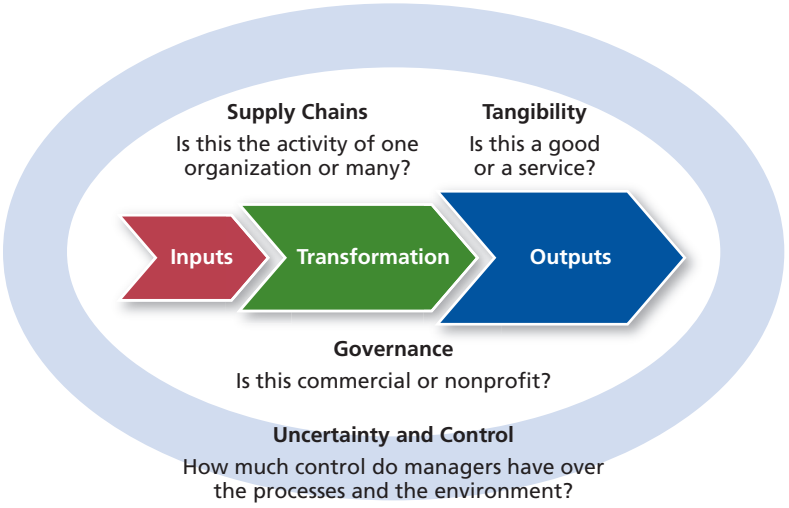
goods
Tangible products.

services
Intangible products.

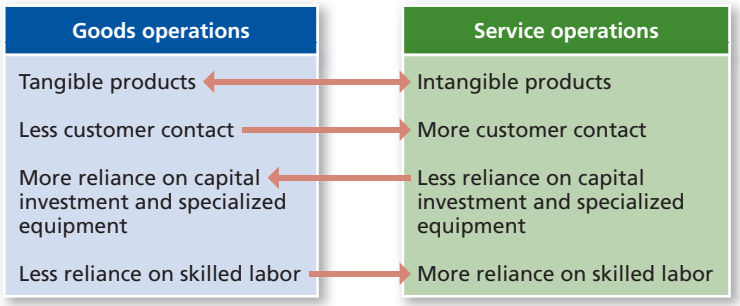
Operations management is often internally organized into goods versus services, classifying each operation according to the tangibility of its product. Declaring something tangible generally indicates that it is solid and can be perceived by sense of touch. However, whether a product is perceivable by touch does not completely explain its tangibility; most products are some mix of tangible and intangible elements. Nonetheless, products recognized by the customer as physical objects, including grocery items, personal electronics, and clothing, are broadly referred to as goods. In contrast, services provide valuable actions but little or no tangible content, describing products from Internet access to education to medical care.

Surprisingly, this seemingly simple issue can have powerful consequences in operations management. Figure 1.4 illustrates a few distinctions between goods and services in operations, although this categorization most accurately represents the two extreme ends of a continuum. While the tangibility of a product is not generally as simple as a yes or

FIGURE 1.3 Classifying an Operation with Four Different Frameworks



Comparing Goods and Services FIGURE 1.4



no answer to a question about touch, it is helpful to look at the two extremes first to better understand the blending of goods and services.

Goods Operations Manufacturing is the production of goods, although not all goods are manufactured. The term *manufacturing* implies mass production, whereas goods might be custom-made or grown or extracted from the ground. One positive result of producing something physical such as an automobile is that this output is likewise storable as inventory, at least for some short period of time. This single condition of storage capability provides multiple benefits:

inventory
Tangible items awaiting sale or use.

- The operation can be located where it is most beneficial for production, and the product shipped elsewhere.
- Less customer contact is required of the operation because goods need not be produced where they are consumed.
- The operation can respond to surges in demand by stockpiling goods early, instead of increasing production capacity.

stockpiling
Producing or securing goods in advance of demand.

Furthermore, goods production tends to involve a lower variability of both inputs and outputs than service operations. This allows easier prediction, planning, and evaluation on behalf of the system. Successful manufacturing operations, then, put this relative wealth of reliable information to use in developing the most efficient processes possible, requiring ~~high~~ levels of capital investment in specialized equipment.

Service Operations Manufacturing presents challenges, but the provision of services may be more challenging. Because services are intangible, they cannot be stored for future use. In general, service operations suffer these restrictions:

- Most services must locate where the customer has access to the operation, not where the operation can function best. This issue of location can become so competitive that a large retailer may purchase strategically located property even though this organization has no intention of building a new store. Rather, the purchase prevents competing retailers from building at that beneficial location.
- Many services require the customer as an input to the process, so customer contact is higher overall. Further, this visibility of the operation itself can potentially bias the customer's perception of product quality.
- Services cannot be stockpiled for future use, so service operations have fewer options to handle fluctuating demand. These operations are often obligated to maintain idle capacity to absorb unexpected demand.

Physical Therapy as a Pure Service

Some health care services are valuable products that include little or no tangible content. In this picture, value is created through the interaction of the physical therapist on the right and her client on the left. One distraction in this pure service example is the presence of specialized tangibles such as the parallel bars the client is using for support, but these are inputs to the physical therapy process, not outputs.

Services usually cope with higher variability of inputs and outputs, making prediction and planning more difficult. Where manufacturers often raise substantial capital to create a competitive factory, service operations are more likely to rely on finding skilled labor for success. Even simple measurements and comparisons can be problematic in a service setting, due to difficulties in capturing input and output information.

Blending of Goods and Services In reality, most products result from a blend of tangible and intangible elements, placing them somewhere along the spectrum first suggested by Figure 1.4. For this reason it is difficult to identify an example of a pure good or pure service. Even something as tangible as a car or clothing usually requires shipping to a convenient retail location, and this intangible but valuable element of the product is bundled into its purchase price. Any example of a theoretically pure service would require valuable action without a trace of physical evidence, not even a paper invoice or billing statement.

With examples from the extremities of Figure 1.4 relatively rare, it is more common to find operations balancing goods production and service provision in the creation of their products. In fact, any tangible good that is highly perishable usually represents a successful balance of goods and service, in that half of the organization's efforts are invested in the creation of the good and the other half in its quick distribution and resupply. Perishable goods can refer to products that literally spoil, such as fresh food and restaurant meals. However, the term *perishable* simply indicates a short shelf life. Many products perish not by physically deteriorating but by becoming obsolete rather quickly. Examples of this type of perishability include newspapers, magazines, fashion apparel, and other time-sensitive merchandise.

Supply Chains

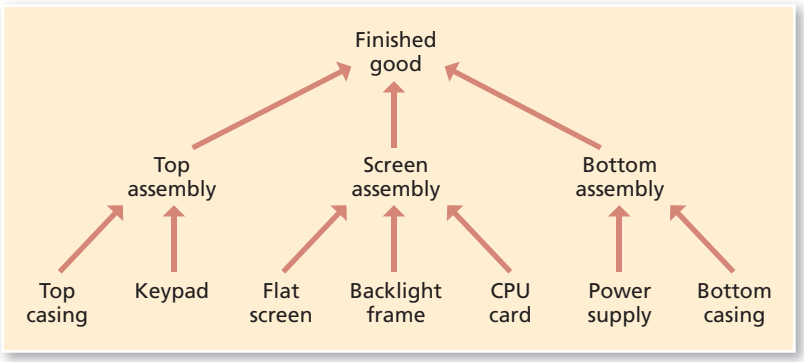
Any operation is a system—a web of related parts cooperating toward some common purpose. Sometimes this system is a set of parts within a single organization, while other operations involve the interactions of multiple organizations as a single system. Figure 1.5 provides a common example from the internal perspective, a so-called bill of materials that describes the assembly of some electronic product. This core concept from inventory planning describes the relationships among production requirements within a particular product, and is crucial to coordinating the larger plans supporting its production.

bill of materials
A description of all raw materials and intermediate assemblies required to create a finished product.

A Bill of Materials

FIGURE 1.5

An example of an internal system in operations management



Operations management addresses these internal issues:

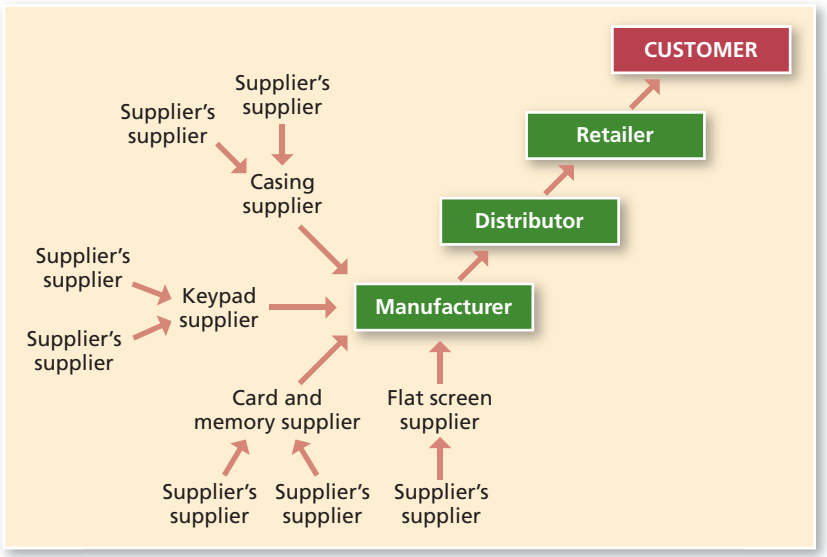
- Facility design, identifying the best layout to support the operation.
- Scheduling of facilities, personnel, and equipment.
- Statistical quality control, monitoring various points in ongoing production for inappropriate deviations from the firm's standards.
- Waiting lines, modeling, and improving any wait time created by the operation.

Coordinating these issues internally is challenging in and of itself but successful management of multiorganizational networks requires more sophisticated efforts. When the scope of a system is wide enough to include every organization participating in the ultimate delivery of a particular product to an end customer, a complete supply chain for that product must be coordinated. Almost all consumer products are provided through supply chain networks like the one pictured in Figure 1.6. Each organization within this

supply chain
A system consisting of all organizations that play some role in supplying a particular product to a customer.

A Supply Chain System

FIGURE 1.6



network might only communicate with one other organization, although the customer's experience with the product is ultimately dependent on all of them. Furthermore, modern supply chains often link up organizations and customers throughout the world, and include additional logistical organizations working in the linkages between those businesses appearing in Figure 1.6, devoted to the transportation of goods along the arrows.

Figures 1.5 and 1.6 are not unrelated; both depict dependencies between parts of a system that progressively add value to some product. Not surprisingly, the processes associated with Figure 1.5 are sometimes referred to as a value chain, signifying an internal network of functions that bring value to the product being produced there. The broader supply chain in Figure 1.6 includes all the complexity of internal value chains while also requiring that these conditions be satisfied throughout the supply chain:

value chain
A system consisting of all functions within an organization that play some role in adding value to the organization's product.

- The flow of both material and information must be coordinated among organizations, which may be located anywhere. For example, cotton grown in North America is often shipped to sites in Asia for processing into thread and fabric, and that fabric is shipped elsewhere for cutting, the result of which is shipped still elsewhere for sewing. It is not uncommon for this product to circle the world twice before arriving in a retail store as finished cotton clothing.
- Vital information must be shared rapidly among different organizations. While modern technology supports these relationships, sharing of information can be complicated by the fact that organizations may be participating together in a supply chain serving customers in one market, but competing against each other in some other market, and thus reluctant to share sensitive information.
- All organizations must cooperate to optimize delivery as a single system. Often the best answer from the organization's isolated perspective is not part of the best answer for the larger system, and supply chain management requires individual firms to support what is best for the chain as a whole. If the more complex supply chain solution is not found and implemented successfully, the broader system falls victim to local optimization, in which each supply chain partner behaves according to their individual internal perspective, dragging down the coordinated performance of the whole.

local optimization
Localized problem solving that ignores any larger problem of which the local decision is a component.

Rapid advances in communication and information technology have elevated some traditionally firm-level functions such as purchasing and quality management to more strategic levels of planning. Although both the term and the practice of supply chain management originated with the manufacturer Hewlett-Packard, this concept is not limited to the delivery of manufactured goods. The opportunities and the challenge of supply chains occur anywhere multiple organizations must interact to provide customer value, which includes many important service industries, including health care.

Containerized Freight and Global Supply Chains

A freight container is a steel box approximately 40 feet long, often seen traveling roads as the box trailer in a truck-and-trailer combination. The advantage of freight containers is that they are easily transferred among roads, railways, and ocean vessels without unpacking the goods within, allowing organizations to move products through global supply chain networks. Pictured here is a typical container yard, where several thousand cargo boxes await loading at a busy port. These boxes likely contain a wide variety of goods, ranging from electronic components, lumber, and food flavorings to finished clothing, microwave ovens, and toothpaste.

Governance

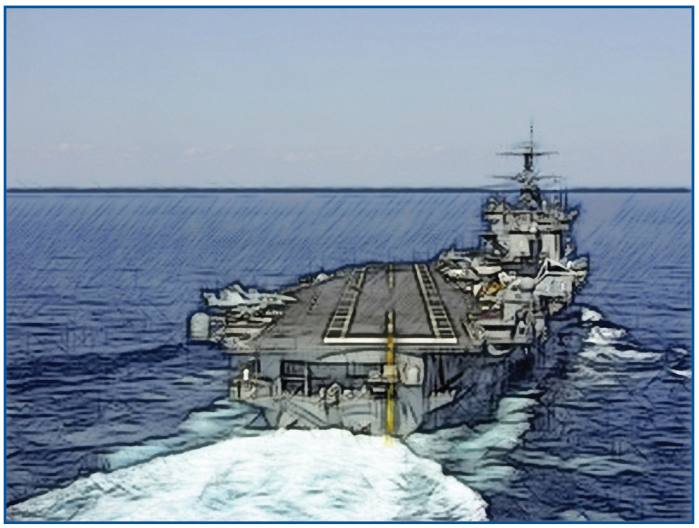
When comparing operations, successful networks pay attention to the different forms of governance, or ownership of the operations. Grouping by governance often brings together operations with common perspectives in decision making.

Commercial Enterprise Generally, commercial enterprise is the most familiar form of governance in the study of business and management. A commercial operation is managed to ultimately yield a profit, distributing some of its value creation back to its ownership. Such an operation may be privately owned or publicly traded, where the payment of dividends to shareholders represents partial distribution of value. This type of operation must account for the interests and income of its ownership when making decisions, and is also most likely to feel the pressures of competition. Not surprisingly, it is a commercial enterprise that often invests considerable effort in branding its output to distinguish itself from its competitors, giving rise to well-known global entities such as Google, McDonald's, and Exxon Mobil.

Nonprofit Operations A nonprofit operation does not distribute surplus value back to its ownership and is often excused from income taxes paid by commercial organizations. A nonprofit operation has governing ownership nonetheless, and is not necessarily immune to the issue of competition. In fact, in some industries commercial, for-profit operations compete with nonprofit counterparts, such as hospitals, package delivery, and education. Nonprofit operations are generally service operations, providing value to some constituency and reinvesting any surplus back into the funding of the operation. A nonprofit organization not owned by a government is known as an NGO, or nongovernmental organization. Who precisely does own and manage an NGO can vary widely, with examples including religious organizations, social clubs, charitable foundations, and individuals. Global disaster relief is an example of one industry dominated by nonprofit organizations in general and NGOs in particular, with the International Red Cross being one well-known participant.

NGO
A nongovernmental organization, understood to be a nonprofit organization as well.

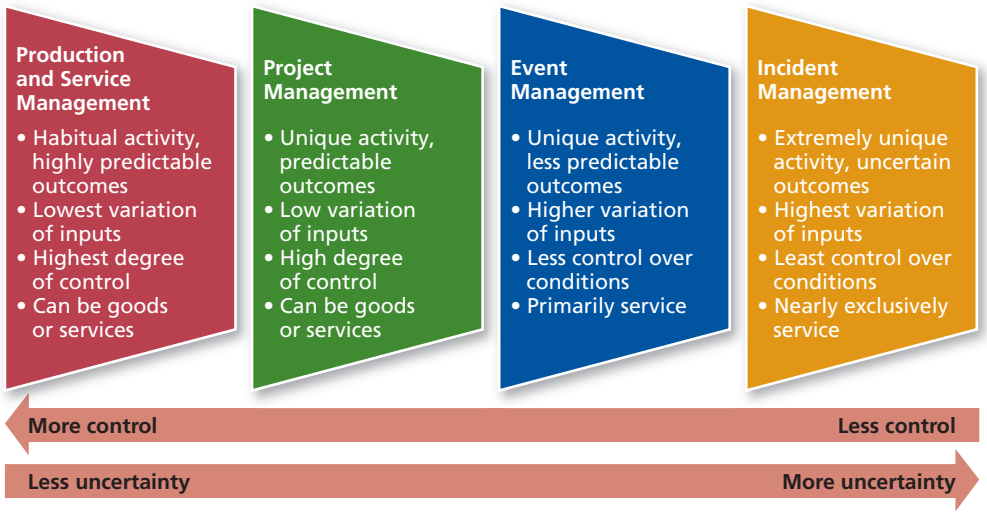
Government Activities Any government is essentially a nonprofit operation, engaged in the provision of government services. Furthermore, some national governments own all or part of manufacturing organizations involved in the production of goods ranging from automobiles to cigarettes. This is a relatively rare condition in the market economy of the



Military Operations

Government and nonprofit organizations often face the most challenging problems in operations management, compared to commercial corporations. As an example, the aircraft carrier here is essentially a mobile airport, and the complexity of managing this operation compared to a land-based airport does not stop with the fact that it changes location. This aircraft carrier requires at least 5,000 employees to operate, planning and serving at least 15,000 meals daily from an internal warehouse storing up to 70 days of groceries. In addition to the complexities of aviation and global travel, the carrier operates a nuclear power plant, a desalinization plant for fresh water, and employs at least six doctors in its own 50-plus bed hospital. While the vessel itself is nuclear and only refuels every 15 to 20 years, it must also store and manage several million gallons of aviation fuel onboard, to supply arriving planes.

FIGURE 1.7 Varying Levels of Uncertainty and Control in Operations



United States, but governmental service operations do make up a significant portion of overall activity within the US nonetheless, accounting for a substantial amount of its gross national product. This aggregated spending represents the provision of services ranging from education to the global logistics of military operations.

Uncertainty and Control

Operations management has historically focused on control. Good control of an operation includes efficient implementation of decisions, accurate prediction of outcomes, and prevention of external interference. These are all reasonable assumptions in some industrial settings, but many modern operations do not enjoy high levels of control, due to the nature of their business.

When control shifts away from a decision maker, uncertainty takes its place, although this person or group must still decide how best to proceed. Operations that are literally exposed to the environment, such as building construction and outdoor events, naturally suffer higher degrees of uncertainty and lower degrees of control. Uncertainty decreases with practice, so managing a unique event presents more uncertainties than the daily management of a long-running operation. When operations management is considered under all possible conditions, it is often loosely subdivided along this range of uncertainty versus control, as illustrated in Figure 1.7.

Production and Service Management Production implies deliberate creation of value over time, such as in the manufacturing of a good or the provision of electricity. While operations management can be argued to be as old as organized human activity, production management was the first form of operations management to be recognized as a teachable business discipline. Mass production minimizes uncertainty because it transforms a narrow range of carefully selected inputs within a facility designed to reliably create only certain outcomes. Ongoing operation of this permanent facility allows for the accumulation of data and experience to use in further improving the efficiency of the system—a methodology known as scientific management.

scientific management A methodology stressing the use of data collection and analysis to redesign processes and improve efficiency.

While high volume production emerged during the Industrial Revolution of the 1770s, production management owes many of its principles to the emergence of scientific

management in the early twentieth century, initially championed by the engineer Frederick W. Taylor. Early production management focused on the manufacturing of goods, but now is equally applicable to services. The routine operation of a multiscreen movie theater is a good example of production management in a service setting, where it can be referred to specifically as service management. Figure 1.6 illustrates this group of goods or service providers as one of four equal-sized categories, although it is important to remember that this left-hand category is the origin and the stronghold of operations management. Most of modern commercial enterprise still falls in this category.

Project Management A project differs from the traditional understanding of production in that a project is completed once, resulting in some unique form of value creation. Projects may create something tangible, such as the construction of a building or the painting of a portrait, or something intangible, such as providing legal service to a particular client concerning a particular case. Some industries are project-based: while the routine operation of a movie theater is as an example of production management, the creation of the movies exhibited in that theater is project-based. The product is unique, but the creation process being governed by project management is still quite predictable; management can make detailed plans and implement these plans with a high degree of efficiency. This uniqueness does, however, usually increase the variability of the inputs required when compared to repetitive production management, increasing uncertainty somewhat and generally increasing the importance of coordination and communication within the system.

project
A unique collection of activities creating a particular outcome.

Project management is arguably older than sustained production management. The Industrial Revolution refers to mass manufacturing taking over from older, more project-based crafting to provide goods. Interestingly, some argue that a revolution in information technology has enabled project management to reclaim much of that territory, as growing sectors of many national economies are dependent on the agile and technology-enabled activities of project-based firms such as software and Web developers. Other firms are under increasing pressure to practice more effective project management within ongoing operations, to respond to the changing conditions of the modern marketplace. Both strategic improvements to existing operations and rapid development of exciting new products rely on teams of employees skilled at project management.

Event and Incident Management The term *event* has several meanings, but the type of operation best known as an event is in fact a particular type of project. The activities associated with the completion of a successful event are undertaken within a known and planned time interval, and thus event planning and management are examples of project management. However, event management is a more challenging form of

Temporary Facilities in Project, Event, and Incident Management

Temporary structures are common to many projects, particularly those subject to higher degrees of uncertainty in the environment. The personnel in this picture are waiting to provide medical assistance during a simulated disaster, working from a series of tents that will serve as a temporary medical center. Similar to these temporary physical facilities, project management often requires use of temporary organizational structures, just as the personnel here are temporarily assigned to this undertaking, leaving their roles in nearby permanent hospitals.

project management because events are highly permeable projects, meaning that they are strongly influenced by their environments. As an example, an event such as an outdoor festival is heavily influenced by issues such as weather and crowd attendance, neither of which managers can plan for precisely or control directly. Although projects in general can provide goods or services, events are usually some form of service involving some issue of performance, and are sometimes described as "softer," meaning more vulnerable, than the "hard" projects discussed under project management, due to their highly dependent and less predictable natures. While filming a movie in a studio requires more traditional project management, staging a concert or play requires event management. Other examples of event management include conference and banquet planning, sports management, scheduled surgery, and time-sensitive logistics.

incident
An unscheduled event requiring immediate resolution.

An incident presents a manager with the maximum challenge of uncertainty, as incidents are essentially unscheduled events that abruptly require completion. Thus, incidents are usually unexpected exceptions or disruptions to other types of planning, creating a need for a specialized form of project management. Incident management includes product recalls, such as the rapid removal of 228 million eggs from US supermarkets in 2010, and large-scale emergencies, such as stopping the high-speed flow of oil from a leaking pipe 1 mile underwater in the Gulf of Mexico. Unlike traditional production management, event and especially incident managers often rely on iterative planning for success. In iterative planning the manager launches and continuously revises plans despite controlling very little of the project and its circumstances. Because the manager is not likely to have all the information needed to create a complete plan before implementation must begin, incidents are the "softest" projects of all.

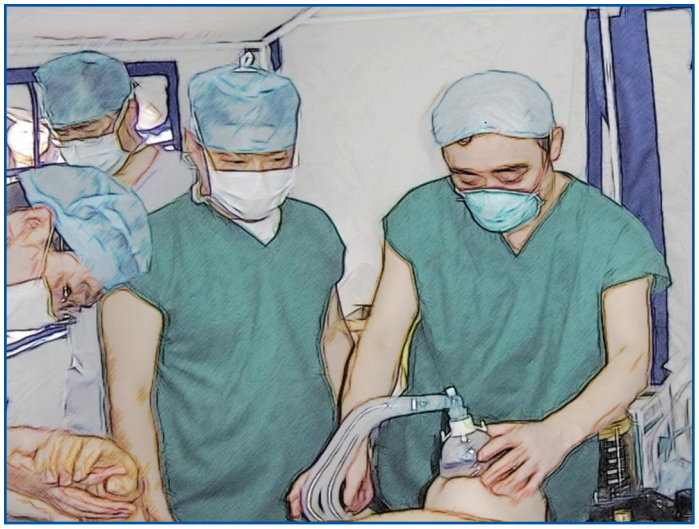
iterative planning
Deliberately adjusting plans at short intervals, to reflect new information.

While grouping operations in Figure 1.7 clarifies when particular approaches such as scientific management or iterative planning are more or less relevant to certain situations, these four categories do not function separately. It is not uncommon to find two or more in practice within a given operation. Consider for example, managing a large resort hotel. The hotel's efficient daily operation (housekeeping, laundry, and grounds maintenance) is an example of *production management*. Installation and changeover of hotel-wide holiday-themed decorations requires good *project management* to avoid disrupting ongoing operations. Generating revenue from booking, hosting and catering events for guests requires skilled *event management*. Finally, assuring the safety and satisfaction of guests requires careful attention to *incident management*, such as resolving complaints or providing emergency response within the resort.

In Scenario 1a we classify operations for an emergency response provider.

Incident Management in Health Care

The health care industry provides examples of operations subject to higher levels of uncertainty and less direct control than other types of businesses. Emergency medicine requires skillful incident management, because little or no patient information is available to the providers in advance of treatment and current conditions can change rapidly. These issues are made even more challenging when this intervention must be accomplished outside of a permanent facility, such as in the temporary field hospital in this picture. This scene also highlights incident management's dependence on the rapid formation of temporary teams, as the exact skill sets of personnel cannot be matched to the exact needs of an incident in advance.



Classifying Operations

Scenario 1a

Regional Disaster Relief Services (RDRS) provides emergency assistance to the victims of large-scale natural disasters. RDRS relies on fund-raising to support its permanent network of 15 warehouses, housing its inventory of tents, trailers, tools, portable lighting, water-filtration equipment, and electrical generators. Upon news of a disaster within its logistical reach, RDRS activates both its permanent staff and groups of volunteers to deploy from one or more of the warehouse headquarters and provide assistance in the field until permanent services are restored to the citizens of the disaster area.

What kind of operation is RDRS?

Analysis

Even with only a brief paragraph of information about RDRS, we know several distinct features of RDRS's operation:

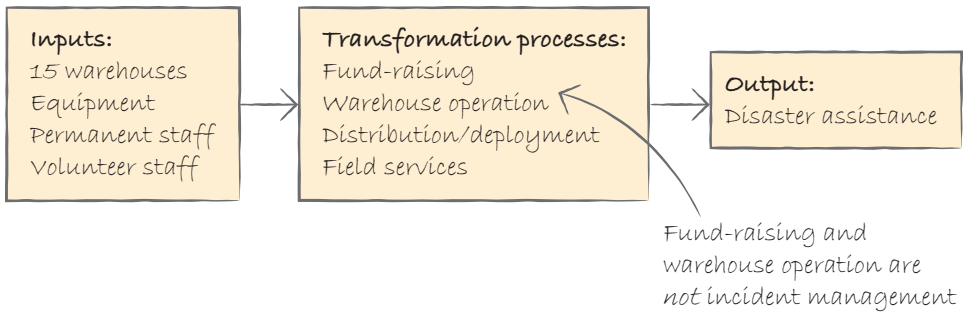
BRIEF ASSESSMENT OF RDRS

Incident Management: Unscheduled activity, little control over deployment conditions.

Governance = nonprofit: Lack of mention of any certain government indicates likely NGO.

Repeating and highlighting the paragraph here, "Regional Disaster Relief Services (RDRS) provides emergency assistance to the victims of large-scale natural disasters. RDRS relies on fund-raising to support its permanent network of 15 warehouses, housing its inventory of tents, trailers, tools, portable lighting, water-filtration equipment and electrical generators. Upon news of a disaster within its logistical reach, RDRS activates both its permanent staff and groups of volunteers to deploy from one or more of the warehouse headquarters and provide assistance in the field until permanent services are restored to the citizens of the disaster area."

INPUT/OUTPUT MODEL



Insight Regional Disaster Relief Services (RDRS), as its name implies, is a service provider, highly reliant on labor and the deployment of stocks of staged equipment. The reference to fund-raising indicates RDRS is a nonprofit organization, and likely an NGO. RDRS provides an interesting example of an operation with both a controlled production management side (its warehouse headquarters and fund-raising operations) and a dynamic, on-demand incident management side (its response and field service operations). ■

OPERATIONS MANAGERS

Since operations management represents the creation of value, just about every purposeful endeavor is practicing (although not necessarily successfully) some aspect of operations management. Operations management is ultimately about decision making, to guide the activities of an organization ever closer to its goals.

Decision Making

All managers are decision makers, selecting alternatives from sets of choices. In the context of organizations, this selection process can be viewed as three layers of an interrelated hierarchy, illustrated in Figure 1.8.

strategy
A methodology and resulting plan that identifies the long-term goals of an organization.

planning horizon
The farthest point in the future considered in decision making.

business analytics
Continuous investigation of business performance using large volumes of data.

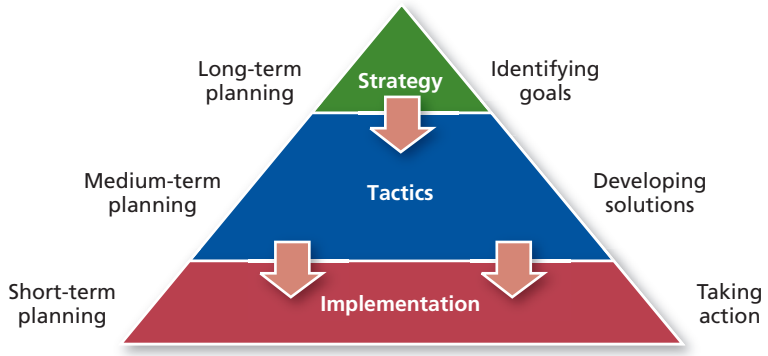
Strategic Decisions In the managerial hierarchy of decision making, strategy is depicted at the top-most level because it occurs first. Strategic decision making focuses on selecting the goals and overall direction of an organization, and can also be described as broadscale, long-term planning. If the consequences of a decision, good or bad, will be felt for more than 1 year, it is usually fair to declare it strategic. This issue of how much of the future is considered in and/or influenced by a decision is known as a planning horizon. Traditionally, long planning horizons have implied infrequent decision making, as each decision itself affects one or more of the years ahead. Modern operations, however, are taking increasing advantage of their access to large volumes of current data to guide decision analysis through business analytics, the continuous investigation of incoming data for strategic insights.

Examples of areas within operations management that fit the description of strategic decision making are product design, capacity planning and location planning. While good decisions at the strategic level are critical, note that the hierarchy of decision making does not mean strategic decisions are necessarily more powerful or significant than decisions made elsewhere in the hierarchy. This hierarchy refers only to chronological sequence: strategic decisions are the first and decisive steps in an ongoing process that continues with tactics.

tactics
Means to pursue strategic goals with available resources.

Tactical Decisions Much of the management in operations management is devoted to tactics, the ongoing process of determining how to pursue goals. Tactical decision making combines the goal-related input from the strategic level with the reality of resources available, identifying solutions ready for implementation. Tactical decisions also differ

FIGURE 1.8 The Hierarchy of Decision-Making



from strategic decisions in that tactics rarely address planning horizons longer than a single year, and may propose solutions only a few weeks in length. Often the focus at the tactical level is optimization, or the development of the best possible solution given the combinination of strategic objective and resource availability. As examples, developing inventory control policies or analyzing waiting lines in a service system often focuses on identifying the least costly alternative. However, the greater the complexity or uncertainty in the planning environment, the more likely tactical decision makers will shift focus to finding good feasible solutions to support strategic goals, as pursuit of one absolute best answer is not practical. Furthermore, at extremely high levels of uncertainty in fast-moving environments, the line between tactical planning and actual implementation becomes quite fuzzy.

Implementation Implementation is the bottom level of the hierarchy of decision making, but no less important. Implementation accepts the solutions identified at the tactical level and puts them into action. Because implementation is guiding action, it is also sometimes referred to as the operational level of the hierarchy, but that label is somewhat of a misnomer because operations management spans the entire area illustrated in Figure 1.8, not simply the base of the pyramid. Implementation involves short-term decisions and may involve very little decision making if the operation enjoys high degrees of control and certainty. As an example, operation of an assembly line at this level consists of assuring that the appropriate personnel and materials required by the tactical design of the assembly line are actually in place for its daily operation. This can involve many small decisions, such as which employee should staff which workstation along the line. In contrast, implementation may require substantial decision making and creativity in situations such as disaster relief, where the overall strategic goal is fairly obvious and implementation must begin before there is time to create a complete and detailed plan at the tactical level.

We explore the hierarchy of decision making further in Scenario 1b.

Classifying Operational Decisions

Scenario 1b

Regional Disaster Relief Services (RDRS) owns a fleet of 500 all-terrain vehicles (ATVs), stationed among its 15 warehouse locations when not in use. Normally, RDRS relies on other agencies for air transport in disaster areas, but recently it proposed the purchase of six helicopters during a joint meeting of its warehouse managers. The RDRS managers were not excited by the opportunity, arguing that ground operations had always been the core competency of RDRS and that it was more important to resolve disputes over the proper allocation of ATVs than to acquire aviation at great expense. These disputes refer to several warehouses located close to large wilderness areas having no idle ATVs available since last spring, keeping their ATVs deployed in support of relief operations throughout the wildfire season instead. These warehouse managers would prefer that idle ATVs from urban-area RDRS warehouses be transferred to their warehouses, but urban RDRS managers argue against this. Urban managers point out that the wilderness area managers are without ATVs because they leave their ATVs in remote areas for long periods, speculating that an additional emergency might occur even after the initial rescue or evacuation is completed. The urban warehouse managers suggest that, if the wilderness area managers want more ATVs sitting in their warehouses, then they should put more effort into promptly retrieving the ones already assigned to them.

How many different decisions have been discussed at this joint meeting of the warehouse managers? At what level in the hierarchy of decision making are these decisions?

Continues

Analysis

This discussion at the RDRS warehouse manager's meeting included three distinct decision points, at three different levels in the hierarchy. We can highlight the first decision like this:

HELICOPTER PURCHASING DECISION

To buy or not to buy?

Acquisition of helicopters would significantly broaden the scope of RDRS

Repeating and highlighting the paragraph here, "The RDRS managers were not excited about the opportunity, arguing that ground operations had always been the core competency of RDRS and that it was more important to resolve the dispute over the proper allocation of ATVs than to acquire aviation at great expense."

Long-term consequences and risk = **strategic**

The second decision frames the dispute between the warehouse managers, while the third decision is the pushback proposal from the urban warehouse managers:

ATV FLEET ALLOCATION DECISION

Where should the ATVs be assigned?

Resource Allocation = **tactical**

Again, we repeat the key sentences: "it was more important to resolve disputes over the proper allocation of ATVs than to acquire aviation at great expense. These disputes refer to several warehouses located close to large wilderness areas having no idle ATVs available since last spring, keeping their ATVs deployed in support of relief operations throughout the wildfire season instead. These warehouse managers would prefer that idle ATVs from urban-area RDRS warehouses be transferred to their warehouses."

ATV RETRIEVAL DECISION

How soon after a remote assignment should an ATV be returned to its warehouse?

Key sentences: "Wilderness area managers are without ATVs because they leave their ATVs in remote areas for long periods, speculating that an additional emergency might occur even after the initial rescue or evacuation is completed. The urban warehouse managers suggest that, if the wilderness area managers want more ATVs sitting in their warehouses, then they should put more effort into promptly retrieving the ones already assigned to them.

Leaving their ATVs on speculation versus retrieving ATVs promptly concern actions = **implementation**

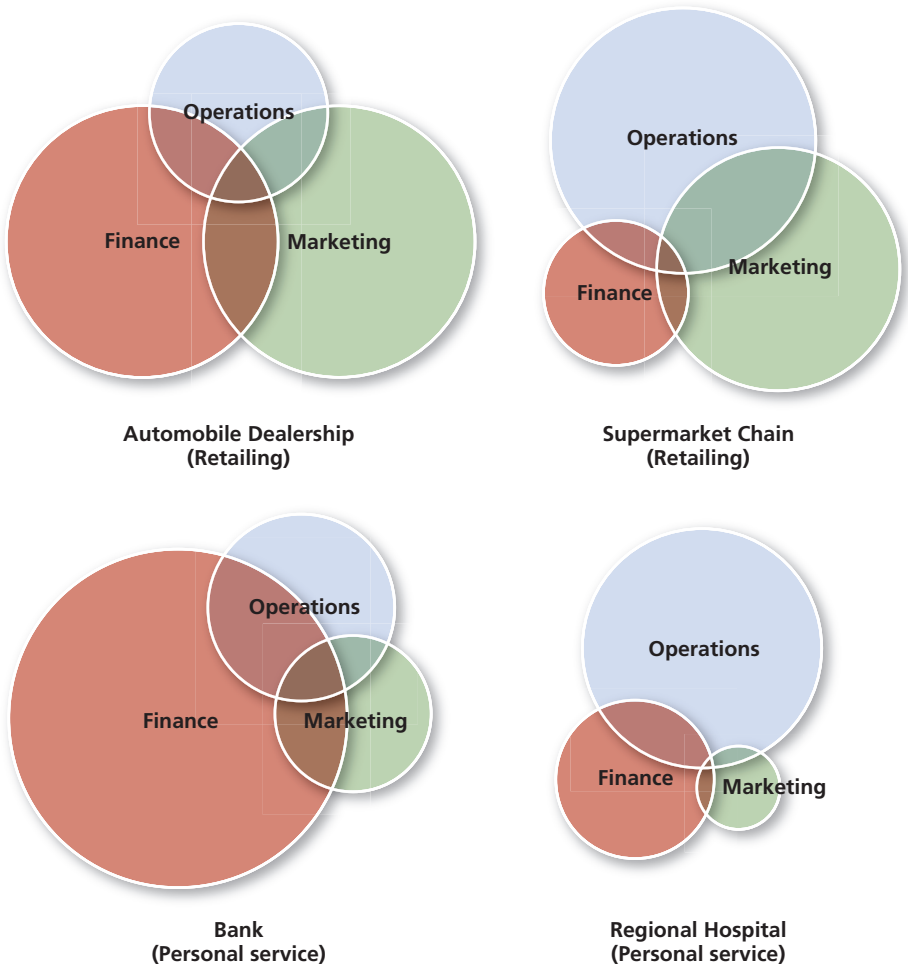
Insight The RDRS warehouse managers discussed three decisions at three different levels of decision making. The opportunity to acquire helicopters is an issue of strategy; it calls for a significant change to the scope of RDRS's operations, with the considerable risk that comes with a large investment outside of its past experience. The dispute over the ATVs is tactical decision making; it is a proposal to reconfigure the distribution of an existing set of resources. Urban warehouse managers are resisting that change by proposing that wilderness area managers change how they currently deploy ATVs. Resolving this suggestion directly guides future actions and is easily reversed if it proves unsuccessful, both strong indications of implementation-level decision making. ■

Operations Management within an Organization

Operations management is a distinct discipline with a membership of people who spend the majority of their time directly involved with operational issues. Locating operations management in an organization begins with considering how it relates to other business disciplines within that particular organization. Operations is considered one of the three central functions of any business organization, sharing this distinction with the disciplines of marketing and finance, while other disciplines such as information technology and human resources support this combined endeavor. Although active in any organization, operations is not necessarily of equal significance relative to other business functions, given the nature of the organization. Figure 1.9 gives four illustrations of the relative mix of these three functions in four different organizations.

In retailing organizations such as car dealerships or supermarkets, marketing naturally plays a central role in the success of the enterprise. However, a supermarket can be considered a somewhat more operations-intensive endeavor than a car dealership, as the nature of its inventory is more complex (multiple suppliers, thousands of items) and not as readily storable for long periods. Similarly, operations management is a concern in both banking and health care, but the lower half of Figure 1.9 emphasizes the hospital

Relative Mix of the Three Business Functions in Various Firms **FIGURE 1.9**



as extremely operations-intensive, requiring the simultaneous coordination of many different patients and professionals, rapid scheduling of a wide variety of resources, and management of a diversity of inventory and information.

Jobs and Job Titles in Operations

Successful entrepreneurs have a solid understanding of operations, fully aware that marketing and finance alone will not keep them afloat. You've probably seen an establishment boasting an "owner operated" plaque. Within larger organizations, people who specialize in operations may be called operations managers, but can also be found working under other job titles:

- Anyone called a manager or a planner in combination with another term is usually dedicated to that aspect of operations management. Examples include production planners, supply chain managers, project managers, and event planners.
- Any job title that indicates responsibility for a mission-critical asset usually focuses on the operation of that asset. Examples here include store manager, branch manager, plant manager, fleet manager, and location manager.
- Other operations-intensive job titles indicate a particular subject area within the discipline of operations that the holder of the title specializes in, such as scheduler, inventory planner, or quality coordinator.

Finally, many consultants work intensively in operations management, particularly when providing assistance with information systems development, business process mapping, and quality improvements.

Professional Organizations and Certifications

Organizations for operations professionals serve a variety of purposes, including social networking and recruiting, developing and distributing new knowledge in the discipline, and recognizing those who have achieved particular levels of knowledge through exams and certifications. Some organizations consist largely of practitioners, while others represent gatherings of practitioners, consultants, and academics. Regardless of their particular emphasis, these groups generally welcome the participation of interested students.

Professional Societies Professional societies are dedicated to supporting the knowledge base of the profession and supporting the careers of those who pursue it. Thus, these societies focus on practitioners and often offer education and certification specific to the profession. Here are some of the most widely recognized professional societies for operations management:

- APICS, The Association for Operations Management (www.apics.org). APICS offers one of the oldest and most widely recognized credentialing programs in operation management, the five-exam CPIM (Certified in Production and Inventory Management).
- ISM, The Institute for Supply Management (www.ism.ws). ISM offers a variety of certifications in purchasing, procurement, and supply chain management, including the CPSM (Certified Professional in Supply Management).
- PMI, Project Management Institute (www.pmi.org). PMI offers a variety of certifications in project management and scheduling, including the PMP, or Project Management Professional.

Professional societies are generally organized into local chapters that meet periodically for educational and networking opportunities, and host larger annual conferences to do the same across regions. These societies often welcome student membership with discounted fees, to support their early pursuit of professional credentials and to provide students with wider access to job networking opportunities.

Academic Societies Other societies consist largely of researchers, professors, and students of subjects related to operations management:

- POMS, The Production and Operations Management Society (www.poms.org).
- DSI, The Decision Sciences Institute (www.decisionsciences.org).
- INFORMS, The Institute for Operations Research and the Management Sciences (www.informs.org).
- The OR Society or Operational Research Society (www.orsoc.org.uk).

Academic societies emphasize the publication and distribution of new research findings, as well as the further development of instructional curriculum. Similar to professional societies, academic societies host regional and international conferences for the exchange of ideas and often welcome student membership at discounted prices.

About this Book

In a certain sense, this book is an operation, whose inputs include paper stock, ink, specialized publishing software, and readers. Hopefully, its outputs are not limited to a somewhat more used version of its physical self once read. To achieve positive value-added, this book must assist in the creation of knowledge, and maybe even enthusiasm, for its subject. It relies heavily on a blended process of written narrative, conceptual graphics, anecdotal illustrations, and practice problems. In the spirit of productivity (every reader has a limited budget of time), the book uses these processes in a consistent fashion within each of its 15 chapters, allowing you to anticipate the road ahead and steer according to your own preferences.

Operations management is a broad topic, and each of the 15 chapters also belongs to one of four smaller focus groups:

- **Chapters 1–4: Essentials.** The first four chapters are devoted to getting started in some sense. This chapter lays out the domain of operations management, a theme that Chapter 2 continues with its discussion of business and operations strategy, including an expanded discussion of productivity. Chapter 3 examines the end product—specifically, how it is chosen and improved. Chapter 4 then supplies the last puzzle pieces needed to get started, some estimate of the future ahead.
- **Chapters 5–8: Planning Operations.** These four chapters borrow mostly from the strategic top of the decision-making pyramid in Figure 1.8, discussing capacity planning and waiting, process and facility selection, project management, and location planning and logistics. These are all complex decisions to be weighed carefully in advance, the essence of good planning.
- **Chapters 9–12: Managing Operations.** These chapters begin travel toward the base of the pyramid in Figure 1.8, beginning with Chapter 9, where we explore vital distinctions between strategic and tactical choices. The remaining three chapters discuss contrasting applications of tactical decision making as inventory management, aggregate and material requirements planning, and lean operations.
- **Chapters 13–15: Action and Adaptation.** The final three chapters of this book are "in the moment," where choices have been made and set in motion, but operations management is far from finished. Chapter 13 describes how ongoing processes can be monitored and managed even as they operate. Chapter 14 explores planning that can't be done in advance and yet may have to be done repeatedly. Chapter 15 concludes with the reality that plans rarely unfold precisely as anticipated, the ultimate challenge in operations management.

Although the chapters follow a logical progression, reading and working through them in numerical order is not mandatory. Each chapter strives to be its own argument for its corner of the larger domain.

SUMMARY

Operations management is a paradox. It is both the oldest and one of the youngest business disciplines, evident when a single entrepreneur opens a small business, a nonprofit organization musters volunteers to fill sandbags against flooding, and a large corporation carefully coordinates shipments across a global supply chain. Each of these settings contains the creation of value, the singular mission of a successful operation.

Operations management bundles together all actions required to create value. These actions transform inputs into a more valuable set of outputs, including but not limited to finished products for the customer. The relative success of this process is expressed by its productivity, although long-term success of the operation should hinge in sustainable and responsible management practices as well. Virtually any organized undertaking can be thought of as an operation, and thus it is useful to categorize similar operations according to important shared features such as tangibility of the product or level of uncertainty in the operating environment. Operations managers can likewise be found in most organizations, working under a variety of related job titles.

Key Terms

bill of materials
biomimicry
business analytics
ethics
goods
green
incident
inventory
iterative planning
lean
local optimization
NGO
operations
planning horizon
processes
productivity
project
responsibility
scientific management
services
stockpiling
strategy
supply chain
sustainability
tactics
tangibility
value-added
value chain
value creation

Discussion Questions

1. Which is more important, strategic or tactical decision making?
2. How does the hierarchy of decision making relate to these four categories of operations: production, project, event, and incident management?
3. Why is the measurement of productivity more challenging in the provision of services, when compared to measuring the productivity of a goods-producing operation?
4. What are the advantages that can be gained if a product does not necessarily need to be consumed at the place it is produced, and how does this relate to supply chain management?
5. Does a pure good exist? If so, what would be an example? Can a pure service exist?
6. Why would sustainability alone not necessarily guarantee the survival of an organization?
7. Identify several situations in which more than one of the following would be practiced simultaneously: production management, project management, event management, and incident management.

PROBLEMS

Minute Answer

Short answers appear in Appendix A. Go to **NoteShaper.com** for full video tutorials on each question.

1. Consider a shipping company that carries freight by truck. Name three inputs to this operation.
2. Value-added refers to the difference in the overall value of what and what?
3. In the hierarchy of decision making, what level is below strategic decision making?
4. Does a service operation usually experience higher or lower variability in its inputs and outputs, when compared to goods production?
5. Ethics are principles that define what?
6. What is the farthest point in the future considered in decision making called?
7. Optimization refers to the identification of what?
8. What are tangible goods awaiting sale or use called?
9. Which involves the greatest degree of uncertainty, an event or an incident?
10. What does NGO stand for?
11. Does a service operation often require higher or lower capital investment at start-up, when compared to goods production?
12. Is the objective of efficiency likely to be more central to planning in production or incident management?

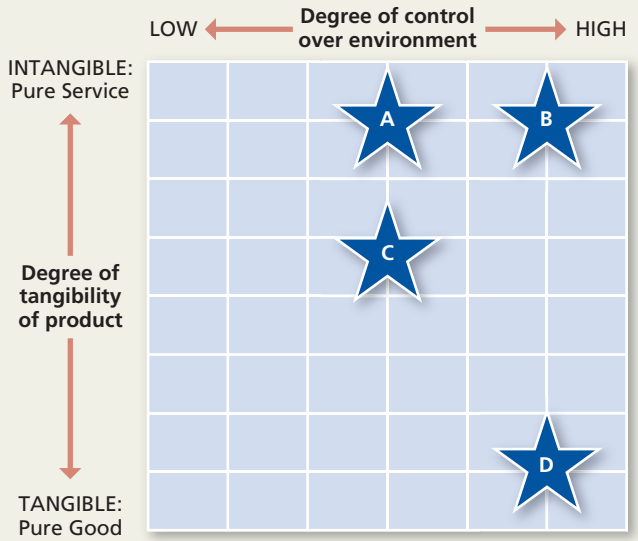
Quick Start

13. A bank must decide which branch office to assign the account of a particularly important and high-maintenance client. Is this an example of a strategic, tactical, or implementation level of decision?
14. A bank must decide if a particular branch office should be closed and its current location sold to another bank. Is this an example of a strategic, tactical, or implementation level of decision?
15. A bank has just received an electronic signal that one of its ATMs is out of service due to a lack of cash to distribute. The bank must decide whether to send a courier to restock the ATM immediately (after business hours) or to allow it to remain out of service until the main banking operation opens the following business day. Is this an example of a strategic, tactical, or implementation level of decision?
16. An organization must decide whether a particular shipment should be sent by air freight or surface (ground) trucking. Is this an example of a strategic, tactical, or implementation level of decision?
17. An organization must decide between Singapore, London, or Buffalo as the location for the construction of a new manufacturing facility. Is this an example of a strategic, tactical, or implementation level of decision?

Ramp Up

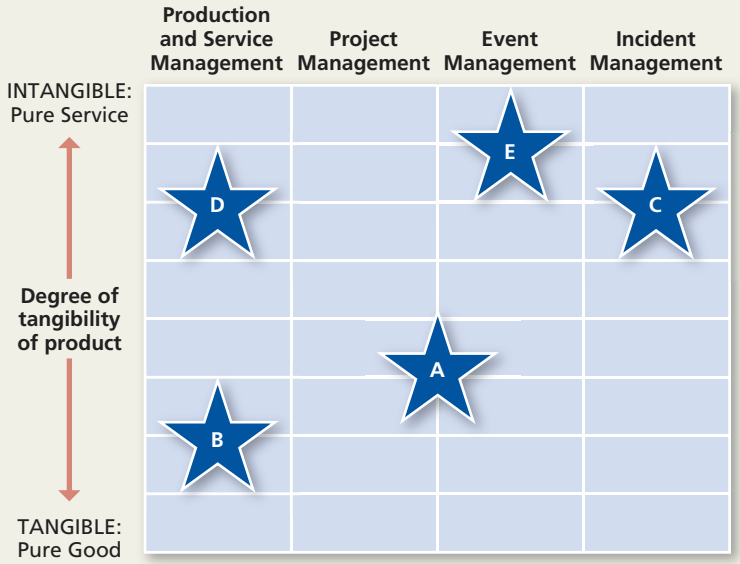
18. Consider the following four situations: negotiating a lease for drilling oil, drilling for oil, refining fuel from oil, and transporting fuel orders to retail locations by tanker trucks. Now consider the following grid, which indicates four positions marked A,

B, C, and D. Each of these positions indicates differing levels of tangibility and control over an operation's external environment:



Match each of the four points on the grid to each of the four operations proposed, assuming each grid location can be used only once.

19. Consider the following five situations: maintenance of a network of ATMs, production and packaging of cake mix, a barn raising in which an entire fast-food restaurant is torn down and completely replaced in 48 hours, hosting and promotion of the performance of a touring musical group, and repair of an electrical grid to restore electricity to homes after a storm. Now consider the following grid, which indicates five positions marked A, B, C, D, and E. Each of these positions indicates differing levels of tangibility and operation types:



Match each of the five points on the grid to each of the four operations proposed, assuming each grid location can be used only once.

CASE STUDY: CONVEX PRODUCTIONS

Convex Productions produces full-length motion pictures for distribution worldwide. Convex has just purchased the rights to a movie script entitled *Native Sun*, which it intends to develop as its next project. *Native Sun* is the story of an orphaned human raised by an alien race, visiting Earth on business and becoming entangled in intrigue there. Its simultaneous classification as science fiction/fantasy and action/adventure is expected to draw a broad audience, and Convex hopes to minimize production costs by recruiting the best business partners early.

Convex cannot start until it raises the funding necessary to film *Native Sun*. At this point, Convex is confident it can finance most of *Native Sun* through a combination of its own cash and a substantial outside investment from executive production company and long-time partner Malomar Pictures. Bringing in Malomar Pictures as a silent partner also secures its subsidary Malomar Worldwide as the distributor of *Native Sun* to theaters upon its release. Other early agreements, providing smaller amounts of initial cash, are listed in the Tentative Licensees table below.

Tentative Licensees in Addition to Malomar Worldwide

Licensee	Subject of License
Stratospheric LLC	Nontheatrical distribution, primarily airlines. Does not include home distribution.
Manta Distribution	All home distribution rights, including the sale of physical formats, video-on-demand, and eventual syndication to television.
Main House Gaming	Permission to create and sell *Native Sun* module for existing *Solar Twilight* multiplayer computer game.
JAZ Events	Production and distribution of all nonelectronic merchandise, including *Native Sun*–themed toys and apparel.

With this combined funding, Convex Productions can launch the preproduction phase of *Native Sun*. Convex intends to run the *Native Sun* production office out of its own organization, so it must begin its search for a director, assistant director, casting director, and production designer immediately. Convex will also contribute a unit production manager, legal services, and storyboard artists from its own staff. Convex hopes this combined group will then complete all preproduction work in no more than 6 months, recruiting the cast and crew and creating the detailed plans to follow during filming. Although Convex is a producer of major motion pictures, it does not itself own any of the infrastructure required for filming. Before the preproduction work of *Native Sun* is finished, Convex must finalize negotiations with several key contractors listed in the Tentative Contracts table, below, to move forward.

Tentative Contractors for *Native Sun*

Contractor	Services Provided
Lamplight Studios	Three sound stages for filming and all associated equipment. Also provides filming equipment and support on location.
Epic Scenery Studios	Scenery and costume construction.
Visual Effects Factory	Special effects, computer-generated imagery, and postproduction filming editing.
Rayburn Logistics	All ground transportation and fleet management, including shipment of scenery pieces from Epic to Lamplight Studios and diesel generators for electricity on location.
Great Plains Catering	All food service, all locations. Includes catering of promotional events and edibles used in the film.

Ideally, all filming and postproduction would be completed within a year of the conclusion of preproduction, although the exact finish time is difficult to estimate this early in the preproduction process. Because investors in *Native Sun* won't receive any return until the finished film starts selling tickets at Palomar Worldwide's theater outlets, Convex Production must use part of its own cash now to purchase a completion insurance policy. This policy covers part of the risk of Convex's business partners should *Native Sun* not finish as planned, which is vital to winning their confidence and investment at this stage in the process.

Questions

1. Write a paragraph describing Convex Production as an operation. Does Convex produce goods or services? What type of operation is it? What does it control and what are its uncertainties?
2. Use the input/output model to diagram *Native Sun* as an operation, organizing the information provided here beneath the three stages suggested by the model.
3. Now use the input/output model to diagram Convex Productions as an operation, organizing the information provided here beneath the three stages suggested by the model.
4. What do your two diagrams reveal about the relationship between *Native Sun* and Convex Productions? (Why are they not identical diagrams?)

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