Operations Management 13th edition Krajewski Solutions Manual

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Chapter

1 Using Operations to Create Value

DISCUSSION QUESTIONS

1. Answering this question demonstrates that processes underlie all of our jobs. What might be surprising is how many students would put their job in the category of "other," suggesting that many jobs do not fall neatly into any one functional area. Perhaps many in the "other" category might best be called "operations" on further reflection. Customers, both internal and external, are part of each process, and the goal is to manage the processes to add the most value for them.

2. Amazon.com offers a very broad range of services and products at competitive prices. Its competitive priorities would include fast delivery time, on-time delivery, customization, variety and low-cost operations. As a business, Amazon.com is actually assembling a customized basket of goods that must be delivered in a short window of time in a dependable fashion. Low-cost operations are needed to remain competitive. To remain in business, Amazon.com needs to maintain high volumes of traffic. Operations strategy must focus on stock availability and quick, economical, and dependable delivery.

3. The hospital's commitment *to provide attention to patients arriving to the emergency unit in less than 15 minutes and never to turn away patients who need to be hospitalized* implies that the facility must be designed to have extra capacity in both beds and emergency room facilities. It must plan on having extra personnel in the emergency room and also plan on having additional emergency personnel on call to take care of unprecedented heavy loads. In line with the mission statement, maximum utilization of the facilities (i.e., beds and emergency room personnel) would not be one of the performance objectives for the hospital.

4. FedEx traditionally has competed on the basis of fast, dependable delivery. Before the boom in Internet applications, many businesses relied on FedEx to get things to other businesses overnight. Now, this need is beginning to diminish as sophisticated systems are being installed to assist companies in planning operations better. And, the Internet based companies are adding more demands for low cost ground deliveries to specific customer doors. FedEx, in order to remain competitive with companies such as UPS, has moved into the door-to-door delivery business, perhaps through acquisition. Nonetheless, it will require changes to this company's competitive priorities.

5. Technology Management. To identify a market segment, we need to determine answers to questions such as: Which colleges and departments currently offer the subject? What do instructors desire in the way of textbook support? Is there a trend toward Technology Management courses? Are there other Technology Management

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texts? Some needs assessment can be accomplished by survey, but the response rate may be low. A high-investment strategy would be to ask or hire instructors to review and critique a list of topics, then an outline, then a draft. Explicit services include supplying information about the subject in the form of a textbook and instructor support in the form of ancillary publications.

6. It is often not a good idea for a company to try to excel in all of the competitive priorities because it is generally impossible to do so. Mediocrity is a predictable result. The choice and the minimum level of one or more of the competitive priorities are set by the order qualifiers for the particular product or service. The choice of the competitive priorities that the company should emphasize is usually governed by the company's strategy driven by its mission statement and the core competencies that the company wants to harness to seek the best competitive advantage.

7. Core processes should link to a firm's core competencies. Core processes are those processes that provide the firm the best competitive advantage. Essential to the definition a firm's core processes is the concept of "interaction costs." These costs include the time and money that are expended whenever people and companies exchange services, products, or ideas. If the transaction costs are higher to retain a process within the firm's organization than to outsource the process, the process should be outsourced.

8. Wendy's assembles hamburgers to order. When materials are held at the stage just before final assembly, they can be used to complete a wide variety of different sandwiches. Because no finished-goods stock exists, when customers say, "Hold the sauce," there is no delay or waste of materials. Service clerks specialize. One clerk takes orders and payment. Others fill portions of the order. Orders are processed in single file. Throughput is normally restricted by transactions at the cash register. At busy times, throughput is increased by splitting the bottleneck operation. One clerk takes customer orders, another receives payment. The Wendy's operation has some characteristics of assembly. Therefore, the impact of new menu items on the production operations must be carefully considered.

9. Grandmother's Chicken.
   a. Kathryn Shoemaker's strategic plans include the following:
      - ❑ Product and service plans: Should the new location offer a new mix?
      - ❑ Competitive priorities: If the product mix and service mix are different at the new location, the thrust could be on low volumes and high quality.
      - ❑ Quality management: Should the goal be reliability or top quality?
      - ❑ Process strategy: What processes will be needed to make chicken dinners in the addition or new facility?
      - ❑ New technologies: Is it time to automate? Is this why there is a problem in service times?
      - ❑ Capacity: How large should the addition or new facility be?
      - ❑ Location: Should we locate in Uniontown or expand in Middlesburg?

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b. Attitudes toward nutrition could change the demand for chicken. Competitors such as Boston Market may be planning to move to Uniontown or even Middlesburg. There may be a trend toward demands for ever-faster service, which cannot be supported by the processes specified in the "unique recipe." The economy of Uniontown might not be supportive of restaurant services. Shoemaker should also consider the availability of key resources, such as servers, whole chickens, spices, and cooking oil. Will Uniontown labor organize?
c. The possible distinctive competencies at Grandmother's Chicken Restaurant include the "unique recipe," the homey atmosphere, and friendly, prompt service.

10. Wild West, is recognizable as US WEST, which was bought out by Qwest in a hostile takeover in June, 2000. But many other "Baby Bells" are in a similar position.
    a. Strategic plans include reducing overhead, reengineering operations, and investing in new technologies to meet competition. The "do-nothing" option of remaining a local monopoly telephone company is not viable because of competition from cable systems and wireless systems that are capable of business and personal communication. If the mission is too broad, Wild West should sell its financial services and commercial real-estate businesses. Those businesses do not match their distinctive competencies.
    b. One environmental issue is whether communication, like health care, will be viewed as a "right" and therefore should be free. A significant portion of Wild West's business is governed by regulatory agencies. Customer service in their core business is essential to maintaining a favorable regulatory environment. Other business opportunities, such as manufacturing and providing information services, are prohibited by the same court order that formed the "Baby Bells" from AT&T.
    c. Wild West's distinctive competency is in connecting people (or machines) for the purpose of communication. A weakness is high overhead inherited from the era of telecommunication monopoly.

11. Although the answers may vary depending on the "niche" elements of the business, the competitive priorities would include on-time delivery, low-cost operations, and customization. The latter competitive priority comes from the capability to assemble unique "baskets" of food items for each customer. There may be a need to coordinate a given basket between two different stores. Capabilities to develop would include information systems and Web page design, efficient scheduling of delivery trucks (which must first collect the items in the basket and then deliver them to the customer's door), and an adequate fleet of trucks with drivers.

12. Additive manufacturing is an excellent approach to achieving low volume, highly customized output. If time is of the essence in producing the parts and the manufacturer has access to 3D printers, they may be able to produce what they need more quickly than working with a subcontractor or outsourcing the work. If volumes increase, then the inexpensive, custom tooling that can be achieved via additive manufacturing may not be the best approach. The high volume of output might enable the manufacturer to recoup their investment in more substantial tooling or by exploring the use of other forms of automation.

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PROBLEMS

Addressing the Trends and Challenges in Operations Management

1. Boehring University

   a. Value of output:

$$75\frac{\text{students}}{\text{class}}\times 3\frac{\text{credit-hours}}{\text{student}}\times\left(\frac{\$200\text{ tuition}+\$100\text{ state support}}{\text{credit-hours}}\right)=\$67,500/\text{class}$$

   Value of input: labor + material + overhead

$$\frac{\$6500+\left(\frac{\$25}{\text{student}}\times 75\text{ students}\right)+\$30,000}{\text{class}}=\$38,375/\text{class}$$

   Multifactor Productivity ratio:

$$\text{Productivity}=\frac{\text{Output}}{\text{Input}}=\frac{\$67,500}{\$38,375}=1.76$$

   Compared to Solved problem 1, multifactor productivity has increased from 1.25 to 1.76.

   b. Value of output is the same as in part a: $\$67,500/\text{class}$

   Labor-hours of input:

$$20\frac{\text{hours}}{\text{week}}\times 16\frac{\text{weeks}}{\text{class}}=320\frac{\text{hours}}{\text{class}}$$

   Productivity ratio:

$$\text{Labor Productivity}=\frac{\text{Output}}{\text{Input}}=\frac{\$67,500}{320\text{ hours}}=\$210.94/\text{hour}$$

   The $192 season ticket price is not used in this calculation. It is a "red herring."

2. Suds and Duds Laundry

   a. Labor productivity

Week	Number of Workers	Input (Labor-hours)	Output (Shirts)	Output/Input Ratio
1	2	24	68	2.83 shirts/hour
2	2	46	130	2.83 shirts/hour
3	3	62	152	2.45 shirts/hour
4	3	51	125	2.45 shirts/hour
5	2	45	131	2.91 shirts/hour

   b. Output per person does not vary much whether it is Sud, Dud, or Jud working. Productivity declines when all three are present. Perhaps there isn't enough work to keep three persons occupied, or perhaps there is not enough work space or equipment to accommodate three workers.

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3. White Tiger Electronics compact disc players
   Value of Output: $300
   Value of Input: Labor + Materials + Overhead

$$\text{Productivity} = \frac{\text{Ouput}}{\text{Input}} = \frac{\$300}{\$30 + \$70 + \$50} = 2.000$$

10% productivity improvement $\rightarrow 2.00 \times 1.10 = 2.200$
Given productivity$= 2.20$, and the value of output $= \$300$, we solve for the cost of inputs:

$$\text{Productivity} = \frac{\text{Ouput}}{\text{Input}} = \frac{\$300}{\text{Input}} = 2.20$$

$$\text{Input} = \frac{\$300}{2.2} = \$136.36 \text{ or } \$136$$

The cost of inputs must decrease by $(\$150 - \$136) = \$14$.

a. A $14 reduction in material costs is $\$14/\$70 = 20.00\%$
b. A $14 reduction in labor costs is $\$14/\$30 = 46.67\%$
c. A $14 reduction in overhead is $14/$50 = 28.00%

4. Symtecks
   The output of a process is valued at $100 per unit. The cost of labor is $50 per hour including benefits. The accounting department provided the following information about the process for the past four weeks:

	Week 1	**Week 2**	**Week 3**	**Week 4**
Units Produced	1124	1310	1092	981
Total Value	112,400	131,000	109,200	98,100
Labor ($)	12,735	14,842	10,603	9526
Labor (hrs)	254.7	296.8	212.1	190.5
Material ($)	21,041	24,523	20,442	18,364
Overhead ($)	8,992	10,480	8,736	7,848
Multifactor Productivity	2.63	2.63	2.75	2.75
Labor Productivity	4.41 units/hr	4.41units/hr	5.15 units/hr	5.15 units/hr

a. Use the multifactor productivity ratio to see whether recent process improvements had any effect and, if so, when the effect was noticeable.

Value of output

$$1124\text{units} \times \$100 = \$112,400$$

Value of input: labor + material + overhead

$$\$12,735 + \$21,041 + \$8,992 = \$42,768$$

Productivity ratio:

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

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Week 1 $\text{Productivity} = \frac{\text{Output}}{\text{Input}} = \frac{\$112,400}{\$42,768} = 2.628$

Week 2 $\text{Productivity} = \frac{\text{Output}}{\text{Input}} = \frac{\$131,000}{\$49,845} = 2.628$

Week 3 $\text{Productivity} = \frac{\text{Output}}{\text{Input}} = \frac{\$109,200}{\$39,781} = 2.745$

Week 4 $\text{Productivity} = \frac{\text{Output}}{\text{Input}} = \frac{\$98,100}{\$35,738} = 2.745$

$$\frac{2.745 - 2.628}{2.628} \times 100\% = 4.45\%$$

Improved 4.45% - noticeable in Week 3

b. Has labor productivity changed? Use the labor productivity ratio to support your answer.

Labor-hours of input: Labor $50/hour

<u>Labor costs</u>

Week 1 = $12,735/$50 = 254.7
Week 2 = $14,842/$50 = 296.84
Week 3 = $10,603/$50 = 212.06
Week 4 = $9,526/$50 = 190.52

Productivity ratio:

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

Week 1 = $\text{Labor Productivity} = \frac{\text{Output}}{\text{Input}} = \frac{1124}{254.7 \text{ hours}} = 4.4130/\text{hour}$

Week 2 = $\text{Labor Productivity} = \frac{\text{Output}}{\text{Input}} = \frac{1310}{296.84 \text{ hours}} = 4.413/\text{hour}$

Week 3 = $\text{Labor Productivity} = \frac{\text{Output}}{\text{Input}} = \frac{1092}{212.06 \text{ hours}} = 5.1495/\text{hour}$

Week 4 = $\text{Labor Productivity} = \frac{\text{Output}}{\text{Input}} = \frac{981}{190.52 \text{ hours}} = 5.1491/\text{hour}$

$$\frac{5.1491 - 4.4130}{4.4130} \times 100\% = 16.68\%$$

Improved 16.68%

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5. Alyssa's Custom Cakes

a.

5 Birthday cakes x $50 per cake = $250

2 Wedding cakes x $150 per cake = $300

3 Specialty cakes x $100 per cake = $300

Total monthly revenue = $850

Multifactor productivity ratio = output/input

1.25 = $850/x

Solve for x = $850/1.25 = $680

Total costs = $680

Average cost per cake = $680/10 = $68/cake

b. Labor productivity

Birthday cake = $50/ 1.5 hours = $33.30/hour

Wedding Cake = $150/ 4 hours = $37.50/hour

Specialty Cake = $100/1 hours = $100/hour

c. Based on labor productivity, Alyssa should try to sell specialty cakes the most.

d. Yes, Alyssa should stop selling birthday cakes. Based on answer a, she loses $68 - $50 = $18 every time she sells a birthday cake.

6. Big Black Bird Company

The Big Black Bird Company problem is based on a product made by Raven Industries. None of the numbers are representative of actual costs or volume.

a. Multifactor Productivity

Original Situation:

Value of output: $(2500 \text{ uniforms} \times \$200) = \$500{,}000$

Value of input: $(2500 \text{ uniforms} \times \$120) = \$300{,}000$

Productivity ratio:

$$\text{Productivity} = \frac{\text{Ouput}}{\text{Input}} = \frac{\$500{,}000}{\$300{,}000} = 1.67$$

Overtime Situation:

Value of output: $(4000 \text{ uniforms} \times \$200) = \$800{,}000$

Value of input: $(4000 \text{ uniforms} \times \$144) = \$576{,}000$

Productivity ratio:

$$\text{Productivity} = \frac{\text{Ouput}}{\text{Input}} = \frac{\$800{,}000}{\$576{,}000} = 1.39$$

Productivity decreases by:

$$\frac{1.67 - 1.39}{1.67} \times 100\% = 16.77\%$$

b. Labor Productivity

Original Situation:

Value of output (from part a) is: $500,000

Labor-hours of input: $(70 \times 40 \text{ hours}) + (30 \times 40 \text{ hours}) = 4000 \text{ hours}$

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Labor productivity = $500,000/4000 hours = $125/hour

Overtime Situation:
Value of output (from part a) is: $800,000
Labor-hours of input: $(70 \times 72 \text{ hours}) + (30 \times 72 \text{ hours}) = 7200 \text{ hours}$
Labor productivity =$800,000 / 7200 hours = $111.11/hours
Labor productivity decreases by:

(125/111.11) / 125 x 100% = 11.1%

c. Gross profits
Original Situation: $500,000 – $300,000 = $200,000
Overtime Situation: $800,000 – $576,000 = $224,000
Weekly profits increased.

7. Mack's Guitar Company
a. Labor productivity = output/input
Output = 100 guitars x 80% completion rate x price/guitar
= 80 guitars/ month x $250/guitar = $20,000
Input
Labor = 10/hours per guitar x 100 guitars = 1000 hours
Labor productivity is $20,000/1000 = $20/hour

Multifactor productivity ratio = output/input
Output = 100 guitars x 80% completion rate x price/guitar
= 80 guitars/ month x $250/guitar = $20,000
Input
Labor = $10/hour x 10/hours per guitar x 100 guitars = $10, 000
Material = $40/guitar x 100 guitars = $4, 000
Overhead = $4,000
Multifactor productivity ratio = $20, 000/$18, 000 = 1.11

b. <u>Option 1.</u> Increase sales price by 10%
Output = 100 guitars x 80% completion rate x ($250 x 1.1) = $22,000
Input
Labor is same as in part (a) = $10,000
Material is same as in part (a) = $4,000
Overhead is same as in part (a) = $4,000
Multifactor productivity ratio = $22,000/$18,000 = 1.22
<u>Option 2.</u> Improve Quality
Output = 100 guitars x 90% completion rate x $250/guitar = $22,500
Input
Labor is same as in part (a) = $10,000
Material is same as in part (a) = $4,000
Overhead is same as in part (a) = $4,000
Multifactor productivity ratio = $22,500/$18,000 = 1.25
<u>Option 3.</u> Reduce costs by 10%
Output = same as in part (a) = $20,000
Input

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Reduce costs by 10% yields 90% of the input costs from part (a).
= $18,000 x 0.90 = $16,200
Multifactor productivity ratio = $20,000/$16,200 = 1.23

Darren should choose Option 2 and improve quality because it yields the greatest improvement in multifactor productivity.

8. Mariah Enterprises Productivity of Process Alpha and Process Beta

Excel used to perform all calculations

	Process		
	Alpha	Beta	
Total Value of Output	$17,150	$16,450	
Total Cost of Labor	$2,600	$3,000	
Total Cost of Materials	$5,500	$4,900	
Total Cost of Overhead	$6,000	$5,000	
Labor Productivity	$6.596	$5.483	unit $/ labor $
Multifactor Productivity	$1.216	$1.275	unit $/ total $

Process alpha has 20% [(6.596-5.483)/5.483] higher labor productivity.

Process beta has 5% [(1.275-1.216)/1.216] higher multifactor productivity.

While process beta generates more dollars of output per dollar invested in input, it doesn't use labor as efficiently as process alpha.

9. Morning Brew Coffee Shop

Excel used to perform all calculations

a. Current labor and multifactor productivity

Currently	Regular Coffee	Cappuccino	Vienna coffee	total
Output in dollars	$700.00	$300.00	$600.00	$1,600.00
Labor cost				$320.00
Material cost	$175.00	$75.00	$187.50	$437.50
Equipment cost				$125.00
Overhead cost				$225.00
			Profit	$492.50

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Labor Productivity	5.0000
Multifactor Productivity	1.4447

After adding new product

After Adding New Product	Regular Coffee	Cappuccino	Vienna coffee	Eiskaffee	total
Output in dollars	$700.00	$300.00	$600.00	$375.00	$1,975.00
Labor cost					$320.00
Material cost	$175.00	$75.00	$187.50	$112.50	$550.00
Equipment cost					$200.00
Overhead cost					$350.00
			Profit		$555.00

Labor Productivity	6.1719
Multifactor Productivity	1.3908

Change in Labor Productivity	23.438%
Change in Multifactor Productivity	-3.727%

b. The units of Eiskaffee that would have to be sold to ensure that the multifactor productivity increases from its current level may be calculated as follows:

$$\frac{output}{input} = \frac{Coffee\ sold\ in\ \$}{Labor\ \cos t + Material\ \cos t + Equipment\ \cos t + Overhead\ \cos t} = 1.4447$$

$$\frac{350(\$2) + 100(\$3) + 150(\$4) + x(\$5)}{\$320 + (350(\$.5) + 100(\$.75) + 150(\$1.25) + x(\$1.5)) + 200 + 350} = 1.4447$$

$$\frac{\$1600 + \$5.0x}{\$1307.5 + \$1.5x} = 1.4447$$

$$\$1600 + \$5x = 1.4447(\$1307.5 + \$1.5x)$$

$$\$1600 + 5x = 1888.945 + 2.1670x$$

$$2.833X = 288.945$$

$$x \cong 102$$

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Calculation confirmed in Excel:

After Adding New Product	Regular Coffee	Cappuccino	Vienna coffee	Eiskaffee	total
Output in dollars	$700.00	$300.00	$600.00	$510.00	$2,110.00
Labor cost					$320.00
Material cost	$175.00	$75.00	$187.50	$153.00	$590.50
Equipment cost					$200.00
Overhead cost					$350.00
			Profit		$649.50

Labor Productivity	6.5938
Multifactor Productivity	1.4447
Change in Labor Productivity	31.875%
Change in Multifactor Productivity	0.001%

CASE: CHAD'S CREATIVE CONCEPTS*

A. Synopsis

This case describes a small furniture manufacturing company that has gained a reputation for creative designs and quality by focusing on producing custom-designed furniture. As its reputation grew, it began to sell some standard furniture pieces to retail outlets. The overall growth in sales volume and the diversification into the production of standard furniture pieces have caused a number of issues to arise concerning both the internal manufacturing operations and its relationship to the other functional areas of the company.

B. Purpose

This case is designed to be used as either a "cold-call" case for class discussion or an assigned homework reading. Major points to be brought out in the discussion include:

1. The range of decisions that are made in designing and operating processes.
2. The impact that these operating decisions have on the organization as a whole, such as on marketing and finance.
3. The impact that decisions made in other functional areas of the organization have on the operating function.
4. The need to go beyond the "functional silo" mentality and manage in an integrative manner.

C. Analysis

* This case was prepared by Dr. Brooke Saladin, Wake Forest University, as a basis for classroom discussion.

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Question 1: *What types of decisions must Chad Thomas make daily for his company's operations to run effectively? Over the long run?*

The students should be able to discuss a number of short-term-oriented decisions that are facing Chad Thomas. These should include:

a. How to set priorities and schedule different orders? Chad is receiving orders for both custom-made, low-volume furniture pieces and higher-volume, standard pieces. Sales have increased, but the amount of equipment and the production capacity of the company have not. Neither has the type or mix of equipment changed. Different orders with different manufacturing requirements are now competing for the same productive capacity.

b. What orders to accept and how long of a lead time to plan for in promising a delivery date?

c. What type of work policies should be maintained for his employees? Decisions such as the number and type of employees to employ, the number of hours to work per day, and the amount of overtime to allow are all work policy decisions that impact the available capacity level.

d. The allocation of resources, equipment, labor, and money to each product line.

e. The level of inventory to maintain at various stages of the production process for both the custom and standard furniture lines (i.e., raw material, WIP, finished goods). These decisions are linked to the longer-term, total inventory-investment decision.

Examples of longer-term decisions that face Chad Thomas include:

a. Amount of money to tie up in the total inventory investment.

b. The type of equipment to invest in to support efficient production. At what point should more specialized equipment be purchased to manufacture high-volume, standard furniture pieces more efficiently?

c. What should be the overall workforce level to maintain, and what should be the proper mix of skills and capabilities?

d. How should the facilities be laid out to accommodate the two different product lines? This gets the students into a whole range of capacity and equipment allocation decisions including size, type, and configuration.

In these decisions it is important that the students see the significance of maintaining consistency of both strategic and operating decisions across functional areas.

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***Question 2**: How did sales and marketing affect operations when they began to sell standard pieces to retail outlets?*

Standard furniture pieces compete on a different set of competitive priorities than custom-designed pieces. Timely delivery and low costs are much more important than product flexibility. Quality may also be defined differently. The existing facilities are set up to provide flexibility with its job-shop orientation and general-purpose equipment. By introducing a standard line that should be manufactured on a flow line with some dedicated, more specialized equipment, a conflict has developed, and scheduling problems have resulted.

***Question 3:** How has the move to producing standard furniture pieces affected the company's financial structure?*

Inventory investment and operating costs are rising because of the frequent changeovers to accommodate the two different product lines and their scheduling conflicts.

Profit margins for the standard line are smaller, which puts pressure on manufacturing to increase productivity and reduce costs. There may also be an issue concerning the assignment of overhead costs to each product line.

Finally, the potential need to rent warehouse space to store either WIP or finished-goods inventory cuts into the profit margin for the standard furniture line.

***Question 4:** What might Chad Thomas have done differently to help avoid some of these problems he now faces?*

Chad needs to address issues relating to functional areas. Make sure the student is able to identify decisions that relate to more than one functional area. Examples include the following:

Operations Function

1. Monitoring capacity and utilization of facilities
2. Formulating inventory policies—dollars, items, and unit levels
3. Setting scheduling policies and priorities
4. Maintaining product line quality

Marketing and Sales

1. Accurately forecasting orders for standard pieces
2. Defining market segments and customer needs
3. Determining what delivery schedules can be promised to customers

Finance

1. Deciding level and type of investment

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2. Investigating the effect of capacity investment decisions on ROI

Distribution/Logistics

1. Managing distribution and pipeline inventory
2. Comparing cost and advantages of various transportation modes
3. Meeting delivery lead times

Three possible avenues that students may focus on are: Chad Thomas might have -

a. Established a plan for a more controlled growth. Part of this plan would be the development of the appropriate infrastructure to manage a controlled growth as to what markets to enter, what product lines to develop, and how to develop the proper manufacturing capabilities.

b. Maintained the company focus on custom-designed furniture only. This alternative presents a whole different set of issues and decisions pertaining to future growth, but it would have avoided the issues of mixed competitive priorities and scheduling conflicts.

c. Realized the different requirements for each product line and focused the manufacturing facilities into two separate sets of production facilities designed to cater to each product line's specific needs.

D. Recommendations

This case is not designed to be a decision-making case per se but rather a vehicle to get students thinking about the types and the integrated nature of decisions that operations managers face. The students may, indeed, have suggestions as to what should be done to help out Chad Thomas. These recommendations will more than likely follow the alternatives already discussed. As recommendations are provided by students, make sure you push them to understand the implications of their recommendations with respect to the company as a whole and the other functional areas.

E. Teaching Strategy

This case can be effectively discussed in 20 to 30 minutes by following the discussion questions provided at the end. The questions are interconnected and somewhat redundant on purpose to reinforce the inter-relatedness of decisions made in various functional areas of the company. The intent is to have the students understand the range of decisions that face managers in the operations function and to realize that different types of products competing in different markets place different demands on the operations function. Therefore, manufacturing systems will take on a variety of configurations.

Exhibit TN.1 lays out a sample table to be written on the board displaying important issues in the class discussion. Each column can be used to compare and contrast the differences in the requirements imposed by custom versus standard furniture for each area.

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EXHIBIT TN.1 Board Plan

Important Issues	Custom Furniture	Standard Furniture
Marketing		
Quality level and quality control		
Process equipment		
Process flow		
Production scheduling system		
Purchasing		
Type of inventory and inventory control system		
Type of engineering		
Type of labor and supervision needed		
Wage/reward system		
Layout		

Crayola: Using Operations to Create Value at Crayola

Length: 07:50

Subject: Using Operations to Create Value at Crayola

Textbook Reference: Chapter 1: Using Operations to Create Value, page 29

Summary

This video discusses the operations and supply chain strategy and challenges at Crayola, the world's leading company in arts and crafts products. A set of supply chain leadership principles are defined as cost, innovation, quality & ethical responsibility, sustainability, and resilience and agility. These principles are derived from the daily decisions Crayola faces such as choosing colors to drive demand, and launching new products while maintaining quality standards. As the supply chain grows globally and the company enters new foreign markets, operational challenges arise in managing fluctuating demands and a complex supply base.

Key Concepts related to the chapter

The video case includes rich discussion avenues in operations strategy, competitive priorities and capabilities. Also, the written case in the textbook covers Crayola's potentially new markets in China, which creates challenges as well as opportunities. The instructor should make sure that students understand and become comfortable in applying the core concepts of operations strategy and competitive priorities/capabilities to this case.

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Operations Strategy

The corporate strategy and market analysis of Crayola can be discussed in detail. In order to develop a corporate strategy, Crayola first monitors and identifies adjustments that need to be implemented. Already being the dominant player in the North American market, Crayola is now looking for new markets overseas including China. Consumer needs are becoming more diversified than ever, and a large portion of purchasing takes place online. Crayola has strong core competencies in terms of customer-focused culture, strong innovation capabilities, and reliable product quality. Another key issue to be pointed out is their strong focus around environmental sustainability, which originated from the founders of the company. By leveraging their core competencies and adjusting to these external changes, Crayola strengthened their operations management functions and supply chain management activities. Four key strategies were developed -- international expansion, consumer commercialization, dot.com strategy, and Crayola experience. Two points to consider for the international expansion are - what works well in their home country might not work well elsewhere?, and secondly, the importance of choosing the appropriate entry strategy such that it can ward off fierce competition and overcome cultural frictions.

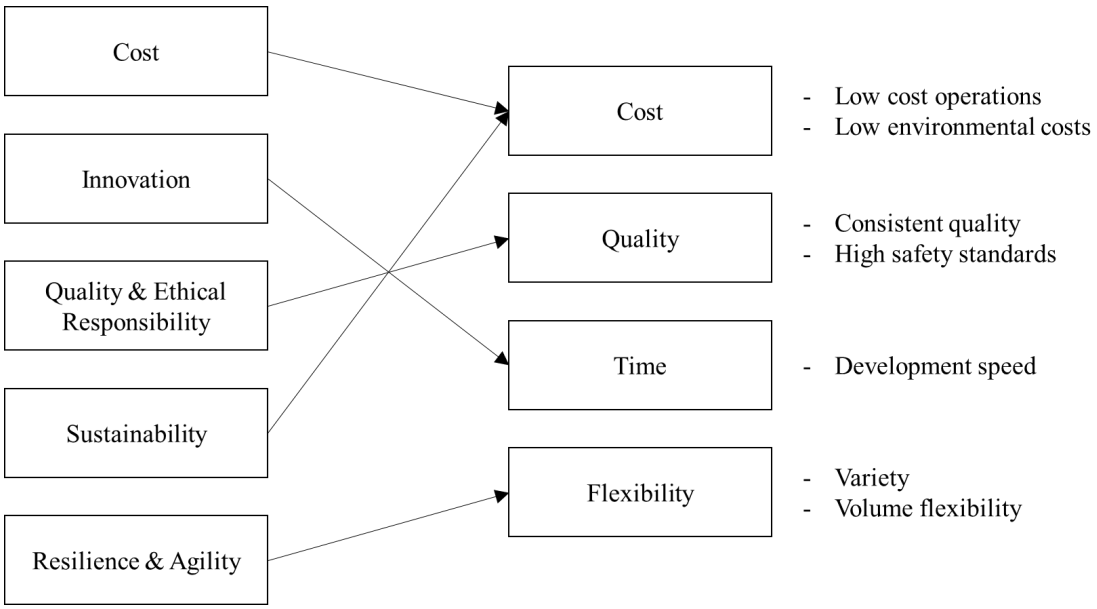
Competitive Priorities and Capabilities

The competitive priorities of Crayola are characterized by its five principles of cost, innovation, quality & ethical responsibility, sustainability, and resilience & agility. These critical operational dimensions can be elaborated in detail based on the case information. Competitive priorities of cost, quality, time, and flexibility should be critically evaluated to make sure that its achieved competitive capability goals are met. Students should be able to make clear distinctions between priorities (targeted) and capabilities (achieved) in order to address the discussion questions at the end of the case.

Another useful way to assess a firm's ability is to use the order winner and order qualifier framework. In the video, Crayola's customers mention order qualifiers as givens, and include consistently top quality, quick and on-time delivery, customized products and displays, variety, and flexibility. Order winners on the other hand, are mentioned as color selection (market knowledge), innovation, and high product reliability.

Discussion Questions Based on Video

1. Map Crayola's five pillars of operational leadership to the competitive priorities in Table 1.3.



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- The figure above shows an example of mapping the five pillars to the four competitive priorities. The pillars can be translated as having low operations and environmental costs, consistent and safe quality levels, fast new product development speed, and high responsiveness via customization and volume flexibility.

2. Create an assessment of Crayola's competitive priorities as it relates to their Asian expansion plants.

Competitive Priority/Pillar	Measure	Capability	Gap	Action
Low cost Operations	Production cost Transportation cost Material cost	Mostly sourced in USA Automated with US workers	Foreign expansion causes additional costs	Multilanguage packaging Offshore production and sourcing
Sustainable efficiency	Carbon dioxide emission Energy consumption	Recycled plastic Reforested wood Solar farm	Acceptable	No action
Ethical responsibility	Fair wages to workers Adherence to all local laws and ethical standards	Meeting laws and standards in North America	Foreign markets may have different laws and standards	Education of local managers for strict adherence to the company's ethical standards
Consistent quality	Percent defects Rework, scrap Product returns	High consistency in packaging and product quality	Acceptable	No action
High safety quality	Certifications Chemical use	All products are non-toxic	Acceptable	No action
Development speed	New product time to market	First to the market with every innovation	Acceptable	No action
Variety	Product mix range	Wide variety of colors	Acceptable	No action
Volume flexibility	Utilization Order-fill rate	Maintains capacity and integrated supply base in US	Less responsive to overseas demand fluctuations	Postponement Modular process

3. Which of the competitive priorities might present the biggest challenge to Crayola as it expands internationally?

In order to maintain their emphasis on quality and environmental sustainability, Crayola sources most of the required materials from the USA. However, this practice could be put into question when they decide to aggressively expand to overseas markets. Studies show that locating production facilities in foreign countries and increasing the local presence reduces customer aversion and enhances market penetration. Crayola would also have to decide whether the benefits arising from the low production cost in the Chinese labor market are sufficient to overcome the disadvantages associated with technology leakage, political risks, quality risks, and increased competition.

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Chapter

2 Process Strategy and Analysis

DISCUSSION QUESTIONS

1. Many processes at manufacturing facilities involve customer contact. Internal customers would include those employees whose operation(s) are subsequent. Quality Control could be considered an internal customer as could design engineering or sales. Quality Control, design engineering, marketing, sales and other organizations represent the customer at various stages of any process. Customer contact can be very high, especially between production and engineering and production and quality control.

2. Some students may see this as a difference in competitive priorities. Others may see a difference in management styles. Ritz-Carlton empowers their employees and the local restaurant does not seem to empower. Ritz-Carlton believes that by having employees treat customers and other employees with respect, customer service is enhanced. A restaurant that does not allow employees to resolve a customer issue may not see enhanced customer service. The restaurant may believe that the to-go customer will be better satisfied with fast and accurate orders. The in-store customer gets the chips and salsa to utilize the time while waiting for an order to be prepared. The to-go customer has already placed that order and it is ready when the customer arrives at the pickup window.

3. eBay has considerable arrival and request variability, because its customers do not want service at the same time or at times necessarily convenient to the company. They have request variability, seeking to buy and sell an endless number of items. Their process strategy allows significant customer involvement. Their customers perform virtually all of the selling and buying processes. McDonald's instead offers a considerable variety of foods, but from a standard menu. Staffing varies, depending on the time of day. Customization is not encouraged, and the hours during which a store is open can be controlled. Its processes have virtually no customer involvement, other than placing the order, picking up condiments or napkins, and possibly disposing of plates and containers when exiting. eBay accomodates customer-introduced variability, whereas McDonald's reduces it.

4. Student answers will vary. One idea that they may come up with is the use of electronic files. The printing industry is undergoing a shift to pdf files. Medical imaging and electronic file sharing is on the immediate horizon. The trick would be to convince physicians that want to keep their pads and pencils, that their "blackberries" are their pads and pencils.

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5. Selling financial services would involve considerable customer contact, and thus be a front office. Likely activities would be to work with the customer to undertand customer needs, make customized presentation to the customer, and maintain a continuing relationship with the customer to react to changing customer needs. Producing monthly client fund balance reports involves little customer contact, and thus be a back office. Likely activities would be to obtain data electronically, run the report using a standardized process, forward the hard copies and electtonic files to analysts, and repeat the process monthly with little variation.

6. The process of call center services is rated in the table below. The combined score is 5.6 if each is given a weight of 0.20. Arguments could be made to give more weight to a dimension such as contact intensity, although more would need to be known about the exact process. The process's alignment on the customer-contact matrix seems to fit a front office, with more jumbled work flows and process divergence. To be properly aligned, there should be considerable resource flexibility in terms of both the employees and their equipment.

Dimension of Customer Contact	Explanation	Score
❑ Physical presence	❑ The customer is present for such steps as working to understand customer needs and answering specific questions. Other steps such as researching product information do not involve as direct contact.	**1**
❑ What is processed	❑ The customer is the focus of what is being processed in certain steps, such as the specific product explanation. However, researching product information lies more in the category of information–based service rather than people-processing services.	**6**
❑ Contact intensity	❑ The customer is actively involved and there is high service customization process	**7**
❑ Personal attention	❑ There is considerable personal attention and confiding in working to understand customer needs and in maintaining a continuing relationship with the customer. .	**7**
❑ Method of delivery	❑ Much of the delivery is through phone-to-phone contact .	**7**

7. The answer can be debated. On one hand, relentless pressure to improve can create considerable benefits over time, and could well put a company at the top of the industry. On the other hand, small improvements do not lead to break-through solutions that might be what is needed to remain competitive, particularly in an industry marked by rapid change. However, radical change and process reengineering is strong medicine and not always needed or successful.

8. This question was inspired by a similar situation faced by Ontario Hydro-Electric. Today electricity is a commodity that competes on the basis of low-cost operations and reliability. If the environmental protection equipment is installed, HEC must either absorb the costs as a loss (immediate bankruptcy) or attempt to pass on the costs to customers and see further erosion of their market (eventual bankruptcy). HEC would probably decide to delay investment in environmental protection equipment

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for as long as possible. Some discussion may focus on the issue of whether customers, as users of both electricity and the environment, are better served by competition (lower cost of electricity) or by regulated monopolies (better environment).

9. For background reading, see: Paul O'Neill, "Why the U.S. Healthcare System Is So Sick and What O.R. Can Do To Cure It." *OR/MS Today* (December, 2007).
   a. Although many ideas are possible, a typical response is some kind of computer order-entry system. Although we asked for blue sky ideas, these systems do cost a medium-sized hospital about $10 million, They also solve only half of the problems, but the remaining half can become complicated and less tractable than the ones you started with.
   b. Same set of ideas possible here as well.
   c. Fill carts on a daily basis, more computerized information system, and so forth.
   d. Ideas could include more nurses, or one of several ways to remind nurses when a drug is to be administered.
   e. Many ideas are possible, ranging from mattresses on the floor to more nurse check-ins during the night.
   f. Better sterilization procedures, better training on patient care, research on the causes of the infections, and more thorough house cleaning are just a few ideas. Students will come up with more.

PROBLEMS

Process Strategy Decisions

1. Dr. Gulakowicz
   Fixed cost, $F = \$150{,}000$
   Revenue per patient, $p = \$3{,}000$
   Variable cost per unit, $c = \$1000$
   Break-even volume, $Q = \dfrac{F}{p-c} = \dfrac{\$150{,}000}{\$3{,}000 - \$1000} = 75$ patients

2. Two manufacturing processes
   a. $F_1 + c_1Q = F_2 + c_2Q$
   $\$50{,}000 + \$700Q = \$400{,}000 + \$200Q$
   $(\$700 - \$200)Q = (\$400{,}000 - \$50{,}000)$
   $Q = \dfrac{\$350{,}000}{\$500} = 700$ units
   b. Choose the second process, because 800 exceeds the break-even volume.

3. Sebago Manufacturing

   The point of indifference (at which the proposals yield the same annual cost) between:
   Proposal 1 and 2: 0.00 + 22x = 150,000 +14x

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X = 18,750 components per year

Proposal 2 and 3: 150,000 +14x = 450,000 + 12.50x

X = 200,000 components per year

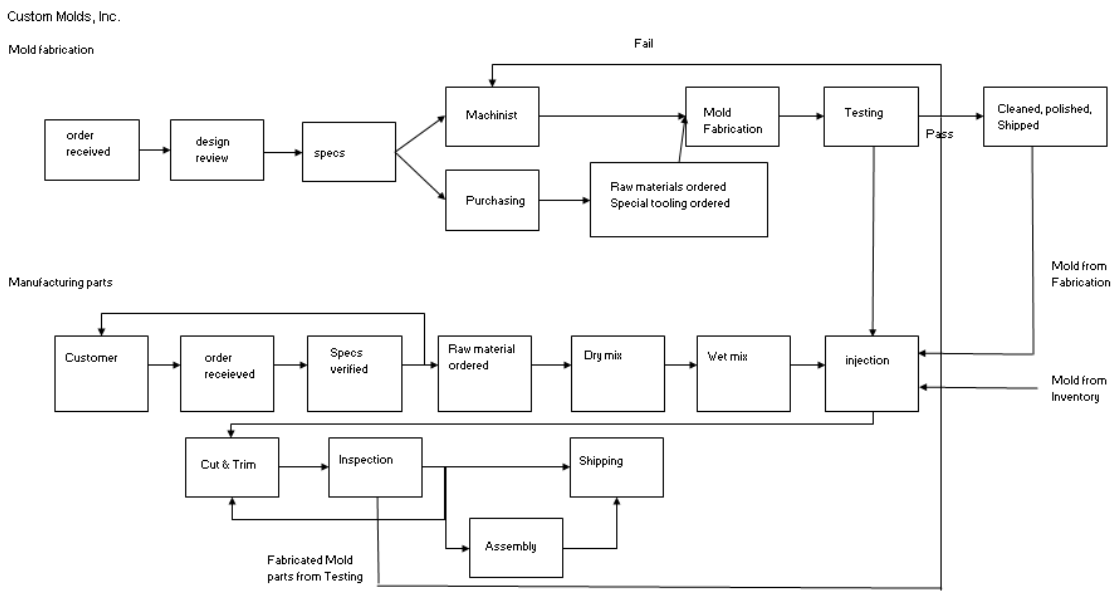
Proposal 1 and 3: 0.00 + 22x = 450,000 +12.50x

X = 47,368.4 components per year

Proposal 1 will provide the lowest annual cost if between 0 and 18,750 components are required annually, proposal 2 will provide the lowest annual cost if between 18,750 and 200,000 components are required annually, and Proposal 3 will provide the lowest annual cost if greater than 200,000 components are required annually.

Defining, Measuring and Analyzing the Process

4. Custom Molds



5. Process chart for Custom Molds with metrics

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**Process Chart for Custom Molds**													
2														
3	**Step**	**Cost ($)**	**Time (min)**	**Time Delay (min)**	**Distance Moved (feet)**	**Scrap (%)**	**Rework (%)**	**Environ-mental waste (lbs)**	**Energy required ($)**	**External customer contact (1–7)**	**Demand rate (units)**	**Process divergence (1-7)**	**Inventory (units)**	**Customer complaints (%)**
4	***Mold fabrication***													
5	1. Order received													
6	2. Design review													
7	3. Specs													
8	4. Machinist													
9	5. Purchasing													
10	6. Order materials and tooling													
11	7. Mold Fabrication													
12	8. Mold Testing													
13	9. Go to Step 10 or 17 as needed													
14	10. Clean, polish and ship													
15														
16	***Manufacturing parts***													
17	11. Customer order received													
18	12. Specs verified with customer													
19	13. Order materials													
20	14. Dry mix													
21	15. Wet mix													
22	16. Get mold from fabrication or inventory													
23	17. Injection													
24	18. Cut and trim													
25	19. Inspection													
26	20. Back to steps 4, 18, 21, or 22 as needed													
27	21. Assembly													
28	22. Shipping													
29	**TOTALS**													

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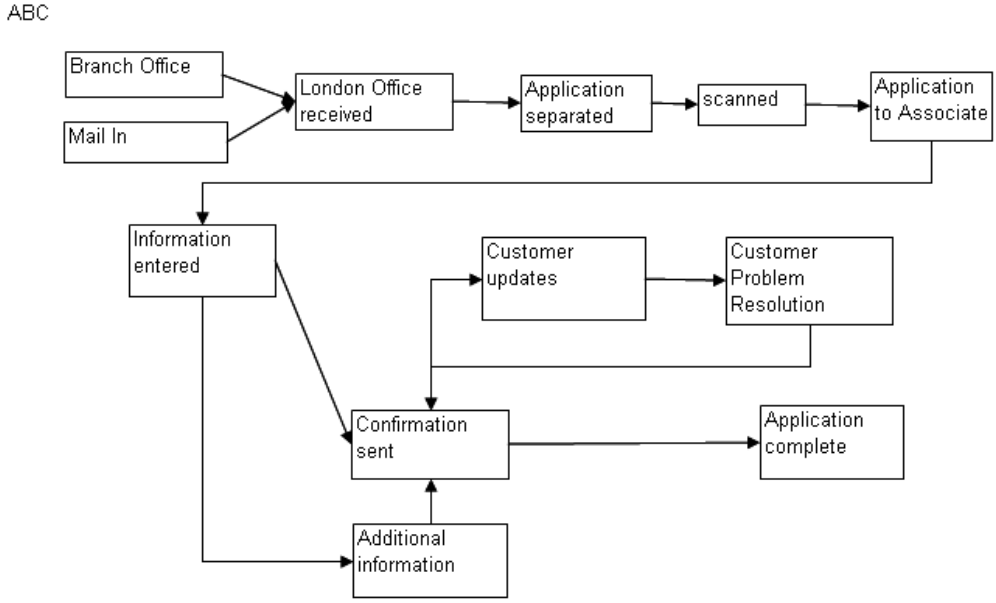
6. ABC Insurance Company

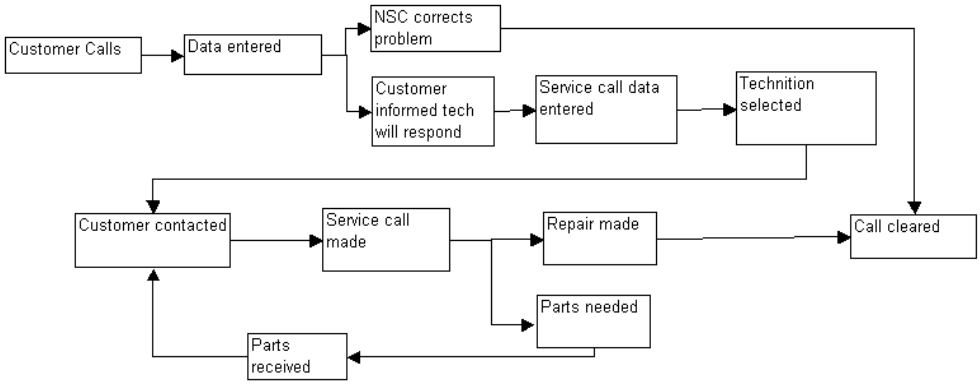


7. ABC Process Chart

Process Chart for ABC

Step	Cost ($)	Process Time (min)	Time Delay (min)	Cumulative Elapsed Time min)	Customer Error (%)	Associate Error (%)	Rework (%)	Environ-mental waste (lbs)	Energy required ($)	External Customer Contact (1-7)	Applications per Week	Process Divergence (1-7)	Customer Satisfaction (1-7)	Number of applications in queue	Customer complaints (%)
1. Branch office															
2. Mail in															
3. London office receives from Steps 1or 2															
4. Application separated															
5. Scanned															
6. Application to associate															
7. Information entered															
8. Go to Steps 9 or 10 as needed															
9. Additional information															
10. Confirmation sent															
11. Go to Step 12 or 15 as needed															
12. Customer updates															
13. Customer problem resolution															
14. Go to Step 10															
15. Application complete															
TOTALS															

8. DEF Flowchart



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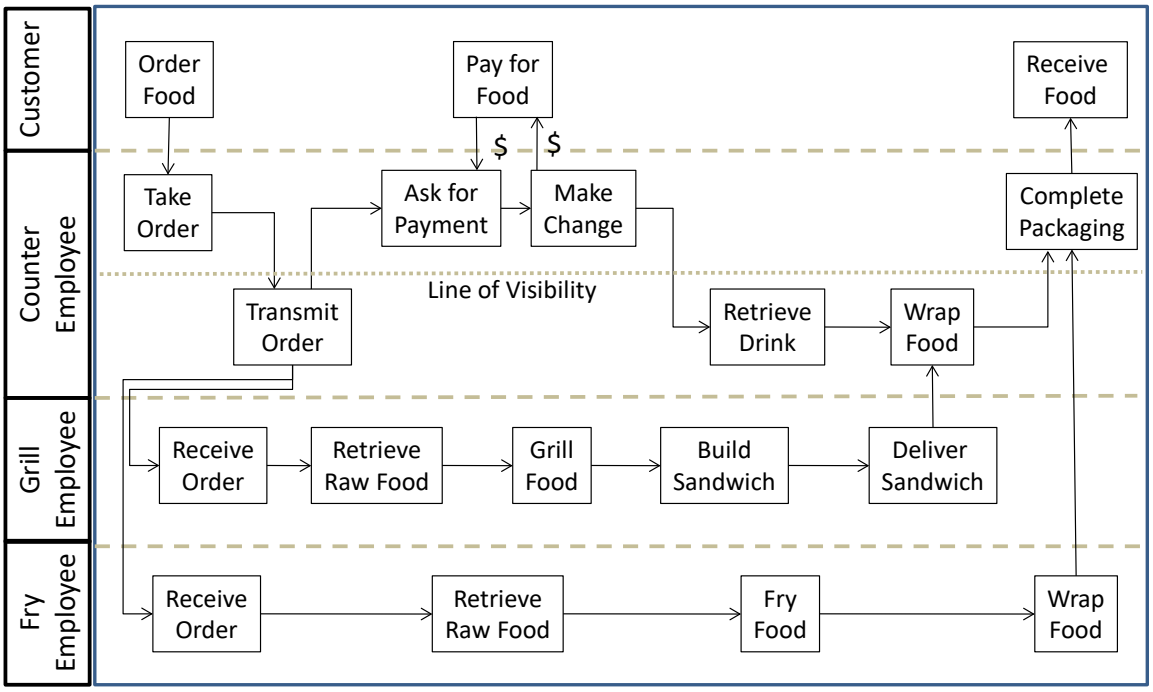
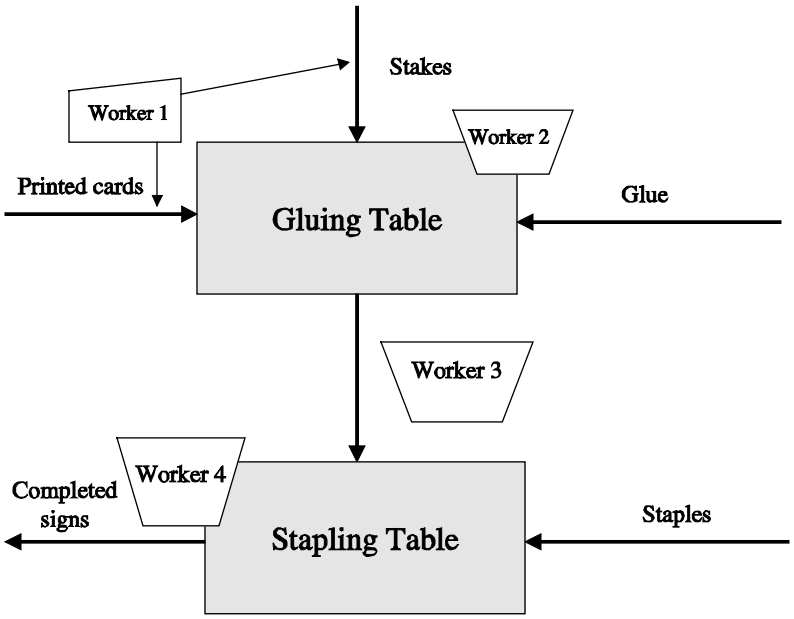
9. Big Bob's Service Blueprint

Service Blueprint for Big Bob's Burger Barn



10. Referendum 13

Flowchart for yard sign assembly:



Human resource requirements:

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One of many possible arrangements is to create several cells with four workers in each cell.

Worker 1 is a materials handler, bringing printed cards and stakes (say in stacks or bundles of 25) to the gluing table and taking completed signs (again in bundles of 25) to the shipping area.

Worker 2 glues printed cards to the stakes. Worker 2 is also responsible for keeping the area supplied with glue, staples, pizza, and soft drinks.

Worker 3 is also a materials handler, transferring glued signs in small quantities (a transfer batch) to the stapling table.

While worker 3 holds the material in place, Worker 4 staples the card to the stake to hold it while the glue dries. Worker 4 also inspects the staples, drives loose ones home with a hammer, and stacks completed signs in bundles of 25 for Worker 1 to take away.

Accounting for interruptions, material shortages, and chaos, each cell will complete about eight signs per minute, or about two signs per worker-minute. 10,000 signs would require about 5,000 worker-minutes, or 83.33 worker-hours. In order to accomplish this work within three hours (maximum attention span of college students) 83.33/3 = 27.78 or about 28 student volunteers are required to staff 7 cells.

Material requirements (for 7 cells of 4 workers each):

10,000	printed cards
10,000	stakes
32,000	staples (16 boxes of 2,000 each)
28	12-ounce bottles of wood glue
4	cases
10	pizzas

Equipment requirements:

14	tables
7	staple guns
7	hammers (to set staples)

Process chart (using *Process Chart Solver of OM Explorer*):

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Process: Yard sign assembly (25)

Subject: Volunteer

Beginning: Material to table

Ending: Completed signs removed

Insert Step

Append Step

Remove Step

Summary

Activity	Number of Steps	Time (min)	Distance (ft)
Operation ●	2	6.2	
Transport ➡	4	4.0	155
Inspect ■	1	1.0	
Delay ◗	1	1.0	
Store ▼	2	1.5	

Step No.	Time (min)	Distance (ft)	●	➡	■	◗	▼	Step Description
1	0.5	50		X				25 printed cards to gluing table
2	0.5	50		X				25 stakes to gluing table
3	3.2		X					Glue 25 cards to 25 stakes
4	2.5	5		X				Transfer individually to stapling
5	1.0					X		Hold in postion for stapling
6	3.0		X					Insert three staples per sign
7	1.0				X			Inspect staples
8	1.0						X	Stack signs into bundles of 25
9	0.5	50		X				Carry signs to shipping area
10	0.5						X	Store signs until distributed

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11. Mailing to the alumni of your college
    a. A sample process chart for 2000 letters follows.

Process: Alumni Mailing
Subject: Letters and envelopes
Beginning: Process letter
Ending: Place stamp on envelope

Insert Step
Append Step
Remove Step

Summary

Activity	Number of Steps	Time (min)	Distance (ft)
Operation ●	5	0.57	
Transport ➡			
Inspect ■			
Delay ◗			
Store ▼			

Step No.	Time (min)	Distance (ft)	●	➡	■	◗	▼	Step Description
1	0.20		X					Process letter
2	0.12		X					Fold letter
3	0.10		X					Stuff into correct envelope
4	0.05		X					Seal envelope
5	0.10		X					Place stamp on envelope

b. Total time for 2000 letters = [(0.57 min) / 60 min per hour] x 2000 letters = 19 hours. The cost to process 2000 letters = ($8/hr)(19 hr) = $152.

c. Changes that would reduce the time and cost of the process:
   - A letterhead with "Dear Alumnus" will make step 1 (process letter) not necessary, saving 400 minutes and $53.33 [$8(400/60)].
   - With mailing labels, step 1 involves matching the letters with labels rather than with addressed envelopes, but now we must stick the label to the envelope. We do everything we did before plus the extra step. The time would increase by 200 minutes and cost $26.66 [$8(200/60)] more.
   - Prestamped envelopes will eliminate step 5 and save 200 minutes and $26.67 [$8(200/60)].
   - If envelopes are to be stamped by a postage meter, it will take, 10 minutes [2000/200]. This results in a savings of 190 minutes and $25.33 [$8(190/60)].
   - Window envelopes eliminate the need to match envelopes to letters, resulting in a savings of $53.33.

d. Using the letter with "Dear Alumnus" may reduce the effectiveness of the project because it would be less personal. This concern goes also for the use of mailing labels.

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e. Although including a preaddressed envelope will increase time and cost of the process, alumni may be more likely to contribute if they have an envelope available to them.

12. Gasoline Stations
    a. The gas station in part (b) has a more efficient flow from the perspective of the customer because traffic moves in only one direction through the system.
    b. The gas station in part (a) creates the possibility for a random direction of flow, thereby causing occasional conflicts at the gas pumps.
    c. At the gas station in part (b) a customer could pay from the car. However, this practice could be a source of congestion at peak periods.

13. Just Like Home Restaurant
    a. The summary of the process chart should appear as follows:

Activity	Number of Steps	Time (min)	Distance (ft)
Operation ●	6	1.70	
Transport ➡	6	0.80	31
Inspect ■	1	0.25	
Delay ◗	1	0.50	
Store ▼	--	--	

    b. Each cycle of making a single-scoop ice cream cone takes 1.70 + 0.80 + 0.25 + 0.50 = 3.25 minutes. The total labor cost is ($10/hr)[(3.25 min/cone)/60 min](10 cones/hr)(10 hr/day)(363 day/yr) = $19,662.50.
    c. To make this operation more efficient, we can eliminate delay and reduce traveling by having precleaned scoops available. The improved process chart follows.

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Process:	Making single-scoop cone
Subject:	Server at counter
Beginning:	Walk to cone storage area
Ending:	Give to server or customer

Insert Step

Append Step

Remove Step

Summary

Activity	Number of Steps	Time (min)	Distance (ft)
Operation ●	5	1.65	
Transport ➡	4	0.45	15
Inspect ■	1	0.25	
Delay ◗	--	--	
Store ▼	--	--	

Step No.	Time (min)	Distance (ft)	●	➡	■	◗	▼	Step Description
1	0.20	5.0		X				Walk to cone storage area
2	0.05		X					Remove empty cone
3	0.10	5.0		X				Walk to scoops storage area
4	0.05		X					Remove scoop
5	0.10	2.5		X				Walk to flavor ordered
6	0.75		X					Scoop ice cream from container
7	0.75		X					Place ice cream in cone
8	0.25				X			Check for stability
9	0.05	2.5		X				Walk to order placement area
10	0.05		X					Give server or customer the cone

The cycle time is reduced to 1.65 + 0.45 + 0.25, or 2.35 minutes. The total labor cost is ($ 10/hr)[(2.35 min/cone)/60 min](10 cones/hr)(10 hr/day)(363 day/yr) = $14,217.50.

Therefore, the annual labor saving is $19,662.50 – $14,217.50 = $5,445.00.

14. Grading Homework Steps:
    1. Check each paper to identify the author of the homework, then mark each paper with section number and graduate status.
    2. Sort by section and graduate status.
    3. Correct and grade papers.
    4. Alphabetize by section.
    5. Record grades.
    6. Return homework to appropriate instructor.

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15. DMV

The process chart is as follows.

Process: Automobile license
Subject: Customer
Beginning: Customer arrives
Ending: Customer leaves

Insert Step
Append Step
Remove Step

Summary

Activity	Number of Steps	Time (min)	Distance (ft)
Operation ●	5	9	
Transport ➡	6	0	265
Inspect ■	1	0	
Delay ◗	4	351	
Store ▼	1	0	

Step No.	Time (min)	Distance (ft)	●	➡	■	◗	▼	Step Description
1			X					Take a number
2		50		X				Walk to waiting area
3	240					X		Wait for service
4					X			Number is called and checked
5		60		X				Walk to clerk
6	4		X					Calculate/pay city sales taxes
7		80		X				Walk to property tax area
8			X					Take a number
9	100					X		Wait for service
10		25		X				Walk to clerk
11	2		X					Calculate/pay property taxes
12		50		X				Walk to license area
13	10					X		Wait for service
14	3		X					Calculate/pay license fee
15	1					X		Abuse license clerk
16				X				Walk to car in parking lot
17							X	Crash with bus, return to step 1

The tax assessment clerks' time is being wasted by an inefficient waiting line process. Whenever the customer arrival rate approaches the service rate, a waiting line will form. While the clerk is waiting for phantom customers, service rate declines, and waiting lines become even longer. More disgusted customers leave the waiting area (renege).

This process can be improved by arranging the waiting area to work like the "batter's circle and batter's box" in baseball. Customers who have reneged would be replaced before the clerks' time is wasted. Service rates would increase and waiting lines would decrease.

Typical of many service situations, the customer's anger is misguided. It is directed at the last person in the process (the license clerk), who has done nothing wrong. The customer pays for this misguided anger. While taking the one minute to abuse the license clerk, a bus approaches. Blinded by rage, the taxpayer drives his new car into the path of the oncoming bus, and the car is totaled. Now the customer will have to start the process again!

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Epilogue.
It is almost sad how little exaggeration was used in creating this problem. When this location of the DMV closed, the local news announcer referred to it as "the city's most popular place to wait in line." This DMV process has since been replaced by an automated one-stop, one-transaction process. Just today I visited the new DMV and completed the entire process in five minutes.

16. Oil Change
    a. Each oil changing cycle takes 16.5 + 5.5 + 5.0 + 0.7 + 0.3 = 28 minutes. The total labor cost is

($40/hr)[(28 min/service)/(60 min/hr)](2 services/hr × 10 hrs/day × 300 days/yr) = $112,000

    b. ($40/hr) × (2.7 minutes saved per service/60 min/hr) (2 services/hr × 10 hrs/day × 300 days/yr) = $10,800 saved per year

17. Time Study of Assembling Peanut Valves

Average Time = [14(15)+12(20)+15(25)] / (14+12+15) = 20.12 seconds

Normal Time = 20.12 × 0.95 = 19.11 seconds

Standard Time = 19.11 × 1.20 = 22.93 seconds

18. Time Study of Process

Element	Performance Rating	Obs 1	Obs 2	Obs 3	Obs 4	Obs 5	Average Time	Normal Time
Element 1	70	4	3	5	4	3	3.8	2.66
Element 2	110	8	10	9	11	10	9.6	10.56
Element 3	90	6	8	7	7	6	6.8	6.12
							Total =	19.34

Standard Time = 19.34 × 1.20 = **23.21 minutes**

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19. Work Sampling on Idle Time

    a. Idle Time = (17+18+14+16) / (44+56+48+60) ×100 = 31.25 percent.

Working Time = 100 – 31.25 = 68.75 percent.

    b. Different root causes can be explored in an expanded work sampling study, with new categories replacing idle, such as: waiting for materials, waiting for instructions, equipment failures, breaks, or conversations with co-workers.

20. Bid on Swimming Pools

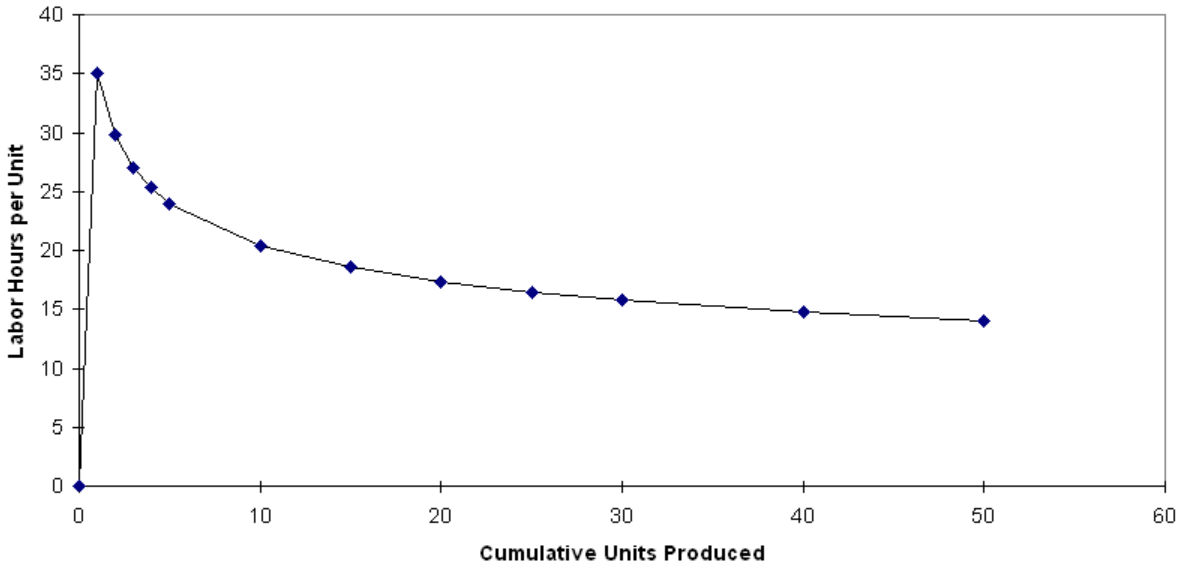
a. 2nd Pool Time = 35 × 0.85 = 29.75 hours

b. 4th Pool Time = 29.75 × 0.85 = 25.29 hours

21. Bid Using *OM Explorer*

Time for first unit	35
Unit number	5
Time for unit 5	24.02
Cumulative average time per unit	28.22

The 5th pool should take just over 24 hours, with the cumulative average time for all five pools being 28.2 hours. Total Time = (28.2)(5) = 141 hours. The learning curve follows.



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22. Rain Tite

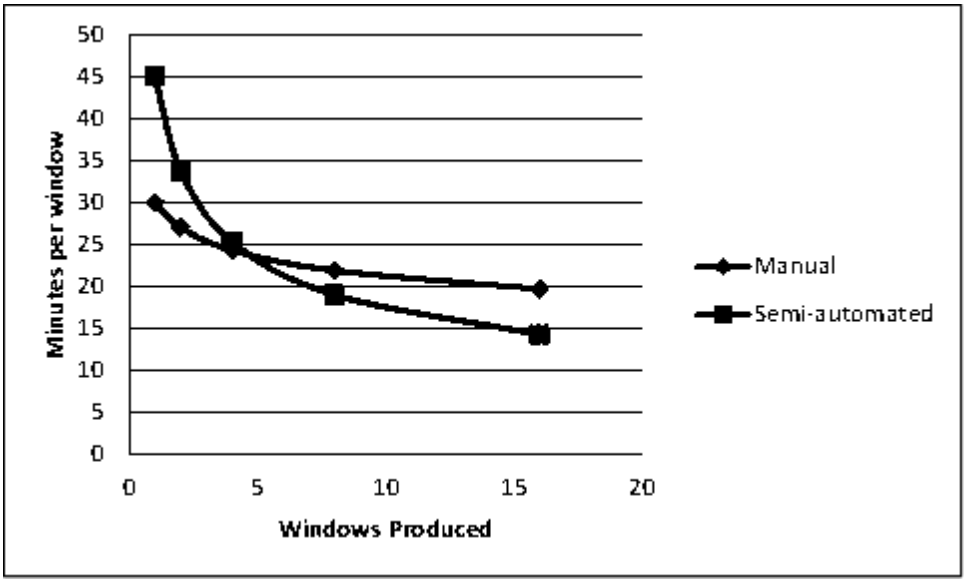
a. Production time on the manual line

1st window = 30 minutes
2nd window = 30 x .90 = 27.00 minutes
4th window = 27 x .90 = 24.30 minutes
8th window = 24.3 x .90 = 21.87 minutes
16th window = 21.87 x .90 = 19.68 minutes

b. Production time on the semi-automated line

1st window = 45 minutes
2nd window = 45 x .75 = 33.75 minutes
4th window = 33.75 x .75 = 25.31 minutes
8th window = 25.31 x .75 = 18.98 minutes
16th window = 18.98 x .75 = 14.24 minutes

As displayed in the graph below, after 4 windows produced, the employee on the semi-automated line will be able to build a window more quickly than an employee on the manual line.



23. Perrotti's Pizza Pareto chart

a. Although the frequency of partly eaten pizza is low, it is a serious quality problem because it is deliberate rather than accidental. It is likely to cause extreme loss of goodwill. A common root cause of many of these problems could be miscommunication between the customer and the order taker, between the order taker and production and between production and distribution. This chart was created using *the Bar, Pareto, and Line Charts Solver of OM Explorer*.

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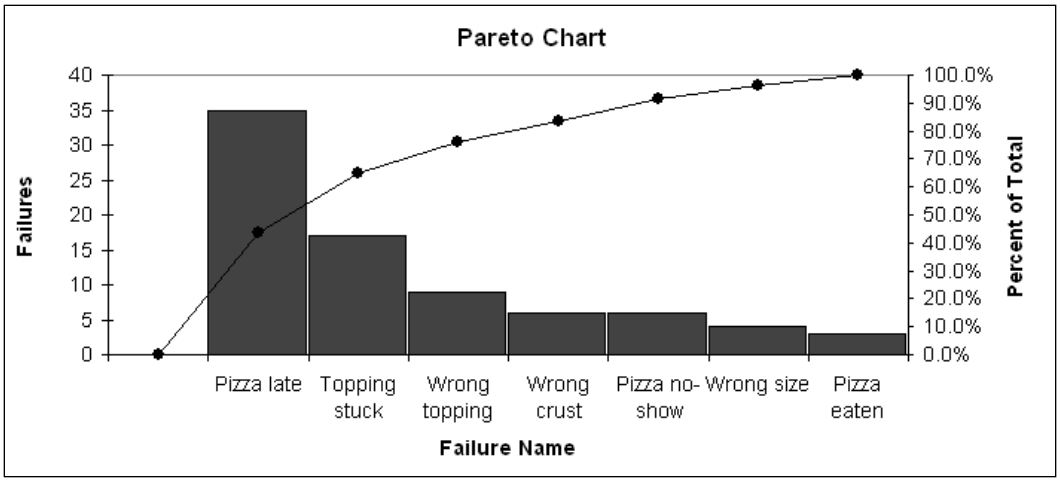
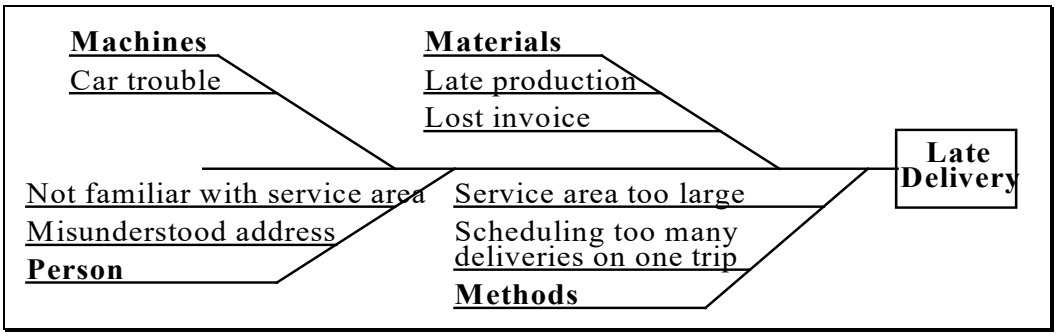


b. Cause-and-effect diagram



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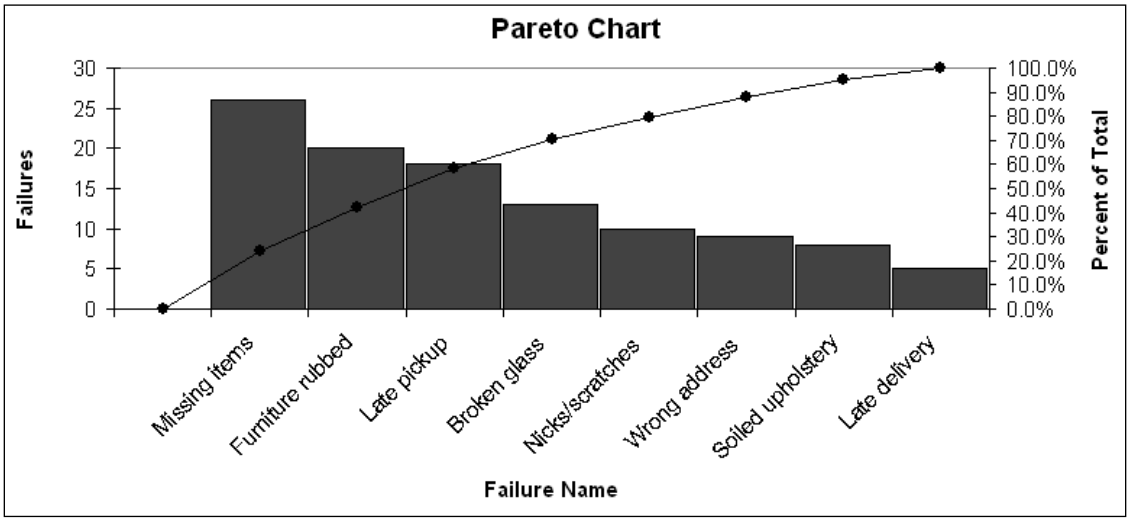
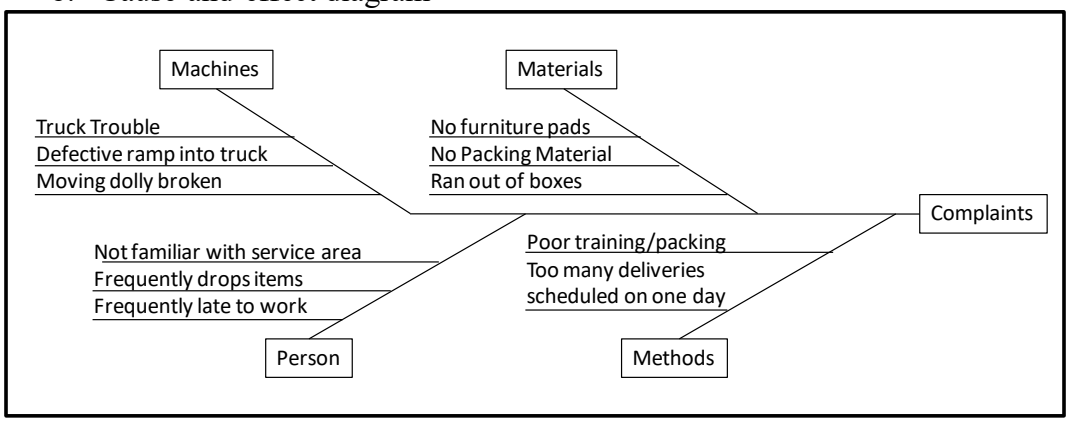
24. Smith, Schroeder, and Torn (short moves)
    a. The tally sheet given in the problem is essentially a horizontal bar chart. To create a Pareto diagram, the categories are arranged in order of decreasing frequency. This diagram was created using *the Bar, Pareto, and Line Charts Solver of OM Explorer*.



    b. Cause-and-effect diagram



25. Golden Valley Bank
    a. Bar chart, from *the Bar, Pareto, and Line Charts Solver of OM Explorer*.

$$\text{average} = \frac{(8\times8)+(19\times11)+(28\times14)+(10\times17)+(25\times20)+(4\times23)+(10\times26)}{104}$$

$$= 16.2 \text{ hours}$$

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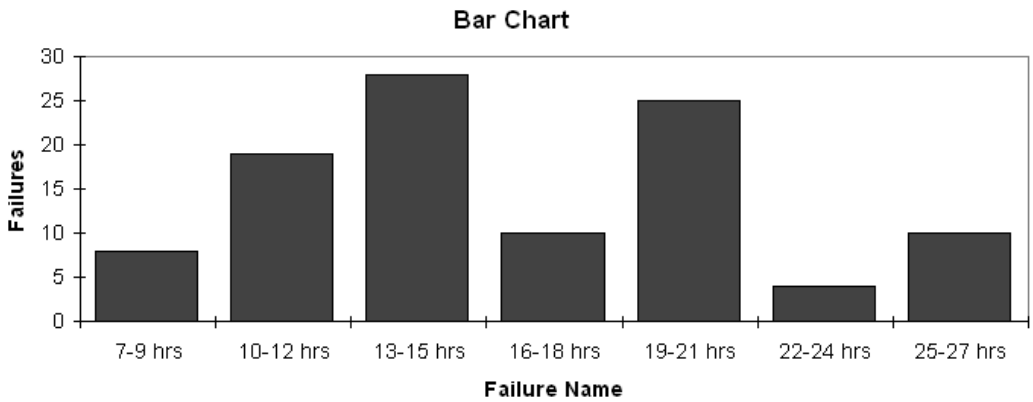
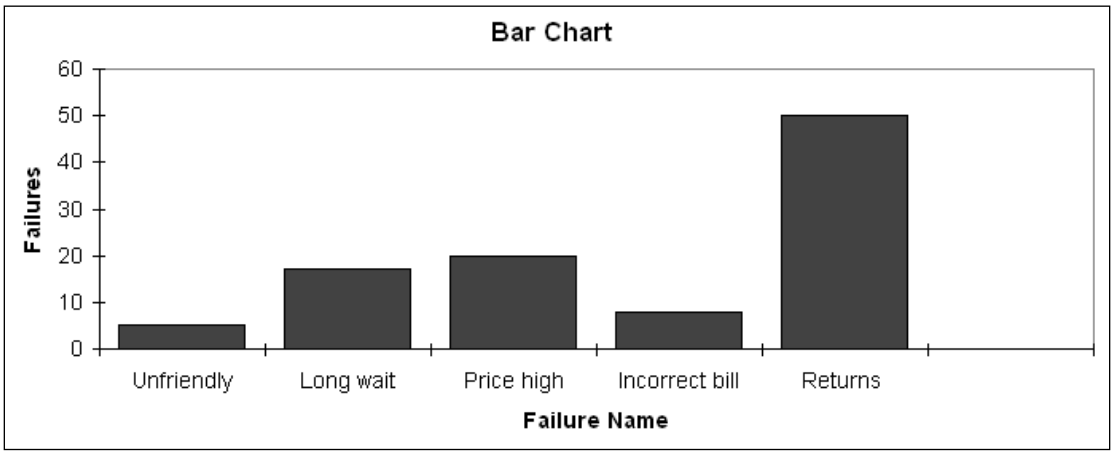


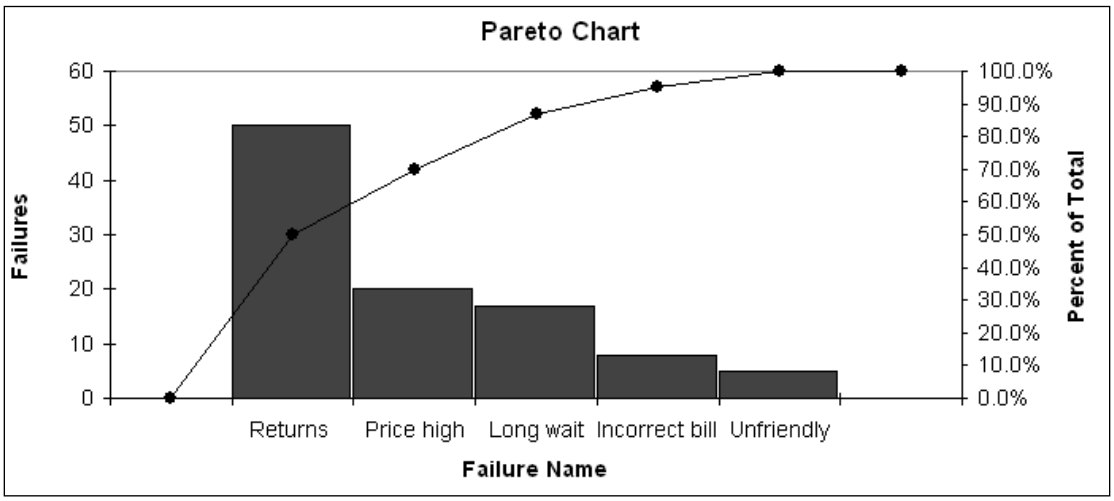
b. Golden Valley's average time is 16.2 hours or about two business days. However, 39 of 104 customers waited longer than 18 "business hours." DeNeefe should first investigate the 14 applications that required more than 22 hours to find causes of long delays.

26. East Woods Ford

a. Bar chart, from *the Bar, Pareto, and Line Charts Solver of OM Explorer*.



Pareto chart, from *the Bar, Pareto, and Line Charts Solver of OM Explorer*..



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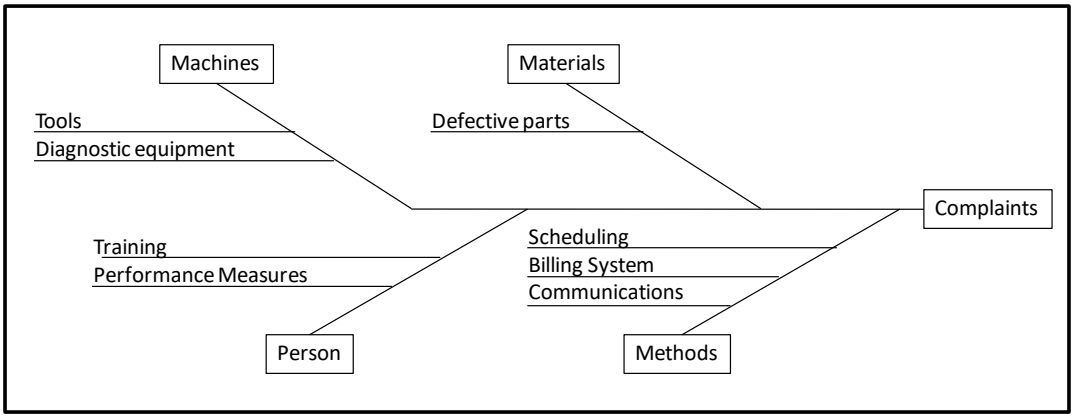
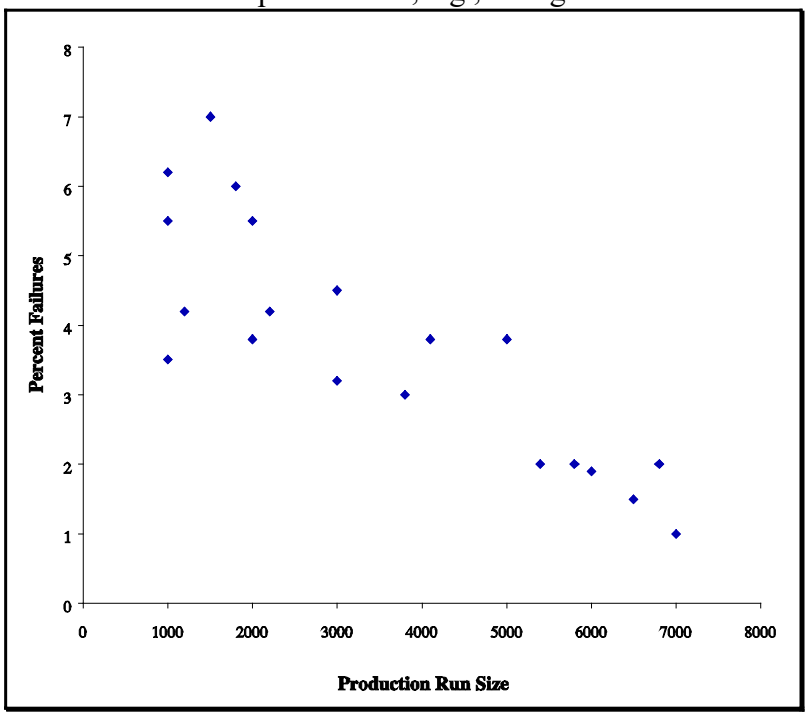
b. Cause-and-effect diagram drawn using PowerPoint.



27. Oregon Fiber Board
    a. Scatter diagram (see following)
    b. As the production run size increases, the percent of failures decreases. Should schedule large runs when possible and determine what causes smaller runs to be problematic, e.g., changeover issues.



28. Grindwell, Inc.
a. Scatter diagram

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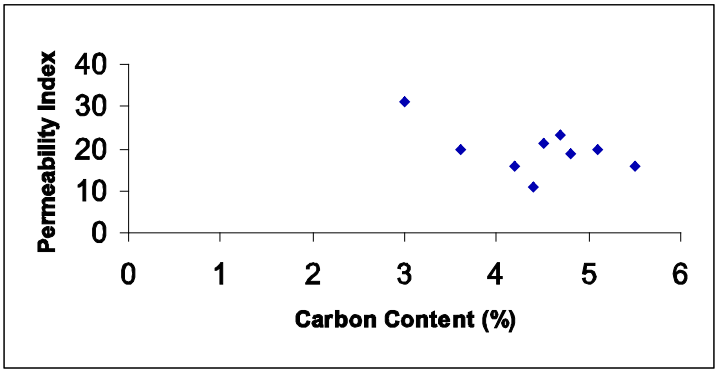
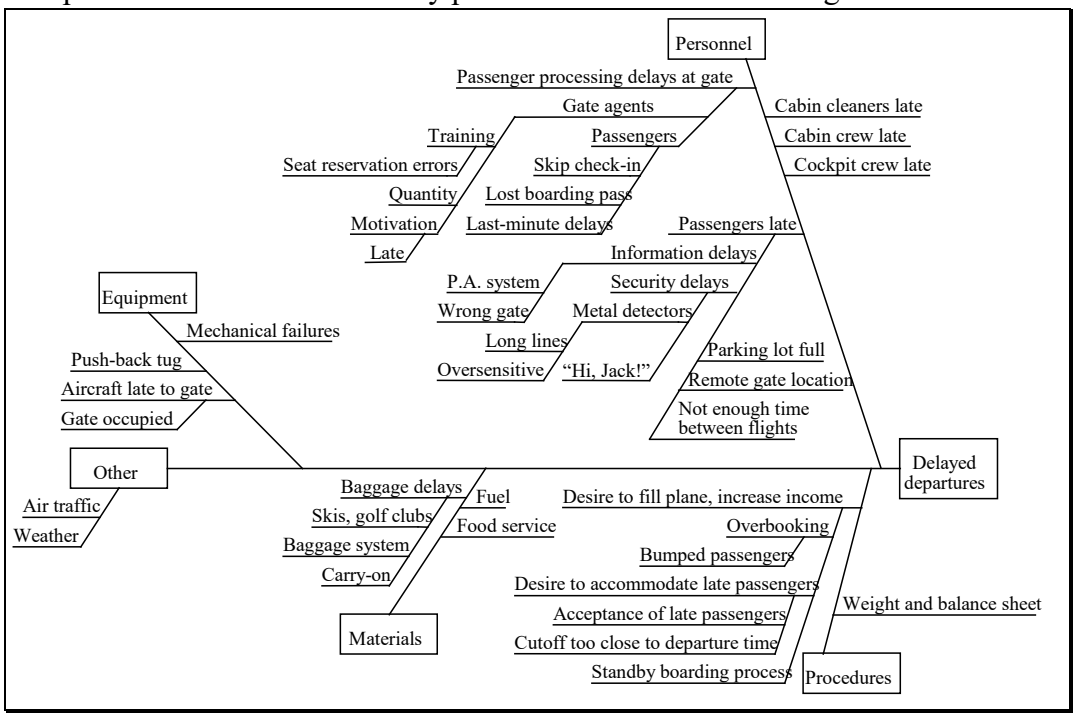


b. Correlation coefficient $\rho = -0.547$. There is a negative relationship between permeability and carbon content, although it is not too strong.
c. Carbon content must be increased to reduce permeability index.

29. Superfast Airlines. One of many possible cause-and-effect diagrams follows.



30. Plastomer, Inc.

Type of Failure	Amount of Scrap (lb)	Percent of Total Amount
1. Air bubbles	500	0.7%
2. Bubble breaks	19,650	29.3%
3. Carbon content	150	0.2%
4. Unevenness	3,810	5.7%
5. Gauge/Thickness	27,600	41.1%
6. Opacity	450	0.7%
7. Scratches	3,840	5.7%
8. Trim	500	0.7%
9 Wrinkles	10,650	15.9%
Totals	67,150	100.0%

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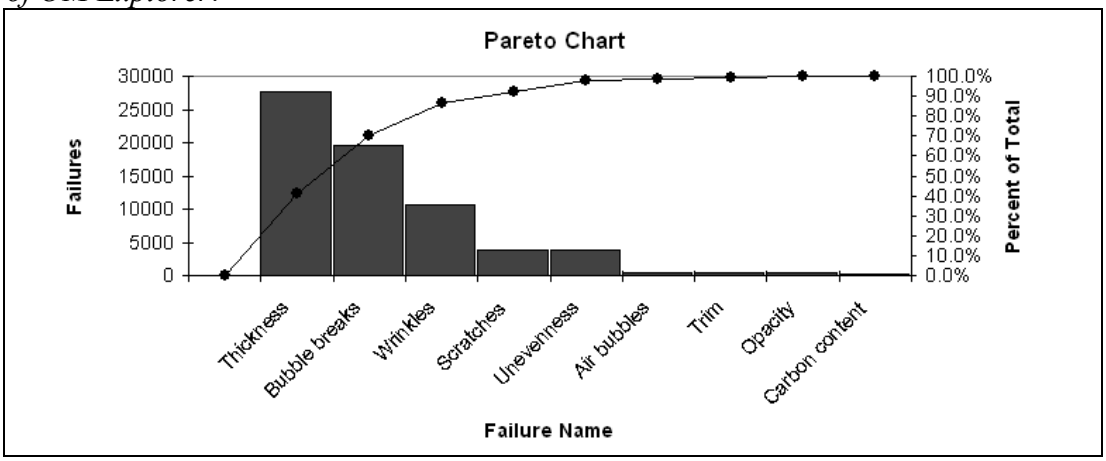
The following Pareto chart was created using *the Bar, Pareto, and Line Charts Solver of OM Explorer*.



Management should attempt to improve the "thickness/gauge" problem first.

31. Shampoo bottling company
    a. The tally of data into cells will be as follows.

Cell Number	Cell Boundaries	Tally	Frequency
1	12.65 up to 12.85	||||	4
2	12.85 up to 13.05	|||| |||	8
3	13.05 up to 13.25	|||| ||||	9
4	13.25 up to 13.45	|||| ||||	9
5	13.45 up to 13.65	|||| |||| |	11
6	13.65 up to 13.85	|||| |||| ||	12
7	13.85 up to 14.05	|||| |||| |||| |	16
8	14.05 up to 14.25	|||| |||| |	11
9	14.25 up to 14.45	|||| ||||	10
10	14.45 up to 14.65	|||| |||	8
11	14.65 up to 14.85	||	2

    b. 4% of the bottles filled by the machine will be out of specification;4% are below the lower limit, and none are above the upper limit. NOTE: If you turn the table 90 degrees counterclockwise, the tallies create a histogram.

32. Team exercise on shaving
    a. One possible solution would look like this:

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Process: Shaving

Subject: Man

Beginning: Remove tools

Ending: Clear area

Insert Step

Append Step

Remove Step

Summary

Activity	Number of Steps	Time (min)	Distance (ft)
Operation ●	4	6.20	
Transport ➡	4	0.50	20
Inspect ■	1	0.50	
Delay ◗	9	9.00	
Store ▼	--	0.00	

Step No.	Time (min)	Distance (ft)	●	➡	■	◗	▼	Step Description
1	0.10	5		X				Remove shaving bowl and soap from cabinet
2	0.10	5		X				Remove brush from cabinet
3	0.10					X		Turn warm water faucet on
4	3.00					X		Hold hand under faucet until water is warm
5	1.00					X		Create shaving lather with brush & warm water
6	1.00		X					Apply shaving lather to face
7	0.10					X		Plug sink
8	3.00					X		Turn faucet off when sink is half full
9	0.10	5		X				Remove razor from cabinet
10	0.50					X		Insert new razor blade
11	0.10		X					Draw blade across face
12	0.10					X		Rinse blade in sink
13	5.00		X					Repeat steps 11-12 until face clear of stubble
14	0.50				X			Inspect face
15	0.20					X		Thoroughly rinse razor
16	0.10		X					Dry face with towel
17	0.20	5		X				Return tools to cabinent
18	1.00					X		Unplug sink, drain completely, and clear area

Additional comments (students may have slightly different observations): After Step 2, he "walks back to sink"; Steps 3-4 and 7 & 8 are operations; The Delay step between 7 & 8 is "Wait for sink to half fill"; Between Steps 8 & 9 he "walks over to cabinet" to remove the razor (unless he gets it at Step 1 or 2) and he needs to "walk back to sink" to unplug and clean.

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b. Some ideas generated from brainstorming the process:

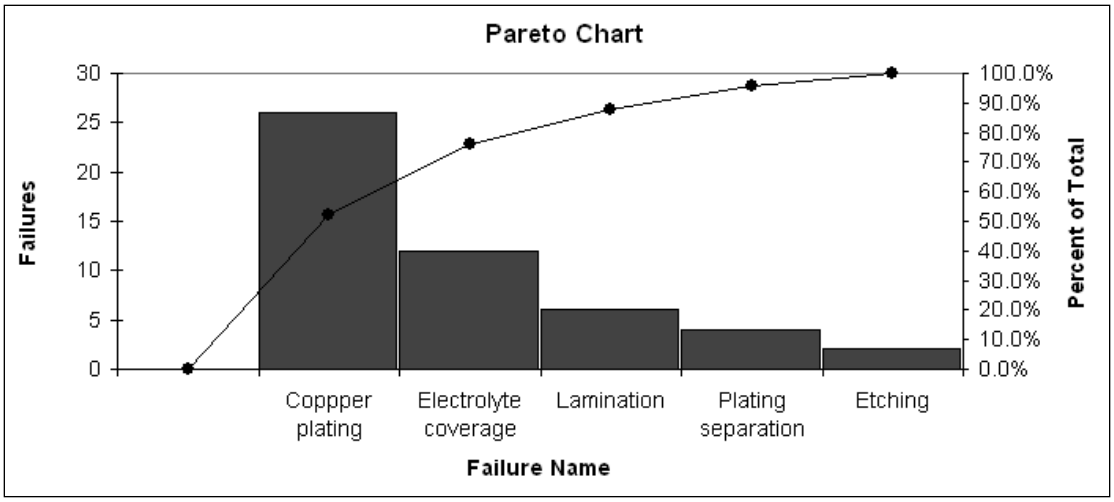
1. Leave bowl, soap, razor, and brush on the counter.
2. Turn water on first.
3. Buy new water heater so water warms faster.
4. Use shaving cream or gel.
5. Shave in the shower.
6. Plug sink before turning water on.
7. Run water while shaving instead of plugging and filling sink.
8. Fill sink one-fourth full instead of half full.
9. Use disposable razor or electric razor.
10. Replace razor every other day.
11. Grow a mustache, beard, or goatee to reduce shaving time.
12. Go to a barber.
13. Let face air dry.
14. Use cold water.
15. Do not inspect the face but shave accurately the first time.
16. Shave every other day.
17. Don't rinse blade each time.

33. Conner Company

a. Tally sheet

Type of Failure	Tally	Number of Rejected Boards
A. Poor electrolyte coverage	𝍸 𝍸 𝍷	12
B. Lamination problems	𝍸 𝍷	6
C. Low copper plating	𝍸 𝍸 𝍸 𝍸 𝍸 𝍷	26
D. Plating separation	𝍸	4
E. Etching problems	𝍷	2
Total	50	50

b. Pareto chart, from OM Explorer.



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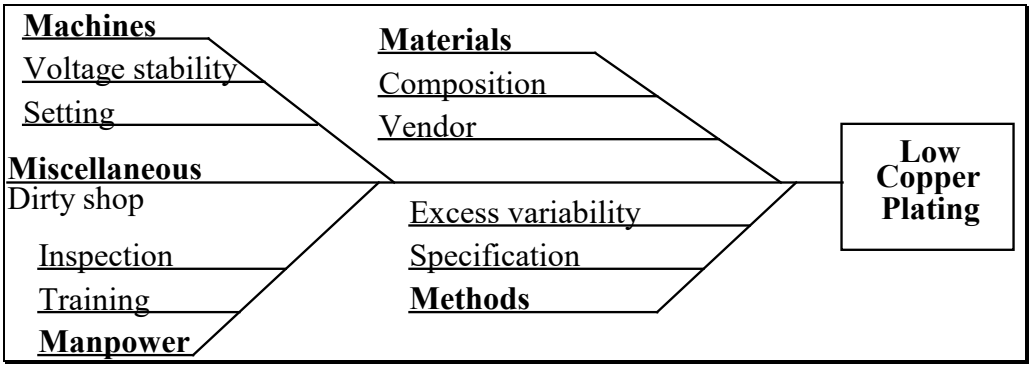
c. Cause-and-effect diagram (Note: several alternative ideas are possible here.)



CASE : CUSTOM MOLDS, INC. *

A. Synopsis

Custom Molds, Inc. is a small fabricator of custom-designed molds that are used in injection molding machines to make plastic parts. Its major customers are in the electronics industry where large volumes of plastic connectors are used. The company has recently noticed a shift in its market as the total demand for molds has declined, but the requests for molded parts have increased. In response to this shift, Custom Molds, Inc. has expanded its operations to include the manufacture of plastic parts. The case provides students with the opportunity to analyze the different processes associated with mold fabrication and parts production and to discuss the interaction between process management decisions and competitive priorities.

B. Purpose

The purpose of this case is to focus the student on issues relating to process strategy and to discuss how decisions involving process structure, customer involvement, resource flexibility, and capital intensity interact with different competitive priorities. Students need to resolve what it will take to compete effectively in each of Custom Molds' markets and how best to configure its processes. One needs to consider specific issues:

1. There are two distinctly different processes taking place in the same facility. The students should diagram each process (see flowcharts in Chapter 2) and compare/contrast the strengths and weaknesses of each.

* This case was prepared by Dr. Brooke Saladin, Wake Forecast Univeristy, as a basis for classroom discussion.

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2. The different processes serve different customer needs. Mold fabrication requires flexibility and quality where parts manufacturing competes on delivery and low cost. The margin for parts is much smaller.
3. Although the number of orders has remained relatively stable, the volume per order for **parts** has increased significantly over the last three years. This increase has caused bottlenecks in the shop and has led to late deliveries of parts.
4. The change in sales mix has created excess capacity in mold fabrication, and the owner has relegated one of the master machinists to the role of expediter.

C. Analysis

Students should begin their analysis by examining the market trend data in the two tables in the case. These data clearly show that although the number of orders received over the three-year period for molds has remained constant, the total number of molds fabricated has shown a declining trend: 722 in 2018, 684 in 2019, and 591 in 2020. With 13 master machinists employed, mold fabrication capacity can be estimated at

$$13 \text{ machinists} \times 250 \text{ days/year} \div 5 \text{ days/mold}$$
$$\text{or } 650 \text{ molds fabricated/year}$$

Another way to look at the excess capacity question is that each master machinist working 250 days per year, averaging five days' processing time per mold fabricated, can produce 50 molds per year. At a current demand rate of 591, only 12 master machinists are required.

As an aside, note that the regular-time capacity of 650 molds per year was actually insufficient to handle the demand in 2018 and 2019. Presumably overtime was used in these earlier years to make up the shortfall, although not stated in the case. At this point the changing sales mix not only alleviated any earlier capacity shortage, but created enough excess capacity now that Tom Miller reassigned one of the master machinists to an expediting function.

Parts manufacturing, however, shows the opposite trend. The number of orders has actually declined a bit but the total of parts processed has risen drastically over three years: 47,200 in 2018, 67,150 in 2019, and 114,850 in 2020. Although data are not provided on the processing times of individual parts, we can see that the order sizes are getting much larger. This trend has most likely caused bottlenecks at the injection molding operation, because the operations both before and after the injection machine take only one or two days to complete. Therefore, the late deliveries that customers are complaining about are probably due to molds being delayed or orders waiting for the injection machines. Delays and time pressures may also be contributing to quality problems as operators hurry to process orders.

The analysis should then determine the process flow in diagrams of each step. This will enable students to see where time and resources are being consumed. These flows can be compared to the layout block plan in Figure 2.21 to get an idea of the material flows in the plant.

In the final phase of the analysis, students should discuss the strengths and weaknesses of each process and relate these to the different competitive priorities needed to compete in each market.

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Mold Fabrication	Parts Manufacturing
Job process	Line process
High customer contact	Less-skilled labor
High-skilled labor	More capital intensive
Divergent processes	Less-divergent process

The mold fabrication market requires a great deal of flexibility in order to design and custom-make molds to meet customer requirements. Quality is also very important in meeting demanding specifications. Short delivery times are less critical, as the design phase, working closely with the customer, can be lengthy. Costs are also a secondary consideration, as the cost of the mold is typically a minor component of the customer's overall cost of manufacturing.

Custom Molds, Inc. has expanded into the manufacturing of plastic parts. Parts manufacturing is a higher-volume, cost-sensitive market. Parts are needed in a timely manner to keep customer production processes running. Volume flexibility becomes more important than product flexibility. So students should be able to see that the company has exposed itself to a different set of competitive priorities.

D. Recommendations

At this stage, early in an operations management course, specific recommendations will be difficult for students and should not be the primary focus. The instructor should look for general recommendations concerning: (1) capacity decisions and the allocation of production resources; (2) the possible orientation toward either molds fabrication or parts manufacturing; and (3) the physical separation and focusing of each distinct process. A sample student response to the discussion questions that follow will give (Exhibit TN.1) some idea of what to expect from a student in an introductory course in operations and supply chain management course.

E. Teaching Strategy

This case is designed to be used early in the course. A primary focus is to expose the students to the concept of flowcharting processes and using the flowcharts to analyze the strengths and weaknesses of the processes. A second focus is to show the students the impact that process choice decisions have on the ability of the company to compete on different competitive priorities.

For best results the instructor should assign this case as a homework assignment. Students should come to class prepared to share their process flow diagrams. The discussion then can pretty much follow the discussion questions at the end of the case. First make sure the students realize the company faces capacity issues brought about by the expansion into parts manufacturing. Then move to the analysis of the flowcharts. As students begin to see the strengths and limitations of each process, you can then move on to a discussion of the interaction between market-required competitive priorities and differing process characteristics.

This case can easily take a full 50- or 75-five-minute class if students share their flowcharts and the instructor has the class as a group develop the two flowcharts on the board. This, however, is a good exercise for students to be involved in, as they learn that flowcharts for even seemingly simple processes may be more difficult to develop than they thought.

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EXHIBIT TN.1 Custom Molds, Inc. Student Responses

Question 1

The Millers face a changing market environment for their two product lines—molds and plastic parts—a problem that they must address. The mold market is in the mature phase. Though the number of mold orders is constant, the average number of molds per orders is decreasing. This information may imply that customers are letting Custom Molds prototype the mold design, but they are then fabricating the molds in-house once they validate the design. The plastic parts market is in a growth phase, at least from the Millers' perspective. The plastic parts market shows a sizable increase in average order size. This market shift is causing the Millers' problems on the shop floor as the company shifts from mold production to plastic parts production.

Question 2

The market shift from molds to plastic parts impacts Custom Molds because of the different production process required for each product. Mold production is a job process environment with only a limited number of molds manufactured per order. This process requires highly trained and skilled workers to manufacture the molds. Plastic parts production is primarily a batch process, with characteristics of a line process, which produces small runs of similar products. Unlike mold production, the skill level of the labor is not as high. However, both products are made to order, so there are similarities between the two, especially in terms of production scheduling.

Quality, product design, and flexibility are important competitive priorities for the molds. Price and delivery are competitive factors but only as order qualifiers, not order winners. For the plastic parts, delivery and price are more important; quality and flexibility become order qualifiers. The importance of maintaining the delivery schedule has caused many of the problems with Custom Molds production.

Both production processes at Custom Molds have a great deal of slack time. For example, the company schedules two to four weeks for fabrication of molds although it takes only three to five days to make the mold. For molds, these delays are not a major factor. For plastic parts, production time for 500 parts is four days' mixing, molding, trimming, inspecting, packing, and shipping. With assembly, the parts require an additional three days. Generally the company waits one week for the compounds to arrive and one week lead time before producing the molds. This provides a tight schedule for the company to meet the three-week lead time for plastic parts order promising.

Question 3

Alternatives for the Millers are as follows:

1. They can shift their focus to plastic parts production. This will require increasing the space dedicated to plastic parts production or adding additional space. This will also require a move away from the expediting mentality. The use of skilled machinists to expedite parts is a waste of resources. It is likely that the delays are due to a combination of expedited orders that slow regular orders and limited capacity. This choice will require commitment to expand resources and maintain delivery reliability. In addition, the company will need to recognize the increased importance of price competition.
2. They can move back to the focus on molds. However, this requires moving against the apparent trend in the industry. This strategy will require Custom Molds to take business away from competitors in order to grow the business. Price competition may become the primary factor in industry competition. However, it is unlikely they can profitably increase their business if they follow this strategy.

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CASE: JOSÉ'S AUTHENTIC MEXICAN RESTAURANT *

A. Synopsis

José's Authentic Mexican Restaurant is a small, independently owned local restaurant. Ivan, the waiter, has noticed a significant reduction in the size of tips, leading him to concerns about the quality of the food and service. The characteristics of the restaurant and the process that takes place in the restaurant are described following. Students are asked to think of the characteristics of this environment that define quality to the various players, identify the implied costs of quality, and apply some of the analysis tools provided in the text.

B. Purpose

This case provides a scenario to which students can relate. Nearly every student has eaten at a small ethnic restaurant, and you can count on their collective experience to flesh out the unspoken issues presented in the case. There is sufficient description of the process to spark considerable discussion as to how the nature of the process (and the internal customer chain) interacts with the external customer's perception of quality. The students need to develop definitions and measures of quality from several perspectives and then think of how to integrate these different views. A discussion of the restaurant's management has been purposefully excluded from this case so that the students can freely devise the interventions that should be taken to improve quality at José's.

C. Discussion

1. The first question, asking how quality is defined, is designed to get students to think of defining quality from the perspective of the various players. At a minimum, the students should be able to describe the external customers as the patrons (diners) and the internal customer chain as the cook and wait staff. Other expansions may be offered as well (hostess, management, busboys, other kitchen staff, suppliers, community, etc.). A partial list of factors is presented below. No doubt, your students will come up with many more characteristics that can be used to define quality.
   A. To the external customers (the diners), quality is defined by their expectations. The case does not explicitly describe all of the following but much may be inferred by the students based on their experiences with restaurants. The customers can expect any or all of the following:
      1. Location and access (to be in a reasonably safe, aesthetically acceptable location, to be within walking distance, have adequate parking, be served by public or other transportation).
      2. Ambiance. The appearance of the facility should fit its place and purpose.
      3. Appropriate recognition on arrival (greeted by the hostess, apprised of any wait, seated in an acceptable location).
      4. Pleasant and attentive interaction with the wait staff (a greeting shortly after being seated, orders taken when *they* are ready, well-paced delivery of food items, periodic checks for additional needs, the bill presented when *they* are

* This case was prepared by Dr. Larry Meile, Boston College, as a basis for classroom discussion.

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ready). Of course, determining the specific desires of each party is a particular challenge that must be met by the waiter. Do they want to speedily complete the meal and be on their way? Or, do they prefer a leisurely paced repast? Is the party in the mood for some light banter from the waiter or do they prefer to be left alone? This may be the quality characteristic over which Ivan has the most control.

5. Good-tasting food served in an appealing fashion (taste, temperature, portion, presentation). This characteristic, if held constant, is probably most important for first-time patrons. Repeat patrons already know what they are in for.
6. Conformance to regulatory agency guidelines. If the restaurant is open, it is assumed that it has been inspected and passed by the appropriate regulatory agencies.
7. Value. The combination of all the preceding when price is factored in.

B. To the cook, an internal customer, quality is largely related to the work environment.
   1. The raw materials are available when needed, are fresh and tasty, have good appearance, are easy to prepare (perhaps even have some of the nasty tasks already completed—like prepeeled potatoes), and are consistent from purchase to purchase.
   2. The equipment is properly suited for the task, performs reliably (e.g., the oven is always at 350° when the dial is set to 350), is easy to use, and is laid out effectively.
   3. The environment is satisfactory; it is well lit and temperature controlled, coworkers and management offer respect, work load is reasonably level (ideally there is no mealtime rush to contend with), working hours are acceptable, wages and benefits are competitive, salary is paid on time.

C. To Ivan (also an internal customer), quality also relates to the workplace environment.
   1. The quality of the finished goods (the meals). The meal is the one described in the menu, it is of adequate portion, it is produced in a timely fashion, it tastes good, and it has a pleasant appearance.
   2. The serving equipment is appropriate, functional, and clean. The dishes, cups, glasses, tableware are clean and appropriate for the purpose. The tablecloth and seating area are clean and orderly. The waitstation has the appropriate equipment (coffeemaker, ice and water dispenser, etc.)
   3. The environment provides a place in which it is pleasant to work (many of the same issues as the cook, listed earlier).

D. To the restaurant's management, quality is primarily related to the firm's image (in addition to the personal working environment issues faced by all employees).
   1. The restaurant's reputation in the community: viewed as an asset to the community, a community supporter, a source of gainful employment, a nonpolluter, a good neighbor.
   2. The restaurant's image in the eye of the consumer (diner): all of the customer's quality issues mentioned previously are met.

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3. The restaurant's image with governmental agencies: the health department finds little fault with its operation, fire codes are met, appropriate security measures have been taken, taxes are paid in full and on time.

Quality definitions can also be discussed by category:

- ❑ Customer-driven definitions of quality
- ❑ Conformance to specifications—food (weight, appearance, congruent with menu description), preparation time, meeting health regulations.
- ❑ Value—customers feel that the food, service, and ambiance are worth the price.
- ❑ Fitness for use—customers leave feeling well fed. Dietary concerns are met (low fat, low sodium, etc. where appropriate)
- ❑ Support (recovery from failure)—if something is not satisfactory, how is it rectified (issue recognized, apology offered, items quickly replaced, substitutes offered, bill adjusted, etc.)?
- ❑ Psychological impressions—the feeling the diner gets based on the atmosphere of the restaurant, the interactions with the staff, and the characteristics of the food.

2. Question two asks the students to list some of the costs of poor quality. Although specific values cannot be placed on them, conceptual sources of costs can be identified. Note that these can be viewed from the restaurant's perspective and from Ivan's perspective, and by shifting the view, the interventions (and costs) change. A short list of possible actions and costs is provided following:

A. Prevention:

Restaurant:	Purchase better food stock (dollars). Reject and reorder sub par supplies (time)
	Set (and meet) food preparation standards (time)
Ivan:	Cull out poorly prepared meals; ask for replacements (time)

B. Appraisal:

Restaurant:	Inspect incoming food stock (time)
	Survey
Ivan:	Inspect meals prepared by the cook (time)

C. Internal failure:

Restaurant:	Replace (or rework) rejected meals (time, dollars)
Ivan:	Help the cook get an order out faster (time)

D. External failure:

Restaurant:	Unsatisfactory customer experience (dollars)
Ivan:	Poor-quality meal to be served to customer (dollars)

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3. Four of the quality tools are appropriate for Question Three. Checklists are already done. Results of the customer satisfaction survey are shown in the case. From this list a histogram or bar chart of the customer complaints can be made (see ExhibitTN.1) and a Pareto chart ranking them in importance can be constructed (see Exhibit TN.2). It may be useful to ask the students if the survey results include all José's customers. The concept of nonresponse bias can be brought forth. Maybe long-time satisfied customers figure if nothing is wrong, no reply is needed. Maybe disgusted customers are so put out that they don't even want to take the time to help rectify the situation. They will simply vote with their feet and not return. Also note that the data collected clusters the results from both first-time and returning customers. Point out to the students that a great deal of information may be lost by not reporting these results separately.

   Also ask the students about what information was *not* captured when a negative response was given to any of the customer survey questions. If they were not seated promptly, how long did they wait? If the waiter was not satisfactory, what was lacking? If the food was not enjoyable, what was the problem? Finally, if the dining experience was not worth the cost, what needs to be changed?

   A cause-and-effect (fishbone) diagram (see Exhibit TN.3) can be constructed from the results of the survey, the information given in the text of the case, and some assumptions about the behavior of the restaurant (as suggested by the students from their dining experiences).

D. Recommendations

Although no specific recommendations are called for, the students should be pressed to think of what Ivan can do to improve his situation. The concept of employee involvement (one of the elements of the TQM Wheel) can be discussed here. This case provides a reverse view of the material discussed in the chapter. The chapter talks of management's challenge in establishing appropriate cultural change (including awareness of the voice of the customer, advocating the concept of an internal customer chain, and quality at the source), promoting individual development, and creating effective awards and incentives. All of these issues can be viewed from Ivan's perspective and point out the frustrations experienced by employees if good quality management is not practiced.

E. Teaching Suggestions

It is effective to ask the students to read this case before the discussion of the material in the chapter. The case then can act as a common situation that can be used when lecturing on the various quality topics. As the topics addressed by the questions at the end of the case are covered by lecture, the students can be asked to respond to them as part of the classroom discussion.

If the case is used after the chapter material has been covered, it can be used as a cold-call case or it can be assigned for preparation before discussion in class. If prior preparation is done, it may be effective to have the students answer the questions by themselves and then meet as small groups to consolidate their ideas.

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When discussing the costs of poor quality, it may be useful to provide a table for the students on the board or on an overhead transparency listing the four costs and providing two columns, one for the restaurant and one for Ivan as follows:

	Restaurant	**Ivan**
Prevention		
Appraisal		
Internal failure		
External failure		

Possible points for discussion (those points in italics are covered in the preceding discussion):

- *Customer-driven definitions of quality*
  - *Conformance to specifications*
  - *Value*
  - *Fitness for use*
  - *Support (recovery from failure)*
  - *Psychological Impressions*
- Quality as a competitive weapon
- Employee involvement
- Customer definition
  - External
  - Internal
- Continuous improvement
- Plan-do-act-check cycle
- *Costs of poor quality*
  - *Prevention*
  - *Appraisal*
  - *Internal failure*
  - *External failure*
- Improvement through TQM
- Benchmarking (Not done within the case but the concept could be discussed.)
- Product/service design
- Reliability
- *Tools for improving quality*
  - *Checklists (customer satisfaction survey)*
  - *Histograms/bar charts*
  - *Pareto charts*
  - *Cause-and-effect (fishbone) diagram*

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EXHIBIT TN.1	A Bar Chart of the Customer Complaints from the Customer Satisfaction Survey Shown in the Case

Were you seated promptly?	Yes	70		No	13
Was your waiter satisfactory?	Yes	73		No	10
Were you served in a reasonable time?	Yes	58		No	25
Was your food enjoyable?	Yes	72		No	11
Was your dining experience worth the cost?	Yes	67		No	16

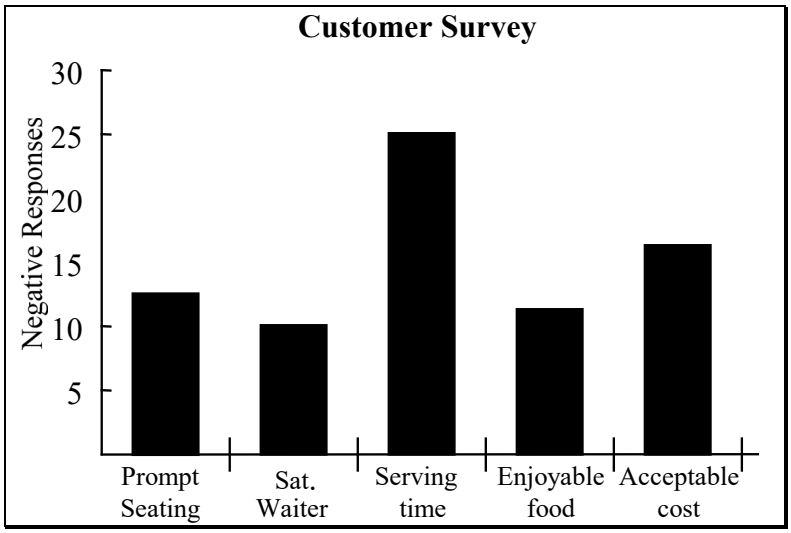

EXHIBIT TN.2	A Pareto Chart Ranking Customer Complaints

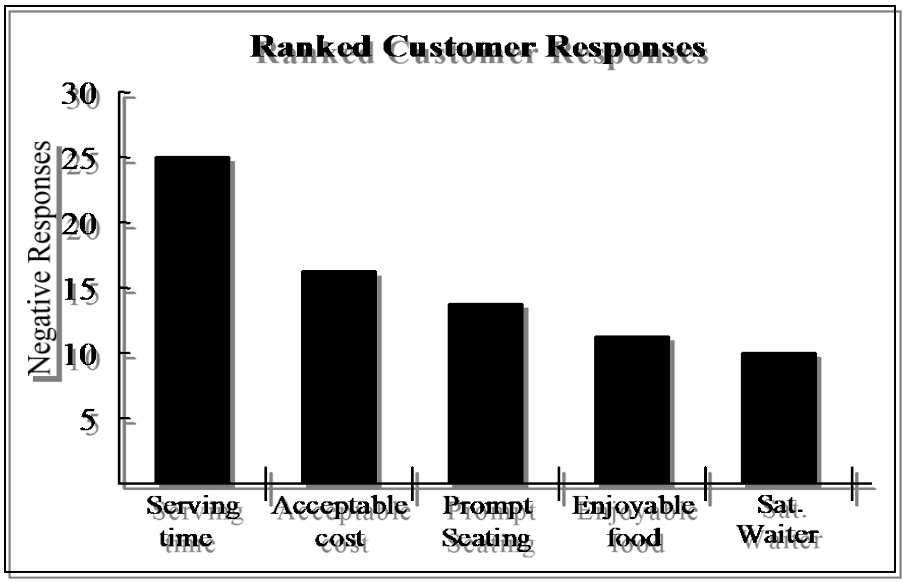

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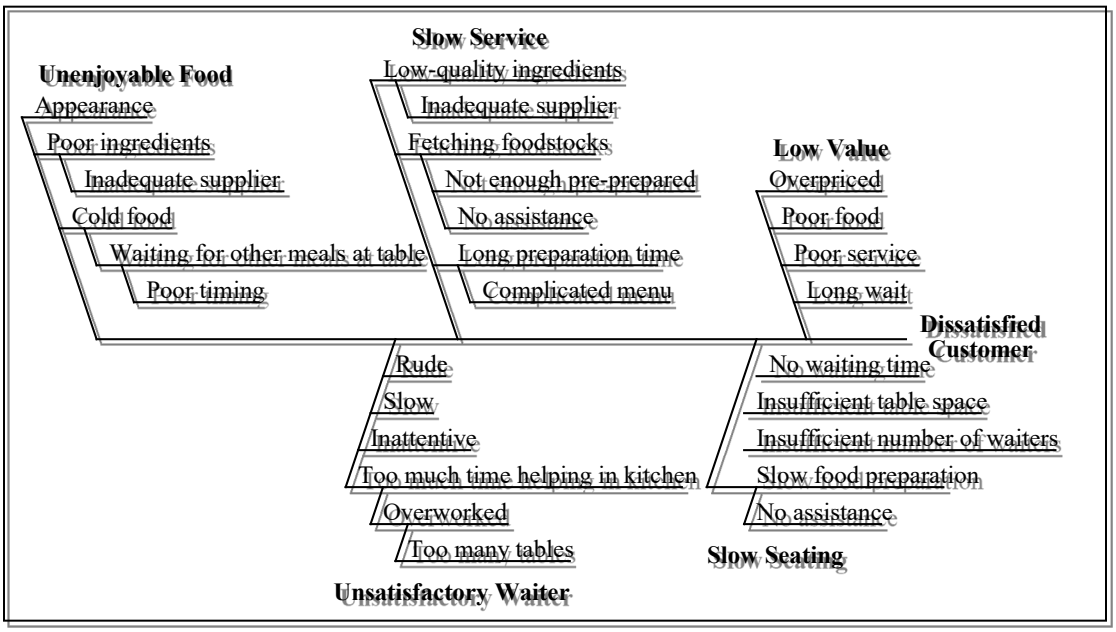
EXHIBIT TN.3	A Possible Cause-and-Effect (Fishbone) Diagram



Alternate survey:
1 = Completely Satisfied; 5 = Extremely Dissatisfied

How satisfied were you with	Customer survey results (Number of replies to each response option)				
	1	2	3	4	5
Promptness of seating	129	63	19	14	9
Service of your waiter	134	56	31	0	14
Speed of service	110	45	40	9	31
Enjoyability of food	122	52	31	16	14
Price of dinner	129	71	19	2	14

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VIDEO CASE: Process Strategy and Analysis at Cleveland Clinic

Length: xx:xx

Subject: Process Strategy and Analysis at Cleveland Clinic

Textbook Reference: Chapter 2: Process Strategy and Analysis, page 100

A. Synopsis

Cleveland Clinic is an outstanding research and teaching hospital headquartered in Ohio with over 260 facilities located throughout the United States. The Inventory Management Transformation team performed work flow analysis using Six Sigma Process Improvement concepts to analyze the management of medical supplies along with the workflows and clinical time required in the surgery department. The team interviewed front line employees involved in the department and mapped the travel activities routinely performed in their duties. The activities were separated into value added and non-value added groups, the latter of which were targeted for elimination. Improved workflows and the hire of dedicated supply chain workers has returned over 22,000 hours of labor back to trained nursing staff to use in patient care. The project also provides for periodic automatic adjustment of inventory levels to set stocking levels and focused attention on managing the perishable supplies. This reorganization gave the supply chain organization the opportunity to optimize stocking levels, saving the organization over $2 million in 2019 alone.

B. Purpose

The purpose of this case is to illustrate the application of process analysis and improvement tools like flow charts, time studies, and process charts, and the define-measure-analyze cycle. The clinic's results clearly demonstrate how a rigorous analysis of work methods can optimize a process that probably evolved organically over time and was wasteful of material and valuable clinical nursing labor. With the ongoing nursing shortage and increased demand forcasted due to an aging population, the hiring of dedicated supply chain workers to replace nursing labor for these tasks also illustrates strategies for change.

C. Analysis

A side by side comparison of the existing stocking location activity and the redesigned process illustrates the elimination of a significant amount of transportation and potential confusion. Both current and future flows traverse three floors of the hospital out of necessity, but the reduction in separate flow paths (from 27 to 6) and roles conducting those trips (from six to one) means that not only are fewer steps required, but the possibility for confusion has been reduced. Each time one function hands responsibility or material off to another, there is a chance for a mistake or miscommunication. By expanding the inventory coordinator role to cover all transportation and storage, the Cleveland Clinic has created a single point of contact to determine the status of needed supplies.

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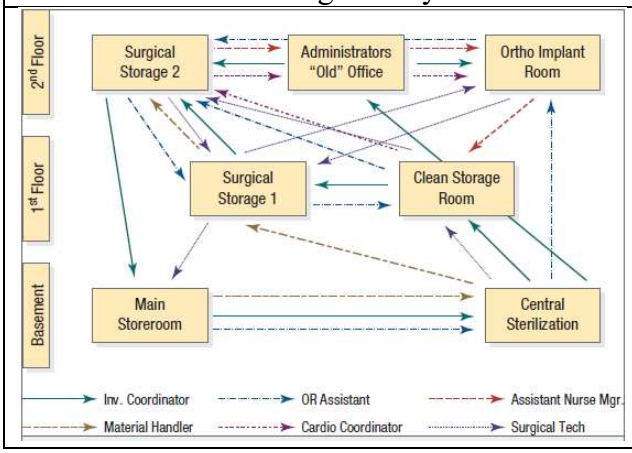
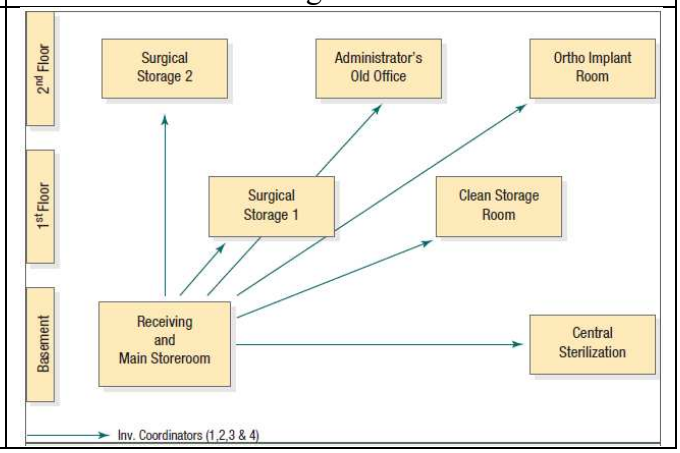
Current state of stocking activity	Future state of stocking
	

D. Recommendations

1. In addition to the time and motion study the Cleveland Clinic followed, what other work measurement techniques might have been used? Why?

The work measurement techniques discussed in the chapter are the time study, the elemental standard data method, the predetermined data method, work sampling method, and learning curve analysis.

From the case, it is apparent that Cleveland Clinic conducted work sampling; the chart on page 101 shows various job titles and the amount of FTEs spent on materials duties. Work sampling is a technique that estimates the percentage of time spent by people or machines on different activities based on randomized observations over time. In this application, Cleveland Clinic might have used as few as three categories for job activity – clinical duties, materials duties, and travel time. Their objective would have been to cut materials duties and travel time out as much as possible out of the clinician's day.

Cleveland Clinic may have used a swim lane flowcharts to organize their thinking about the issues. The swim lane flow chart parses process flow into departments responsible for each step. During the initial flowchart phase of the analysis, the improvement team might have constructed a basic flow chart detailing the process steps in maintaining surgical supplies. If they had then separated those process steps into rows dedicated to the materials management function and the nursing function, it would have been a dramatic reveal of the misallocation of labor.

The case does not mention learning curve analysis, however Cleveland Clinic undoubtedly reaped the benefits of learning effects when responsibility for the daily surgical item inventory shifted from clinical personnel to the materials management team. Items that clinicians would recognize at a glance in a cabinet drawer would have initially taken a while for a material handler to recognize. Through sheer repetition, the material handler would be able to take inventory as quickly and accurately as it was done before.

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It is unlikely that Cleveland Clinic employed the predetermined data method or the elemental standard data method. The motions described in the case are not well-suited for these approaches. The service blueprint is also not mentioned in the case and likely would have been of little value in this analysis as customer contact is not at issue in this process.

2. Which data analysis tools and metrics might have been used to quantify what the project team observed in the daily travel workflow?

The data analysis tools and metrics discussed in the chapter are the checklist, histograms and bar charts, Pareto charts, scatter diagrams, cause and effect diagrams, and graphs.

Once Cleveland Clinic performed their work sampling study, a number of graphical techniques could be used to display and document the current state as well as the new design. Cleveland Clinic's improvement team may have used Pareto charts and bar charts to show the percentage of time spent in each activity category for different job functions.

Once the job was redesigned, scatter charts or line charts could display the time required each day to take inventory of the surgical supplies or count mistakes.

Cause and effect diagrams are typically used to find root causes of problematic effects, but Cleveland Clinic might have used them to determine the necessary elements to achieve a desired state. So rather than troubleshooting, they might have had an outcome of "nursing staff time devoted 100% to patient care" and then questioned and brainstormed ideas to make that happen, categorizing them into the six M's.

3. After reviewing the various process strategy and analysis techniques in this chapter, what else could Cleveland Clinic do to make the Six Sigma process improvement project even more effective?

One technique that was not mentioned in the case is benchmarking. Cleveland Clinic might have engaged in some process benchmarking with other industries to uncover best practices, particularly in the stocking of the items needed for surgical procedures. For many years, manufacturers have used a process called kitting where materials management workers stock a small container with all the parts, and sometimes even specialized tools, that a line worker needs to perform a specific task. This enables the line worker, for example, a skilled (and well compensated) airframe mechanic, to remain in place with their hands on the product rather than making a lengthy trip to the parts department and the tool crib to check out a tool. The kit is delivered to the line at the right time and in the right place, which has the effect of increasing the capacity of the mechanic. Cleveland Clinic's solution is the same approach, borne out through their own investigation.

The case does not explicitly discuss the Implementing phase (pp. 82-3) of improvements but their success suggests that they avoided a great many of these mistakes. The activities indicated in the case suggest that this was a one-time initiative, focused on returning nursing hours directly to patient care. The seventh mistake as discussed in the text is not creating an infrastructure for continuous improvement – this is possibly the one element lacking in Cleveland Clinic's approach. They have indeed achieved their initial objective;

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the case reports that they have not reduced costs. Perhaps a continuous improvement mindset would enable them to consider approaches to reducing costs in this process.

E. Teaching Strategy

The instructor could use the case to motivate discussion of the tools and techniques at the introduction of the material, but the case is probably best used as a chapter ending exercise.

One suggestion is to assign students to look up classified listings on Monster.com or Jobs.com to see the typical pay and demand for all the positions shown in the stocking activity flowchart. Then, using the hourly pay or annual salary figures from these sources, calculate the value of the 22,000 clinical hours saved based on a 2000 hours/year standard. Estimating benefits at 30% of salary makes the savings Cleveland Clinic achieved even more impressive.

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ADDITIONAL CASE IN MyLab Operations Management

CASE:THE FACILITIES MAINTENANCE PROBLEM AT MIDWEST UNIVERSITY *

A. Synopsis

This case describes the problems facing a medium-sized university, Midwest University, as it tries to maintain 60 buildings on campus. The specific problem is slow response time in completing work-order requests. The facilities maintenance area is organized, structured, and scheduled around skilled craft areas. The issue facing Sean Allen, manager of the facilities area, is how to organize and manage his personnel to reduce this poor response time.

B. Purpose

The focus of this case is to highlight the importance that job design plays in the delivery of a quality service package. As it now stands, the facilities maintenance area at Midwest University is organized around craft functions, in much the same way most traditional organizations are organized around finance, marketing, and operations. The problem is that the processes necessary to provide a quality service require coordination and integration across the skilled crafts. This leads to the necessity of redesigning the way work is to be completed. The issues of job design brought out in the case include:

1. Movement from a vertical organizational structure to a multicraft team-oriented, horizontal organization
2. Use of enlargement, rotation, and enrichment as jobs are redesigned
3. Training requirements necessary to support the new job designs
4. Measuring the performance of the new organizational structure and providing appropriate recognition

C. Analysis

The analysis and class discussion should begin by focusing on the issue of why facilities maintenance is providing such poor response times to work-order requests. Students who have ever lived on campus will readily identify with this problem. Five- to ten-day lead times for work requests that, for the most part, take less than one hour do seem a little absurd. The analysis of the problem should focus on the key factors that contribute to this poor performance. Students should quickly be able to identify the following three factors:

1. The difficulty in prioritizing work-order requests across both crafts and buildings for scheduling purposes
2. The frequent need to involve more than one craft in order to complete the work-order request
3. The geographical dispersion of 60 different buildings that need to be maintained

* This case was prepared by Dr. Brooke Saladin, Wake Forest University, as a basis for classroom discussion.

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As the problem-identification discussion continues, students may add other factors to these three. The instructor's job here is to bring the students to the realization that the top-down scheduling of work-order requests across crafts and 60 different buildings is a very complex and integrative process. Students should begin to realize that poor lead-time performance is actually a symptom of a much larger problem, that is, the conflicts that are present by having a "functional silo" orientation to job design when the performance of the job to meet customer requirements calls for a multidisciplinary team approach. The rest of the analysis should focus on the seven key elements of job design for horizontal organizations:

1. *Organize around processes:* Ask students to identify the core processes that are critical to the success of the facilities maintenance area. Key processes identified should include:
   - ❑ Order receipt and processing
   - ❑ Work scheduling and dispatching
   - ❑ Physical maintenance and repair
2. *Flatten the organizational hierarchy:* Supervision can be reduced by breaking down the "functional craft silos" and the inherent managerial redundancy created by each craft managing itself.
3. *Teams manage the organization:* Teams can be organized around the core processes identified in point #1. Another factor to consider is the geographical dispersion of the buildings on campus. Teams could be organized not only as multicraft maintenance and repair groups but also around specific geographical areas of the campus. Teams could then receive, schedule, and repair their own work requests over a designated number of buildings. This would push responsibility through to the teams and help alleviate the problem of travel across campus.
4. *Customers drive performance:* By having teams assigned to specific buildings, relationships that would enhance the teams' knowledge of customer requirements could be developed. Specific measures of customer satisfaction would need to be developed.
5. *Management rewards team per performance:* This structure naturally leads to cross-training opportunities for which team members could be rewarded. Other measures, such as number of work requests completed per time period, average time to complete a work request, and customer satisfaction index ranking, need to be established to evaluate the performance of the team as a whole.
6. *Supplies and customer contact:* Geographical assignments will help foster customer contact. This decentralization may, however, remove the teams from maintenance and repair suppliers.

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7. *Training programs for all employees:* Training should not only include the opportunity for cross-craft skill training but should also look at communication, team building, process improvement, problem solving, and administrative skills.

D. Recommendations

The instructor should focus the students on looking at the "big picture" in making recommendations with respect to job design. Students should address the issue of moving toward a horizontal organization and away from the traditional, vertically oriented craft silos. Their recommendations should encompass each of the seven key factors of job design.

As a side note, the manager of facilities maintenance actually created cross-functional craft teams and assigned these teams to specific areas of the campus. Individual teams were responsible for scheduling and completing work within their own assigned geographical area. The custodial staff was also integrated into the team, which helped in planning and completing routine maintenance. The teams were able to become familiar with both their "customers" and the individual needs of the buildings in their area. Response times have been drastically reduced, with 50% of the requests getting same-day service and 80% of the work-order requests getting next-day service. Large requests that exceed the resources of an individual team are still coordinated by the main office.

E. Teaching Strategy

This is a short cold-call case that is positioned to get students thinking about the impact job design has on an organization's ability to satisfy customer needs. Students should draw not only from the material on teams in Chapter 5, "Quality and Performance", but also from the concepts in Chapter 3, "Process Strategy".

If you like using groups, this case can be effectively discussed by breaking the class into groups and giving them 15 to 20 minutes to brainstorm alternative approaches to reducing the response time to work-order requests. Then get them back together and go around to each group for a report on what they brainstormed, putting each group's responses on the board. Compare and contrast the similarities and differences in each group's approach.

The instructor should take the last 10 to 15 minutes to categorize the group's responses on the board with respect to the major concepts of the chapter. Indicate which alternatives focus on each of the seven key factors of job design; which responses deal with enlargement, rotation, or enrichment; which focus on the development of standards, training needs, or incentive plans. By doing this summary, the instructor has the opportunity to tie the concepts of job design together into an integrated whole. You can conclude by describing briefly what actually happened as presented in the recommendation section.

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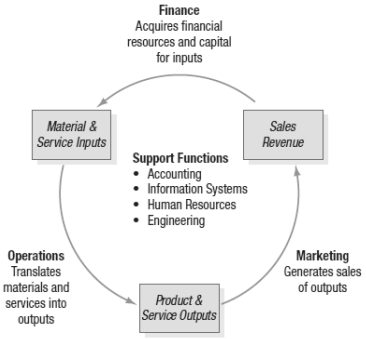
Chapter 1 Using Operations to Create Value

Course Introduction

1. What is Operations Management (OM) and why do we study it?



2. What is the primary goal of this textbook?

3. Define Process

4. Define OM in terms of one of several functions within an organization

5. Define supply chain management

1. Role of Operations in an Organization

1. Operations serve as an excellent career path to upper management positions in many organizations because operations managers are responsible for key decisions that affect the success of the organization.
2. Operations is one of several functions within an organization.

   a.

   b.

3. Historical Evolution and Perspectives

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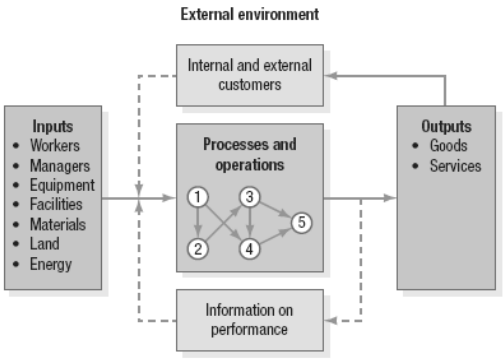
2. A Process View

1. Describe how processes work



2. What are nested processes?

3. What are the two major processes?

   a. How do they differ?

   b. How are they similar?

3. A Supply Chain View

1. Define a value chain in terms of the types of processes:

2. Core processes

3. Support processes

4. Adding value with process innovation in supply chains

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4. Operations Strategy

1. Define Operations strategy

2. Define Corporate strategy

   a. Environmental scanning

   b. Developing core competencies

   c. Developing core processes

   d. Developing global strategies

3. Market analysis

   a. Market segmentation

   b. Needs assessment

      -
      -
      -
      -

5. Competitive Priorities and Capabilities

1. Competitive priorities

2. Competitive capabilities

Dimension	Definition	Example
Low-cost operations		
Top quality		
Consistent quality		

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Delivery speed		
On-time delivery		
Development speed		
Customization		
Variety		
Volume flexibility		

a.

3. Order winners

4. Order qualifiers

5. Using competitive priorities: an airline example (two market segments: first-class passengers and coach passengers)
   a. Customer relationships

   b. New service development

   c. Order fulfillment

   d. Supplier relationship

6. Identifying gaps between competitive priorities and capabilities

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6. Trends and Challenges in Operations Management

1. Productivity improvement
   a. Productivity formula

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

   b. Two approaches for productivity measures

Labor Productivity

Multifactor Productivity

Application problem

	This Yr.	**Last Yr.**	**Year Before Last**
Factory unit sales ($)	2,762,103	2,475,738	2,175,447
Employment (hrs)	112,000	113,000	115,000
Sales of manufactured products ($)	$49,363	$40,831	—
Total manufacturing cost of sales ($)	$39,000	$33,000	—

- Calculate the year-to-year labor productivity.

	This Yr.	**Last Yr.**	**Year Before Last**
$\frac{factory\ \ unit\ \ sales}{employment}$			

- Calculate the multifactor productivity.

	This Yr.	**Last Yr.**
$\frac{sales\ \ of\ \ mfg\ \ products}{total\ \ mfg\ \ cost}$		

2. Global competition

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a. Firms can increase their market penetration by locating in foreign countries.

b. Five developments have stimulated the need for sound global strategies.

(1)

(2)

(3)

(4)

(5)

c. Comparative cost advantages

What role does China play in globalization today?

What role does India play?

d. Disadvantages of globalization

(1)

(2)

(3)

3. Ethical, workforce diversity and environmental issues

7. Fourth Industrial Revolution (Industry 4.0)

Fourth industrial revolution

a.

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b.

2. The Internet of Things

   a. Operations Management Applications

   b. Concerns and Barriers

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Chapter 2 Process Strategy and Analysis

1. Processes are everywhere, in all functional areas of the enterprise.

2. Managers must see to it that processes in all departments are adding as much customer value as possible.

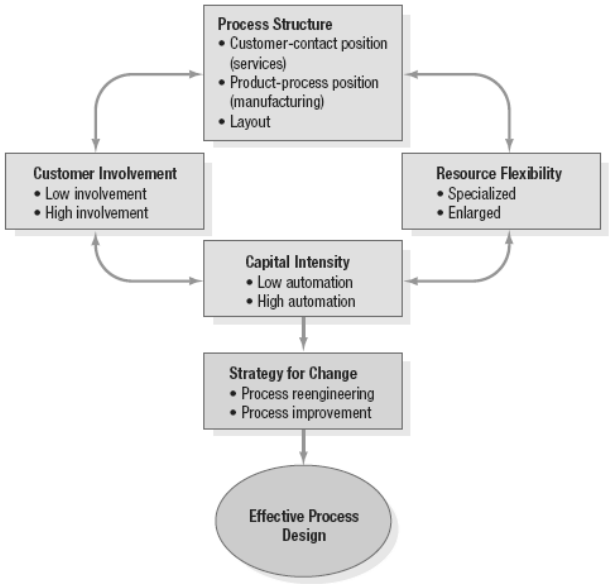
3. Two basic strategies
   a. Process Engineering

   b. Process improvement

4. Three important principles concerning process strategy
   a.

   b.

   c.



5. Four common process decisions

   a.

   b.

   c.

   d.

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1. Process Structure in Services

1. Describe the nature of service processes

2. Dimensions of customer contact

    a. Physical presence

    b. What is processed

    c. Contact intensity

    d. Personal attention

    e. The method of delivery used in contact

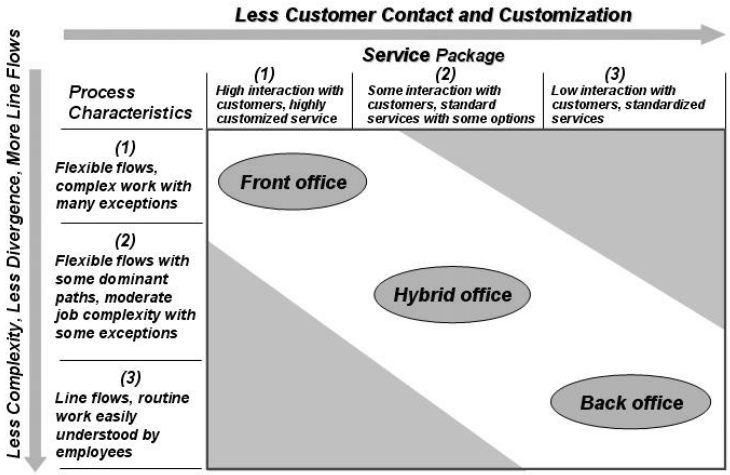
3. Elements of customer-contact matrix (fitting service process with customer contact)
    a. Customer contact and customization

    b. Process divergence, and flow

4. Service process structuring (three process structures forming a continuum)

    a. Front office:

    b. Hybrid office:



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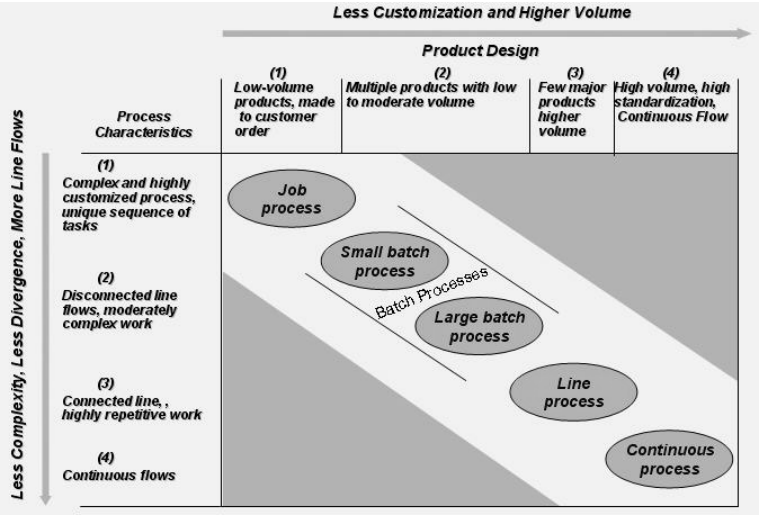
c. Back office:

2. Process Structure in Manufacturing

Manufacturing processes convert materials into goods that have a physical form.

1. Elements of product-process matrix (how manufacturing processes relate to volume)
   a.
   b.
   c.

2. Manufacturing process structuring (four process choices, forming a continuum)
   a. Job process:
   b. Batch process:
   c. Line process:
   d. Continuous flow process:



3. Production and Inventories
   a. Design-to-Order Strategy
   b. Make-to-order strategy
   c. Assemble-to-order strategy

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d. Make-to-stock strategy

4. Layout

a. Layout:

b. Operation:

3. Process Strategy Decisions

1. Customer Involvement

a. Possible advantages

b. Possible disadvantages

c. Emerging technologies

2. Resource Flexibility: managers must account for process divergence and diverse process flows.

a. Workforce

b. Equipment

c. **Application 2.1: Break-Even Analysis in Process Choice**

BBC is deciding whether to weld bicycle frames manually or to purchase a welding robot. If welded manually, investment costs for equipment are only $10,000. The per-unit cost of manually welding a bicycle frame is $50.00 per frame. On the other hand, a robot capable of performing the same work costs $400,000. Robot operating costs including support labor are $20.00 per frame. At what volume would BBC be indifferent to these alternative methods?

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	If welded manually (Make)	**If welded by robot (Buy)**
Fixed costs	$10,000	$400,000
Variable costs	$50	$20

$$Q = \frac{F_m - F_b}{c_b - c_m} =$$

3. Capital Intensity: is the mix of equipment and human skills in the process; the greater the relative cost of equipment, the greater is the capital intensity.
   a. Automating manufacturing processes
      - Advantage:
      - Disadvantages:
   b. Automating service processes
   c. Economies of Scope: Requires a family of products having enough collective volume to utilize equipment fully

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4. Strategic Fit

The process strategist should understand how the four major process decisions tie together.

1. Decision patterns for service processes
   a.

   b.

   c.

   d.

2. Decision patterns for manufacturing processes
   a.

   b.

   c.

   d.

3. Gaining focus

5. Strategies for Change

1. Process reengineering

2. Process improvement

3. Process Analysis
   a. Six Sigma Process Improvement Model: employees must be trained in the "whys" and the "how-tos" of process performance and what it means to customers, both internal and external
      - Define:

      - Measure:

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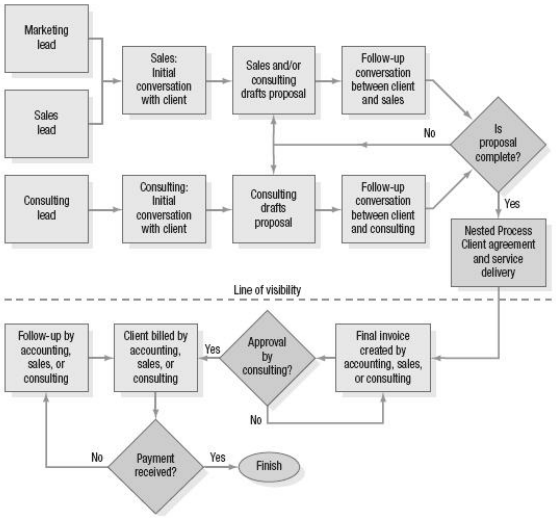
- Analyze:

- Improve:

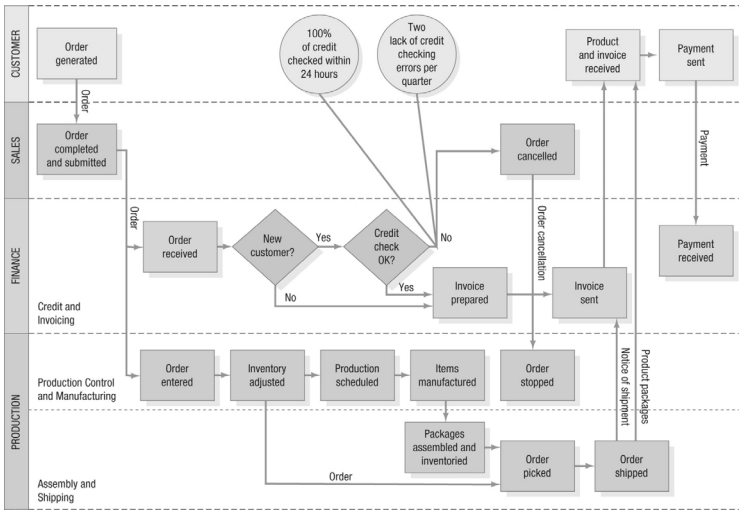
- Control:

6. Defining, Measuring, and Analyzing the Process

1. Flowcharts



a. Swim lane flowcharts



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b. Service blueprints

2. Work Measurement techniques

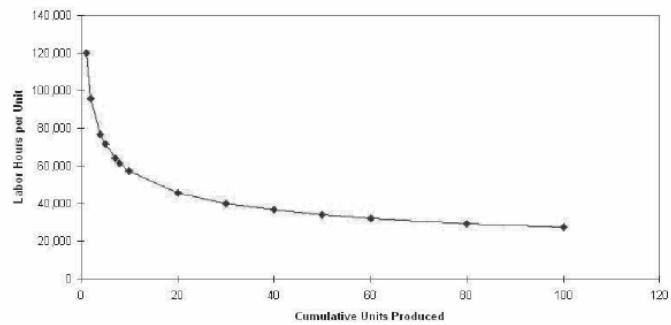
a. Time study methods

b. Elemental standard data approach

c. Predetermined data approach

d. Work sampling method

e. Learning curve analysis



3. Process Charts

a. Purpose

b. Possible categories

c. Estimate the annual cost of the entire process

Process: *Emergency room admission*
Subject: *Ankle injury patient*
Beginning: *Enter emergency room*
Ending: *Leave hospital*

Insert Step
Append Step
Remove Step

Summary

Activity		Number of steps	Time (min)	Distance (ft)
Operation	●	5	23	—
Transport	➡	9	11	815
Inspect	■	2	8	—
Delay	◗	3	8	—
Store	▼	—	—	—

Step no.	Time (min)	Distance (ft)	●	➡	■	◗	▼	Step description
1	0.50	15		X				Enter emergency room, approach patient window
2	10.0	-	X					Sit down and fill out patient history
3	0.75	40		X				Nurse escorts patient to ER triage room
4	3.00	-			X			Nurse inspects injury
5	0.75	40		X				Return to waiting room
6	1.00	-				X		Wait for available bed
7	1.00	60		X				Go to ER bed
8	4.00	-				X		Wait for doctor
9	5.00	-			X			Doctor inspects injury and questions patient
10	2.00	200		X				Nurse takes patient to radiology
11	3.00	-	X					Technician x-rays patient
12	2.00	200		X				Return to bed in ER
13	3.00	-				X		Wait for doctor to return
14	2.00	-	X					Doctor provides diagnosis and advice
15	1.00	60		X				Return to emergency entrance area
16	4.00	-	X					Check out
17	2.00	180		X				Walk to pharmacy
18	4.00	-	X					Pick up prescription
19	1.00	20		X				Leave the building

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4. Data analysis tools

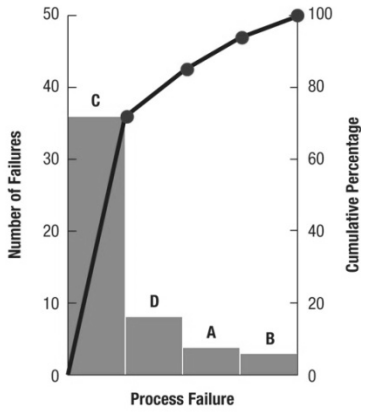
a. Checklists

Step 1. Checklist

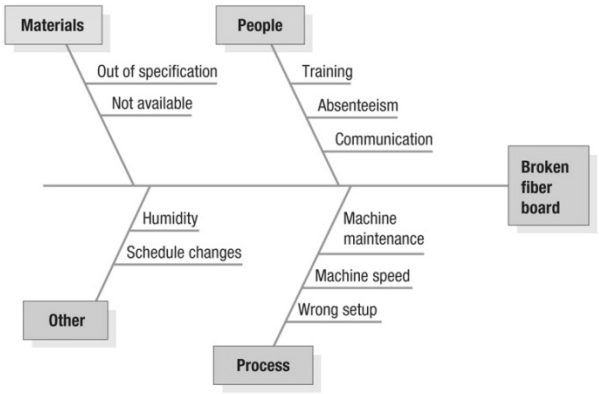
Headliner failures

Process failure	Tally	Total
A. Tears in fabric	IIII	4
B. Discolored fabric	III	3
C. Broken fiber board	~~IIII~~ ~~IIII~~ ~~IIII~~ ~~IIII~~ ~~IIII~~ ~~IIII~~ ~~IIII~~ I	36
D. Ragged edges	~~IIII~~ II	7
		Total 50

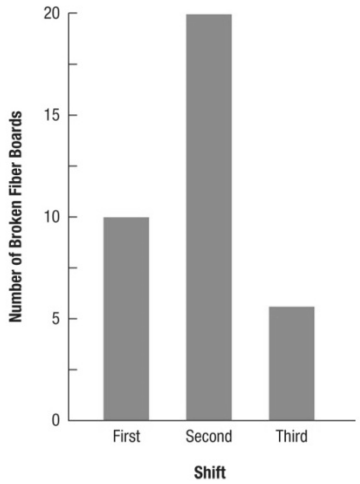
Step 2. Pareto Chart



Step 3. Cause-and-Effect Diagram



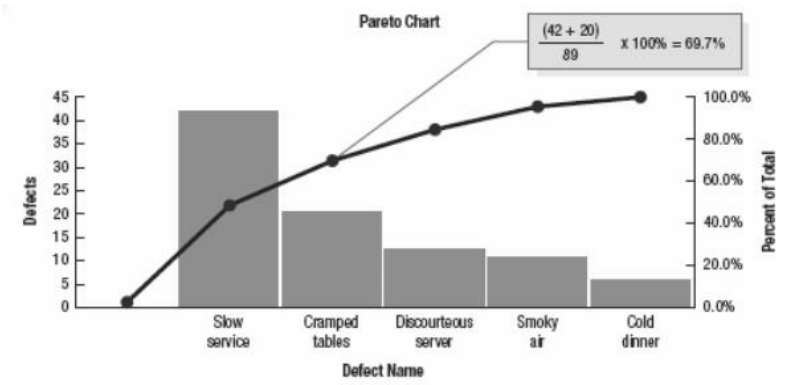
Step 4. Bar Chart



b. Histograms and bar charts

c. Pareto charts

Example 2.2



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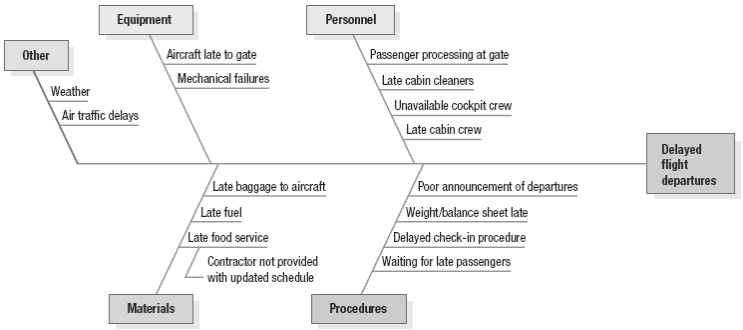
d. Scatter diagrams

e. Cause-and-effect diagram

Example 2.3



f. Graphs

5. Data snooping

6. Simulation

7. Redesigning and Managing Process Improvements

1. Generating ideas: questioning and brainstorming

   ask six questions about each step in the process

   - *What* is being done?
   - *When* is it being done?
   - *Who* is doing it?
   - *Where* is it being done?
   - *How* is it being done?
   - *How* well does it do on the various metrics of importance?

2. Benchmarking

   a. Types

   - Competitive
   - Functional
   - Internal

3. Implementing: Seven mistakes to avoid:

   (1)

   (2)

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(3)

(4)

(5)

(6)

(7)

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Chapter 1 Using Operations to Create Value

Course Introduction

1. Today's objectives:
   a. What are the course requirements?
   b. What is OM? OM deals with processes that produce services and goods that people use every day.

TEACHING TIP
Ask the students to share their ideas on a business they would like to start. Discuss the major OM, Accounting, Finance, Human Resources, Management Information Systems, and Marketing decisions.

   c. Why study OM?
2. Course objectives:
   a. Primary goal of this textbook is to gain an understanding of how to make operations a competitive weapon
   b. Strategy and analysis
3. Syllabus
   a. Go over course outline
   b. Performance measures
   c. Office hours and other administration
   d. Questions
   e. Nature of assignments

TEACHING TIP
Introduce with Disney. The operational planning at Disney provides one example of designing processes for competitive operations.

1. Operations management deals with the systematic design, direction, and control of processes.
   a. "A **process** is an activity or group of activities that takes one or more inputs, transforms them, and provides one or more outputs for its customers."
   b. An "**Operation** is a group of resources performing all or part of one or more processes."
   c. "**Supply chain management** is the synchronization of a firm's processes with those of its suppliers and customers to match flow of materials, services, and information with customer demand."

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1. Role of Operations in an Organization

1. Operations serve as an excellent career path to upper management positions in many organizations because operations managers are responsible for key decisions that affect the success of the organization.

2. Operations is one of several functions within an organization

a. Cross-functional coordination is essential to effective management

b. Operations plays an important role in meeting global competition

3. Historical Evolution and Perspectives

a. James Watt invented the steam engine in 1785.

b. With the invention of the cotton gin in 1794, Eli Whitney introduced the concept of interchangeable parts.

c. The foundations of modern manufacturing and technological breakthroughs were also inspired by the creation of a mechanical computer by Charles Babbage in the early part of the nineteenth century.

d. Scientific management of operations and supply chain management was further improved upon by Frederick Taylor in 1911

e. First is the invention of the assembly line for the Model T car by Henry Ford in 1909

f. Alfred Sloan in the 1930s introduced the idea of strategic planning for achieving product proliferation and variety

g. Toyota Production System in 1978, Taiichi Ohno laid the groundwork for removing wasteful activities from an organization.

h. The 1980s were characterized by wide availability of computer aided design (CAD), computer aided manufacturing (CAM), and automation.

2. A Process View

Departments within an organization typically have their own set of objectives and a set of resources with capabilities to meet those objectives. The concept of a process is much broader: a process can have its own set of objectives where the work flow may cross different department boundaries, and require resources from several departments.

1. How Processes Work

a. Inputs can include a combination of human resources (workers and managers), capital (equipment and facilities), purchased materials and services, land, and energy.

b. Processes provide outputs to customers. Outputs could be services (that can take the form of information) or a tangible product.

c. Customer-supplier relationships

- Every process and every person within an organization has customers

  ⇒ External customers

  ⇒ Internal customers

- Every process and every person in an organization also relies on suppliers

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⇒ External suppliers

⇒ Internal suppliers

d. Inputs and outputs vary, depending on the service or product (examples)

- Jewelry store

  ⇒ Inputs: merchandise, the store building, registers, the jeweler, and customers

  ⇒ Outputs: to the external customers are services and sold merchandise

- Factory manufacturing blue jeans

  ⇒ Inputs: denim, machines, the plant, workers, managers, and services by outside consultants

  ⇒ Outputs: clothing and supporting services

2. Nested Processes

   a. Process within a process

   b. Interconnectivity within a business

   c. Nature of each process's inputs and outputs

   d. Greater detail in Chapter 4 "Process Analysis"

3. Service and Manufacturing Processes

   a. Ratio of services to manufacturing jobs

   b. Differences

      - Nature of output

      - Degree of customer contact

   c. Similarities

      - Customers expect good service and good products

3. A Supply Chain View

The strategic view is that processes must add value for customers throughout the supply chain; reinforcing the link between processes and performance. This includes a firm's internal processes with those of external customers and suppliers.

1. Core Processes

   a. Supplier relationship process

   b. New service/product development process

   c. Order fulfillment process

   d. Customer relationship process

2. Support Processes

   a. provide vital resources and inputs to the core processes

   b. capabilities

   c. other inputs that allow core processes to function

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3. Supply Chain Processes
   a. Adding value with process innovation in supply chains
      - Outsourcing
      - Warehousing
      - Sourcing
      - Customer Service
      - Logistics
      - Cross-docking

4. Operations Strategy

1. Operations Strategy
   a. Specifies the means by which operations implements corporate strategy and helps to build a customer-driven firm.
   b. It links long-term and short-term operations decisions to corporate strategy and develops the capabilities the firm needs to be competitive.
2. Corporate Strategy
   a. Environmental scanning
   b. Developing core competencies
      - Workforce
      - Facilities
      - Market and financial know-how
      - Systems and technology
   c. Developing core processes
   d. Developing global strategies
      - Strategic alliance
      - Locating abroad.
3. Market Analysis
   a. Market segmentation
   b. Needs assessment
      - Service or Product Needs. Attributes of the service or product, such as price, quality, and degree of customization.
      - Delivery System Needs. Attributes of the processes and the supporting systems, and resources needed to deliver the service or product, such as availability, convenience, courtesy, safety, accuracy, reliability, delivery speed, and delivery dependability.
      - Volume Needs. Attributes of the demand for the service or product, such as high or low volume, degree of variability in volume, and degree of predictability in volume.

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- Other Needs. Other attributes, such as reputation and number of years in business, after-sale technical support, ability to invest in international financial markets, and competent legal services.

5. Competitive Priorities and Capabilities

1. **Competitive priorities** are the critical operational dimensions a process or supply chain must possess to satisfy internal or external customer, both now and in the future.
2. **Competitive capabilities** are the cost, quality, time, and flexibility dimensions that a process or supply chain actually processes and is able to deliver. An abbreviated list with examples is provided here.

Dimension	Definition	Example
Low-cost operations	Delivering a service or product at the lowest cost possible.	**Costco** achieves low costs by designing all processes for efficiency.
Top quality	Delivering an outstanding service or product.	**Rolex** is known globally for top-quality precision timepieces
Consistent quality	Producing services or products that meet design specifications on a consistent basis.	**McDonald's** standardizes work methods, staff training processes, and procurement to achieve consistency.
Delivery speed	Quickly filling customer orders	**Dell** engineered processes to deliver reliable and inexpensive computers with short lead times.
On-time delivery	Meeting delivery-time promises	**United Parcel Service (UPS)** uses expertise in logistics and warehousing processes to deliver on-time.
Development speed	Quickly introducing new services or products.	**Zara** is known by its ability to bring fashions from the runway to market quickly
Customization	Satisfying unique needs of customers	**Ritz Carlton** customizes services to individual customers.
Variety	A wide assortment of services or products.	**Amazon.com** uses information technology along with order fulfillment processes to deliver a vast variety of items to customers.
Volume flexibility	Accelerating or decelerating the rate of production	**The United States Post Office (USPS)** can have severe demand peak fluctuations.

TEACHING TIP
Managerial Practice 1.1 - Zara. Leveraging development speed for gaining competitive advantage provides one example of companies using their competitive capabilities.

3. Order Winners and Qualifiers
   a. Order winner is a criterion that customers use to differentiate the services or products of one firm from those of another, such as cost, quality, time, and flexibility
   b. Order qualifier is the minimal requirement for doing business in a particular market segment.

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4. Using Competitive Priorities: an airline example (two market segments: first-class passengers and coach passengers)
    a. Customer relationships
        - Top quality: High levels of customer contact and lounge service for the first-class passengers
        - Consistent quality: The information and service must be error free
        - Delivery speed: Customers want immediate information regarding flight schedules and other ticketing information
        - Variety: The process must be capable of handling the service needs of all market segments and promotional programs
    b. New service development
        - Developing speed: It is important to get to the market fast to preempt the competition
        - Customization: The process must be able to create unique services
        - Top quality: New services must be carefully designed because the future of the airline industry depends on them
    c. Order fulfillment
        - Low-cost operations: Airlines compete on price and must keep operating costs in check
        - Top quality: High quality meal and beverage service delivered by experienced cabin attendants ensures that the service provided to first-class passengers is kept top notch.
        - Consistent quality: Once the quality level is set, it is important to achieve it every time
        - On-time delivery: The airline strives to arrive at destinations on schedule, otherwise passengers might miss connections to other flights
        - Variety: Maintenance operations are required for a variety of aircraft models
    d. Supplier relationship
        - Low-cost operations: Costs of acquiring inputs must be kept to a minimum to allow for competitive pricing
        - Consistent quality: Quality of the inputs must adhere to the required specifications. In addition, information provided to suppliers must be accurate
        - On-time delivery: Inputs must be delivered to tight schedules
        - Variety: Many different inputs must be acquired, including maintenance items, meals and beverages.
        - Volume flexibility: The process must be able to handle variations in supply quantities efficiently
5. Identifying Gaps Between Competitive Priorities and Capabilities
    a. Operations strategy translates service or product plans and competitive priorities for each market segment into decisions affecting the supply chains that support those market segments.

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b. Once managers determine the competitive priorities for a process, it is necessary to assess the competitive capabilities of the process.

6. Trends and Challenges in Operations Management

1. Productivity Improvement

   a. The value of outputs produced is divided by the value of input resources.

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

   b. In the United States, while there are signs of improvement, service sector productivity gains have been much lower than those in the manufacturing sector.

   c. Use **Example 1.1: Productivity Calculations** to give students the chance to make their own productivity calculations.

   d. Productivity measures – two approaches

   - Single factor

     ⇒ In example 1.1, the single (input) factor is employee hours

   - Multifactor

     ⇒ In example 1.1, the multiple (input) factors are labor cost, materials cost, and overhead costs.

   e. Managers must examine productivity from the level of the value chain, i.e., the collective performance of individual processes.

   f. Additional examples are provided as Solved Problems

   g. **Application 1.1**

	This Yr.	**Last Yr.**	**Year Before Last**
Factory unit sales ($)	2,762,103	2,475,738	2,175,447
Employment (hrs)	112,000	113,000	115,000
Sales of manufactured products ($)	$49,363	$40,831	—
Total manufacturing cost of sales ($)	$39,000	$33,000	—

- Calculate the year-to-year labor productivity.

	This Yr.	**Last Yr.**	**Year Before Last**
$\frac{factory\ \ unit\ \ sales}{employment}$	$\frac{2{,}762{,}103}{112{,}000} = \$24.66/hr$	$\frac{2{,}475{,}738}{113{,}000} = \$21.91/hr$	$\frac{2{,}175{,}447}{115{,}000} = \$18.91/hr$

- Calculate the multifactor productivity.

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	This Yr.	Last Yr.
$\frac{sales\ of\ mfg\ products}{total\ mfg\ cost}$	$\frac{\$49{,}363}{\$39{,}000} = 1.27$	$\frac{\$40{,}831}{\$33{,}000} = 1.24$

2. Global Competition
   a. Firms can increase their market penetration by locating their production facilities in foreign countries because it gives them a local presence that reduces customer aversion to buying imports
   b. Five developments have stimulated the need for sound global strategies
      - Improved transportation and communication technology
      - Loosened regulations on financial institutions
      - Increased demand for imported services and goods
      - Reduced import quotas and other international trade barriers
        - ⇒ European Union (EU)
        - ⇒ North American Free Trade Agreement (NAFTA)
      - Comparative cost advantages
   c. Comparative cost advantage
      - What role does China play in globalization today?
      - What role does India play?
   d. Disadvantages of globalization
      - Relinquish proprietary technology
      - Political risks
      - Employee skills may be lower in foreign countries

TEACHING TIP
"Japanese Earthquake and its Supply Chain Impact." Japanese earthquake disaster exposes supply chain weakness: reliance on small, concentrated network of suppliers. Economic losses have been felt worldwide.

3. Ethical, Workforce Diversity, and Environmental Issues
   a. Decisions about the design and operations of production systems consider the environment, ethics, and workplace diversity issues

TEACHING TIP
Discuss examples such as: toxic waste, poisoned drinking water, poor air quality, and climate change.

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7. Fourth Industrial Revolution (Industry 4.0)

Fourth Industrial Revolution: Ongoing automation of traditional manufacturing and industrial practices using modern smart technology

a. **Smart Manufacturing Technologies** help a company's internal operations to become more efficient and can serve to increase virtual integration, augment virtualization, enhance automation, improve product traceability, and facilitate efficient energy management.

b. **Manufacturing execution systems (MES)**: Computerized systems used in manufacturing to track and document the transformation of raw materials to finished goods and optimize their production output

c. **Artificial intelligence (AI)**: A constellation of technologies, from machine learning to natural language processing, that allows machines to sense, comprehend, act, and learn

1. The Internet of Things

   a. The impact of the Internet of Things (IoT) on operations as objects embedded with software, sensors and actuators collect and exchange data

   b. Examples of how IoT affects the field of operations management today

      - Product design and development
      - Health care
      - Preventative maintenance
      - Inventory management
      - Logistics
      - City management

   c. Concerns and Barriers

      - Technology
      - Privacy
      - Security
      - Organizational roles

2. Additive Manufacturing

   a. **Additive Manufacturing (AM):** The technologies that build 3D objects by adding layers of material such as plastic, metal, or concrete

   b. Operations and Supply Chain Implications of AM

      - Reduced material inputs
      - Simplified production
      - Production and supply chain flexibility
      - Decentralized, distributed production networks

   c. Enablers of Adopting AM

      - Talent/Workforce

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- Intellectual property rights
- Quality assurance
- Process

8. Developing Skills for Your Career

1. Developing skills to understand how organizations meet challenges by better design of its operating processes and supply chains.
   a. The management of processes and supply chains goes beyond designing them; it requires the ability to ensure they achieve their goals.
   b. All effective operations decisions follow from a sound operations strategy.
   c. The text has three major parts:
      - Part 1: "Managing Processes"
        ⇒ Focus on analyzing processes and how they can be improved to meet the goals of the operations strategy.
      - Part 2: "Managing Customer Demand"
        ⇒ Focus of this part of the book is on effectively forecasting and managing customer demand.
      - Part 3: "Managing Supply Chains"
        ⇒ Focus of Part 3 is on supply chains involving processes both internal and external to the firm and the tools that enhance their execution.
2. Adding Value with Process Innovation
   a. Each part of an organization, not just the operations function, must design and operate processes that are part of a supply chain and deal with quality, technology, and staffing issues.
   b. Each function of an organization has its own identity and yet is connected with operations through shared processes.

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Chapter 2 Process Strategy and Analysis

TEACHING TIP
This chapter focuses on process strategy and analysis, which specifies the pattern of decisions made in managing processes so that the processes will achieve their competitive priorities assigned to it, such as quality, flexibility, time, and cost. Note that supply chains have processes also, they just have external suppliers and customers. The chapter then provides some tools and perspectives of process analysis.

TEACHING TIP
Introduce with a business example, such as CVS Pharmacy. The opening illustrates that careful design and execution of processes can have a positive impact on customer satisfaction and ultimately on the business outcomes and financial success.

1. Emphasize that processes are everywhere, in all functional areas of the enterprise.
   a. As explained in Chapter 1: processes are found in accounting, finance, human resources, management information systems, marketing, supply chain, and operations.
   b. They are the basic unit of work.
2. Managers must see to it that processes in all departments are adding as much customer value as possible.
3. Two basic change strategies for analyzing and modifying processes: process reengineering and process improvement
4. Three particularly important principles concerning process strategy
   a. Successful process decisions require choices that fit the situation and make sense together (*strategic fit*).
   b. Individual processes are the building blocks that eventually create the firm's whole supply chain.
   c. Management must pay particular attention to the interfaces between processes whether they are performed internally or externally by outside suppliers or customers. These interfaces underscore the need for cross-functional coordination.
5. Four common process decisions
   a. Process structure
   b. Customer involvement
   c. Resource flexibility
   d. Capital intensity

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1. Process Structure in Services

TEACHING TIP
One of the first decisions a manager makes in designing a well-functioning process is to choose a process type that best achieves the relative importance of quality, time, flexibility, and cost for that process.

1. Nature of Service Processes: Customer Contact
   a. A good process strategy for a service process:
      - Depends on the type and amount of customer contact.
      - Customer contact: the extent to which the customer is present, is actively involved, and receives personal attention during the service process.
   b. Dimensions of customer contact
      - Physical presence (face-to-face interaction is sometimes called a *moment of truth*, or *service encounter*)
      - What is processed
        ⇒ People-processing services
        ⇒ Possession-processing services
        ⇒ Information-based services
      - Contact intensity
        ⇒ Active contact: the customer is very much a part of the creation of the service, and affects the service process itself. Dental, psychiatric services for example.
        ⇒ Passive contact: the customer is not involved in tailoring the process to meet special needs, or in how the process is performed. Public transportation, theaters, for example.
      - Personal attention
        ⇒ When contact is more personal, the customer *"experiences"* the service rather than just receiving it.
      - Method of delivery used
        ⇒ Face-to-face or telephone versus regular mail or standardized e-mail message
2. Customer-contact matrix (fitting the service processes with customer contact)
   a. Customer contact and customization
      - A key competitive priority is how much customization is needed
      - Competitive priorities require more customization, the more the customer is present and actively involved.
   b. Process divergence and flow
      - Process divergence: extent to which the process is highly customized with considerable latitude as to how it is performed

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- ⇒ High divergence involves much judgment and discretion. Consulting and law, for example
- ⇒ Low divergence is more repetitive and standardized

- Process flow, closely related to divergence, may range from highly diverse to linear.
  - ⇒ Flexible flow means movements in diverse ways.
  - ⇒ Line flow means movement in fixed sequence.

3. Service process structuring (three process structures forming a continuum)
   a. Front office: a process with higher customer contact where the service provider interacts directly with the customer
   b. Hybrid office: a process with moderate levels of customer contact and standard services with some options available
   c. Back office: a process with low customer contact where the service provider interacts little with the customer

TEACHING TIP
The Ritz-Carlton Hotel Company targets the top 1 to 3 percent of luxury traveler, and so gives a huge emphasis on customization and top quality. The associates at the front desk characterize a front office, because the customers are present, take an active part in creating the service, receive personal attention, and have face-to-face contact.

2. Process Structure in Manufacturing

TEACHING TIP
Emphasize that many processes in a manufacturing setting are actually services to internal (or external) customers, so the previous section applies also to manufacturing.

Manufacturing processes convert materials into goods that have a physical form.

1. Product-process matrix
   - Three elements
     - Volume
     - Product customization
     - Process characteristics
   - A good strategy for a manufacturing structure depends first on volume.
   - Customer contact is not normally a consideration for manufacturing processes, although it is a factor for the service processes in manufacturing organizations.
   - Vertical dimension deals with the same two characteristics in the customer-contact matrix: divergence and flow
2. Manufacturing process structuring

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- Process choice: A way of structuring the process by organizing resources around the process or organizing them around the products
- Four process choices, forming a continuum
  - Job process, high variety of products
  - Batch process, higher volumes, batching of customer orders. Further differentiated as small batch and large batch processes.
  - Line process, high-volumes, standardized products, dedicated resources, repetitive manufacturing
  - Continuous flow process, the extreme end of high-volumes, rigid line flows. Primary material moves without stopping.

3. Production and inventory strategies

- Design-to-Order Strategy
  - Designing new products that do not currently exist.
  - Manufacturing to meet unique customer specifications.
- Make-to-order strategy
  - Make products to customer specifications in low volumes with job or small batch processes,
  - Matches up with flexibility (customization) and top quality
- Assemble-to-order strategy
  - Producing a wide variety of products from relatively few subassemblies and components after the customers orders are received
  - Allows delivery speed and high process divergence
  - Principle of *postponement*
- Make-to-stock strategy
  - Feasible for standardized products with high volumes and reasonably accurate forecasts with line or continuous flow processes
  - Holding items in stock for immediate delivery
  - Combined with line process, it is sometimes called **mass production**
  - Choice for delivery speed and low cost

4. Layout

A *layout* is the physical arrangement of operations (or departments) created from the various processes and puts them in tangible form. An *operation* is a group of human and capital resources performing all or part of one or more processes. See Supplement K.

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3. Process Strategy Decisions

1. Customer Involvement

TEACHING TIP
McDonald's uses its self-ordering kiosks to get its customers involved in the ordering process and to customize their orders This process not only increases accuracy of the order, but also streamlines the process.

   a. Possible advantages
      - Improved competitive capabilities
      - Can increase value to customer
      - Can improve quality for some services if the customer seeks to be more active and to receive more attention
      - Can mean better quality and speed up delivery, or at least reduce the perceived waiting time
      - Might help when customization and high variety are highly valued
      - Costs can be reduced
      - Customers can perform final assembly: bicycles, toys for example
      - Can also help coordinate across the supply chain.

   b. Emerging technologies: in a market where customers are technology-enabled, companies can now engage in an active dialogue with customers and make them partners in creating value.

   c. Possible disadvantages
      - Can be disruptive, making the process less efficient
      - Can make the process too divergent
      - Quality measurement becomes more difficult
      - Requires more interpersonal skills
      - Layouts may have to be revised
      - Can require many smaller decentralized facilities closer to the customer or a mobile service capability

2. Resource Flexibility

   a. Workforce
      - Implications of a flexible workforce
        - ⇒ Requires more education and training
        - ⇒ Alleviates capacity bottlenecks, volume flexibility
        - ⇒ Often increased job satisfaction
      - Volume flexibility and needed skills determine the type of workforce.

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⇒ Steady volume, high skills—permanent workforce

⇒ Variable volume, low skills—part-time or temporary employees to supplement permanent workforce

⇒ Variable volume, high skills—trained flexible force that can be moved to produce whatever the market demands

b. Equipment

- Managers must account for process divergence and diverse process flows when making resource flexibility decisions. Break-even analysis can be useful.
- **Application 2.1 Break-Even Analysis in Process Choice**.

BBC is deciding whether to weld bicycle frames manually or to purchase a welding robot. If welded manually, investment costs for equipment are only $10,000. The per-unit cost of manually welding a bicycle frame is $50.00 per frame. On the other hand, a robot capable of performing the same work costs $400,000. Robot operating costs including support labor are $20.00 per frame. At what volume would BBC be indifferent to these alternative methods?

	If welded manually (Make)	**If welded by robot (Buy)**
Fixed costs	$10,000	$400,000
Variable costs	$50	$20

$$Q = \frac{F_m - F_b}{c_b - c_m} = \frac{(10{,}000 - 300{,}000)}{(20 - 50)} = 13{,}000 \quad frames$$

- **Tutor 2.2** in MyLab Operations Management demonstrates how to do a break-even analysis for equipment selection.

3. Capital Intensity

a. Capital intensity is the mix of equipment and human skills in the process; the greater the relative cost of equipment, the greater is the capital intensity.

b. Automating manufacturing processes

- Advantage

⇒ Classic way of improving productivity when volume is high

- Disadvantages

⇒ Automated (capital intensive) operations must have high utilization.

⇒ Automation may not fit with competitive priorities being emphasized.

⇒ More capital intensity is not always best.

TEACHING TIP
Give business example, such as Gillette's package customization.

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- Fixed automation: a manufacturing process that produces one type of part or product in a fixed sequence of simple operations
  - ⇒ High demand volume
  - ⇒ Stable product design
  - ⇒ Long life cycle

TEACHING TIP
Mention chemicals and oil or industrial robot.

- Flexible (or programmable) automation: a manufacturing process that can be changed easily to handle various products.
  - ⇒ Useful in both low-customization and high-customization
  - ⇒ Can be quickly set up to make a variety of products in small batches
  - ⇒ Perhaps show photos of the JustBorn robots

c. Automating service processes

- Using capital inputs as a labor-saving device is also possible for service processes. Examples:
  - ⇒ Long-distance learning technology
  - ⇒ ATMs
  - ⇒ Financial services
  - ⇒ Need volume to justify expensive automation, just as in manufacturing
  - ⇒ May be front or back office

d. Economies of Scope

Requires a family of products having enough collective volume to utilize equipment fully

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4. Strategic Fit

The manager process strategist should understand how the four major process decisions tie together.

1. Decision patterns for service processes
   a. Process structure
   b. Customer involvement
   c. Resource flexibility
   d. Capital intensity
2. Decision patterns for manufacturing processes
   a. Process structure
   b. Customer involvement
   c. Resource flexibility
   d. Capital intensity
3. Gaining focus
   a. Focus by process segments
      - Plants within plants (PWPs)
   b. Focused service operations
   c. Focused factories

5. Strategies for Change

1. Process reengineering

TEACHING TIP
Mention Bell Atlantic reengineered its telephone business. After 5 years, it cut the time to connect new customers from 16-days to just hours.

   a. Critical processes
      - Emphasis is placed on core business processes.
      - Processes are broadly defined in terms of costs and customer value.
   b. Strong leadership
      - Senior executives must provide a strong leadership for reengineering success.
   c. Cross-functional teams
      - Reengineering works best at high-involvement workplaces.
   d. Information technology
      - Primary enabler of process engineering.

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e. Clean-slate philosophy

- Start with the way a customer wants to deal with the company.

f. Process analysis.

- Understanding current processes can reveal areas where new thinking will provide the biggest payoff

2. Process Improvement

a. The systematic study of the activities and flows of each process to improve it.

b. The purpose is to understand the process.

3. Process Analysis

a. The documentation and detailed understanding of how work is performed and how it can be redesigned

b. Six Sigma Process Improvement Model: employees must be trained in the "whys" and the "how-tos" of process performance and what it means to customers, both internal and external

- Define: the scope and boundaries of the process to be analyzed are first established.
- Measure: once the metrics are identified, it is time to collect information on how the process is currently performing on each one.
- Analyze: use the data on measures to perform process analysis to determine where improvements are necessary.
- Improve: design team generates a long list of ideas for improvements. These ideas are then sifted and analyzed.
- Control: monitor the process to make sure that high performance levels are maintained.

6. Defining, Measuring and Analyzing the Process

TEACHING TIP
Introduce this section with business examples. It could be how processes were improved at McDonald's Corporation, which increased customer value with better processes, informed by innovative data collection.

1. Techniques give management insight on current processes and possible changes.

a. flowcharts

b. work measurement techniques

c. process charts

2. Flowcharts

a. Diagrams that trace the flow of information, customers, equipment, or materials through the various steps of a process.

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b. Flowcharts show how organizations produce their outputs through a myriad of cross functional work processes, allowing the design team to see all the critical interfaces between functions and departments.

c. Swim Lane Flowcharts

- A diagram that groups functional areas responsible for different sub-processes into lanes.
- It is most appropriate when business processes span several departmental boundaries.

d. Service blueprints

- A special flowchart of a service process that shows which of its steps has high customer contact.
- Special feature: line of visibility that identifies which steps are visible to the customer.

TEACHING TIP
A more comprehensive treatment of work measurement techniques is provided in MyLab Operations Management *Supplement H, "Measuring Output Rates"* *Supplement I, "Learning Curve Analysis"*

3. Work Measurement techniques

a. Time study method

- Selecting the work elements within the process to be studied
- Timing the elements
- Determining the sampling size
- Setting the final standard

b. Elemental standard data approach

- Database of standards compiled internally for basic elements
- Works well when work elements within a certain jobs are similar to those in other jobs
- Sometimes the time required for a work element depends on variable characteristics of the jobs

c. Predetermined data approach

- Published database that divides each work element even more, into micromotions

d. Work sampling method

- Estimates proportion of time spent on different activities
- *Supplement H, "Measuring Output Rates" in MyLab Operations Management*

e. Learning curve analysis

- Takes into account learning that takes place on ongoing basis
- Learning curve and concept of doubling

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- *Supplement I, "Learning Curve Analysis" in MyLab Operations Management*

4. Process Charts
   a. Concentrates in more detail on a smaller number of steps than does a flowchart.
   b. It is an organized way of documenting all of the activities performed by a person or a group of people at a workstation, with a customer, or working with certain materials.
   c. Five possible categories
      - Operation
      - Transportation
      - Inspection
      - Delay
      - Storage
   d. Estimate the annual cost of the entire process.
      - It becomes a benchmark against which other methods for performing the process can be evaluated.
      - Annual labor cost can be estimated by finding the product of
        - ⇒ (1) time in hours to perform the process each time
        - ⇒ (2) variable costs per hour
        - ⇒ (3) number of times the process is performed each year

TEACHING TIP
Mention Video Case: "Process Strategy and Analysis at Cleveland Clinic" If possible, show the video that accompanies it, using the questions at the end of the written case and the "pause point" in the video itself to encourage class discussion.

5. Data analysis tools
   a. Checklists: a form used to record the frequency of occurrence of certain process failures.
   b. Histograms and bar charts
      - Histogram: summarizes data measured on a continuous scale, showing the frequency distribution of some process failures.
      - Bar chart: a series of bars representing the frequency of occurrence of data characteristics measured on a yes-and-no basis
      - Use **Figure 2.11**
   c. Pareto Charts: a bar chart on which the factors are plotted in decreasing order of frequency along the horizontal axis.
      - Use **Example 2.2**
   d. Scatter diagrams: a plot of two variables showing whether they are related.
   e. Cause-and-effect diagram: relates a key performance problem to its potential causes (sometimes called a *fishbone diagram*).

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- Use **Example 2.3**

f. Graphs: representations of data in a variety of pictorial forms, such as line and pie charts.

- Line charts (see the "Quality and Performance" Chapter)
- Forecasting (see Chapter 8, "Forecasting")

6. Data snooping

a. The power of the data analysis tools is greatest when they are used together.

b. Data snooping is the use of the tools to sift data, clarify issues and deduce causes.

c. Use **Example 2.4**

7. Simulation

a. The act of reproducing the behavior of a process using a model that describes each step of the process.

b. Shows how the process performs dynamically over time.

c. See **Supplement E**, "Simulation"

7. Redesigning and Managing Process Improvements

1. Questioning and Brainstorming

a. A questioning attitude: ask six questions about each step in the process.

- *What* is being done?
- *When* is it being done?
- *Who* is doing it?
- *Where* is it being done?
- *How* is it being done?
- *How* well does it do on the various metrics of importance?

TEACHING TIP
For each question, ask why? As time permits, have the class "brainstorm" Solved Problem 2 on changing auto engine oil. Have students shout out their ideas in rapid fire manner without time lost just yet for evaluation.

2. Creativity can be stimulated by having a **brainstorming** session: a time when a group of people, knowledgeable on the process propose ideas for change by saying whatever comes to mind.

3. Benchmarking: focuses on setting quantitative goals for improvement

a. Competitive benchmarking is based on comparisons with a direct industry competitor.

b. Functional benchmarking compares areas such as administration, customer service, and sales operations with those of outstanding firms in any industry.

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c. Internal benchmarking involves using an organizational unit with superior performance as the benchmark for other units.

4. Implementing: Seven mistakes to avoid in managing processes:
   a. Not connecting with strategic issues
   b. Not involving the right people in the right way
   c. Not giving the design teams and process analysts a clear charter, and then holding them accountable
   d. Not being satisfied unless fundamental "reengineering" changes are made
   e. Not considering the impact on people
   f. Not giving attention to implementation
   g. Not creating an infrastructure for continuous improvement

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