Solutions for Operations Management 13th Edition by Heizer

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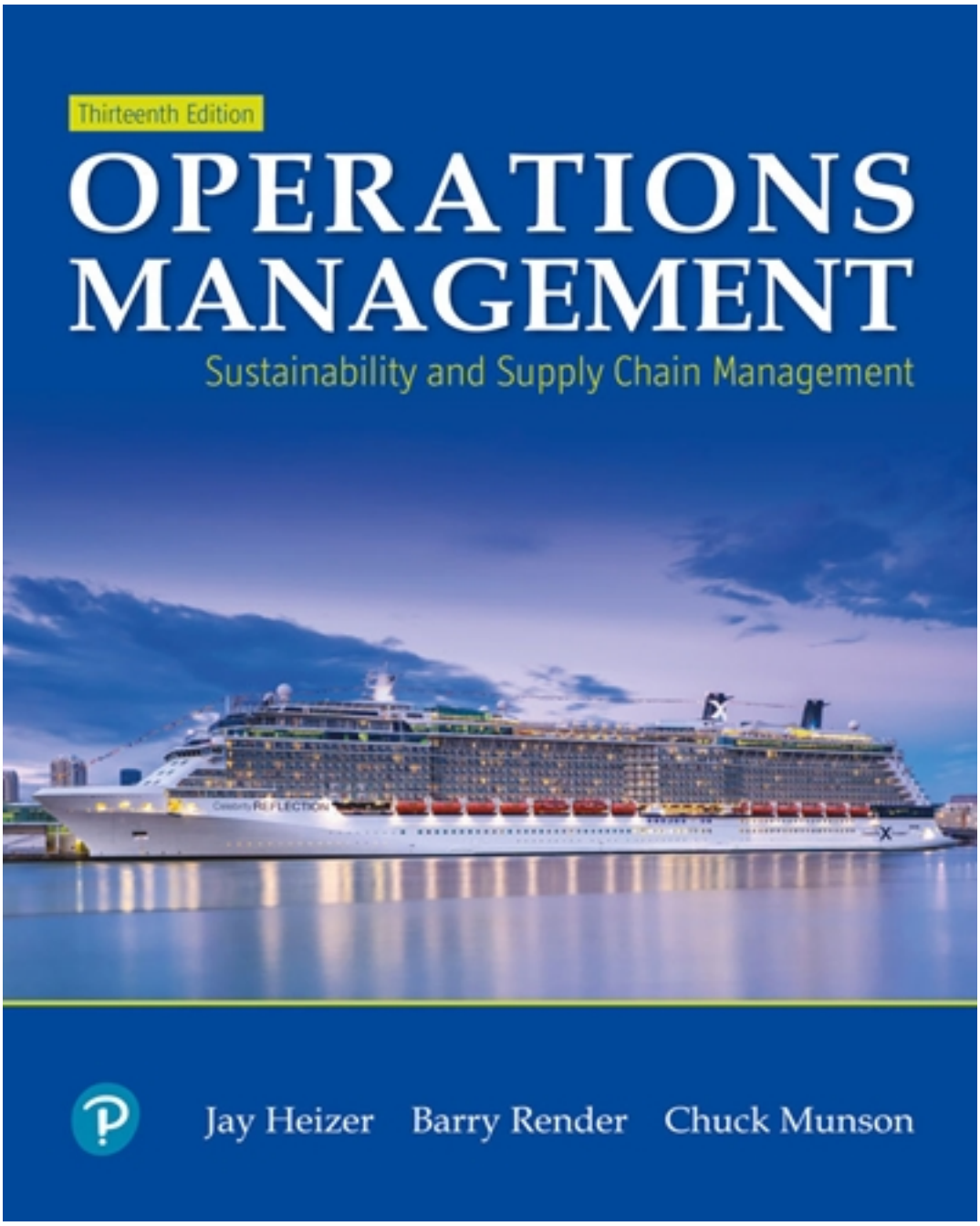

Solutions

Instructor's Solutions Manual (Download only) for Operations Management, 13e and Principles of Operations Management 11e

Operations Management
Thirteenth Edition

Principles of Operations Management
Eleventh Edition

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CHAPTER 1

Operations and Productivity

DISCUSSION QUESTIONS

1. The text suggests four reasons to study OM. We want to understand (1) how people organize themselves for productive enterprise, (2) how goods and services are produced, (3) what operations managers do, and (4) this costly part of our economy and most enterprises.

LO 1.1: Define operations management

AACSB: Application of knowledge

2. With some 40% of all jobs being in the OM field, the career opportunities are prolific. The text suggests many career opportunities. OM students find initial jobs throughout the OM field, including supply chain, logistics, purchasing, production planning and scheduling, plant layout, maintenance, quality control, inventory management, etc.

LO 1.3: Identify career opportunities in operations management

AACSB: Application of knowledge

3. Possible responses include: Adam Smith (work specialization/ division of labor), Charles Babbage (work specialization/division of labor), Frederick W. Taylor (scientific management), Walter Shewart (statistical sampling and quality control), Henry Ford (moving assembly line), Charles Sorensen (moving assembly line), Frank and Lillian Gilbreth (motion study), Eli Whitney (standardization).

LO 1.1: Define operations management

AACSB: Application of knowledge

4. See references in the answer to Question 3.

LO 1.1: Define operations management

AACSB: Application of knowledge

5. The actual charts will differ, depending on the specific organization the student chooses to describe. The important thing is for students to recognize that all organizations require, to a greater or lesser extent, (a) the three primary functions of operations, finance/accounting, and marketing; and (b) that the emphasis or detailed breakdown of these functions is dependent on the specific competitive strategy employed by the firm.

LO 1.1: Define operations management

AACSB: Application of knowledge

6. The answer to this question may be similar to that for Question 5. Here, however, the student should be encouraged to utilize a more detailed knowledge of a past employer and indicate on the chart additional information such as the number of persons employed to perform the various functions and, perhaps, the position of the functional areas within the overall organization hierarchy.

LO 1.1: Define operations management

AACSB: Application of knowledge

7. The basic functions of a firm are marketing, accounting/ finance, and operations. An interesting class discussion: "Do all firms/organizations (private, government, not-for-profit) perform these three functions?" The authors' hypothesis is yes, they do.

LO 1.1: Define operations management

AACSB: Application of knowledge

8. The 10 strategic decisions of operations management are product design, quality, process, location, layout, human resources, supply-chain management, inventory, scheduling (intermediate and short-term), and maintenance. We find this structure an excellent way to help students organize and learn the material.

LO 1.1: Define operations management

AACSB: Application of knowledge

9. Four areas that are important to improving labor productivity are (1) basic education (basic reading and math skills), (2) diet of the labor force, (3) social overhead that makes labor available (water, sanitation, transportation, etc.), and (4) maintaining and expanding the skills necessary for changing technology and knowledge, as well as for teamwork and motivation.

LO 1.8: Identify the critical variables in enhancing productivity

AACSB: Application of knowledge

10. Productivity is harder to measure when the task becomes more intellectual. A knowledge society implies that work is more intellectual and therefore harder to measure. Because the U.S. and many other countries are increasingly "knowledge" societies, productivity is harder to measure. Using labor-hours as a measure of productivity for a postindustrial society versus an industrial or agriculture society is very different. For example, decades spent developing a marvelous new drug or winning a very difficult legal case on intellectual property rights may be significant for postindustrial societies, but not show much in the way of productivity improvement measured in labor-hours.

LO 1.8: Identify the critical variables in enhancing productivity

AACSB: Analytical thinking

11. Productivity is difficult to measure because precise units of measure may be lacking, quality may not be consistent, and exogenous variables may change.

LO 1.8: Identify the critical variables in enhancing productivity

AACSB: Reflective thinking

12. Mass customization is the flexibility to produce to meet specific customer demands, without sacrificing the low cost of a product-oriented process. Rapid product development is a source of competitive advantage. Both rely on agility within the organization.

LO 1.1: Define operations management

AACSB: Application of knowledge

13. Labor productivity in the service sector is hard to improve because (1) many services are labor intensive and (2) they are individually (personally) processed (the customer is paying for that service—the haircut), (3) it may be an intellectual task performed by professionals, (4) it is often difficult to mechanize and automate, and (5) it is often difficult to evaluate for quality.

LO 1.8: Identify the critical variables in enhancing productivity

AACSB: Reflective thinking

14. Taco Bell designed meals that were easy to prepare; with actual cooking and food preparation done elsewhere; automation to save preparation time; reduced floor space; manager training to increase span of control.

LO 1.8: Identify the critical variables in enhancing productivity

AACSB: Application of knowledge

15. Bureau of Labor Statistics (stats.bls.gov) is a good place to start. Results will vary for each year, but overall data for the economy will range from 0.9% to 4.8%, and mfg. could be as high as 5% and services between 1% and 2%. The data will vary even more for months or quarters. The data are frequently revised, often substantially.

LO 1.7: Compute multifactor productivity

AACSB: Application of knowledge

ETHICAL DILEMMA

AMERICAN CAR BATTERY INDUSTRY

You may want to begin the discussion by asking how ethical it is for you to be in the lead battery business when you know that any batteries you recycle will very likely find their way to an overseas facility (probably Mexico) with, at best, marginal pollution containment. Then after a likely conclusion of "Well someone has to provide batteries," you can move to the following discussion.

(a) As owner of an independent auto repair shop trying to dispose of a few old batteries each week, your options may be limited. But as an ethical operator, your first option is to put pressure on your battery supplier to take your old batteries. Alternatively, shop for a battery supplier who wants your business enough to dispose of your old batteries. Third, because there is obviously a market for the lead in old batteries, some aggressive digging may uncover an imaginative recycler who can work out an economical arrangement for pickup or delivery of your old batteries. Another option is, of course, to discontinue the sale of batteries. (This is a problem for many small businesses; ethical decisions and regulation may be such that they often place an expensive and disproportionate burden on a small firm.)

(b) As manager of a large retailer responsible for disposal of thousands of used batteries each week, you should have little trouble finding a battery supplier with a reverse supply chain suitable for disposal of old batteries. Indeed, a sophisticated retailer, early on in any supply-chain development process, includes responsible disposal of environmentally dangerous material as part of the negotiations. Disposal of old batteries should be a minor issue for a large retailer.

(c) For both a small and large retailer, the solution is to find a "sustainable" solution or get out of the battery business. Burying the batteries behind the store is not an option. *Supplement 5: Sustainability in the Supply Chain* provides some guidelines for a deeper class discussion.

END-OF-CHAPTER PROBLEMS

1.1 (a) $\dfrac{120 \text{ boxes}}{40 \text{ hours}} = 3.0 \text{ boxes/hour}$

(b) $\dfrac{125 \text{ boxes}}{40 \text{ hours}} = 3.125 \text{ boxes/hour}$

(c) Change in productivity = 0.125 box/hour

(d) Percentage change $= \dfrac{0.125 \text{ box}}{3.0} = 4.167\%$

1.2 (a) Labor productivity is 160 valves/80 hours = 2 valves per hour

(b) New labor productivity = 180 valves/80 hours = 2.25 valves per hour

(c) Percentage change in productivity = .25 valve/2 valves = 12.5%

1.3 $0.15 = \dfrac{57{,}600}{(160)(12)(L)}$, where L = number of laborers employed at the plant

So, $L = \dfrac{57{,}600}{(160)(12)(0.15)} = 200$ laborers employed

1.4 (a) $\frac{\text{Units produced}}{\text{Input}} = \frac{100 \text{ pkgs}}{5} = 20 \text{ pkgs/hour}$

(b) $\frac{133 \text{ pkgs}}{5} = 26.6 \text{ pkgs per hour}$

(c) Increase in productivity $= \frac{6.6}{20} = 33.0\%$

1.5

Resource	Last Year	This Year	Change	Percentage Change
Labor	$\frac{1,000}{300} = 3.33$	$\frac{1,000}{275} = 3.64$	0.31	$\frac{0.31}{3.33} = 9.3\%$
Resin	$\frac{1,000}{50} = 20$	$\frac{1,000}{45} = 22.22$	2.22	$\frac{2.22}{20} = 11.1\%$
Capital	$\frac{1,000}{10,000} = 0.1$	$\frac{1,000}{11,000} = 0.09$	–0.01	$\frac{-0.01}{0.1} = -10.0\%$
Energy	$\frac{1,000}{3,000} = 0.33$	$\frac{1,000}{2,850} = 0.35$	0.02	$\frac{0.02}{0.33} = 6.1\%$

1.6

	Last Year	This Year
Production	1,000	1,000
Labor hr. @ $10	$3,000	$2,750
Resin @ $5	250	225
Capital cost/month	100	110
Energy	1,500	1,425
	$4,850	$4,510

$$\frac{[(1,000 / 4,510) - (1,000 / 4,850)]}{(1,000 / 4,850)} =$$

$$\frac{0.222 - 0.206}{0.206} = \frac{0.016}{0.206} = 7.8\% \text{ improvement*}$$

*with rounding to 3 decimal places.

1.7 Productivity $= \frac{\text{Output}}{\text{Input}}$

(a) Labor productivity $= \frac{65}{(520 \times 13)} = \frac{65}{\$6,760}$

$= .0096$ rug per labor \$

(b) $\frac{\text{Multifactor}}{\text{productivity}} = \frac{65}{(520 \times \$13) + (100 \times \$5) + (20 \times \$50)}$

$= \frac{65}{\$8,260} = .00787$ rug per \$

1.8 (a) Labor productivity = 1,000 tires/400 hours = 2.5 tires/hour.

(b) Multifactor productivity is 1,000 tires/(400 × $12.50 + 20,000 × $1 + $5,000 + $10,000) = 1,000 tires/$40,000 = 0.025 tire/dollar.

(c) Multifactor productivity changes from 1,000/40,000 to 1,000/39,000, or from 0.025 to 0.02564; the ratio is 1.0256, so the change is a 2.56% increase.

1.9

	Last Year	This Year	Change	Percentage Change
Labor hrs.	$\frac{1,500}{350} = 4.29$	$\frac{1,500}{325} = 4.62$	$\frac{0.33}{4.29}$	= 7.7%
Capital invested	$\frac{1,500}{15,000} = 0.10$	$\frac{1,500}{18,000} = 0.08$	$\frac{-0.02}{0.1}$	= –20%
Energy (btu)	$\frac{1,500}{3,000} = 0.50$	$\frac{1,500}{2,750} = 0.55$	$\frac{0.05}{0.50}$	= 10%

Productivity of capital did drop; labor productivity increased as did energy, but by less than the anticipated 15%.

1.10 Multifactor productivity is:

375 autos/[($20 × 10,000) + ($1,000 × 500) + ($3 × 100,000)] = 375/(200,000 + 500,000 +300,000) = 375/1,000,000 = .000375 auto per dollar of inputs

1.11 (a) Before: 500/20 = 25 boxes per hour;

After, 650/24 = 27.08

(b) 27.08/25
= 1.083, or an increase of 8.3% in productivity

(c) New labor productivity = 700/24 = 29.167 boxes per hour

1.12 1,500 × 1.25 = 1,875 (new demand)

$$\frac{\text{Outputs}}{\text{Inputs}} = \text{Productivity}$$

$$\frac{1,875}{\text{Labor-hours}} = 2.344$$

$$\text{New process} = \frac{1,875}{2.344} \cong 800 \text{ labor-hours}$$

$$\frac{800}{160} = 5 \text{ workers}$$

$$\text{Current process} = \frac{1,500}{\text{labor-hours}} = 2.344$$

$$\frac{1,500}{2.344} = \text{labor-hours} \cong 640$$

$$\frac{640}{160} = 4 \text{ workers}$$

Add one worker.

1.13 (a) Labor change:

$$\frac{1{,}500}{(640 \times \$8)} = \frac{1{,}500}{5{,}120} = .293 \text{ loaf/\$}$$

$$\frac{1{,}875}{(800 \times \$8)} = 0.293 \text{ loaf/\$}$$

(b) Investment change:

$$\frac{1{,}500}{(640 \times \$8)} = \frac{1{,}500}{5{,}120} = .293 \text{ loaf/\$}$$

$$\frac{1{,}875}{(640 \times 8) + (100)} = \frac{1{,}875}{5{,}220} = .359 \text{ loaf/\$}$$

(c) Percentage change: $\frac{.293 - .293}{.293} = 0$ (labor)

Percentage change: $\frac{.359 - .293}{.293} = .225$

$= 22.5\%$ (investment)

The better option is to purchase a new blender because it generates more loaves per dollar.

1.14

$$\text{Old process} = \frac{1{,}500}{(640 \times 8) + 500 + (1{,}500 \times 0.35)}$$

$$= \frac{1{,}500}{6{,}145} = 0.244 \text{ loaf/\$}$$

$$\text{New process} = \frac{1{,}875}{(800 \times 8) + 500 + (1{,}875 \times 0.35)}$$

$$= \frac{1{,}875}{7{,}556.25} = 0.248 \text{ loaf/\$}$$

$$\text{Percentage change} = \frac{0.248 - 0.244}{0.244} = 1.6\%$$

1.15 (a) $\frac{6{,}600 \text{ vans}}{x \text{ labor-hours}} = 0.10$

$x = 66{,}000$ labor-hours

There are 300 laborers. So,

$$\frac{66{,}000 \text{ labor-hours}}{300 \text{ laborers}} = 220 \text{ labor-hours/laborer on average, per month}$$

(b) Now $\frac{6{,}600 \text{ vans}}{x \text{ labor-hours}} = 0.11$, so $x = 60{,}000$ labor-hours

so, $\frac{60{,}000 \text{ labor-hours}}{300 \text{ laborers}} = 200$ labor-hours/laborer on average, per month

1.16

$$\frac{\$ \text{ output}}{\text{labor-hours}} = \frac{52(\$90) + 80(\$198)}{8(45)}$$

$$= \frac{\$20{,}520}{360} = \$57.00 \text{ per labor-hour}$$

1.17
$$\text{Last year} = \frac{1,500}{(350 \times 8) + (15,000 \times 0.0083) + (3,000 \times 0.6)}$$
$$= \frac{1,500}{2,800 + 124.50 + 1,800}$$
$$= \frac{1,500}{4,724.5} = 0.317 \text{ doz / \$}$$
$$\text{This year} = \frac{1500}{(325 \times 8) + (18,000 \times 0.0083) + (2,750 \times 0.6)}$$
$$= 0.341 \text{ doz / \$}$$
$$\text{Percentage change} = \frac{0.341 - 0.317}{0.317}$$
$$= 0.076, \text{ or } 7.6\% \text{ increase}$$

CASE STUDY

UBER TECHNOLOGIES, INC.

1. First, some drivers (maybe most) may not require a wage that equals those fully engaged in the "taxi" business. It truly could be a supplemental income. . . . "I'm going that way anyhow so let's make a few dollars while on the way." Similarly, the capital investment cost approaches zero as the car is going that direction anyhow. These are idle or underutilized resources.

From society's perspective, Uber and its like competitors are desirable because both idle or wasted labor and capital resources are being utilized. At the same time, as a bonus, Uber is reducing traffic and auto pollution while speeding up the transport of individuals and local commerce.

As a competitor for the traditional taxi service, Uber seems to be an enhancement in efficiency.

For those faculty who what to spend some time on the larger productivity message, this case provides such an opportunity. Uber, as Joseph Schumpeter would suggest, has developed a disruptive technology (creative destruction, in a Schumpeterian translation). Innovations such as this are exactly how economic efficiency is enhanced. The traditional taxi services, with some imagination, could have developed and adopted this technology, but most were ensconced in their own regulatory cocoon. As is often the case, it takes an outsider, such as Uber et al. to be creative by putting unused resources to use and providing society greater efficiency.

LO 1.8: Identify the critical variables in enhancing productivity

AACSB: Analytical thinking

2. Perhaps a business model similar to Uber's can be applied to the trucking industry. And, indeed, Uber has established an Uber app for the trucking industry. An estimated 30% of trucking backhauls are empty. However, the number of independent truckers or truckers with the latitude to alter their route may be very small. And this number must be a tiny fraction of independent automobile drivers. So, the ability to "Uberize" trucking may be very difficult, but utilizing that idle 30% would be huge benefit to society.

LO 1.8: Identify the critical variables in enhancing productivity

AACSB: Analytical thinking

3. Perhaps the Uber model can be used for package delivery, documents, and everything from flowers to groceries. Airbnb (www.airbnb.com) is applying a similar model to short-term rentals of rooms, apartments, and homes—competing with more traditional bed and breakfast facilities and hotels.

LO 1.8: Identify the critical variables in enhancing productivity

AACSB: Analytical thinking

VIDEO CASE STUDIES

1 FRITO-LAY: OPERATIONS MANAGEMENT IN MANUFACTURING

This case provides a great opportunity for an instructor to stimulate a class discussion early in the course about the pervasiveness of the 10 decisions of OM with this case alone or in conjunction with the Hard Rock Cafe case. There is a short video (7 minutes) available in MyLab Operations Management that is filmed specifically for this text and supplements this case.

1.

- *Product design:* Each of Frito-Lay's 40-plus products must be conceived, formulated (designed), tested (market studies, focus groups, etc.), and evaluated for profitability.
- *Quality:* The standards for each ingredient, including its purity and quality, must be determined.
- *Process:* The process that is necessary to produce the product and the tolerance that must be maintained for each ingredient by each piece of equipment must be specified and procured.
- *Location:* The fixed and variable costs of the facility, as well as the transportation costs and the delivery distance, given the freshness, must be determined.
- *Layout:* The Frito-Lay facility would be a process facility, with great care given to reducing movement of material within the facility.
- *Human resources:* Machine operators may not have inherently enriched jobs, so special consideration must be given to developing empowerment and enriched jobs.
- *Supply chain management:* Frito-Lay, like all other producers of food products, must focus on developing and auditing raw material from the farm to delivery.
- *Inventory:* Freshness and spoilage require constant effort to drive down inventories.
- *Scheduling:* The demand for high utilization of a capital-intensive facility means effective scheduling will be important.
- *Maintenance:* High utilization requires good maintenance, from machine operator to the maintenance department and depot service.

LO 1.1: Define operations management

AACSB: Reflective thinking

2. Determining output (in some standard measure, perhaps pounds) and labor-hours would be a good start for single-factor productivity.

For multifactor productivity, we would need to develop and understand capital investment and energy, as well as labor, and then translate those into a standard, such as dollars.

LO 1.6: Compute single-factor productivity

LO 1.7: Computer multifactor productivity

AACSB: Reflective thinking

3. Hard Rock performs all 10 of the decisions as well, only with a more service-sector orientation. Each of these is discussed in the solution to the Hard Rock Cafe case.

LO 1.8: Identify the critical variables in enhancing productivity

AACSB: Reflective thinking

2 HARD ROCK CAFE: OPERATIONS MANAGEMENT IN SERVICES

There is a short video (7 minutes) available in MyLab Operations Management that is filmed specifically for this text and supplements this case.

1. Hard Rock's 10 decisions: This is early in the course to discuss these in depth, but still a good time to get the students engaged in the 10 OM decisions around which the text is structured.

- *Product design:* Hard Rock's tangible product is food and like any tangible product it must be designed, tested, and "costed out." The intangible product includes the music, memorabilia, and service.
- *Quality:* The case mentions the quality survey as an overt quality measure, but quality can be discussed from a variety of perspectives—hiring the right people, food ingredients, good suppliers, speed of service, friendliness, etc.
- *Process:* The process can be discussed from many perspectives: (a) the process of processing a guest, to their seat, taking the order, order processing, delivery of the meal, payment, etc., (b) the process of how a meal is prepared (see, for instance, how one would make a Hard Rock Hickory BBQ Bacon Cheeseburger (Figure 5.9) or a Buffalo Chicken Mac & Cheese (Figure 14.9) or use the Method Analysis tool discussed in Chapter 10, or (c) some subset of any of these.
- *Location:* Hard Rock Cafes have traditionally been located in tourist locations, but that is beginning to change.
- *Layout:* Little discussion in the case, but students may be very aware that a kitchen layout is critical to efficient food preparation and that a bar is critical in many food establishments for profitability. The retail shop in relation to the restaurant and its layout is a critical ingredient for profitability at Hard Rock.
- *Human resources:* Jim Knight, VP for Human Resources at Hard Rock, seeks people who are passionate about music, love to serve, can tell a story. This OM decision is a critical ingredient for success of a Hard Rock Cafe and an integral part of the Hard Rock dining experience.

- *Supply chain management:* Although not discussed in the case, students should appreciate the importance of the supply chain in any food service operation. Some items like leather jackets have a 9-month lead time. Contracts for meat and poultry are signed 8 months in advance.
- *Inventory:* Hard Rock, like any restaurant, has a critical inventory issue that requires that food be turned over rapidly and that food in inventory be maintained at the appropriate and often critical temperatures. But the interesting thing about Hard Rock's inventory is that they maintain $40 million of memorabilia with all sorts of special care, tracking, and storage issues.
- *Scheduling:* Because most Hard Rock Cafe's sales are driven by tourists, the fluctuations in seasonal, daily, and hourly demands for food are huge. This creates a very interesting and challenging task for the operations managers at Hard Rock. (Not mentioned in the case, linear programming is actually used in some cafes to schedule the waitstaff.)
- *Maintenance/reliability:* The Hard Rock Cafe doors must open every day for business. Whatever it takes to provide a reliable kitchen with hot food served hot and cold food served cold must be done. Bar equipment and point-of-sale equipment must also work.

LO 1.1: Define operations management

AACSB: Reflective thinking

2. Productivity of kitchen staff is simply the output (number of meals) over the input (hours worked). The calculation is how many meals prepared over how many hours spent preparing them. The same kind of calculation can be done for the waitstaff. In fact, Hard Rock managers begin with productivity standards and staff to achieve those levels. (You may want to revisit this issue when you get to Chapter 10 and Supplement 10 on labor standards and discuss how labor can be allocated on a per-item basis with more precision.)

LO 1.6: Compute single-factor productivity

AACSB: Analytical thinking

3. Each of the 10 decisions discussed in Question 1 can be addressed with a tangible product like an automobile.

- *Product design:* The car must be designed, tested, and costed out. The talents may be those of an engineer or operations manager rather than a chef, but the task is the same.
- *Quality:* At an auto plant, quality may take the form of measuring tolerances or wear of bearings, but there is still a quality issue.
- *Process:* With an auto, the process is more likely to be an assembly-line process.
- *Location:* Hard Rock Cafe may want to locate at tourist destinations, but an auto manufacturer may want to go to a location that will yield low fixed or variable cost.
- *Layout:* An automobile assembly plant is going to be organized on an assembly line criterion.
- *Human resources:* An auto assembly plant will be more focused on hiring factory skills rather than a passion for music or personality.
- *Supply chain management:* The ability of suppliers to contribute to design and low cost may be a critical factor in the modern auto plant.
- *Inventory:* The inventory issues are entirely different—tracking memorabilia at Hard Rock, but an auto plant requires tracking a lot of expensive inventory that must move fast.
- *Scheduling:* The auto plant is going to be most concerned with scheduling material, not people.
- *Maintenance:* Maintenance may be even more critical in an auto plant as there is often little alternate routing, and downtime is very expensive because of high fixed and variable cost.

LO 1.4: Explain the distinction between goods and services

AACSB: Reflective thinking

3 CELEBRITY CRUISES: OPERATIONS MANAGEMENT AT SEA

There is a short video (6.5 minutes) available in MyLab Operations Management that is filmed specifically for this text and supplements this case.

1. Celebrity's 10 decisions: It is early in the course to discuss these in depth, but still a good time to get the students engaged in the 10 OM decisions around which the text is structured.

- *Product design:* Celebrity's product consists of a complete 'premium' vacation/holiday experience. It includes accommodations, ports-of-call, shipboard facilities, food, service, etc. Students should appreciate the full scope of how Celebrity Cruises designs all of the many attributes of its 'product.'
- *Quality:* The case mentions the quality survey as an overt quality measure, but quality can be discussed from a variety of perspectives—hiring the right people, food ingredients, good suppliers, speed of service, cleanliness, friendliness, etc.

- *Process:* Operation of a successful cruise line consists of many processes. The process can be discussed from various perspectives: (a) the process of welcoming a guest aboard, (b) bill and payment processing, (c) delivery of meals, (d) supply chain, (e) off ship excursions, etc. The methods analysis tools discussed in Chapter 10 provide a way for students to address and analyze these processes.
- *Location:* Celebrity Cruises provides a unique opportunity for students to address the many aspects of the location decision. First, where in the world are the customers? Second, from what home ports will Celebrity operate? Third, where are the locations of the ports-of-call for the ship?
- *Layout:* How should the ship itself be designed…how many restaurants, how many kitchens, what other amenities (i.e. gym, spa, theater, shops, library, etc.)? What shipboard features will distinguish differences in pricing?
- *Human resources:* The unique international flavor of the crew on cruise ships generates a wide variety of special recruiting, motivational, and teamwork issues. A service-oriented staff, carefully recruited and well trained, is a critical ingredient for success of a 'hotel at sea' and an integral part of the premium Celebrity Cruises experience.
- *Supply chain management:* Students should appreciate the importance of the supply chain for a floating hotel that is going to be at sea for days or even weeks at a time.
- *Inventory:* Because there is seldom resupply once at sea, inventory, but particularly food inventory for hundreds of people, is a critical issue. Food requirements must be accurately forecasted and be maintained at the appropriate and often critical temperatures. Food is only one of the many inventory items to be maintained: water, fuel, cleaning supplies, clothes, and memorabilia require all sorts of special care, tracking, and storage issues.
- *Scheduling:* Fluctuations in location and season create a very interesting and challenging task for the operations managers. Not only the ships and port access and excursions, but also food deliveries and crews, must all be scheduled.
- *Maintenance/reliability:* The ship is open every day for business. Minor maintenance is performed while the ship is operating, with more significant maintenance performed annually and major long-term maintenance conducted in dry dock every 5 years.

LO 1.2: Identify the 10 strategic decisions of operations management

AACSB: Reflective thinking

2. Celebrity's 10 OM decisions are also executed by a manufacturing firm. See, for instance, the Frito-Lay case discussed earlier in this chapter. Indeed, the theme of the text is that these 10 decisions are pervasive in OM. It matters little if the product is a Frito-Lay product, an iPhone, or a premium vacation with Celebrity Cruises; all of these 10 decisions are going to be made. The distinction is the implementation and emphasis placed on each. For instance, product design at Frito-Lay may begin with selecting the proper potatoes, cooking oils, and temperature. Celebrity, as noted above, has a very different product design task. Similarly, quality of Frito-Lay chips may be dependent on precise cutting blades and processing temperature, while Celebrity's quality manifests itself in accommodations, food, and service. Students should be challenged to recognize that the 10 decisions are made, albeit with distinctions dependent upon the product and strategy.

LO 1.2: Identify the 10 strategic decisions of operations management

ACSB: Reflective thinking

3. Celebrity's 10 OM decisions are also executed by a retail firm. Indeed, the theme of the text is that these 10 decisions are pervasive in OM. It matters little if the product is a retail firm or a restaurant (such as Hard Rock, discussed in the prior case) or a premium vacation with Celebrity Cruises; all of these 10 decisions are going to be made. Perhaps in a different way and with different emphasis, but they will be made. For instance, Hard Rock's product is a unique memorabilia-filled dining experience. Celebrity's product is a holiday with premium accommodations, food, and service. Students should be challenged to recognize that the 10 decisions are made, albeit with distinctions dependent upon the product and strategy.

LO 1.2: Identify the 10 strategic decisions of operations management

ACSB: Reflective thinking

4. The differences between a land-based hotel and the "hotel at sea" may be very small in terms of guest expectations and the quality decision. However, the emphasis on various aspects of the other decisions can be expected to change. For instance, for the "hotel at sea" the location decision changes as a function of the season, port-of-call performance, and even weather. A hotel may or may not include dining excellence a part of its product, but for most cruise lines, a premium dining experience is critical. In the case of supply chain, logistics, and inventory, for the ship there is often no resupply; therefore, there is an added emphasis on forecasts, logistics, and inventory. Forecasts must be accurate, suppliers punctual, and inventory counts precise. Similarly, maintenance onboard ship must remove all variability; the emergency backup may be days away. Most hotels will very likely have little in common with the implementation of the human resource function at an international cruise line with employees from dozens of countries. But they both must be successful at the HR decision.

LO 1.2: Identify the 10 strategic decisions of operations management

ACSB: Reflective thinking

ADDITIONAL CASE STUDIES (available in MyLab Operations Management)

1 NATIONAL AIR EXPRESS

This case can be used to introduce the issue of productivity and how to improve it, as well as the difficulty of good consistent measures of productivity. This case can also be used to introduce some of the techniques and concepts of OM.

1. The number of stops per driver is certainly a good place to start. However, mileage and number of shipments will probably be good additional variables. (Regression techniques, addressed in Chapter 4, can be addressed here.)

LO 1.8: Identify the critical variables in enhancing productivity

AACSB: Analytical thinking

2. Customer service should be based on an analysis of customer requirements. Document requirements in terms of services desired (supply needs, preprinted waybills, package weights, pickup and drop-off requirements) should all be considered. (The house of quality technique discussed in Chapter 5 is one approach for such an analysis.)

LO 1.8: Identify the critical variables in enhancing productivity

AACSB: Analytical thinking

3. Other companies in the industry do an effective job of establishing very good labor standards for their drivers, sorters, and phone personnel. Difficult perhaps, but doable. (Work measurement in Chapter 10 addresses labor standards.)

LO 1.8: Identify the critical variables in enhancing productivity

AACSB: Analytical thinking

2 ZYCHOL CHEMICALS CORPORATION

1. The analysis of the productivity data is shown on the next page. Both labor and material productivity increased, but capital equipment productivity did not. The net result is a large negative change in productivity. If this is a one-time change in the accounting procedures, this negative change should also be a one-time anomaly. The effect of accounting procedures is often beyond the control of managers. For example, perhaps the capital allocation is based on an accelerated allocation of depreciation of newly installed technology. This accounting practice will seriously impact near-term productivity and then later years' productivity figures will benefit from the reduced depreciation flows. This highlights the difficulty in accounting for costs in an effective managerial manner. Decisions and evaluation of operating results should be based on sound managerial accounting practices and not necessarily generally accepted financial accounting principles.

LO 1.6: Compute single-factor productivity

LO 1.7: Compute multifactor productivity

AACSB: Analytical thinking

2. An analysis of adjusted results reduces the negative impact on the capital allocation but there is still a negative growth in multifactor productivity. After adjustment for inflation, the material costs are still higher in 2019. Yet, one must be aware of the extra volatility of the cost of petroleum-based products. Did the manager have control over his price increases? One should look at the changes in a petroleum-based price index, including the cost of oil, over the last two years in order to gain a better understanding of the degree to which the manager had control over these costs. The increase in wages was beyond the manager's control, and a constant rate should be used for comparing both years' results. Yet a negative result still remains. Even when material costs in 2019 are converted to the original cost of $320, a negative 5% growth in productivity remains. The increase in the capital base is responsible yet should not persist in future years if the increase was the result of an adoption of new technology.

LO 1.6: Compute single-factor productivity

LO 1.7: Compute multifactor productivity

AACSB: Analytical thinking

3. The manager did not reach the goal. An analysis of the changes in capital costs is warranted. Even after adjusting for inflation, multifactor productivity was not positive. However, labor and materials productivity were favorable. The capital investment cost (as figured by the accounting department) was so large as to make his multifactor productivity negative. Multifactor productivity has fallen by 11.61% before adjustment and by 7.87% after the adjustment for inflation.

LO 1.7: Compute multifactor productivity

AACSB: Application of knowledge

Single-Factor Productivity Analysis	**2018**	**2019**	**Adjusted Cost***	**Adjusted Total Cost**
Production (units)	4,500	6,000		
Material Used (Barrels)	700	900		
Material Cost per Barrel	$320.00	$360.00	$345.60 (360/1.04167)	$311,040 (900 × 345.60)
Labor-Hours	22,000	28,000		
Compensation Rate	$13.00	$14.00	$13.44 (14/1.04167)	$376,320 (28,000 × $13.44)
Capital Applied ($)	$375,000	$620,000	$595,200 (620,000)/1.04167)	$595,200
Producer Price Index (PPI)	120	125		$1,282,560
*Change in PPI = 4.167% = (125/120 − 1) = 0.04167				
Total Cost	$885,000	$1,336,000		$1,282,560 (Adjusted)

Multifactor Productivity (MFP) Analysis	**2018**	**2019**	**% Change**	
Labor Productivity (Units per hr.)	4,500/22,000 = 0.2045	6,000/28,000 = 0.2143	4.79%	Nearly reached the goal
Material Productivity (Units per barrel)	4,500/700 = 6.4286	6,000/900 = 6.6667	3.70%	Positive change
Capital Productivity (Units per $)	4,500/375,000 = 0.0120	6,000/620,000 = 0.0097	−19.17%	Large negative change

	2018	**2019**	
MFP Before Adjustment per $)	0.00508	0.00449	(0.00449 − 0.00508)/0.00508 = −11.61%
MFP After Adjustment (per $)	0.00508	0.00468	(0.00468 – 0.00508)/0.00508 = −7.88%

Chapter 1
Operations and Productivity

Background

Operations management has created industry giants. The Ritz-Carlton Hotel Company's mission is to provide an outstanding customer experience through a complete focus on quality management. UPS operates trucks that run for 20 years because their drivers care. Disney has made a science of accurate forecasts and queuing theory. Darden restaurants (Olive Garden and others) view operations as their strategy for success. Frito-Lay dominates the snack market by keeping fresh snacks on the shelves with a production process that converts raw materials into a bag of chips sitting in a grocery store in as little as a day or two.

The importance of operations management can be highlighted early in the course with humorous videos or stories about "operations gone wrong." Most people can share "disaster" stories about poor experiences that they have had dealing with companies.

It can be useful as well to spend some class time right away on the job market for operations management majors, showing starting salaries and job titles compared to other business majors. It can also be helpful to find an MBA program with a strong operations focus and display the starting salaries of those graduates. (Such data are available on many MBA program websites.) Instructors can also share research results showing that (1) more CEOs "learn the ropes" by coming up through operations than any other functional area, and (2) Chief Operating Officer salaries tend to be approximately 10% higher than the salaries of the other "Chiefs" (CFO, CMO, and CIO).

Videos from recent graduates who now work in some aspect of operations management are available in MyLab Operations Management. These 2- to 4-minute video clips feature young professionals talking about their jobs in the gamut of OM functions—each tied to a specific chapter and accompanied by multiple-choice quizzes that may be assigned.

Class Discussion Ideas

1. Choose an organization the students will be familiar with and ask them to identify and describe the product of that organization. Direct the discussion to highlight the complex nature of the product offerings of most organizations today where product and service elements are found to some degree in almost all organizations.

2. Have the students choose a few different tasks or jobs and identify possible productivity measures for these. They should describe how they would go about making the necessary measurements. Student and faculty productivity are easy examples that can generate quite a bit of discussion. One possible way to start the discussion is to ask whether grades or research output is an effective measure of student and faculty productivity, respectively.

Active Classroom Learning Exercises

1. Labor productivity is sometimes perceived to be driven by employee motivation. Have the students split up into small groups to discuss effective ways to motivate hourly employees vs. salaried managers. If productivity of these workers is below expectation, what are good and poor ways to try to motivate them? What methods might work well with blue collar employees but not white collar employees, and vice versa? What methods might work well in the short run but not in the long run, and vice versa? Have each student group report its ideas to the whole class. (And if any group has little to say, ask them what could have been done to motivate them to do better!)

2. Companies often locate in other countries to take advantage of low wage rates. However, the difference in labor costs should be adjusted to account for productivity differences among the workers in the two locations. One way to do this is to compute a "relative wage rate" R of operating in another country. Note that R is not the actual wage rate paid, but it is the hourly wage rate of operating in another country *relative* to the home country, after taking productivity differences into account. If the foreign country's workers are more productive, R will decrease, and vice versa. The formula is $R = (W \div X)(U \div F)$, where W = the foreign wage rate (in foreign currency per hour), X = the exchange rate (in foreign currency per local currency), U = home country productivity (in units per hour), and F = foreign country productivity (in units per hour).

   A problem could be described as follows. Suppose that workers in Britain earn £10/hour. The exchange rate with the U.S. is $1.5 per £1. American workers can produce 40 units per hour, while British workers at a similar facility can produce 50 units per hour. If the U.S. wage rate is $14 per hour, should the firm produce in the U.S. or in Britain?

   Have the students try the exercise in class. They will probably analyze this problem by computing a labor cost per unit in each country (35 cents vs. 30 cents). Then introduce the concept and formula for relative wage rate (R = $12 in Britain). Both approaches are equally accurate, but using a relative wage rate has political advantages, i.e., it seems easier to talk about one wage rate vs. another ($14 vs. $12) as opposed to comparing costs per unit (35 cents vs. 30 cents).

3. A Class Exercise Relating Productivity and the Olympics (Guest Post by Howard Weiss)
https://heizerrenderom.wordpress.com/2014/02/17/guest-post-a-class-exercise-relating-productivity-and-the-olympics/

4. A First Day of Class OM Exercise (Guest Post by Steven Harrod)
https://heizerrenderom.wordpress.com/2013/07/11/guest-post-a-first-day-of-class-om-exercise/

Company Videos

1. *Frito-Lay: Operations Management in Manufacturing (7:11)*
   Frito-Lay, a subsidiary of PepsiCo, has over 40 product lines, seven of which having sales exceeding $1 billion *each*. In this video, the textbook authors review the 10 OM strategy decisions and briefly describe how Frito-Lay addresses each one. For example, the company is constantly innovating with new products. For quality assurance, it uses multiple inspection points both within and outside the factory, and it utilizes statistical process control. The plant applies a product focus strategy, which is appropriate for a high-volume, low-variety producer. As raw materials are perishable and shelf life is relatively short, plant location decisions are driven by proximity to raw materials or markets. The plant has low employee turnover, driven by good benefits, respect for people, and a strong concern for safety and ergonomics. Inventory levels are quite low, and inventory is turned over 200 times per

year. Potatoes are delivered 10 times per day. Schedules are driven by demand forecasts and adjusted for local events, such as the annual Daytona 500 auto race. All of these practices, along with excellent layout, supply chain, and maintenance policies, have helped to make Frito-Lay the world's largest snack manufacturer.

If the video is shown before the 10 OM decisions are covered, prior to showing the video, the instructor could ask the students to list the major decisions that they think operations managers make. Afterwards, the 10 decisions from the book can be compared to the students' lists. Then the instructor can choose a different company, perhaps a service organization, with which students might be familiar. The class could try to identify ways in which that organization addresses the 10 decisions and perhaps compare those to some of Frito-Lay's tactics.

2. *Hard Rock Cafe: Operations Management in Services (8:26)*
   Hard Rock is interesting because it's so much more than just a restaurant. Management speaks about its "experience strategy," which, in addition to quality food, includes rock-and-roll memorabilia, music, lighting, jovial staff, and a retail store. The video is sprinkled with scenes of happy employees dancing around or volunteering in the community. Most of the video is spent covering how Hard Rock Cafe approaches some of the 10 operations management decisions. For example: (1) scheduling is driven by forecasts that are based on prior sales, seasonality, recent trends, and current local events; (2) cafe layout focuses on maximizing the customer experience and driving customers toward revenue-generating activities; and (3) inventory management goes well beyond the inventory of food and retail items—Hard Rock has a $40 million inventory of rock-and-roll memorabilia to manage, and each restaurant goes through a complete changeover of memorabilia every 5-7 years.

   As an entertaining piece and one that covers a variety of OM decisions, this is certainly a good video to show early in the course when discussing Chapter 1. Many students will have eaten at a Hard Rock Cafe themselves, and most should enjoy seeing memorabilia from rock stars such as Madonna and KISS. This is also a good way, early in the course, to show that operations management is just as important in services as it is in manufacturing. Prior to showing the video, the instructor might ask the students to think about the 10 OM decisions and how Hard Rock approaches them. Afterwards, discussion might revolve around aspects of those decisions that are unique to service businesses in general and then to Hard Rock Cafe in particular. Two clear differences about Hard Rock Cafe itself are: (1) because of and contributing to such successful branding, the cafe's retail sales (shirts, etc.) account for nearly the same amount of revenue as the main product (the food) itself; and (2) the management of the memorabilia around the world represents a unique and extremely important management effort on its own.

3. *Celebrity Cruises: Operations Management at Sea (6:39)*
   A Celebrity Cruise ship is a floating "city on the sea," with a world-class hotel sitting on top of a power plant. This video describes how the 10 OM decisions affect the outcome of every voyage. Celebrity must manage both shoreline and marine operations. The *design* decision includes numerous features, including the physical ship itself, the food, and shore excursions. The floating city houses tens of thousands of SKUs, which must be loaded quickly when the ship is docked and meticulously managed to have everything in place when needed. The *maintenance* decision is especially important for a cruise ship because human lives are at stake and mechanical problems could ruin a voyage. Celebrity ships undergo complete dry-dock maintenance every 2–5 years. The international crews stay with the company for an impressive 5–7 years, which no doubt contributes heavily to Celebrity's quality image, including being named the Best Premium Cruise line for 9 consecutive years.

   Prior to showing the video, instructors might ask students to list all of the different types of decisions that they think operations managers of a cruise line would need to make, both in the corporate office

for all of their ships as well as for an individual cruise on a specific ship. Afterwards, it could be interesting to compare the aggregate student responses to the 10 OM decisions, placing special emphasis on the decisions that students didn't identify. As with most any service business, employees can make all the difference. Class discussion could revolve around Celebrity's impressively low turnover rate. How can the firm attract and retain the best talent? How can management ensure a constantly friendly staff? What types of general training should all staff undergo when first hired?

Cinematic Ticklers

1. *Fawlty Towers*: "*Waldorf Salad*" *(John Cleese and Prunella Scales), CBS/FOX VIDEO, 1986 (1979)*
   This can actually be the first thing done in class all semester. The very start of the episode contains a funny scene about suppertime in the dining room of a bed and breakfast in England. The owners and staff make numerous errors. A class discussion can directly follow, listing what went well (almost nothing) and what didn't (many things). This clip can start a course off well because: (1) it's a very easy way to create an atmosphere of student participation right away in the course because identifying poor operations is easy in this clip, (2) it emphasizes right away that operations management applies to services, not just manufacturing, and (3) it's a fun way to begin a course.

2. *The Simpsons, Season 7: "King-Size Homer," 20th Century Fox Video, 2006 (1995-1996)*
   Homer gets so fat that he is allowed to work from home. He realizes that he can triple his productivity by just pressing "Y" on his computer instead of typing "YES."

3. *The Simpsons*, *Season 8: "You Only Move Twice," 20th Century Fox Video, 2006 (1996-1997)*
   Homer gets a new job working for a James Bond-like villain. He is put in charge of a set of three workers. It's his job to motivate them. As they type along, Homer asks if they are working. "Yes," they reply. "Can you work any faster than that?" he asks. "Sure thing, Mr. Simpson," they say, as they start typing faster. (If only motivation were that easy.)

4. *Modern Times (Charlie Chaplin), CBS/FOX VIDEO, 1992 (1936)*
   The movie deals with worker alienation in an assembly line environment and offers an interesting historical perspective on early Taylorism. Interesting issues arise, including workers having to clock out to go to the bathroom, the automatic assembly line being sped up as the day wears on, sneezing or scratching being enough to make one behind on his or her work, and, most importantly, the de-humanization of early assembly line work.

Jay, Barry, and Chuck's OM Blog

1. *OM in the News: Seven Jobs Robots Will Create*
   The newest generation of robots continues to replace human jobs, but the existence of robots also creates new job opportunities—perhaps 20–50 million globally by 2030. Seven such new jobs include: AI builders, customer-robot liaisons, robot managers, data labelers, drone-performance artists, AI lab scientists, and safety & test drivers.

https://heizerrenderom.wordpress.com/2018/05/07/om-in-the-news-seven-jobs-robots-will-create/

2. *OM in the News: Machines are Making Your Sushi, and That's Good*
   Services have lagged behind other sectors in spending on labor-saving equipment, but that is beginning to change. A sushi robot can churn out 200 precisely calibrated sushi rolls per hour compared to approximately 50 per human chef. Given the rising chef shortage, that's a good thing.
https://heizerrenderom.wordpress.com/2018/01/07/om-in-the-news-machines-are-making-your-sushi-and-thats-good/

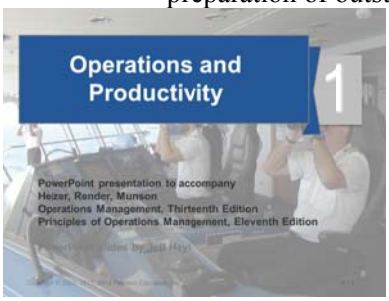
3. *OM in the News: Robots Aren't Destroying Enough Jobs*
   "Too many sectors, such as health care or personal services, are so resistant to automation that they are holding back the entire country's standard of living." (*The Wall Street Journal*, 5/11/17) By enabling society to produce more with the same workers, automation is a major driver of rising standards of living.
https://heizerrenderom.wordpress.com/2017/05/15/om-in-the-news-robots-arent-destroying-enough-jobs/

4. *OM in the News: German Apprenticeships in South Carolina*
   BMW's plant in Spartanburg, SC, trains 100 apprentices at any given time. This practice contributes to a skilled and motivated American workforce as an alternative to a college education. That approach in Germany has provided a solid return on companies' investment, helped them to innovate, and contributed to warm relations between employers and employees.
https://heizerrenderom.wordpress.com/2017/05/12/om-in-the-news-german-apprenticeships-in-south-carolina/

Presentation Slides

INTRODUCTION (1-1 through 1-6)

Slide 4: This Global Company Profile from the first chapter helps to illustrate the wide variety of decisions that an operations manager must face. In the case of Hard Rock Cafe, the "product" includes more than tasty meals—the layout, the memorabilia on display, and the service all encompass the dining package at Hard Rock that consumers now expect. The meals themselves are designed, tested, and then analyzed for the cost of ingredients, labor requirements, and customer satisfaction. Among other tasks, the operations manager must consider both the attractiveness and efficiency of restaurant layout, supplier quality and reliability, employee motivation and training, maintenance of tight schedules, and preparation of outstanding meals.



1-1

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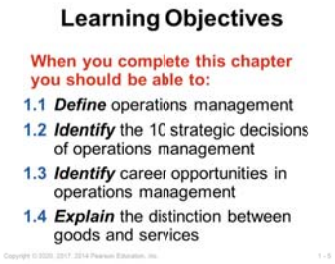
1-4



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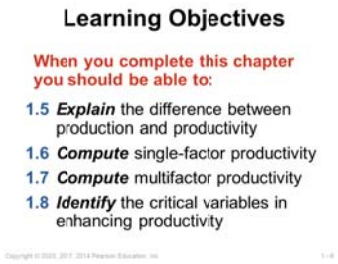


1-6

WHAT IS OPERATIONS MANAGEMENT? (1-7)

Slide 7: Starting with the Hard Rock Cafe example, it is important to stress from the very beginning of the course that operations management applies just as much to service businesses as to manufacturing businesses.

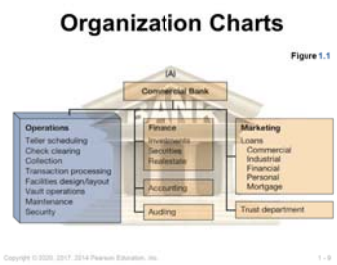
1-7

ORGANIZING TO PRODUCE GOODS AND SERVICES (1-8 through 1-11)

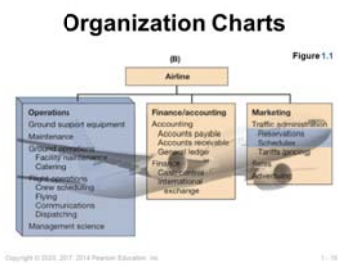
Slide 8: To create goods and services, all organizations must perform the three functions identified on this slide. Firms must create demand, satisfy that demand, and manage and monitor the financial flows associated with creating and satisfying that demand.

Slides 9-11: These slides (Figure 1.1) present example organization charts from three different companies. The areas in blue indicate the significant role that operations management plays in both manufacturing and service firms.

1-8



1-9



1-10

1-11

THE SUPPLY CHAIN (1-12)

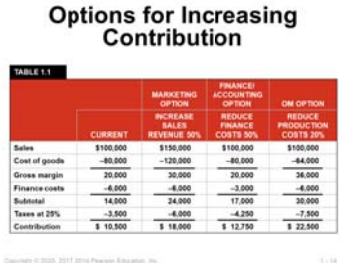
Slide 12: The supply chain is described right at the beginning of the book to emphasize that competition is no longer between companies; it is between *supply chains*. Companies no longer try to do everything themselves. Rather, they outsource numerous functions and activities to specialized providers. Supply chains that have members who effectively collaborate foster an enormous competitive advantage. Chapter 11, Supplement 11, and part of Chapter 2 provide comprehensive coverage of this topic.

1-12

WHY STUDY OM? (1-13 through 1-14)

Slides 13-14: These slides can be used early on in the course to help "sell" the usefulness and importance of the class. In most cases, a large percentage of revenue is spent on the OM function. Slide 14 (Example 1) shows a common circumstance, that is, often the best and easiest way to meet improved contribution targets is through finding efficiencies in operations. In this particular example, the hefty requirements for the marketing and finance options might make them infeasible anyway.

1-13



1-14

WHAT OPERATIONS MANAGERS DO (1-15 through 1-24)

Slide 15: All good managers, including operations managers, perform the basic management functions identified in this slide.

Slides 16-21: The 10 strategic OM decisions are useful to cover one by one, not only as a precursor to the rest of the text, but also to emphasize the wide array of responsibilities that are under an operation manager's jurisdiction. Slide 16 maps them to the rest of the text, while Slides 17-21 provide examples for each decision of issues that the operations manager must address.

Slides 22-24: Salary information pertaining to local students (perhaps with help from the university's career center) can be combined with Slides 22 through 24 to help sell the operations management field as a viable career option for students. A very common entry-level position for OM majors is in the *purchasing* area of organizations. Slide 23 (Figure 1.3) identifies several of the many types of career opportunities that exist for operations managers. The organizations identified in Slide 24 provide various certifications that may help forward students' careers. The Six Sigma Green Belt and Black Belt certifications offered through the American Society for Quality represent particularly highly sought-after acknowledgements of professional expertise.

1-15

1-16

1-17

1-18

1-19

1-20

1-21

1-22

1-23

Certifications

- APICS, the Association for Operations Management
- American Society for Quality (ASQ)
- Institute for Supply Management (ISM)
- Project Management Institute (PMI)
- Council of Supply Chain Management Professionals
- Chartered Institute of Procurement and Supply (CIPS)

1-24

THE HERITAGE OF OPERATIONS MANAGEMENT (1-25 through 1-32)

Slide 25: This slide (Figure 1.4) presents a nice summary of the past and future of OM. Videos showing historical footage (see Other Supplementary Material below), can fit in well here.

Slides 26-31: Presenting students with a good historical context of the field is important. There is a lot of important history there that is directly tied to the economic growth of nations. These slides provide information about some of the most important historical figures in the field.

Slide 32: Operations management continues to progress with innovations and contributions from other disciplines, particularly those identified on this slide.

Significant Events in OM

Figure 1.4

1-25

Eli Whitney

- Born 1765; died 1825
- In 1798, received government contract to make 10,000 muskets
- Showed that machine tools could make standardized parts to exact specifications
  - Musket parts could be used in any musket

1-26

Frederick W. Taylor

- Born 1856; died 1915
- Known as 'father of scientific management'
- In 1881, as chief engineer for Midvale Steel, studied how tasks were done
  - Began first motion and time studies
- Created efficiency principles

1-27

Taylor's Principles

Management Should Take More Responsibility for:

1. Matching employees to right job
2. Providing the proper training
3. Providing proper work methods and tools
4. Establishing legitimate incentives for work to be accomplished

1-28

Frank and Lillian Gilbreth

- Frank (1868-1924); Lillian (1878-1972)
- Husband and wife engineering team
- Further developed work measurement methods
- Applied efficiency methods to their home and 12 children!
- Book and Movie: "Cheaper by the Dozen," "Bells on Their Toes"

1-29

Henry Ford

- Born 1863; died 1947
- In 1903, created Ford Motor Company
- In 1913, first used moving assembly line to make Model T
  - Unfinished product moved by conveyor past work station
- Paid workers very well for 1911 ($5/day!)

1-30

W. Edwards Deming

- Born 1900; died 1993
- Engineer and physicist
- Credited with teaching Japan quality control methods in post-WW2
- Used statistics to analyze process
- His methods involve workers in decisions

1-31

OM Relies on Contributions From

- Industrial engineering
- Statistics
- Management
- Analytics
- Economics
- Physical sciences
- Information technology

1-32

OPERATIONS FOR GOODS AND SERVICES (1-33 through 1-38)

Slides 33-35: The manufacturing-service distinction is more like a continuum, as most manufacturing companies provide some services (e.g., financing from an auto manufacturer) and most service companies provide some goods (e.g., shampoo at a hair salon). Nevertheless, the two extremes differ in important ways, which may impact how operations managers approach decision making in one case vs. another. Slide 35 identifies the major differences.

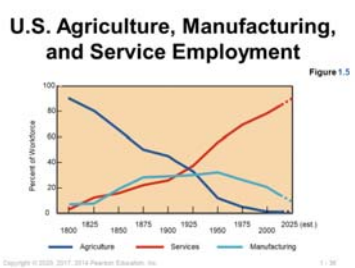
Slides 36-37: These slides illustrate the tremendous growth of services over time. Slide 36 (Figure 1.5) shows that, after peaking around 1950, the percentage of U.S. workers in manufacturing has declined steadily while service employment continues to capture a larger and larger share of the jobs. The huge productivity increases in agriculture and manufacturing have allowed more of our economic resources to be devoted to services. Consequently, much of the world can now enjoy the pleasures of education, health services, entertainment, etc. Slide 37 (Table 1.4) provides examples of firms and percentages of employment in the U.S. in various sectors of the economy. Well more than half of the students taking this class will likely end up working for a firm in the service sector.

Slide 38: Salaries in services present a mixed bag. Some jobs, such as airline maintenance operations managers, pay very well, while others lag behind the national average. Not all jobs in services are low paying, but some can be.

1-33

1-34

1-35



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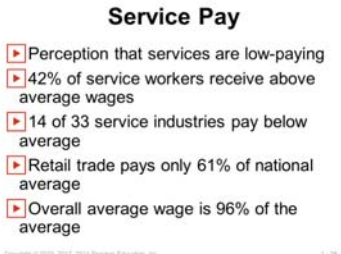
1-37



1-38

THE PRODUCTIVITY CHALLENGE (1-39 through 1-58)

Slide 39: The basic formula for productivity is simple: *outputs* ÷ *inputs*. This sometimes varies as interest focuses on a specific output or input, or a set of outputs or inputs. At the firm level, productivity improvement usually leads to greater profits. At a macro level, productivity improvement in an economy usually leads to a higher standard of living. Productivity improvement means getting more "bang for the buck"—either (1) reducing inputs while keeping output constant, or (2) increasing output while keeping inputs constant.

Slide 40: This slide (Figure 1.6) describes how productivity in the U.S. economy grows at about 2.5% per year, comprised of capital factors (0.95%), labor factors (0.25%), and management factors (1.3%). The picture also suggests that an effective feedback loop is an important component for continuous improvement.

Slides 41-42: These slides (OM in Action) describe how some relatively simple management and equipment changes improved Starbuck's productivity significantly, which led to six-figure increases in revenue *per outlet*.

Slides 43-45: The most common productivity formulas are presented in these slides. Slide 43 shows the basic formula. Slide 44 provides an example of a *single-factor* productivity measure, in this case, the common measure of labor productivity. Slide 45 is a *multifactor* productivity measure. Note that a multifactor measure only makes sense if all of the inputs are expressed in the same units (usually a monetary unit such as dollars).

Slides 46-49: These slides illustrate Example 2 from the text, calculating both single-factor and multifactor productivity measures. Here, as in most cases, the multifactor measure makes more sense because it includes all costs connected with the increase in output. In fact, a situation that replaces workers with more expensive robots may appear to improve labor productivity but may actually be decreasing multifactor productivity (and firm profits) overall.

Slide 50: These potential measurement problems with productivity should be emphasized. If evaluating performance of a plant, a manager, a division, etc., it is important to compare "apples to apples" and to evaluate individuals on outcomes over which they have control.

Slide 51: The three factors identified in this slide are critical to achieving improved productivity. The percentages listed represent their respective historical contributions to productivity improvement.

Slide 52: As we see in this slide, sometimes training and education produce more productive workers, while in other cases, the workers' general health along with environmental factors may determine their respective capabilities.

Slide 53: As unbelievable as it seems, a large number of U.S. high school students cannot solve very simple math problems, such as those shown in this slide (Figure 1.7). It has been suggested that perhaps up to 25% of U.S. workers lack the basic skills needed for their current job. The situation may be even worse in some other countries, particularly in some of the low-wage countries.

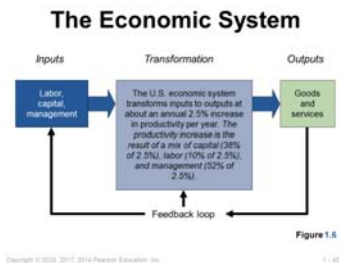
Slide 54: Historically, annual capital investment in the U.S. has increased at an annual rate of 1.5% after allowances for depreciation. In general, higher investment levels lead to higher productivity gains.

Slide 55: At 52%, management provides the biggest contribution toward productivity gains. Effective management is challenging, especially now that much of the labor force in postindustrial countries has migrated from manual work to work based on knowledge (knowledge societies) and requires ongoing education.

Slide 56: The items identified in this slide all contribute to the difficulty in improving productivity in the service sector.

Slides 57-58: The service firm Taco Bell (OM in Action) implemented several innovative productivity improvement measures (Slide 57), which produced impressive results (Slide 58).

1-39



1-40

1-41

Improving Productivity at Starbucks

A team of 10 analysts continually look for ways to shave ti… improveme…

Stop requiri… on credit car… under $25

Change the s… scoop

New espress… per shot

Operations improvements have helped Starbucks increase yearly revenue per outlet by $250,000 to $1,000,000.

Productivity has improved by 27%, or about 4.5% per year.

1-42

Productivity

$$\text{Productivity} = \frac{\text{Units produced}}{\text{Input used}}$$

- Measure of process improvement
- Represents output relative to input
- Only through productivity increases can our standard of living improve

1-43

Productivity Calculations

Labor Productivity

$$\text{Productivity} = \frac{\text{Units produced}}{\text{Labor-hours used}}$$

$$= \frac{1{,}000}{250} = 4 \text{ units/labor-hour}$$

One resource input ⇨ single-factor productivity

1-44

Multi-Factor Productivity

$$\text{Multifactor} = \frac{\text{Output}}{\text{Labor + Material + Energy + Capital + Miscellaneous}}$$

- Also known as total factor productivity
- Output and inputs are often expressed in dollars

Multiple resource inputs ⇨ multi-factor productivity

1-45

Collins Title Productivity

Old System:

Staff of 4 works 8 hrs/day, Payroll cost = $640/day

8 titles/day, Overhead = $400/day

Old labor productivity = $\frac{\text{8 titles/day}}{\text{32 labor-hrs}}$ = .25 titles/labor-hr

1-46

Collins Title Productivity

Old System:

Staff of 4 works 8 hrs/day, Payroll cost = $640/day

8 titles/day, Overhead = $400/day

New System:

14 titles/day, Overhead = $800/day

Old labor productivity = $\frac{\text{8 titles/day}}{\text{32 labor-hrs}}$ = .25 titles/labor-hr

New labor productivity = $\frac{\text{14 titles/day}}{\text{32 labor-hrs}}$ = .4375 titles/labor-hr

1-47

Collins Title Productivity

Old System:

Staff of 4 works 8 hrs/day, Payroll cost = $640/day

8 titles/day, Overhead = $400/day

New System:

14 titles/day, Overhead = $800/day

Old multifactor productivity = $\frac{\text{8 titles/day}}{\$640 + 400}$ = .0077 titles/dollar

1-48

Collins Title Productivity

Old System:

Staff of 4 works 8 hrs/day, Payroll cost = $640/day

8 titles/day, Overhead = $400/day

New System:

14 titles/day, Overhead = $800/day

Old multifactor productivity = $\frac{\text{8 titles/day}}{\$640 + 400}$ = .0077 titles/dollar

New multifactor productivity = $\frac{\text{14 titles/day}}{\$640 + 800}$ = .0097 titles/dollar

1-49

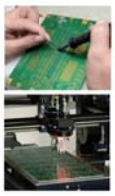
Measurement Problems

1. ***Quality*** may change while the quantity of inputs and outputs remains constant
2. ***External elements*** may cause an increase or decrease in productivity
3. ***Precise units of measure*** may be lacking

1-50

Productivity Variables

1. ***Labor*** - contributes about 10% of the annual increase
2. ***Capital*** - contributes about 38% of the annual increase
3. ***Management*** - contributes about 52% of the annual increase



1-51

Key Variables for Improved Labor Productivity

1. Basic education appropriate for the labor force
2. Diet of the labor force
3. Social overhead that makes labor available
   - Challenge is in maintaining and enhancing skills in the midst of rapidly changing technology and knowledge

1-52

Labor Skills

About half of the 17-year-olds in the U.S. cannot correctly answer questions of this type

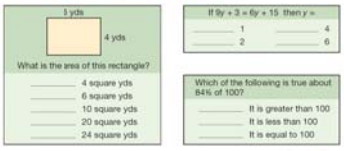
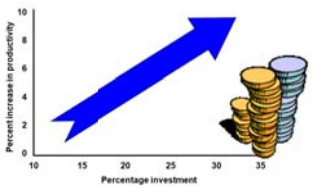


Figure 1.7

1-53

Capital



1-54

Management

- Ensures labor and capital are effectively used to increase productivity
  - Use of knowledge
  - Application of technologies
- Knowledge societies
  - Labor has migrated from manual work to technical and information-processing tasks
- More effective use of technology, knowledge, and capital

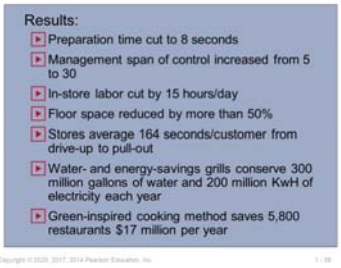
1-55

Productivity in the Service Sector

- Productivity improvement in services is difficult because:
  1. Typically labor intensive
  2. Frequently focused on unique individual attributes or desires
  3. Often an intellectual task performed by professionals
  4. Often difficult to mechanize and automate
  5. Often difficult to evaluate for quality

1-56

1-57



1-58

CURRENT CHALLENGES IN OPERATIONS MANAGEMENT (1-59)

Slide 59: Some traditional operations areas of emphasis are changing. New challenges based on these changes are identified on this slide. Each of these issues will be explored more fully later in the book.

1-59

ETHICS, SOCIAL RESPONSIBILITY, AND SUSTAINABILITY (1-60 through 1-61)

Slide 60: Managers must address the challenges identified in the slide, along with many other challenges, in an ethical and socially responsible way while meeting demands of the marketplace.

1-60

1-61

Additional Assignment Ideas

1. Search the Internet for organizations that offer productivity consulting services; there will be quite a few. Different organizations will offer different service packages and specialize in different areas. Pick two organizations that demonstrate differences and compare and contrast their services, their areas of specialization, and their approach to productivity. That is, explain how they are similar and how they are different. Make sure you include examples from their websites that support your analysis. (Two examples are Alexander Proudfoot at http://www.proudfoot.com/ and West Monroe Partners at http://www.westmonroepartners.com/.)

2. Labor productivity is by far the most commonly seen expression of productivity. Search the Internet for sites that offer labor productivity statistics. Certainly, the Bureau of Labor Statistics (www.bls.gov) is one, but there are others from around the world. Compare the labor productivity in the U.S. for the past decade to that of another country of your choosing. How and why are they different or similar?

3. Students can be assigned a paper that compares the service company Hard Rock Cafe to the manufacturing firm Frito-Lay, both of which have videos for Chapter 1. Specifically, the paper could compare and contrast how the two firms approach the 10 major OM decisions described in the text.

Internet Resources

American Productivity and Quality Center (APQC)	www.apqc.org/
American Statistical Association (ASA) offers business and economics DataLinks, a searchable index of statistical data	www.econ-datalinks.org/
National Bureau of Economic Research	www.nber.org
U.S. Bureau of Labor Statistics	www.bls.gov
U.S. Census Bureau	www.census.gov

Other Supplementary Material

Videos

1. *Modern Marvels*, "The Assembly Line"
   https://www.history.com/shows/modern-marvels/season-12/episode-26
   The first part of this History Channel production shows Henry Ford and the Ford assembly line, with real historical footage. It describes the poor working conditions, as well as Ford's response, which was to pay a very high hourly rate for the time.

2. *"Loose Bolts?"* (30:00), http://www.merrimack-films.com/loose.html
   Offers a more modern perspective on assembly lines and highlights the difficulties of making changes in existing organizations when implementing productivity improvement programs.

3. *Ford Historic Model T*, CarDataVideo (5:16), http://www.youtube.com/watch?v=S4KrIMZpwCY
   This narrated video is a very detailed look at the first assembly lines at the original Ford auto plant, plus some driving scenes with the Model T.