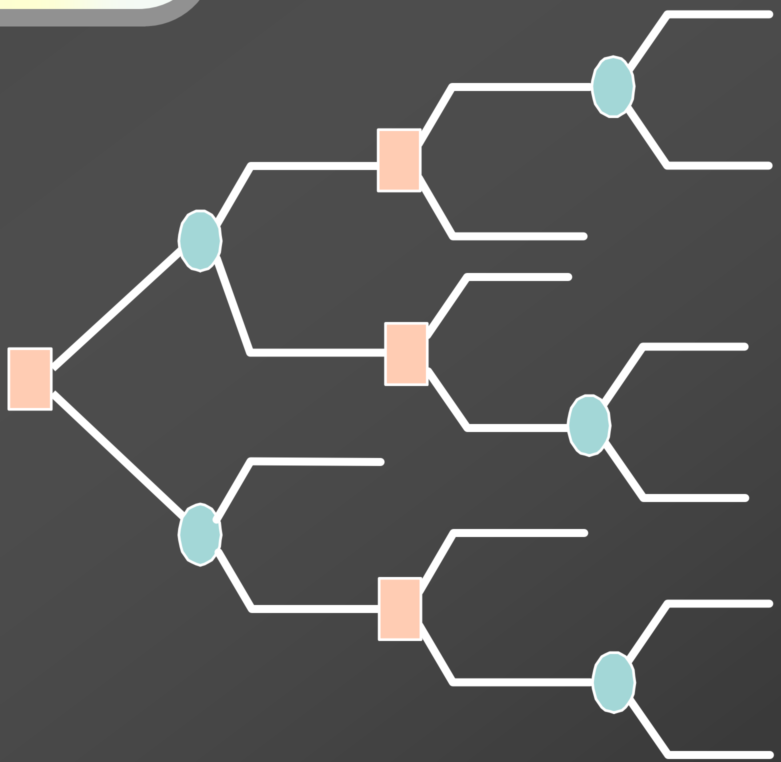
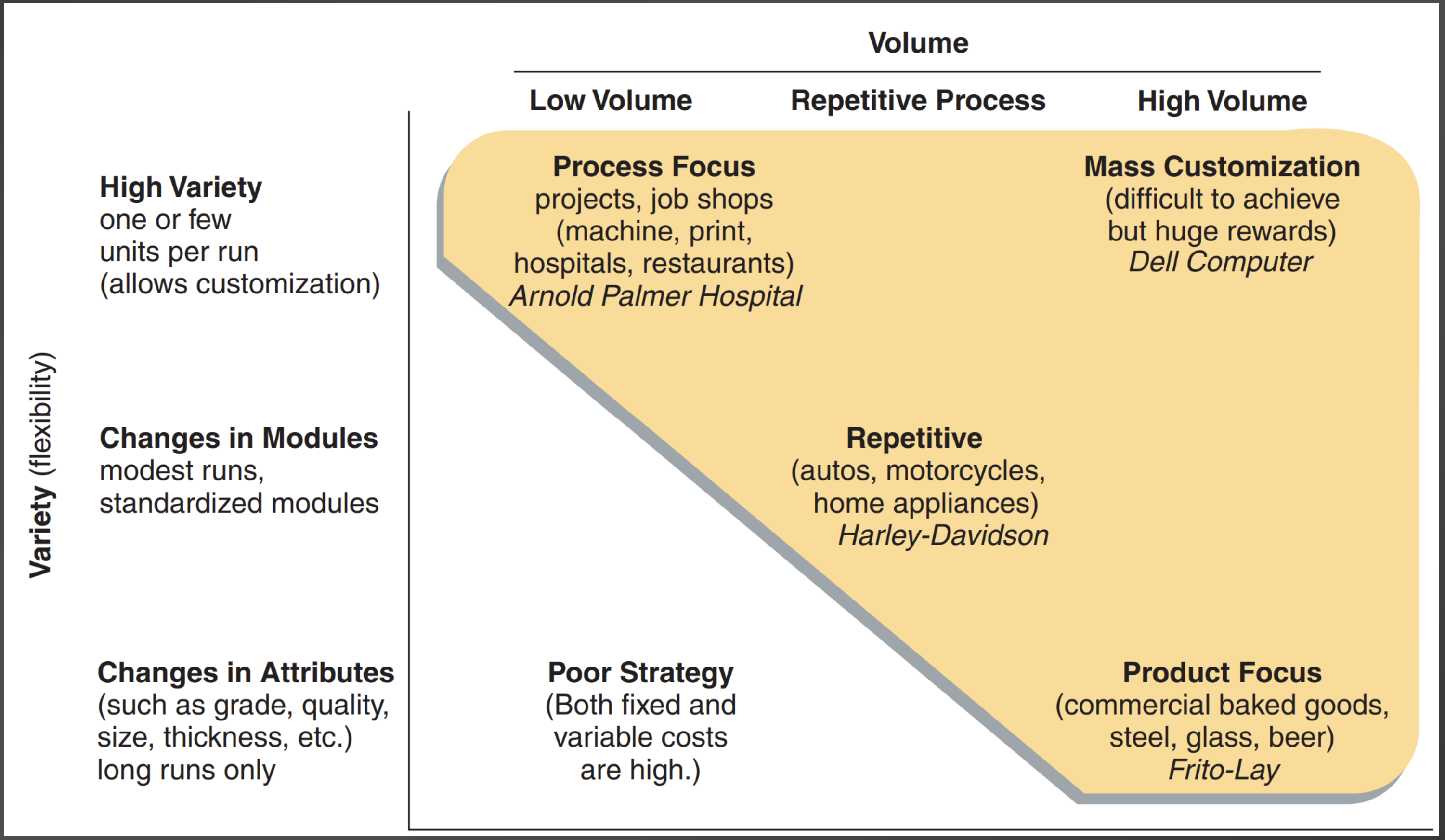
Part II- Process Capacity

Chapter 1 - introduction



Redesigning a Process Through Capacity Change



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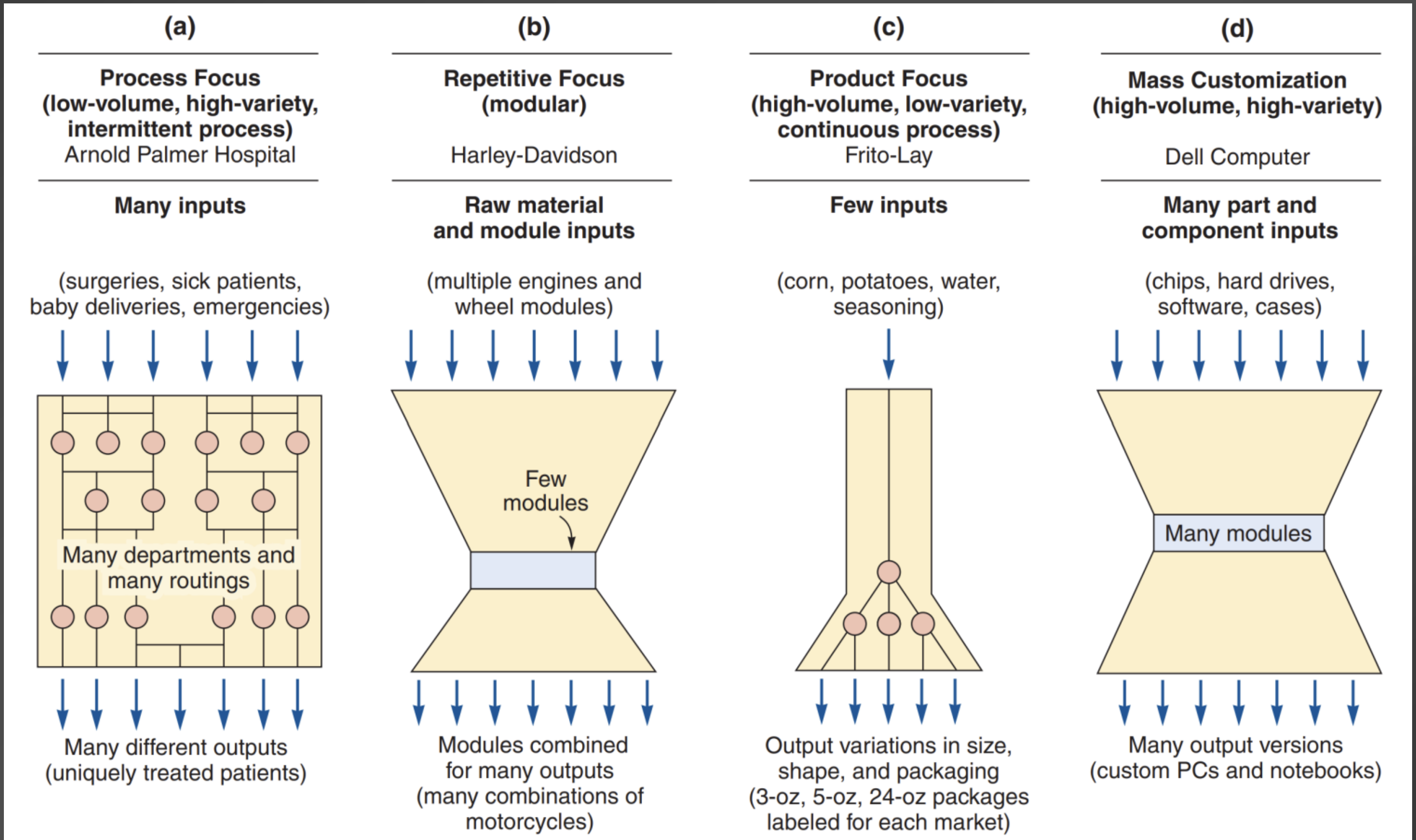


Redesigning a Process
Value Stream Mapping

Present Method ☒ PROCESS CHART Proposed Method ☐

SUBJECT CHARTED Hamburger Assembly Process DATE 12 / 1 / 15

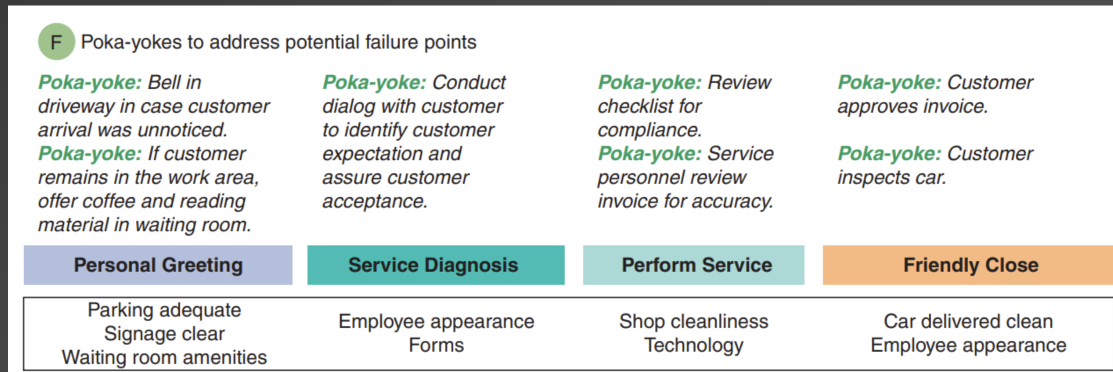
DEPARTMENT ______ CHART BY KH SHEET NO. 1 OF 1

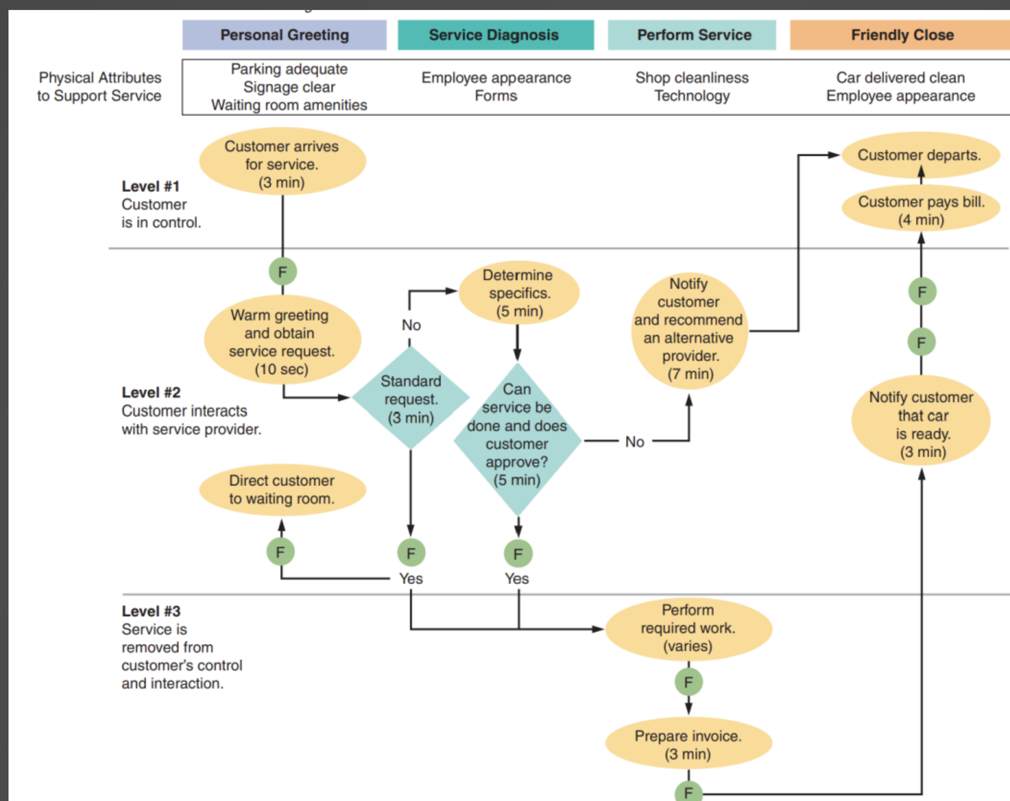
DIST. IN FEET	TIME IN MINS.	CHART SYMBOLS	PROCESS DESCRIPTION
	—	storage	Meat Patty in Storage
1.5	.05	transport	Transfer to Broiler
	2.50	operation	Broiler
	.05	inspect	Visual Inspection
1.0	.05	transport	Transfer to Rack
	.15	storage	Temporary Storage
.5	.10	transport	Obtain Buns, Lettuce, etc.
	.20	operation	Assemble Order
.5	.05	transport	Place in Finish Rack
3.5	3.15	2 4 1 – 2	TOTALS

Value-added time = Operation time/Total time = (2.50+.20)/3.15 = 85.7%

○ = operation; ⇨ = transport; ☐ = inspect; D = delay; ▽ = storage.

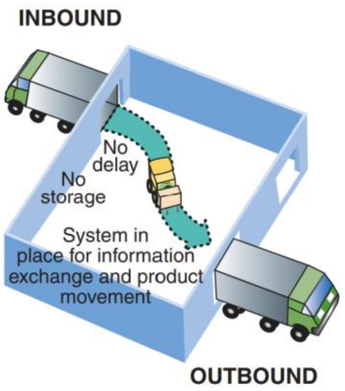
PROCESS ANALYSIS





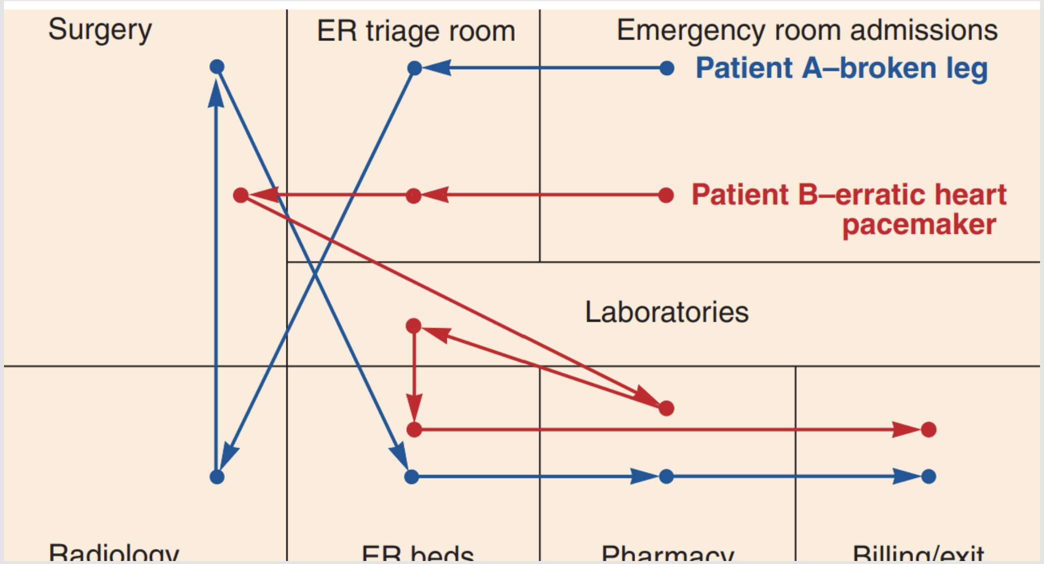
Lay out
Maximum use of a place

- Cross docking



- Random stocking
  1. Maintaining **a list of "open" locations**
  2. Maintaining accurate records of existing inventory and its locations
  3. Sequencing items **to minimize the travel time required to "pick" orders**
  4. **Combining orders** to reduce picking time
  5. Assigning certain items or **classes of items**, such as high-usage items, to particular warehouse areas so that the total distance traveled within the warehouse is minimized

Layout patterns



- **Fixed position layout**
  - A system that addresses the layout requirements of stationery products
- Process oriented layout
  - deals with low-volume, high-variety production in which like machines and equipment are grouped together

Goal is to minimize the cost

$$\text{Minimize cost} = \sum_{i=1}^{n}\sum_{j=1}^{n} X_{ij}C_{ij}$$

where n = total number of work centers or departments

i, j = individual departments

X_{ij} = number of loads moved from department i to department j

C_{ij} = cost to move a load between department i and department j

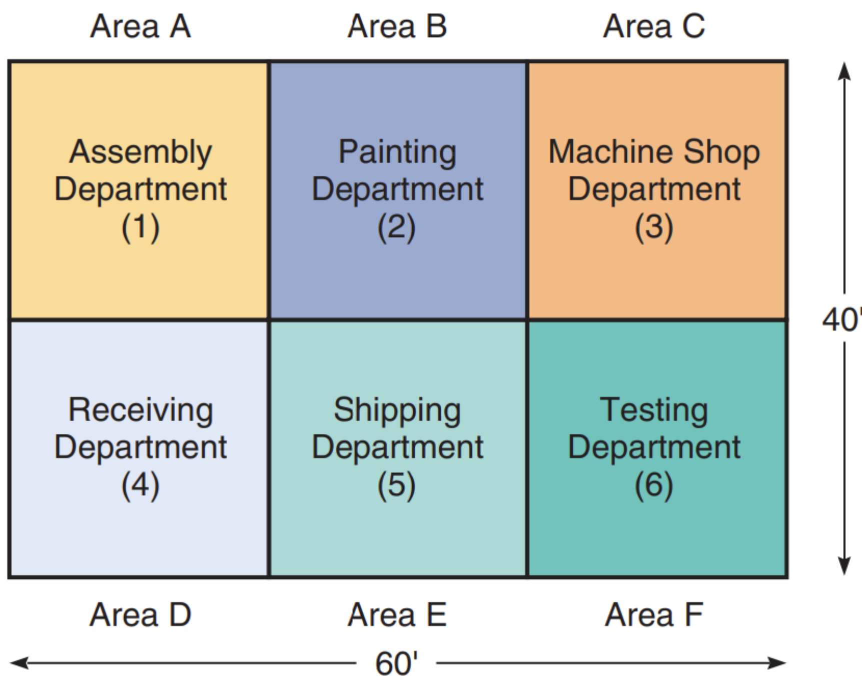
Example

Minimizing interdepartmental
material handling cost (through distances)

Number of loads per week

Department	Assembly (1)	Painting (2)	Machine Shop (3)	Receiving (4)	Shipping (5)	Testing (6)
Assembly (1)		50	100	0	0	20
Painting (2)			30	50	10	0
Machine Shop (3)				20	0	100
Receiving (4)					50	0
Shipping (5)						0
Testing (6)						

Determine space requirement

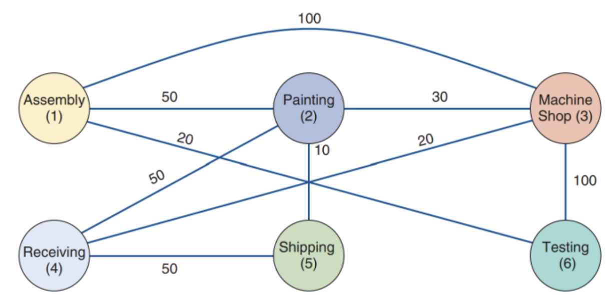


Let’s try to do by yourself

In minimizing cost as we know that transport cost is $1 for adjacent departments and $2 for non adjacent departments

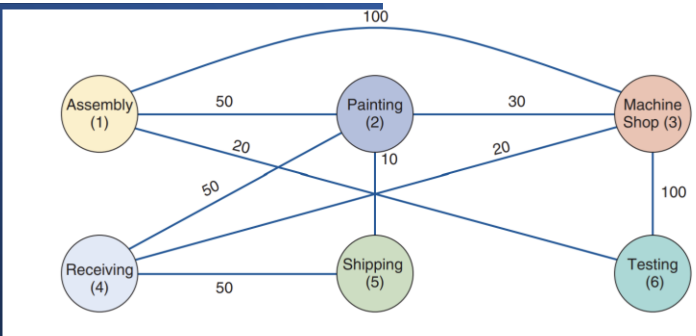
Number of loads per week

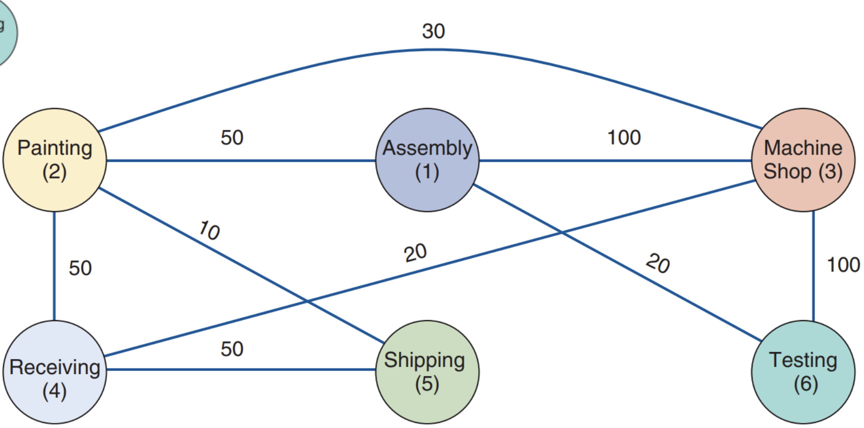
Department	Assembly (1)	Painting (2)	Machine Shop (3)	Receiving (4)	Shipping (5)	Testing (6)
Assembly (1)		50	100	0	0	20
Painting (2)			30	50	10	0
Machine Shop (3)				20	0	100
Receiving (4)					50	0
Shipping (5)						0
Testing (6)						



$$
\begin{aligned}
\text{Cost} = \; & \underset{(1 \text{ and } 2)}{\$50} + \underset{(1 \text{ and } 3)}{\$200} + \underset{(1 \text{ and } 6)}{\$40} + \underset{(2 \text{ and } 3)}{\$30} + \underset{(2 \text{ and } 4)}{\$50} \\
& + \underset{(2 \text{ and } 5)}{\$10} + \underset{(3 \text{ and } 4)}{\$40} + \underset{(3 \text{ and } 6)}{\$100} + \underset{(4 \text{ and } 5)}{\$50} \\
= \; & \$570
\end{aligned}
$$

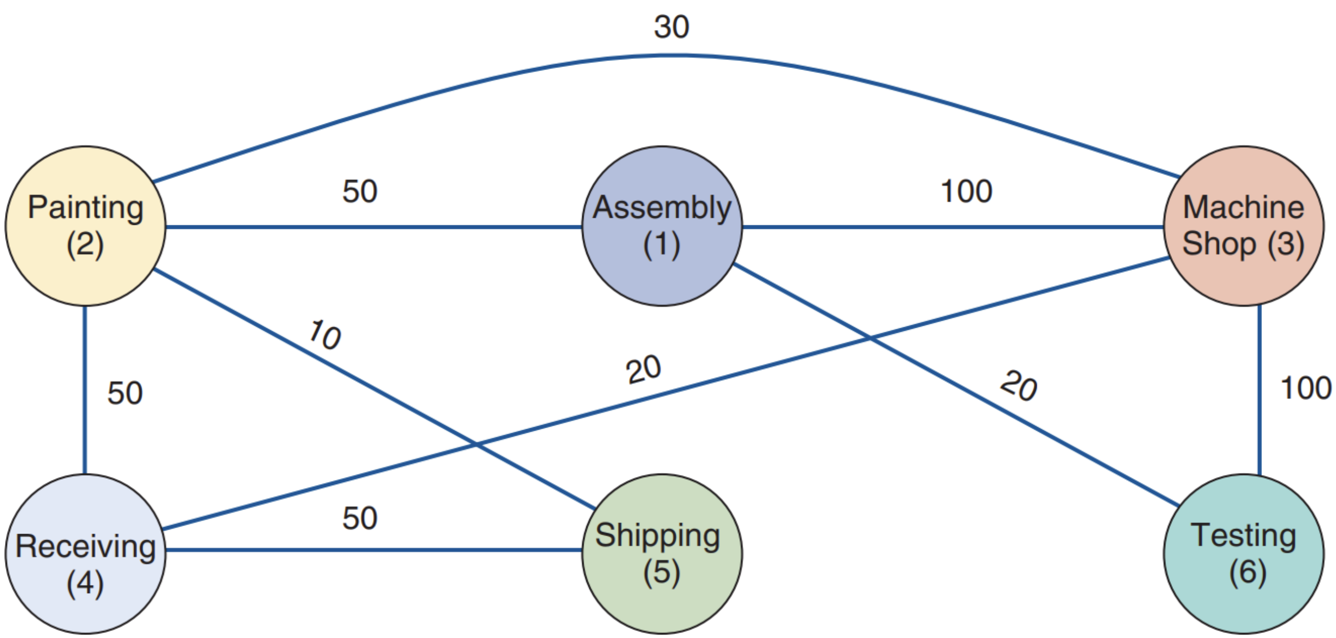
Number of loads moving between departments … we might improve them





$$
\begin{aligned}
\text{Cost} = \; & \underset{(1 \text{ and } 2)}{\$50} + \underset{(1 \text{ and } 3)}{\$100} + \underset{(1 \text{ and } 6)}{\$20} + \underset{(2 \text{ and } 3)}{\$60} + \underset{(2 \text{ and } 4)}{\$50} \\
& + \underset{(2 \text{ and } 5)}{\$10} + \underset{(3 \text{ and } 4)}{\$40} + \underset{(3 \text{ and } 6)}{\$100} + \underset{(4 \text{ and } 5)}{\$50} \\
= \; & \$480
\end{aligned}
$$

Solution is here below,
however some solver help is useful.
Let's build it up together

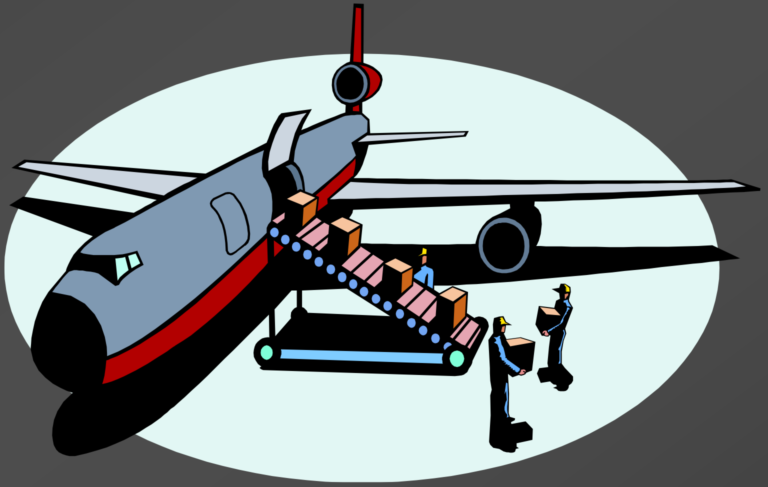


Capacity planning

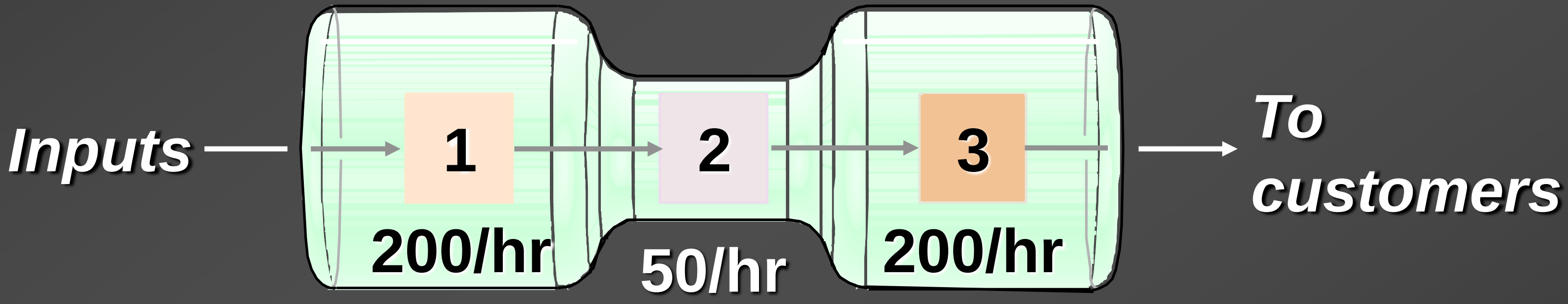
- Measures of capacity
  - Output measures
  - Input measures

Utilization

$$\text{Utilization} = \frac{\text{Average output rate}}{\text{Maximum capacity}} \times 100 \text{ in } \%$$



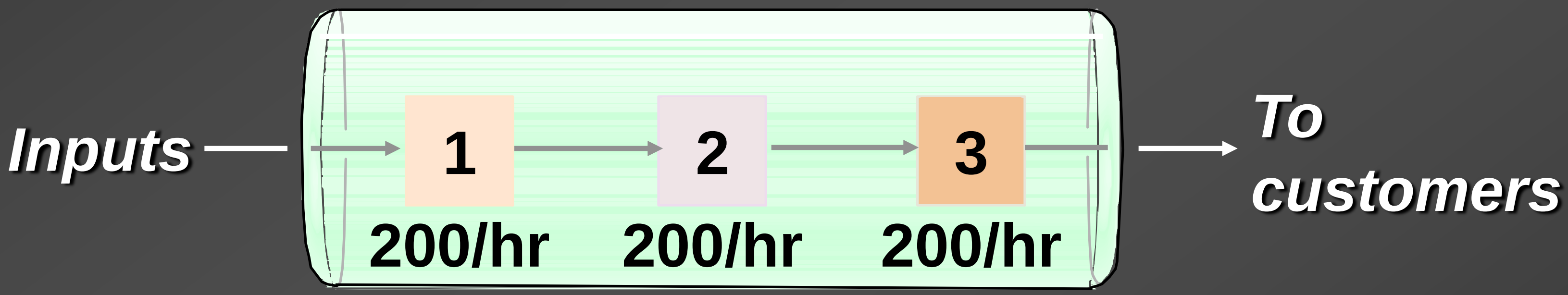
Capacity Bottlenecks



(a) Operation 2 a bottleneck

Figure 6.2

Capacity Bottlenecks

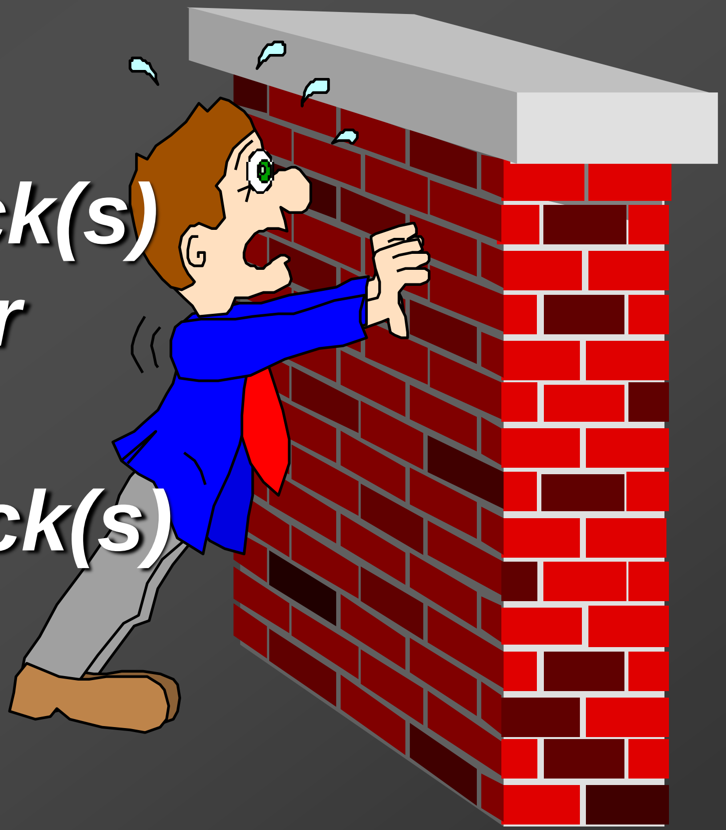


(b) All operations bottlenecks

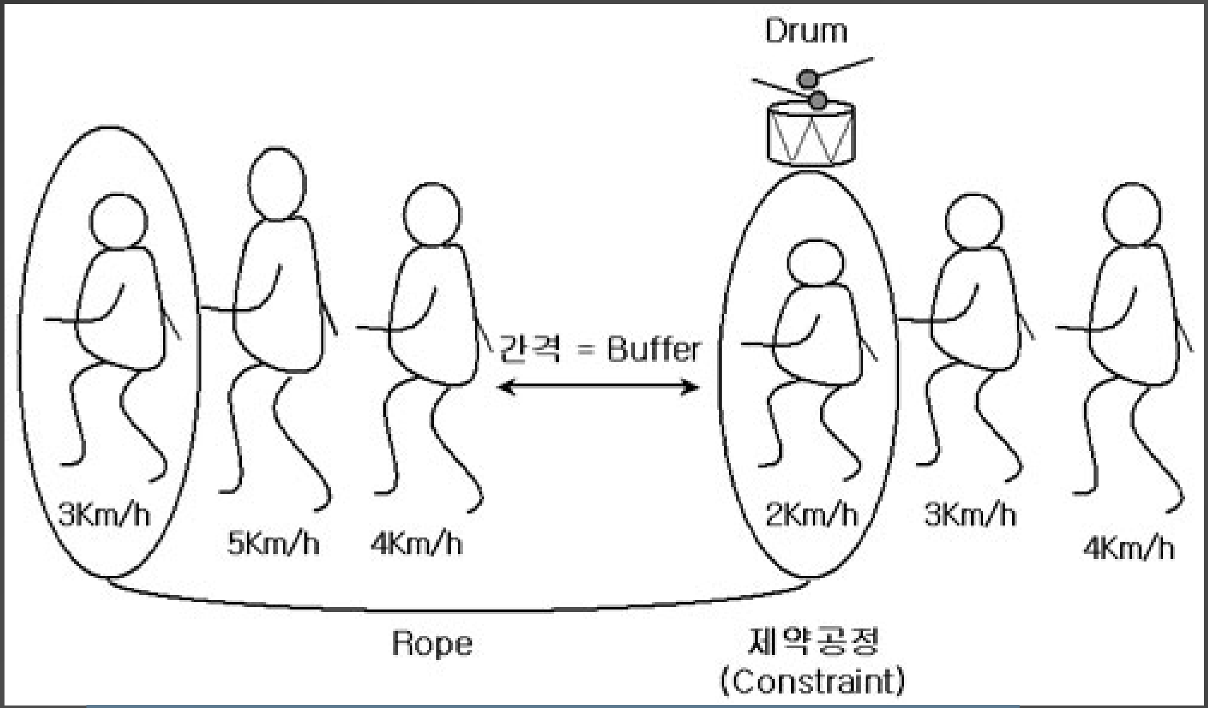
Figure 6.2

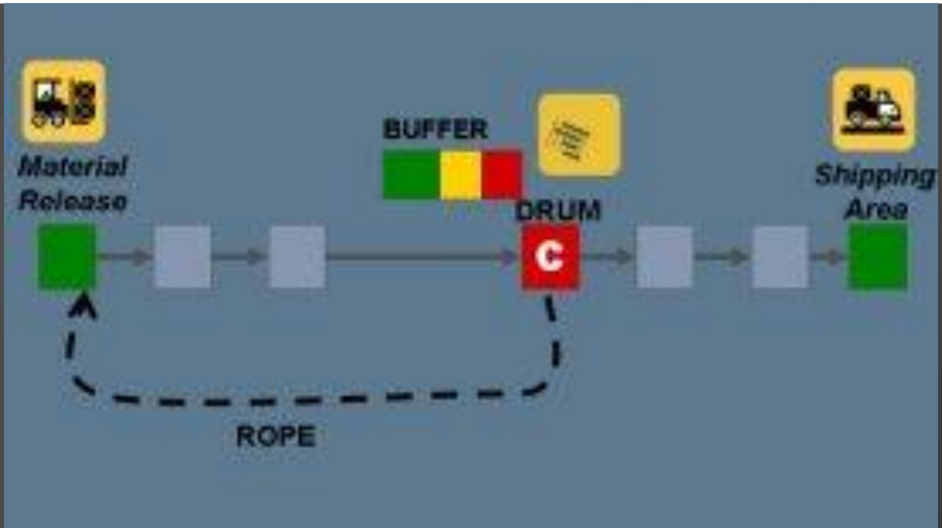
Theory of Constraints

1. Identify the system bottleneck(s)
2. Exploit the bottleneck(s)
3. Subordinate all other decisions to Step 2
4. Elevate the bottleneck(s)
5. Do not let inertia set in



Drum-buffer-rope method





Economies and Diseconomies of Scale

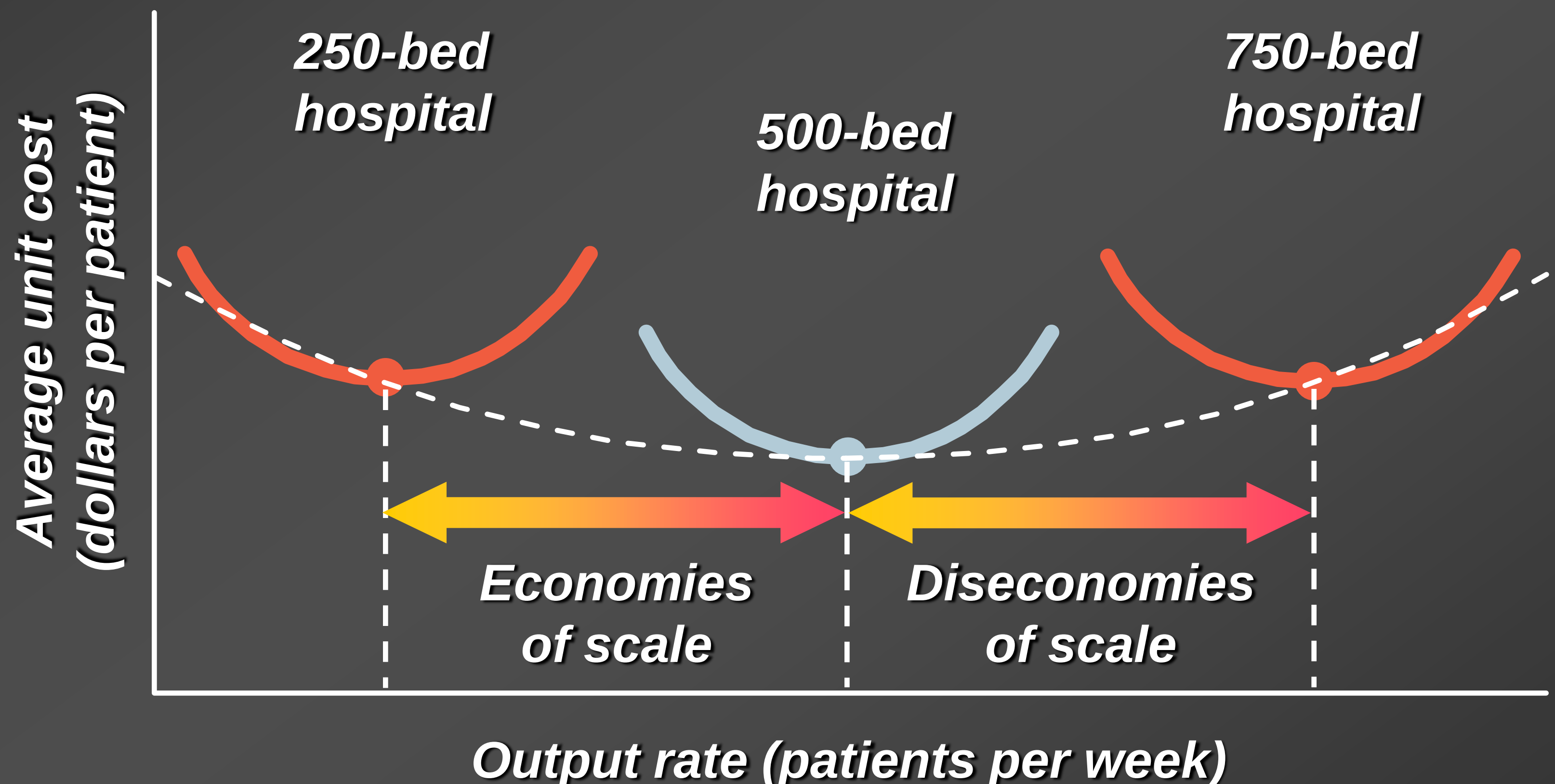


Figure 6.3

Economies of scale

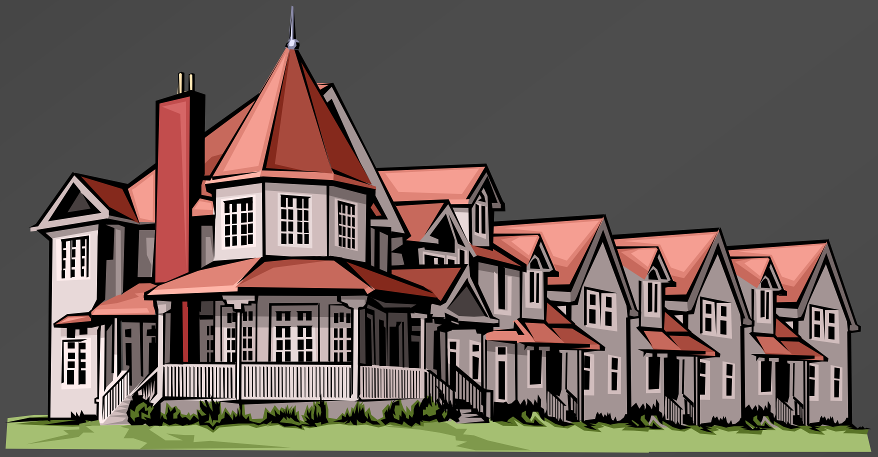
- Spreading fixed costs
- Reducing construction costs
- Cutting costs of purchased materials
- Looking for process advantages

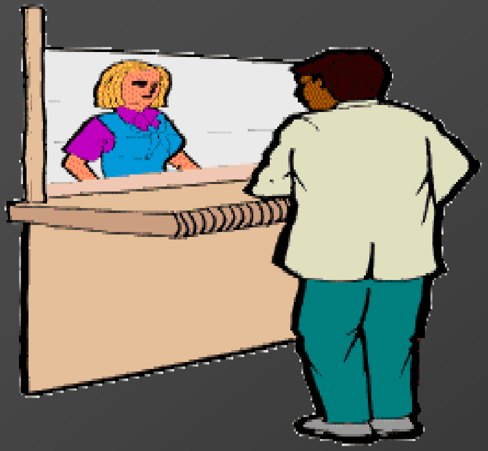
Diseconomies of scale

- The size enlargement might creates cost : complexity, inefficiencies …
  - Bureaucracy
- Loss of flexibility

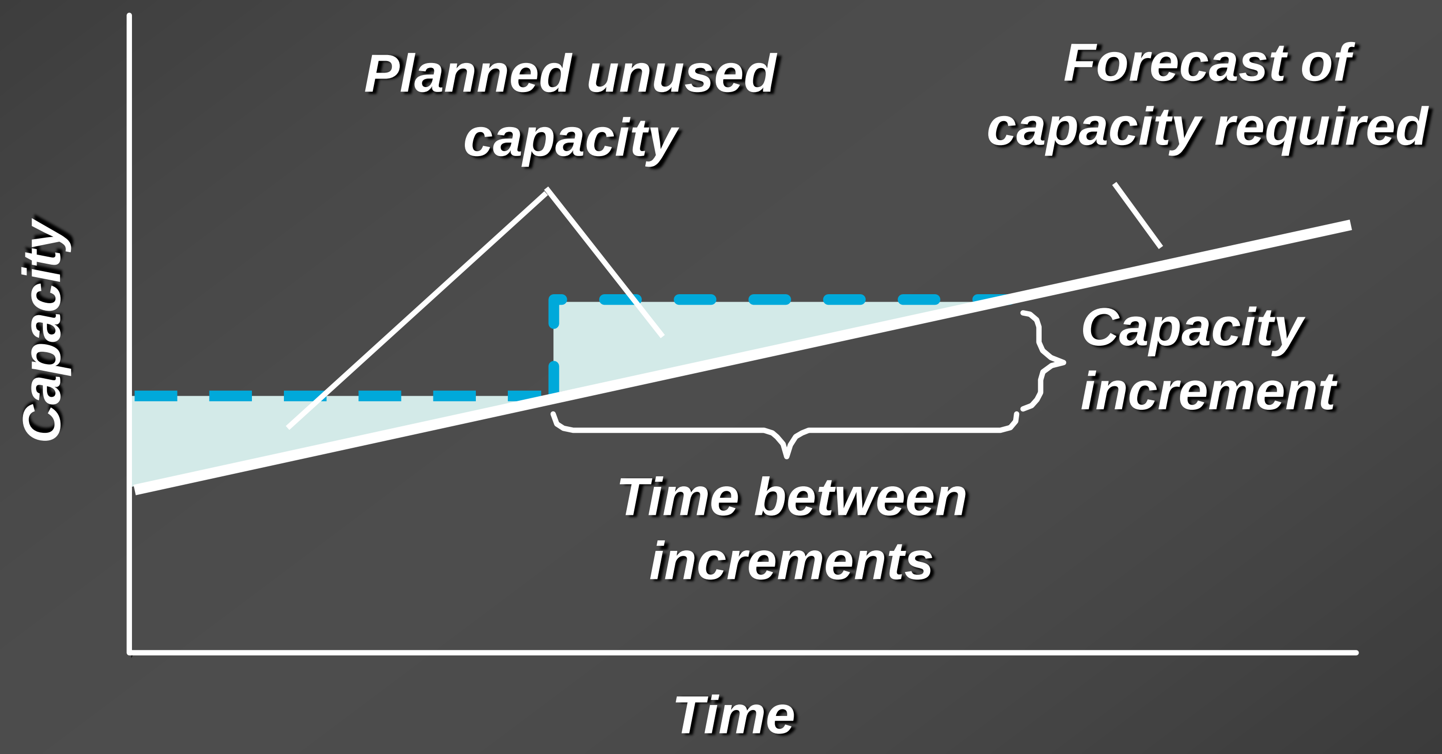
Capacity Cushions

Capacity Cushion = 100% - Utilization Rate (%)





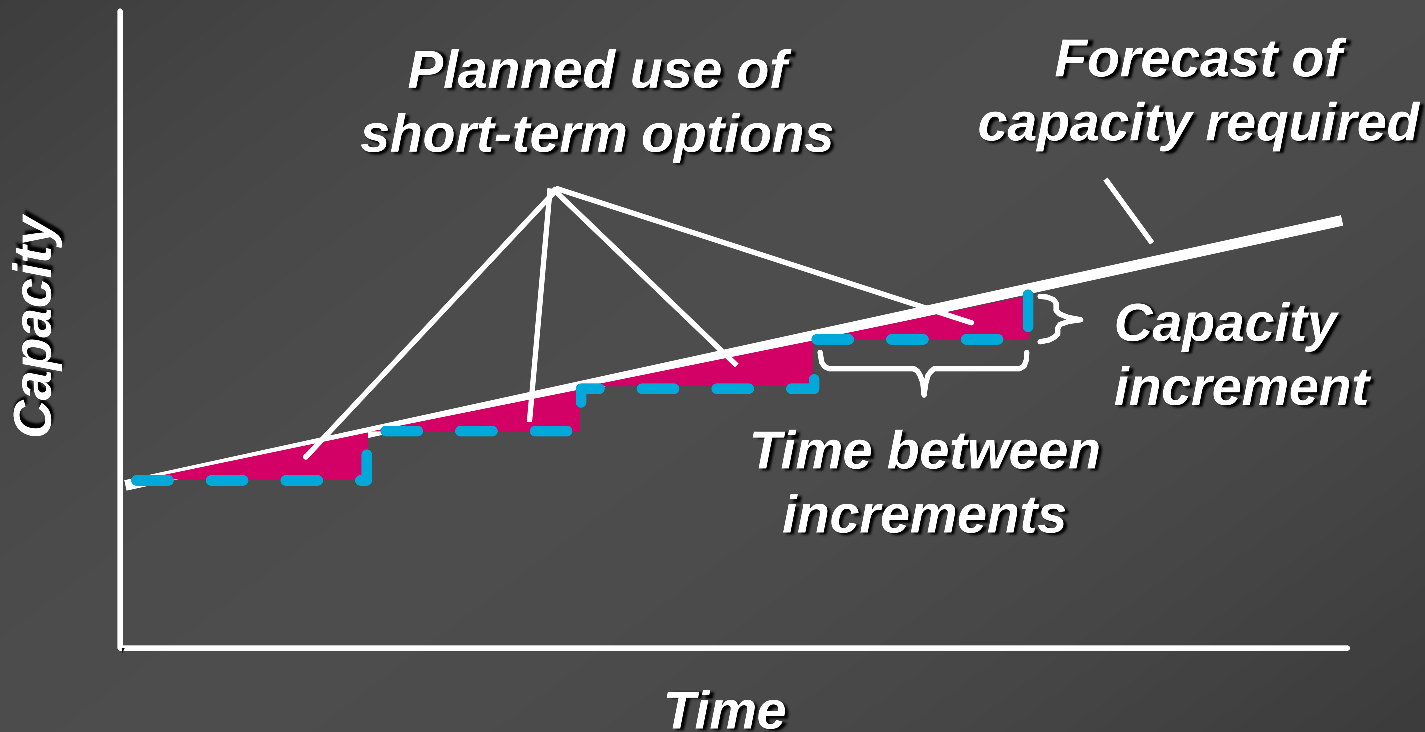
Capacity Strategies



(a) Expansionist strategy

Figure 6.4

Capacity Strategies

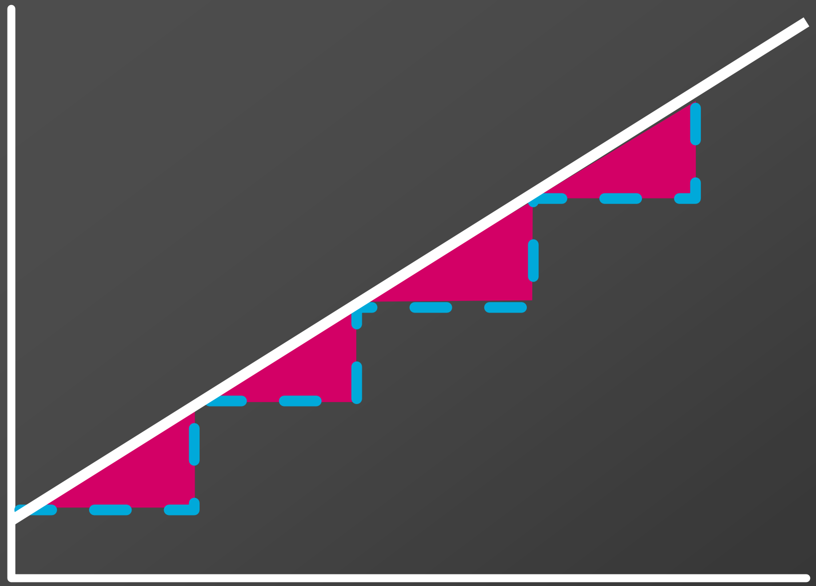


(b) Wait-and-see strategy

Figure 6.4

Linking Process Capacity and Other Decisions

- ***Competitive Priorities***
- ***Quality***
- ***Process Design***
- ***Aggregate Planning***



A systematic approach to capacity decisions

- Estimate capacity requirements
  - Using output measures

Estimating Capacity Requirements

A process serves 50 customers per day, utilization is about 90%, and demand is expected to double in five years. Management wants to increase the capacity cushion to 20%.

$$M = \frac{50}{[1.0 - .20]} = 62.5 \text{ customers per day}$$

In 5 years if demand doubles,

M = 2 x 62.5 or 125 customers per day

Example 6.1

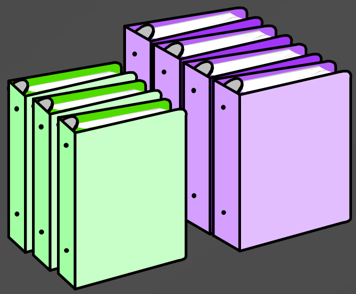
Estimating Capacity Requirements

Capacity requirement =

$$\frac{\text{Processing hours required for year's demand}}{\text{Hours available from a single capacity unit per year, after deducting desired cushion}}$$

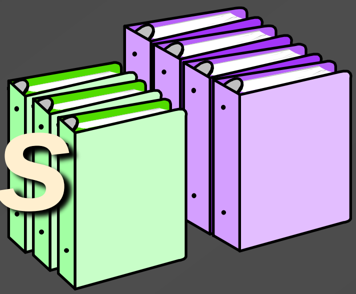
$$M = \frac{Dp}{N[1 - (C/100)]}$$

D = demand forecast for the year
p = processing time
N = total number of hours per year during which the process operates
C = desired capacity cushion



Chapter 2
Capacity Decisions

Capacity Decisions



Estimate Capacity Requirements

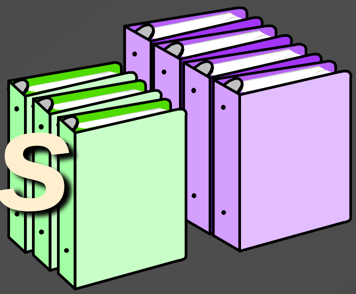
Item	Client X	Client Y
Annual demand forecast (copies)	2000.00	6000.00
Standard processing time (hour/copy)	0.50	0.70
Average lot size (copies per report)	20.00	30.00
Standard setup time (hours)	0.25	0.40

Data

250 working days a year
1 shift 8 hours a day
Capacity cushion 15%

Example 6.2

Capacity Decisions



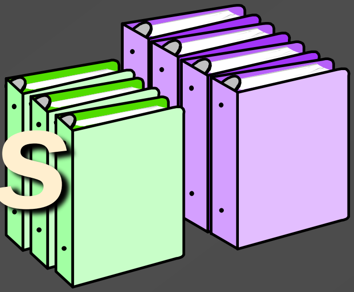
Estimate Capacity Requirements

Item	Client X	Client Y
Annual demand forecast (copies)	2000.00	6000.00
Standard processing time (hour/copy)	0.50	0.70
Average lot size (copies per report)	20.00	30.00
Standard setup time (hours)	0.25	0.40

$$M = \frac{[Dp + (D/Q)s]_{\text{product 1}} + \ldots + [Dp + (D/Q)s]_{\text{product } n}}{N[1 - (C/100)]}$$

Example 6.2

Capacity Decisions



Estimate Capacity Requirements

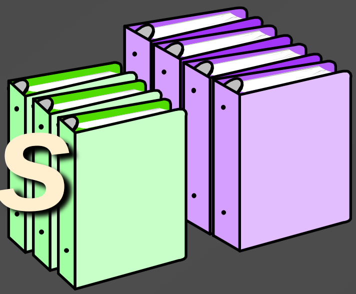
Item	Client X	Client Y
Annual demand forecast (copies)	2000.00	6000.00
Standard processing time (hour/copy)	0.50	0.70
Average lot size (copies per report)	20.00	30.00
Standard setup time (hours)	0.25	0.40

$$M = \frac{[2000(0.5) + (2000/20)(0.25)]_{\text{client X}} + [6000(0.7) + (6000/30)(0.4)]_{\text{client Y}}}{(250 \text{ days/year})(1 \text{ shift/day})(8 \text{ hours/shift})(1.0 - 15/100)}$$

Example 6.2

Capacity Decisions

Estimate Capacity Requirements



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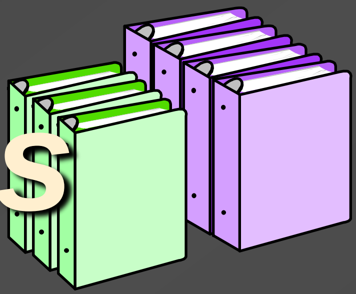
Example 6.2

Capacity Decisions



Estimate Capacity Requirements

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Annual demand forecast (copies)	2000.00	6000.00
Standard processing time (hour/copy)	0.50	0.70
Average lot size (copies per report)	20.00	30.00
Standard setup time (hours)	0.25	0.40

$$M = \frac{5305}{1700} = 3.12 \approx 4 \text{ machines}$$

Example 6.2

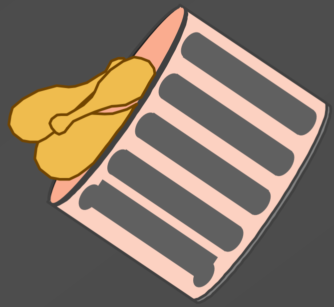
- Step 2 : identify gaps
  - Between projected demand and current capacity
- Step 3 : develop alternatives
  - To cope with project gaps
- Step 4 : evaluate alternatives
  - Evaluate each alternative
  - Qualitative concerns : uncertainties about demand …
  - Quantitative concerns
    - Distribution of demand, peaks …

Example

Grandmother's chicken restaurant is experiencing a boom in business. The owner expects to serve a total of 80000 meals this year. Although the kitchen is operating at a 100% capacity, the dining room can handle a total of 105000 diners per year, followed by a 10000 meal increase in each of the succeeding years. One alternative is to expand both the kitchen and the dining room now, bringing their capacities up to 130000 meals per year. The initial investment would be $ 200000, made at the end of this year (year 0). The average meal is priced at $ 10, and the before tax profit margin is 20%. The 20% figure was arrived at by determining that, for each $ 10 meal, $6 covers variable costs and $2 goes toward fixed costs. The remaining $2 goes to pretax profit.

What are the pretax cash flows from this project to the next 5 years compared to those of the basic case of doing nothing ?

Capacity Decisions



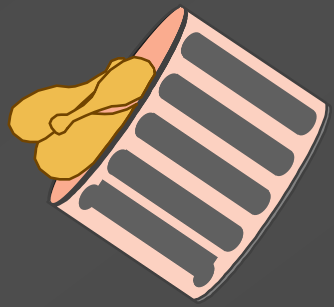
Evaluate Alternatives

Expand capacity to meet expected demand through Year 5

Year	Demand	Cash Flow

Example 6.3

Capacity Decisions



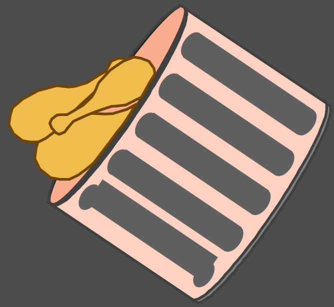
Evaluate Alternatives

Expand capacity to meet expected demand through Year 5

Year	Demand		Cash Flow
1	90,000	(90,000 – 80,000)2 =	$20,000

Example 6.3

Capacity Decisions



Evaluate Alternatives

Expand capacity to meet expected demand through Year 5

Year	Demand		Cash Flow
1	90,000	(90,000 – 80,000)2 =	$20,000
2	100,000	(100,000 – 80,000)2 =	$40,000
3	110,000	(110,000 – 80,000)2 =	$60,000
4	120,000	(120,000 – 80,000)2 =	$80,000
5	130,000	(130,000 – 80,000)2 =	$100,000

Example 6.3

Capacity Decisions

Simulation

Figure 6.5

Solver - Waiting Lines

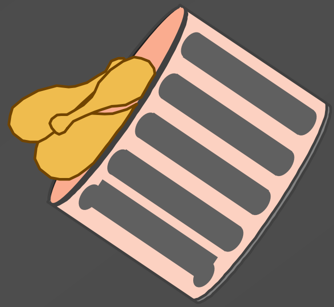
Enter data in yellow shaded areas.

◉ Single-server model ○ Multiple-server model ○ Finite-source model

Servers	1	(Number of servers is assumed to be 1 in single-server model.)
Arrival Rate (λ)	3	
Service Rate (μ)	6	

Probability of zero customers in the system (P_0)	0.5000
Probability of [at most] 2 customers in the system (P_n)	0.8750
Average utilization of the server (ρ)	0.5000
Average number of customers in the system (L)	1.0000
Average number of customers in line (L_q)	0.5000
Average waiting/service time in the system (W)	0.3333
Average waiting time in line (W_q)	0.1667

Capacity Decisions



Decision Trees

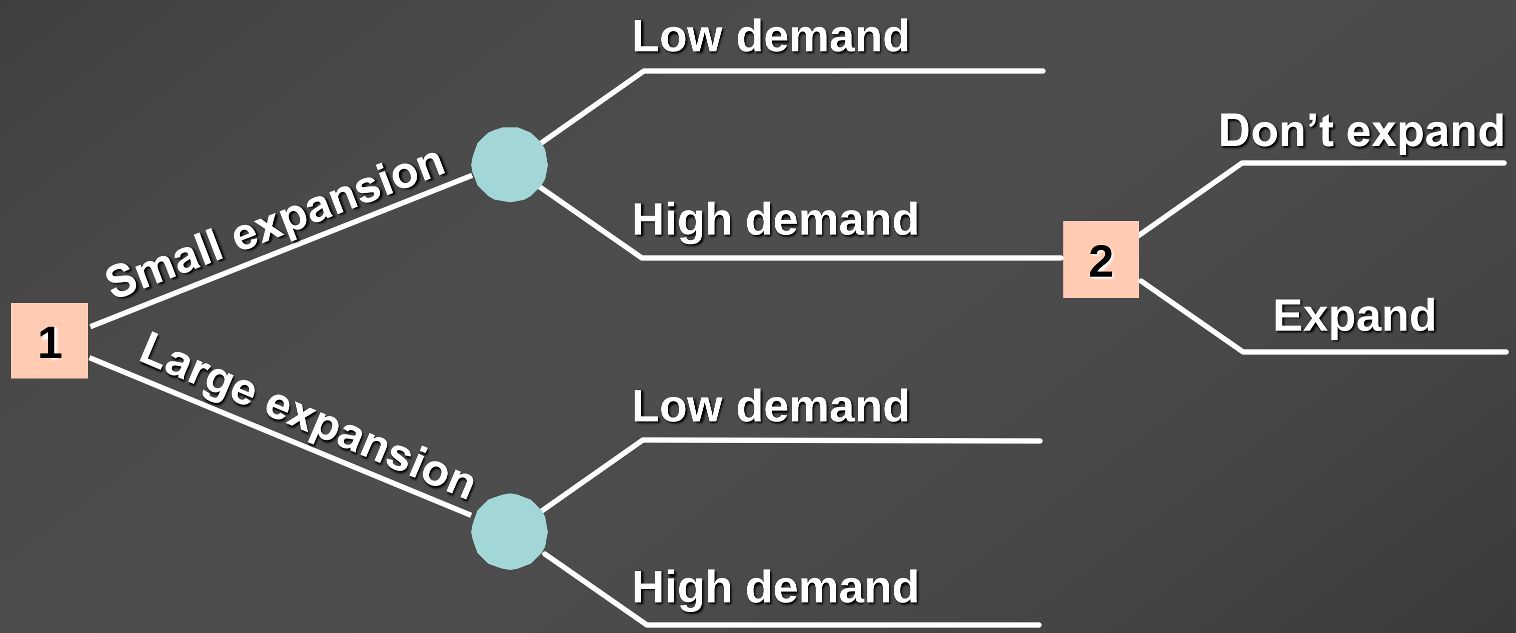
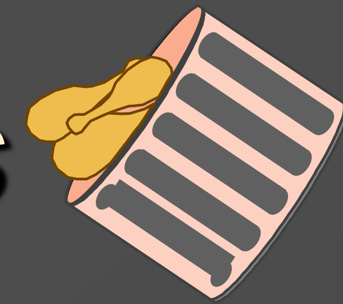


Figure 6.7

Capacity Decisions



Decision Trees

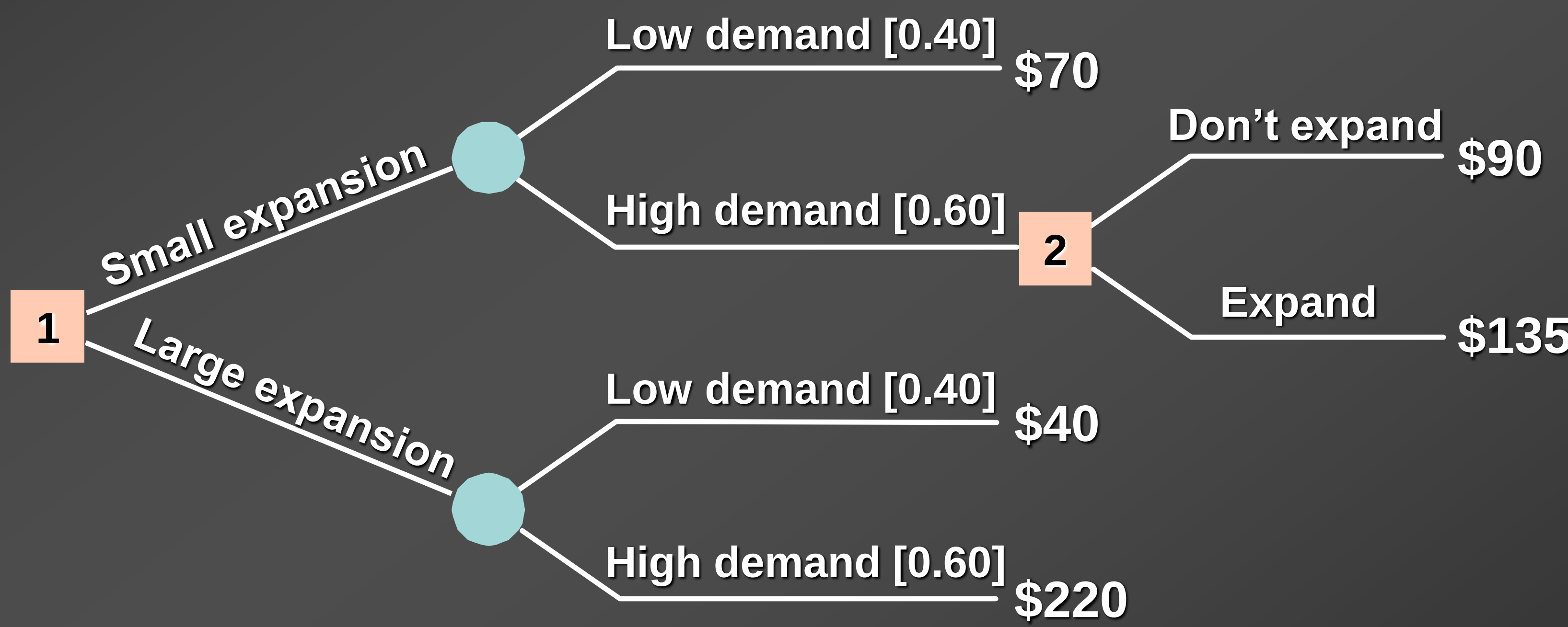
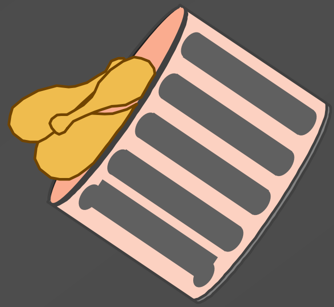


Figure 6.7

Capacity Decisions



Decision Trees

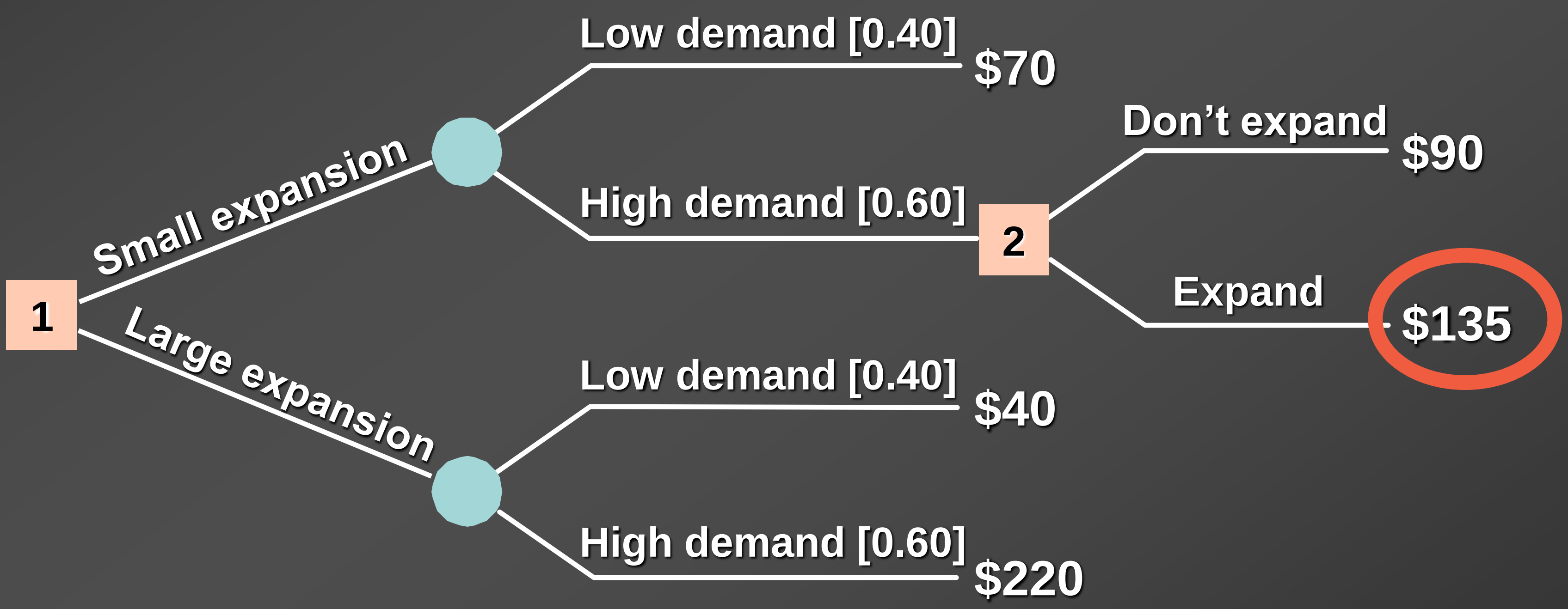


Figure 6.7

Capacity Decisions

Decision Trees

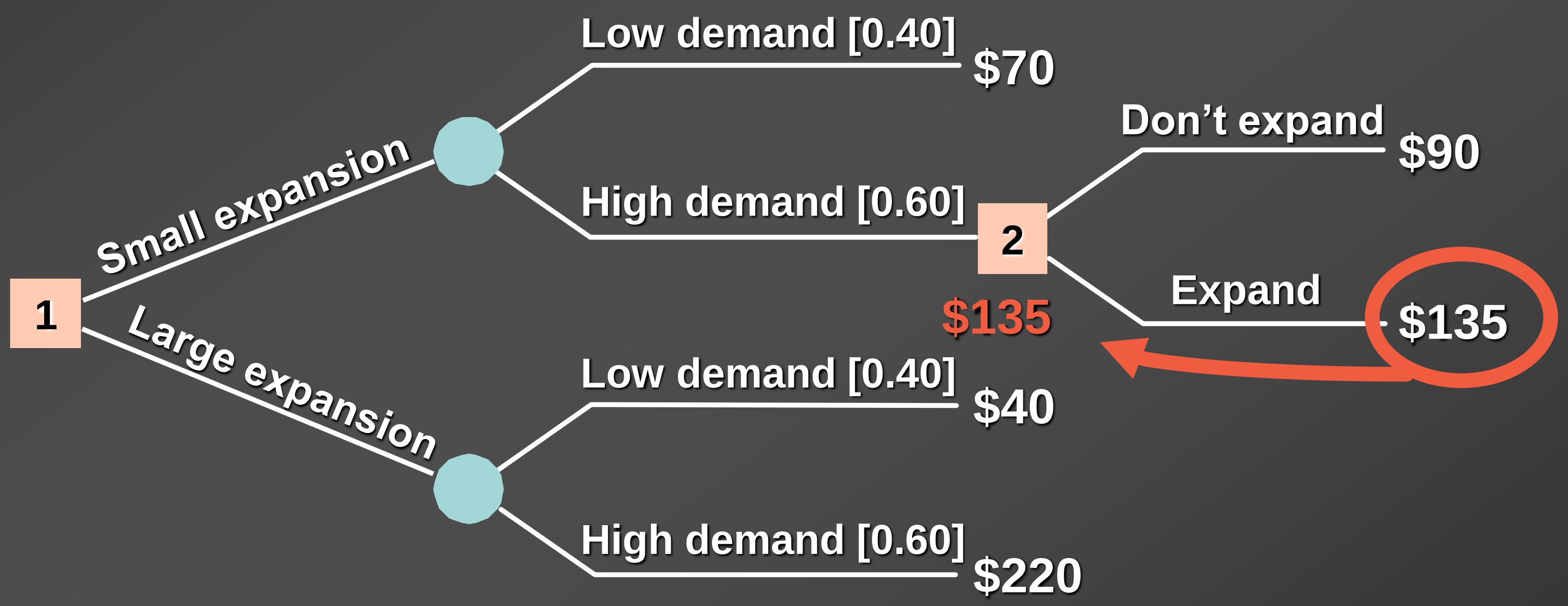


Figure 6.7

Capacity Decisions

Decision Trees

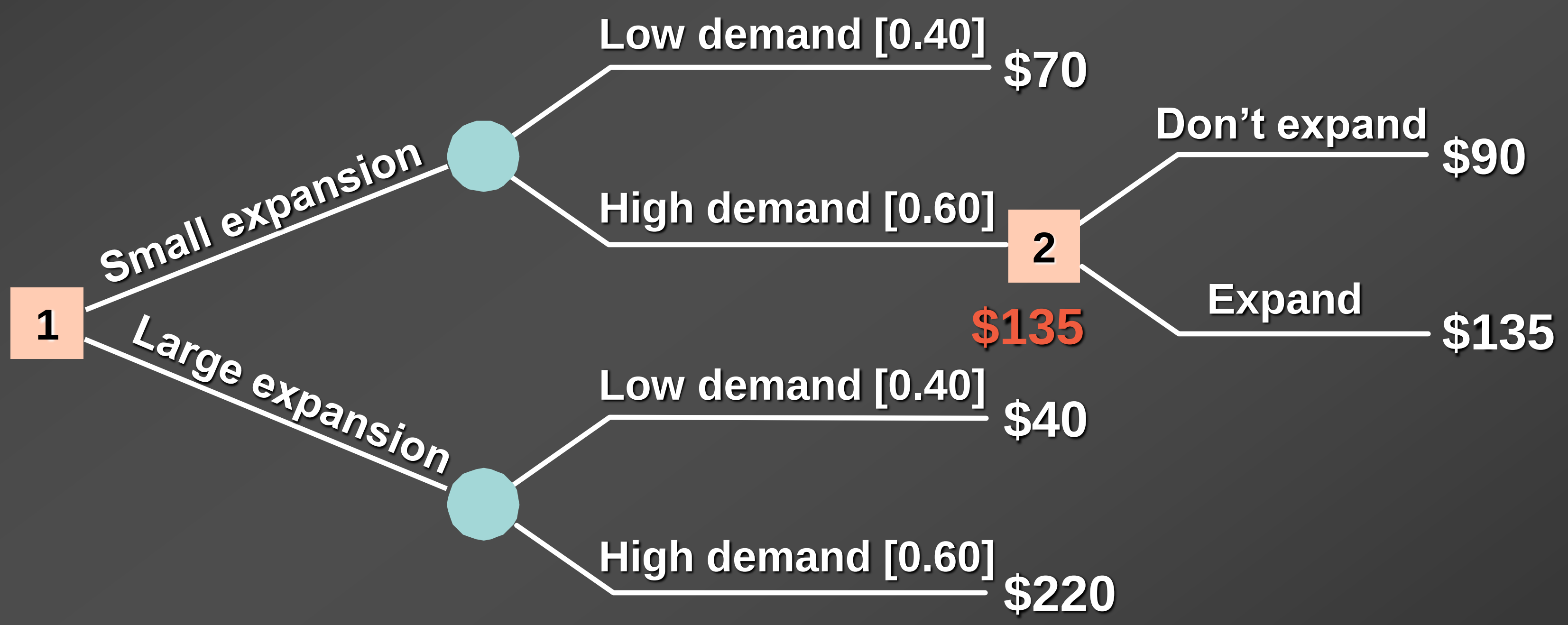


Figure 6.7

Capa

Decision T

Expected Payoff = Event * Event Probability

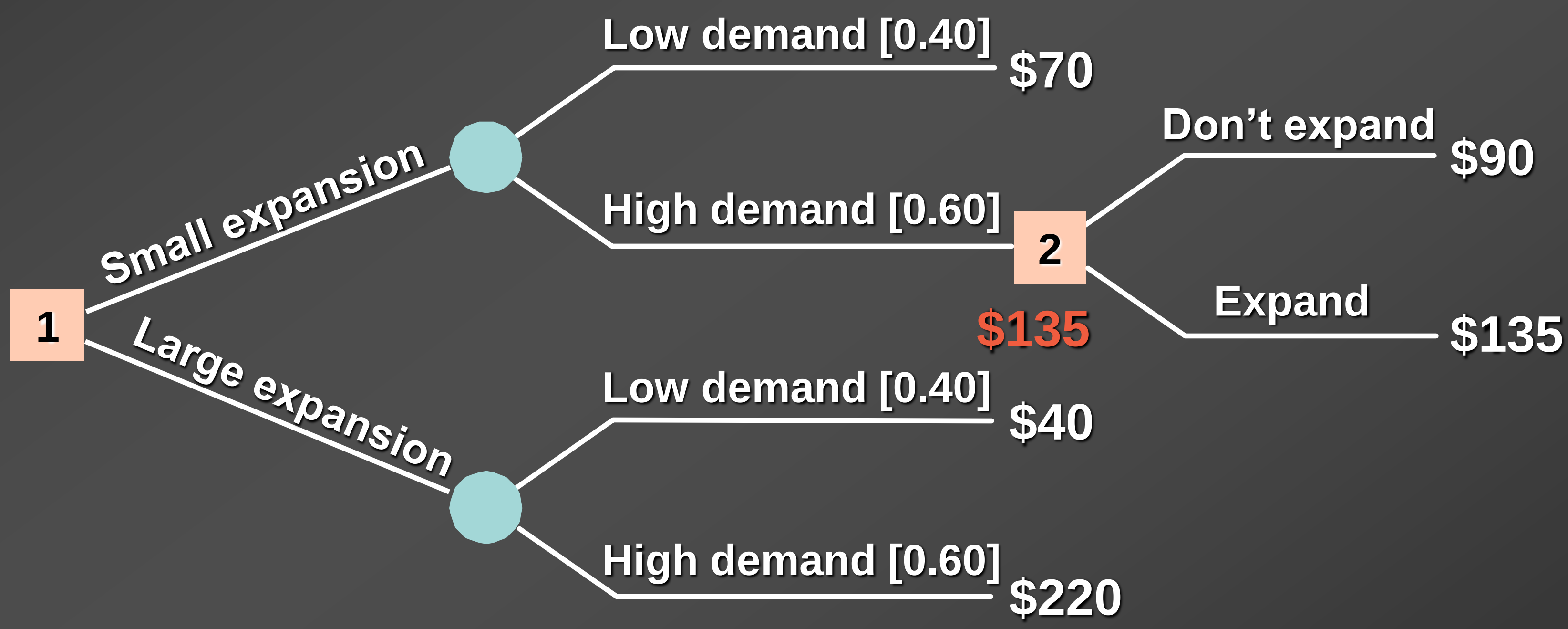


Figure 6.7

Expected Payoff = Event * Event Probability

Small/Low = $70 (0.40)

Capa

Decision

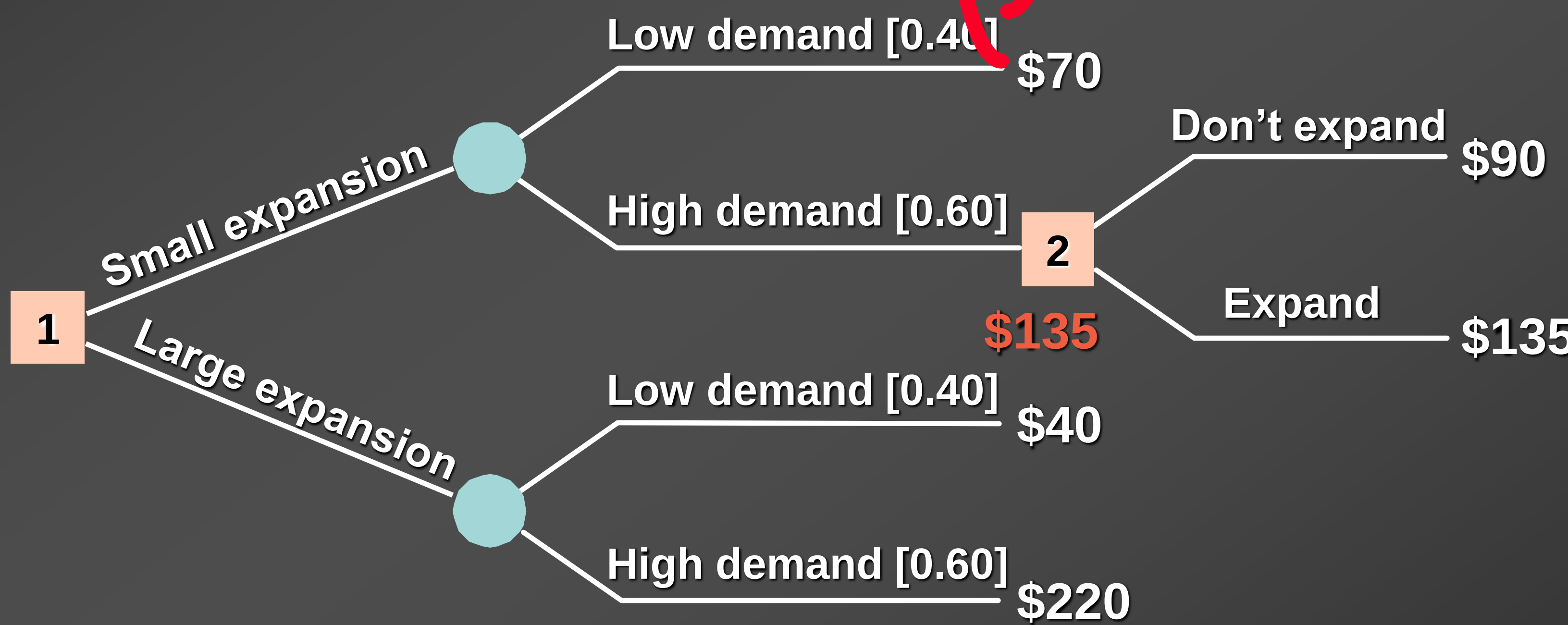


Figure 6.7

Capa

Decision T

Expected Payoff = Event * Event Probability

Small/Low = $70 (0.40) = $28

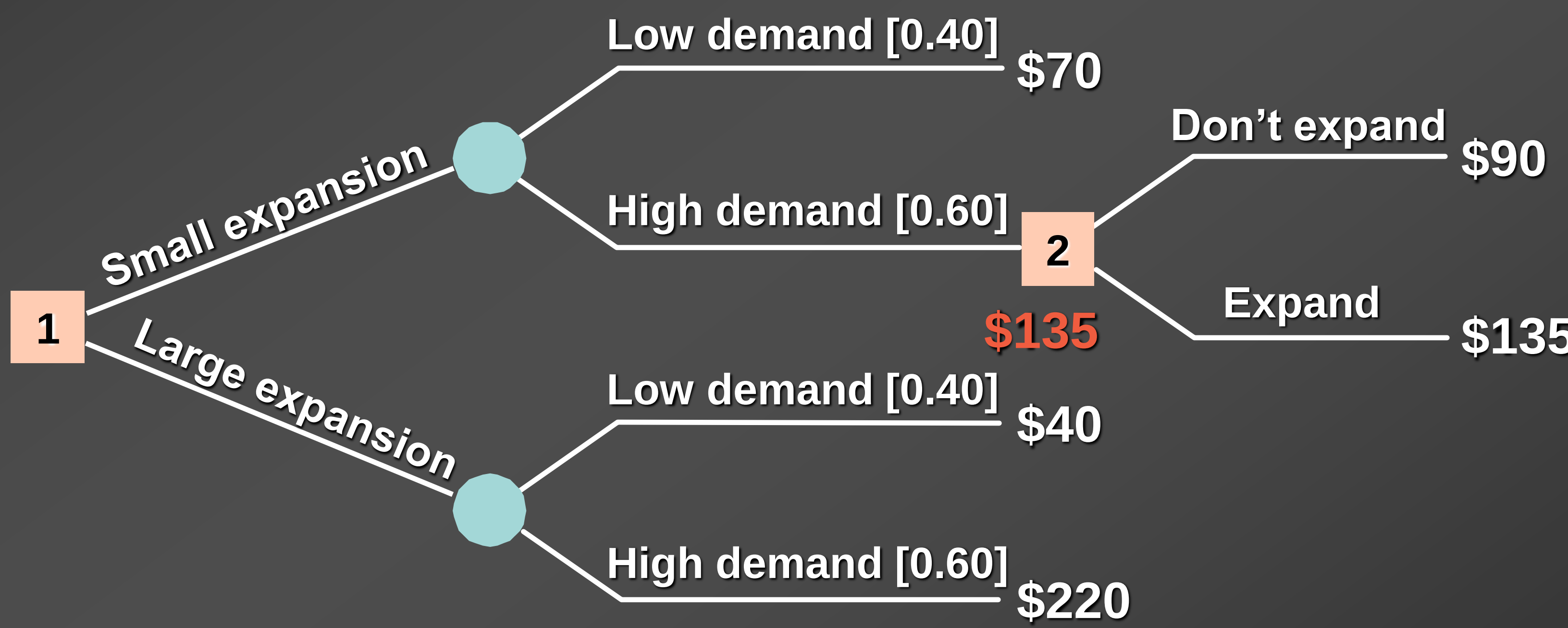


Figure 6.7

Capa

Decision

Expected Payoff = Event * Event Probability

Small/Low = $70 (0.40) = $28
Small/High = $135 (0.60)

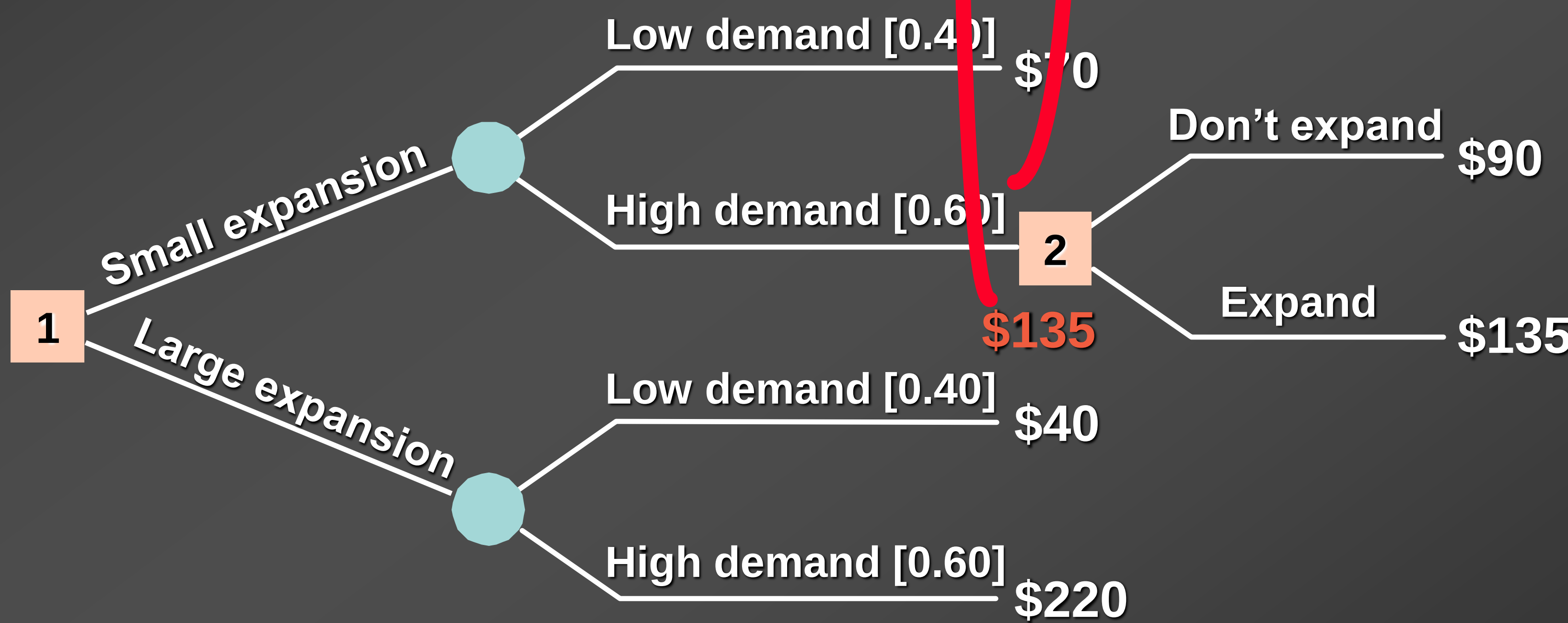


Figure 6.7

Capa

Decision T

Expected Payoff = Event * Event Probability

Small/Low = $70 (0.40) = $28
Small/High = $135 (0.60) = $81

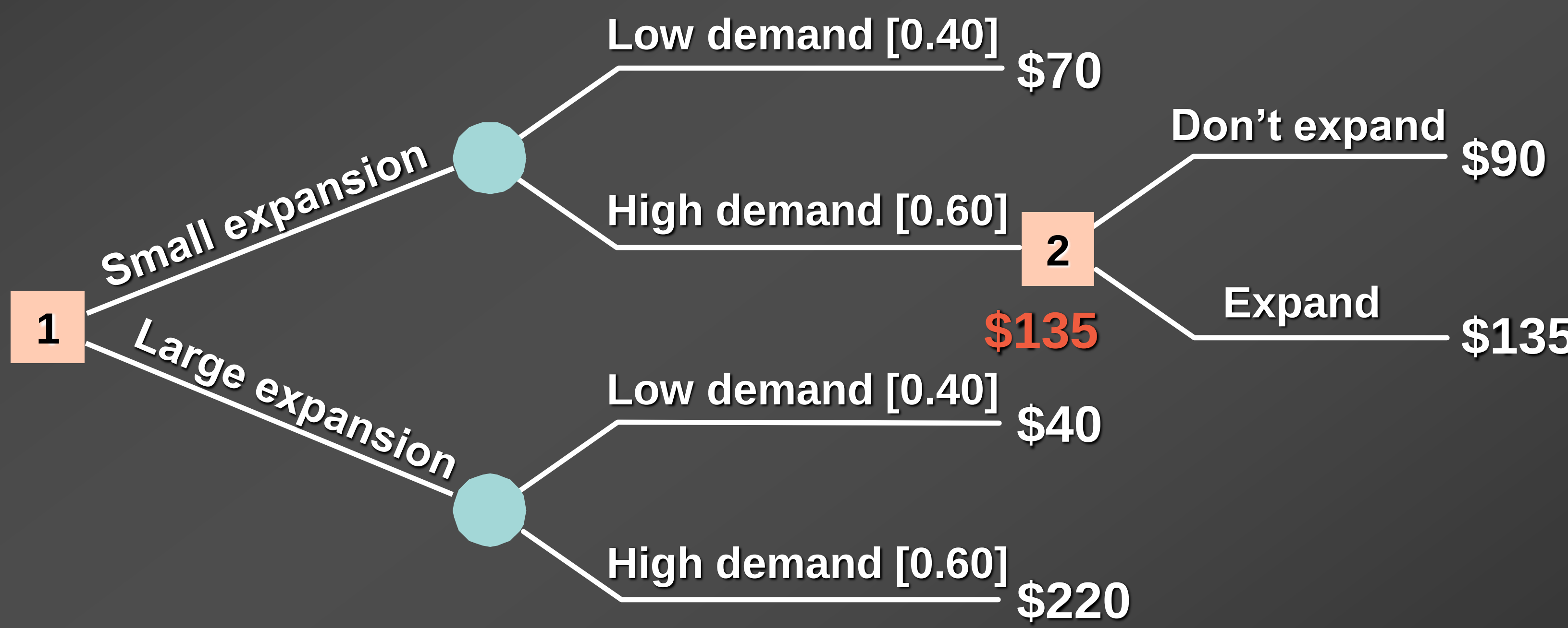


Figure 6.7

Capa

Decision T

Expected Payoff = Event * Event Probability

Small/Low = $70 (0.40) = $28
Small/High = $135 (0.60) = $81

Small = $28 + $81 = $109

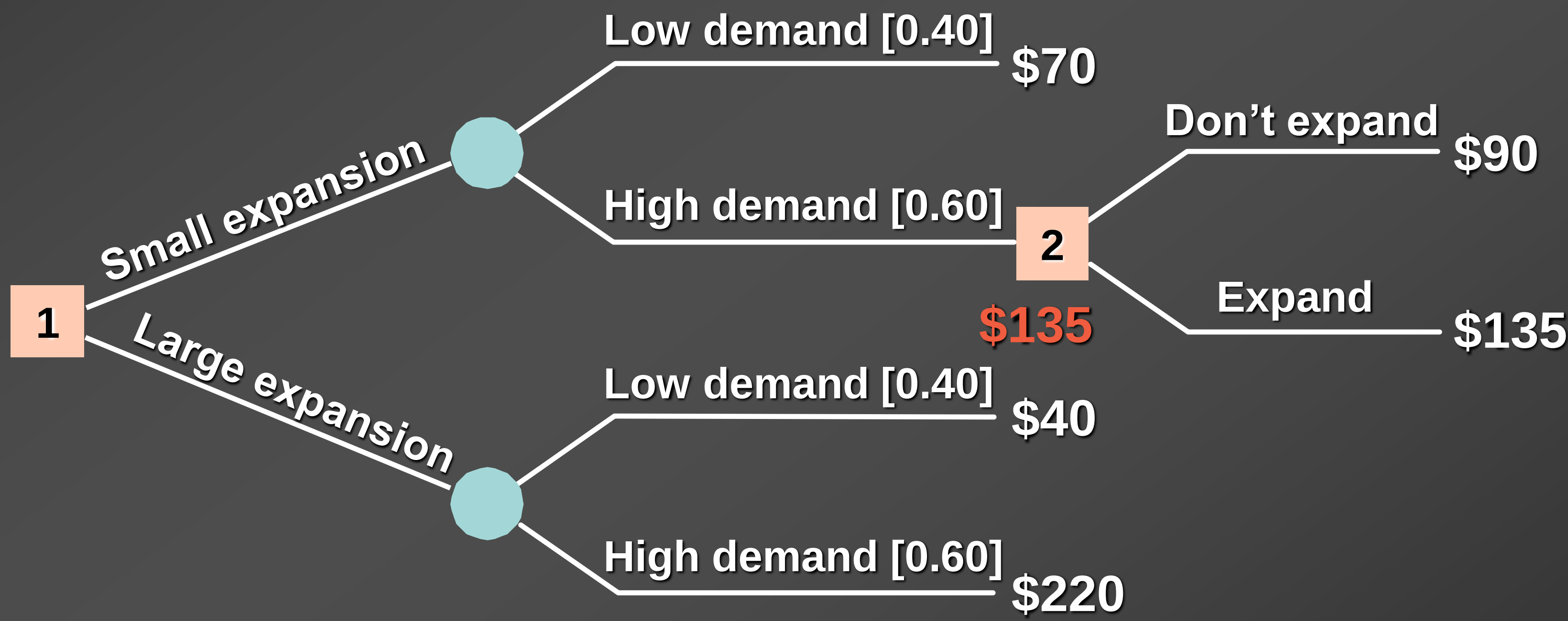


Figure 6.7

Capa

Decision T

Expected Payoff = Event * Event Probability

Small/Low = $70 (0.40) = $28
Small/High = $135 (0.60) = $81

Small = $28 + $81 = $109

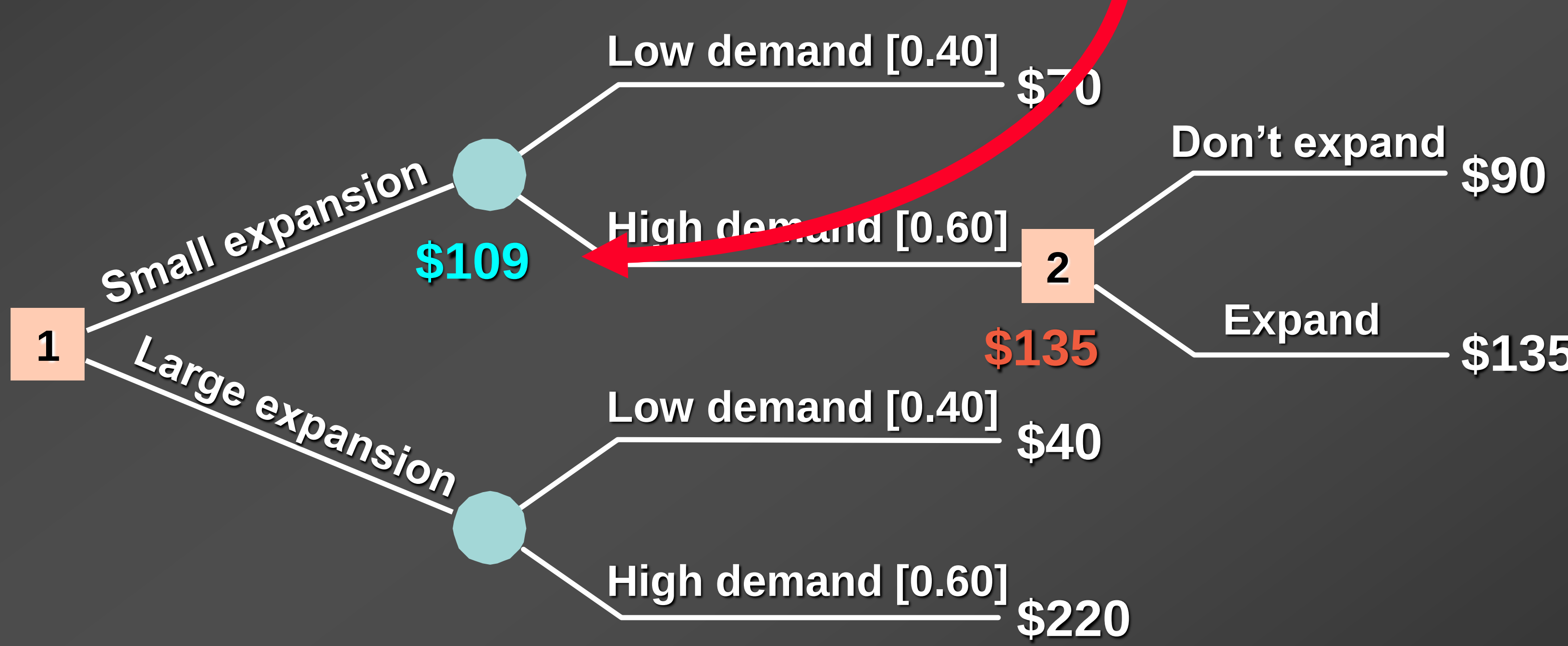


Figure 6.7

Capa

Decision T

Expected Payoff = Event * Event Probability

Small/Low = $70 (0.40) = $28
Small/High = $135 (0.60) = $81

Small = $28 + $81 = $109

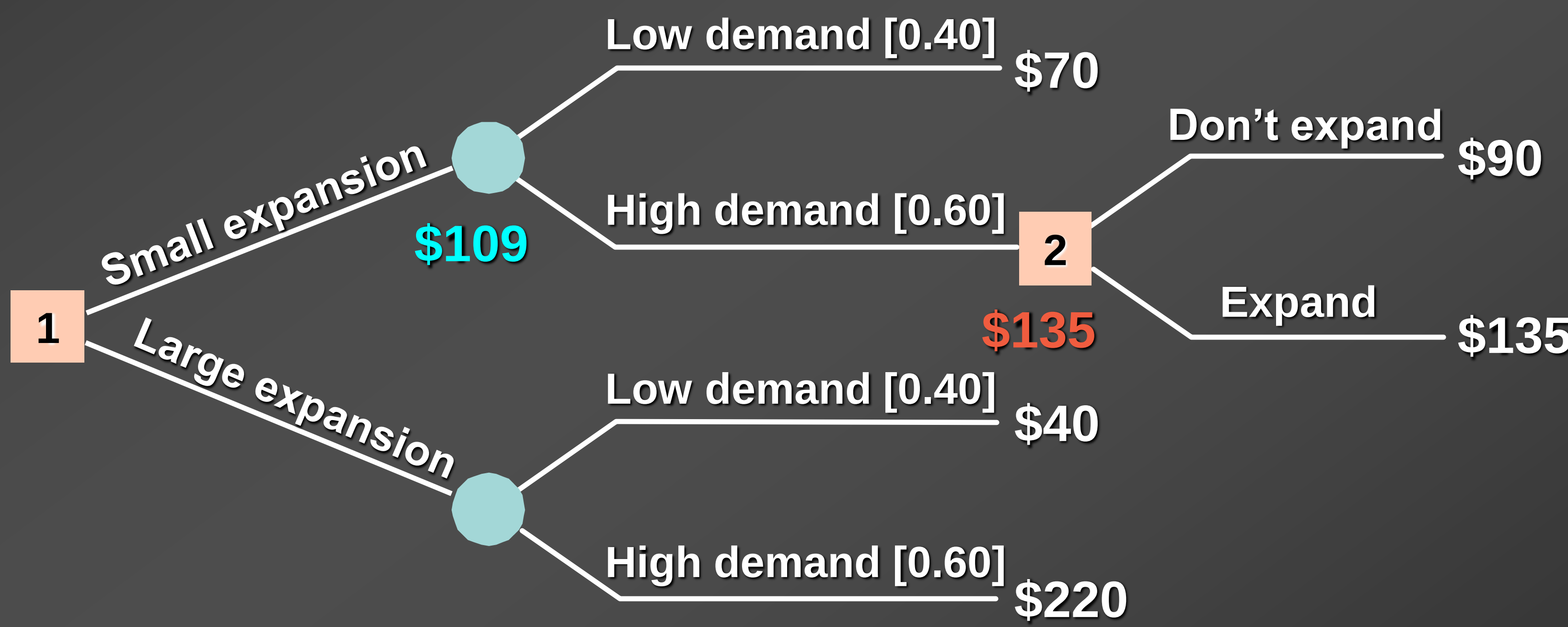


Figure 6.7

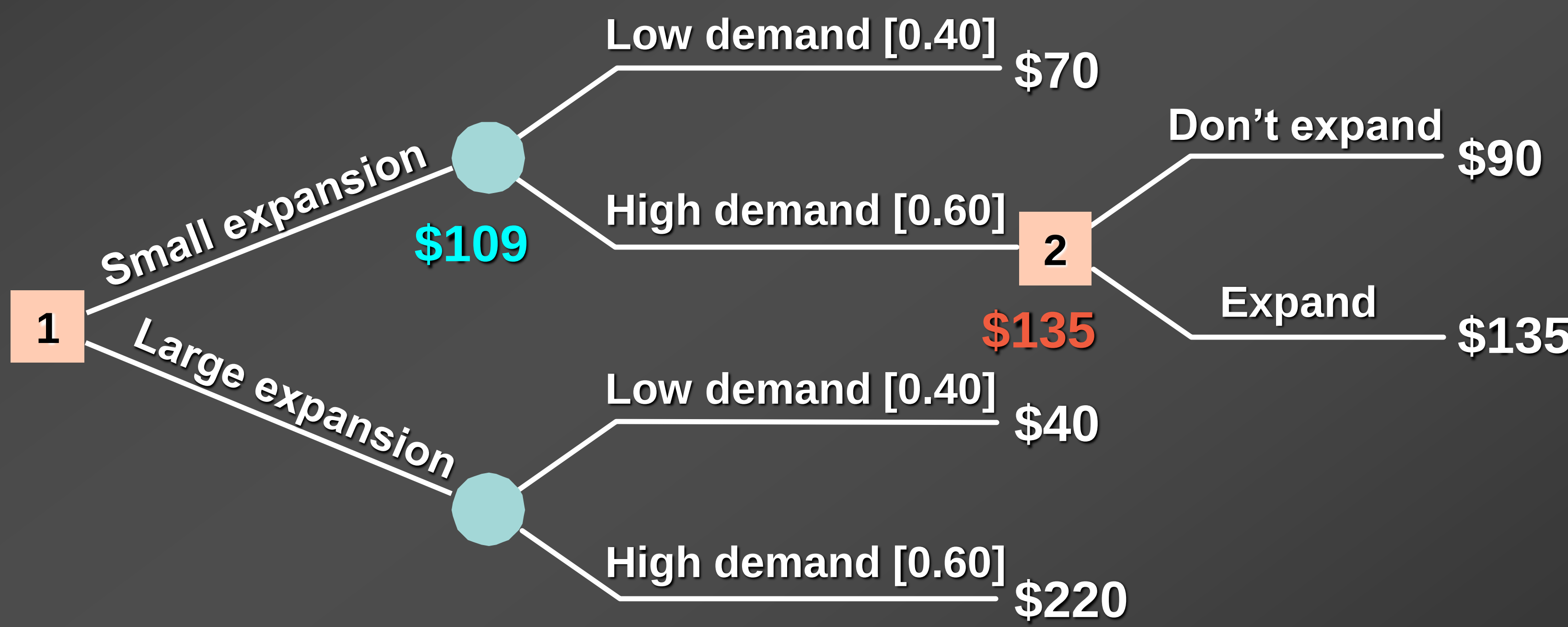
Capa

Decision T

Expected Payoff = Event * Event Probability

Large/Low = $40 (0.40) = $16
Large/High = $220 (0.60) = $132

Large = $16 + $132 = $148



Capa

Decision T

Expected Payoff = Event * Event Probability

Large/Low = $40 (0.40) = $16
Large/High = $220 (0.60) = $132

Large = $16 + $132 = $148

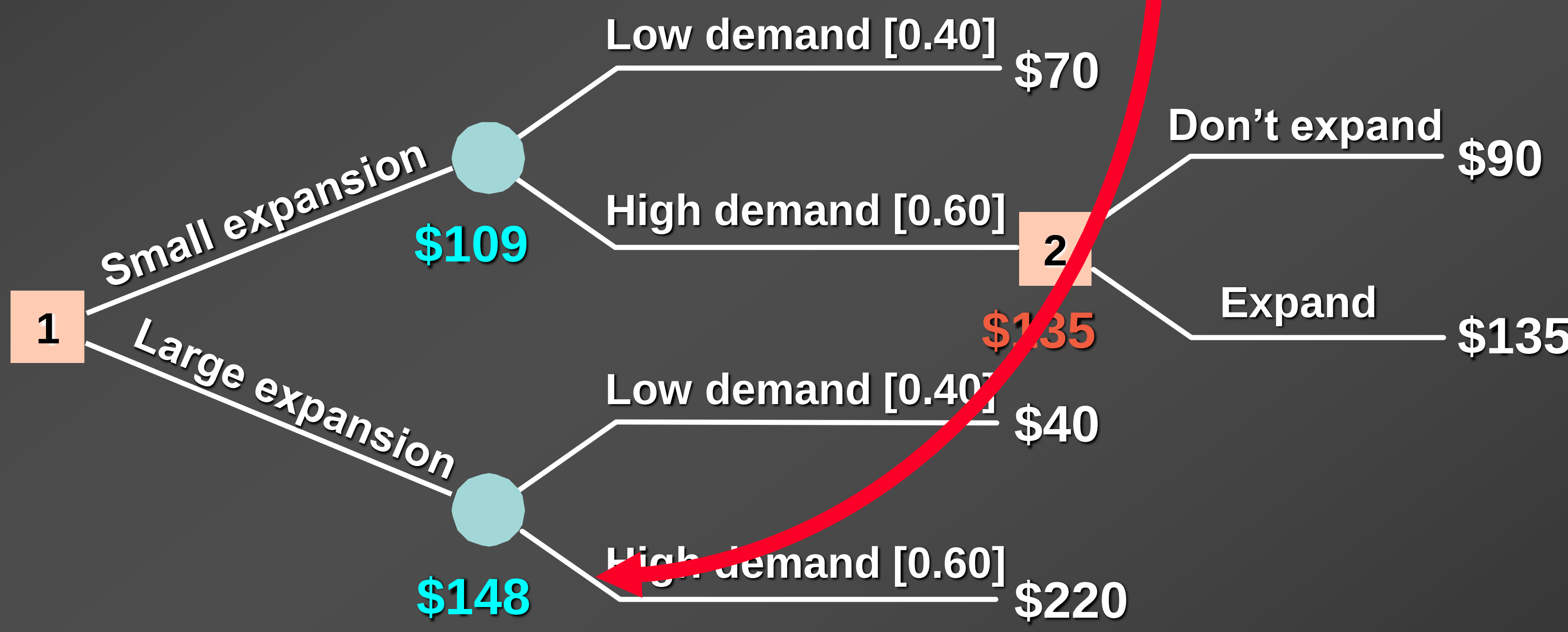
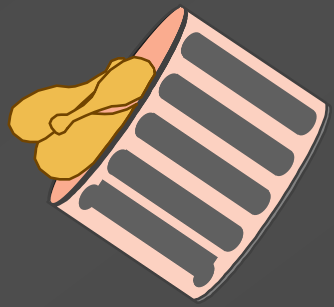


Figure 6.7

Capacity Decisions



Decision Trees

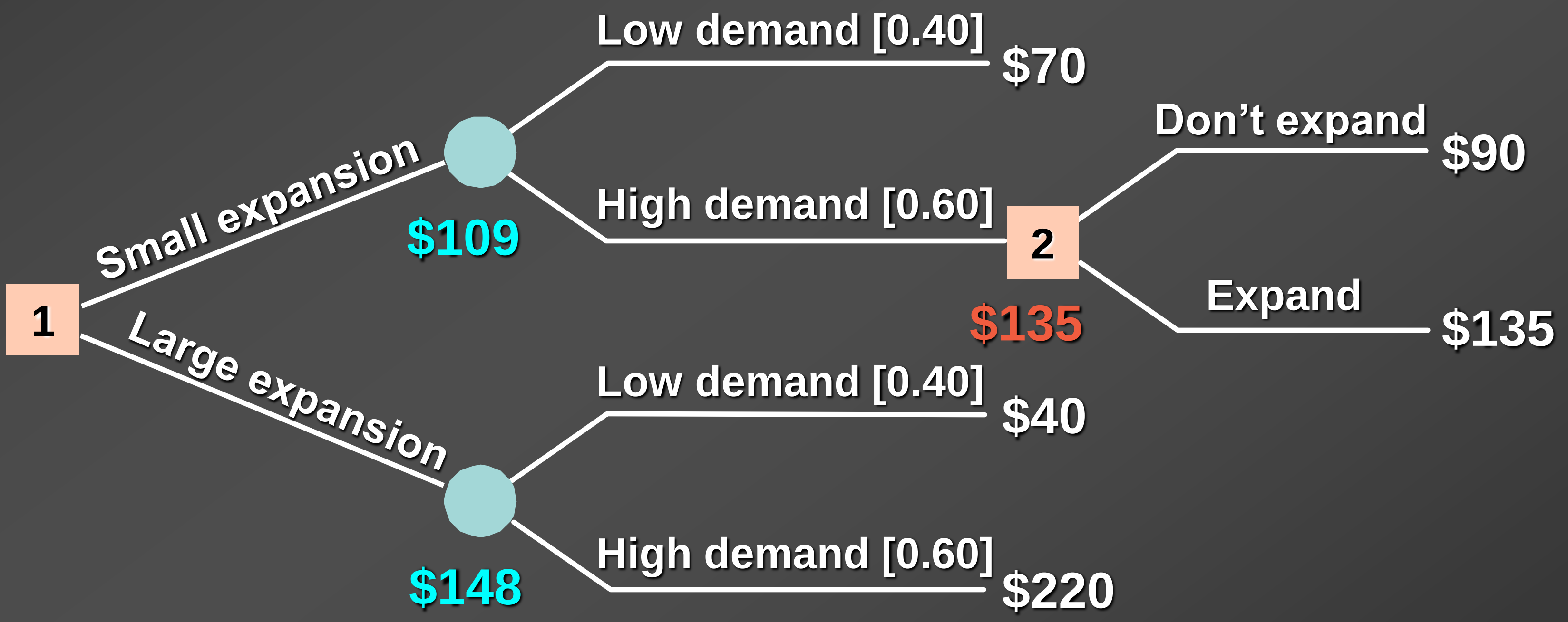
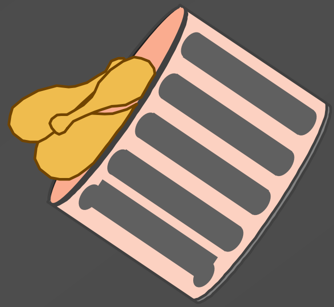


Figure 6.7

Capacity Decisions



Decision Trees

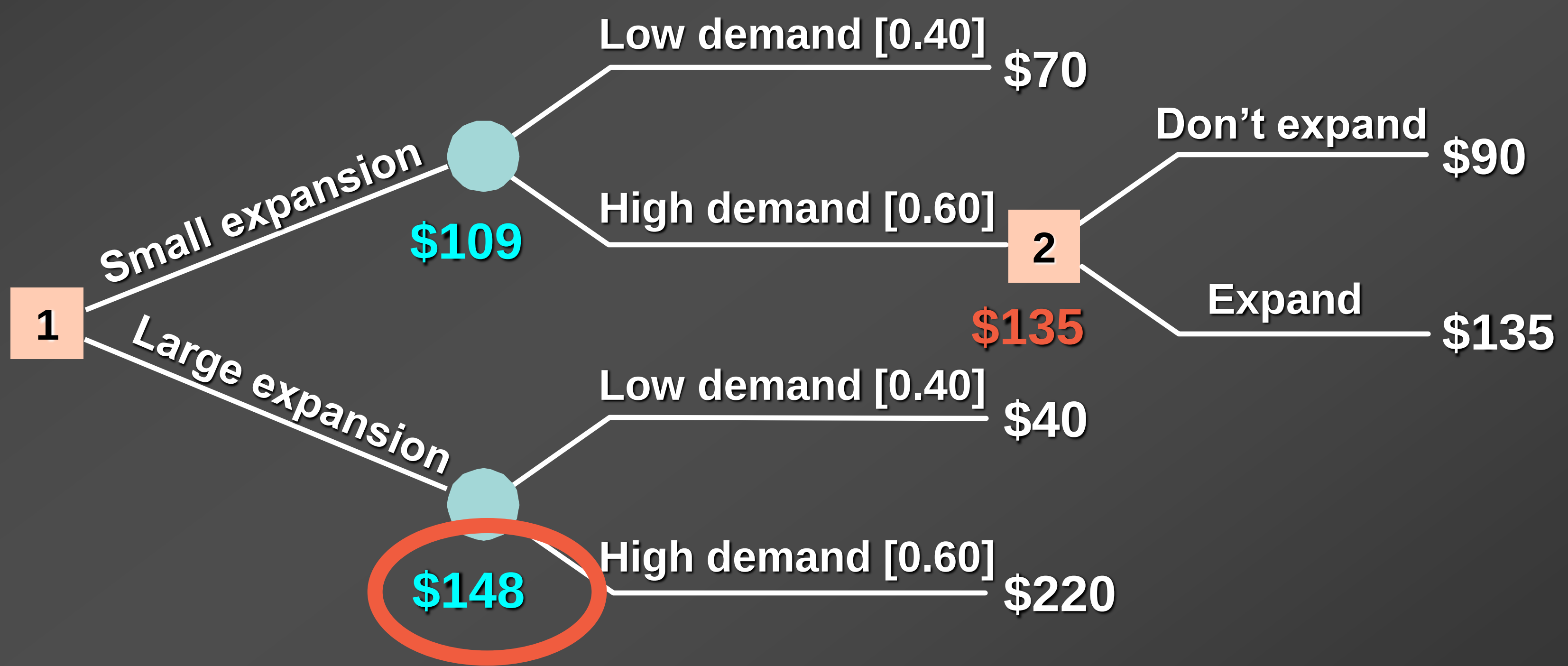
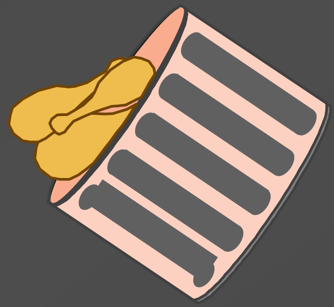


Figure 6.7

Capacity Decisions



Decision Trees

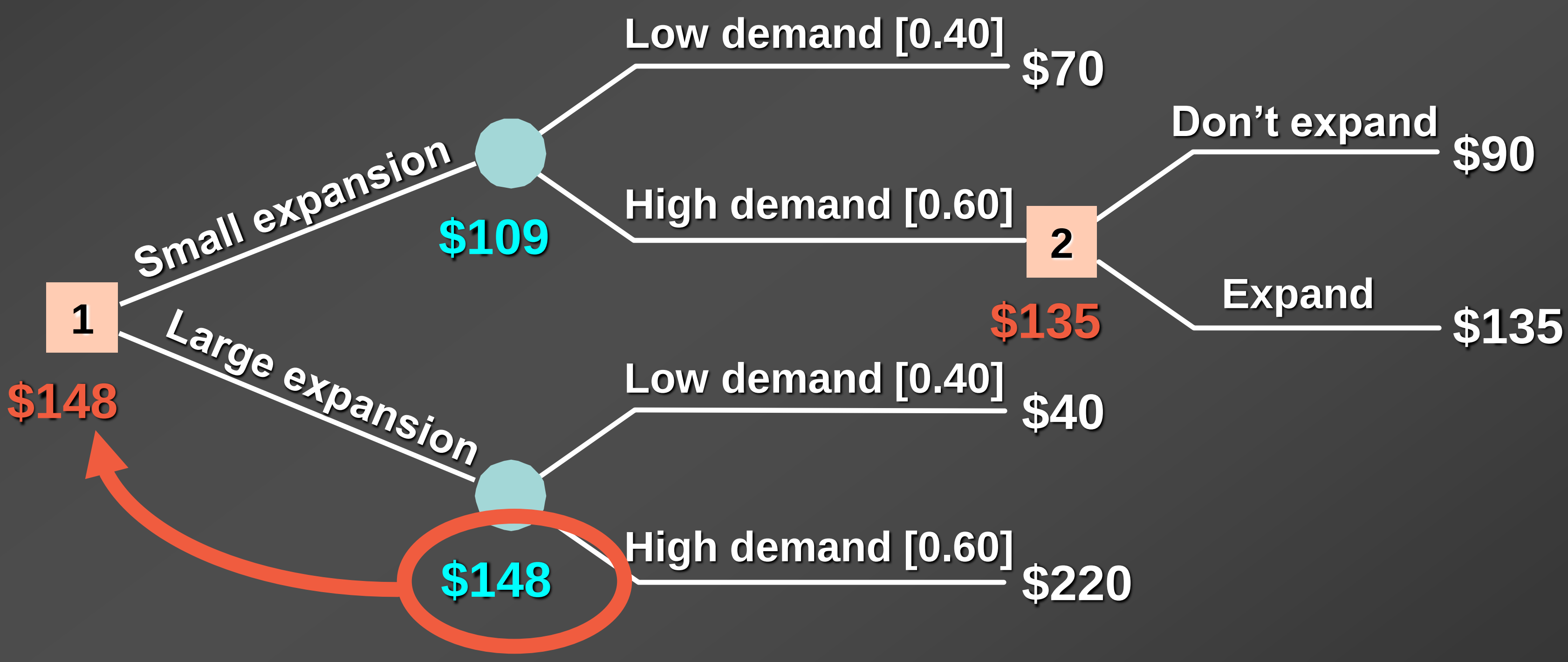
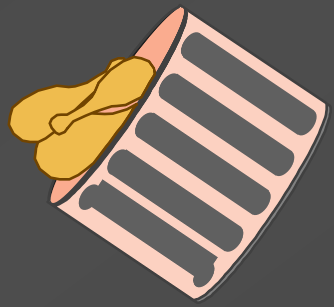


Figure 6.7

Capacity Decisions



Decision Trees

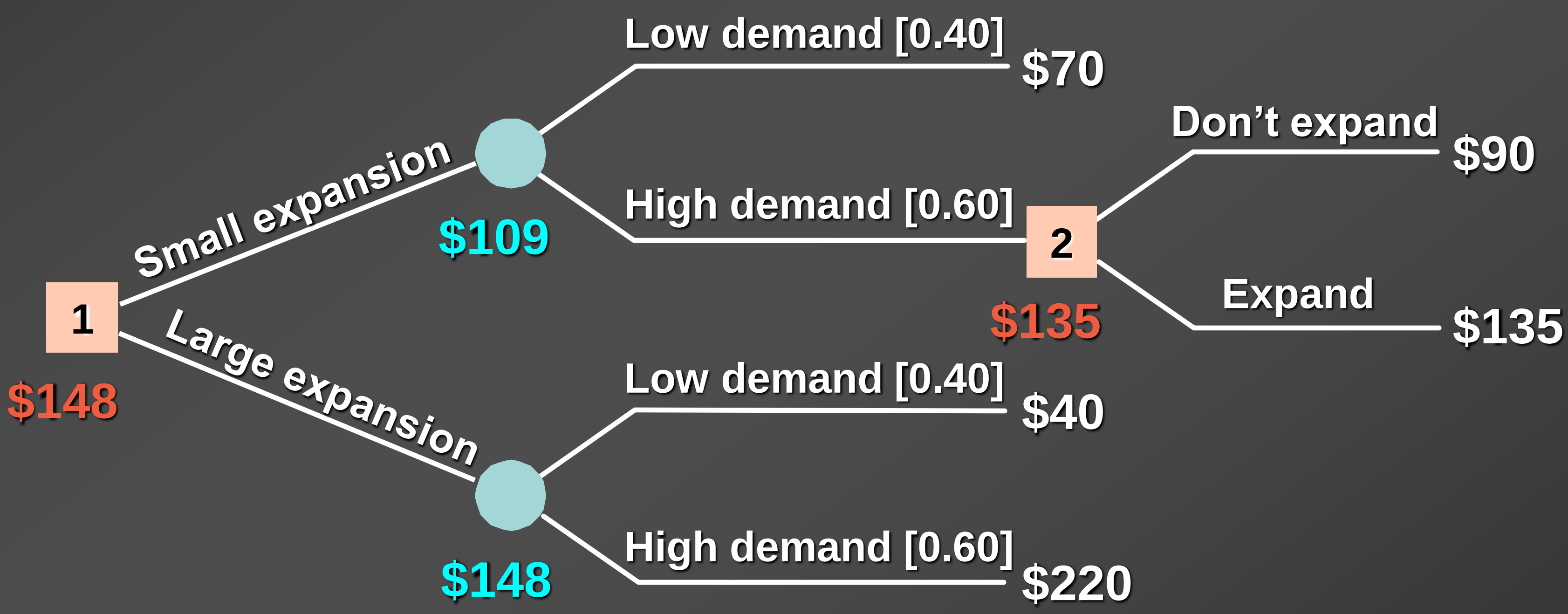


Figure 6.7

Problem 1

You have been asked to put together a capacity plan for a critical bottleneck operation at the Surefoot Sandal Company. Your capacity measure is number of machines. Three products (men's, women's, and children's sandals) are manufactured. The time standards (processing and setup), lot sizes, and demand forecasts are given in the following table. The firm operates two 8 hour shifts, 5 days per week, 50 weeks per year. Experience shows that a capacity cushion of 5 percent is sufficient :

	Time Standards			
Product	Processing (hr/pair)	Setup (hr/pair)	Lot Size (pairs/lot)	Demand Forecast (pairs/yr)
Men's sandals	0.05	0.5	240	80,000
Women's sandals	0.10	2.2	180	60,000
Children's sandals	0.02	3.8	360	120,000

a. How many machines are needed?
b. If the operation currently has two machines, what is the capacity gap?

Problem 2

The base case for Grandmother's Chicken Restaurant (see Example 6.3) is to do nothing. The capacity of the kitchen in the base case is 80,000 meals per year. A capacity alternative for Grandmother's Chicken Restaurant is a two-stage expansion. This alternative expands the kitchen at the end of year 0, raising its capacity from 80,000 meals per year to that of the dining area (105,000 meals per year). If sales in year 1 and 2 live up to expectations, the capacities of both the kitchen and the dining room will be expanded at the *end* of year 3 to 130,000 meals per year. This upgraded capacity level should suffice up through year 5. The initial investment would be $80,000 at the end of year 0 and an additional investment of $170,000 at the end of year 3. The pretax profit is $2 per meal. What are the pretax cash flows for this alternative through year if compared with the base case?

Capacity Decisions

Solved Problem 1

Figure 6.8(a)

Solver - Capacity Requirements

Enter data in yellow-shaded areas.

Shifts/Day	2
Hours/Shift	8
Days/Week	5
Weeks/Year	50
Cushion (as %)	5%
Current capacity	2

Components: 3

↑ More Components
↓ Fewer Components

Components	Processing (hr/unit)	Setup (hr/lot)	Lot Size (units/lot)	Demand Forecasts: Pessimistic	Demand Forecasts: Expected	Demand Forecasts: Optimistic
Men's sandals	0.05	0.5	240		80,000	
Women's sandals	0.10	2.2	180		60,000	
Children's sandals	0.02	3.8	360		120,000	

Productive hours from one capacity unit for a year: 3,800

Capacity Decisions

Solved Problem 1

Figure 6.8(b)

	Pessimistic		Expected		Optimistic	
	Process	Setup	Process	Setup	Process	Setup
Men's sandals	0	0.0	4,000	166.7	0	0.0
Women's sandals	0	0.0	6,000	733.3	0	0.0
Children's sandals	0	0.0	2,400	1,266.7	0	0.0
	0	0.0	12,400	2,166.7	0	0.0
Total hours required		0.0		14,566.7		0.0
Total capacity requirements (M)		0.00		3.83		0.00
Rounded		0		4		0
Scenarios that can be met with current systems/capacity:				Pessimistic, Optimistic		
If capacity increased by		0%				
Expanded current capacity		3,800				
Total capacity requirements (M)		0.00		3.83		0.00
Rounded		0		4		0
Scenarios that can be met with expanded current capacity:				Pessimistic, Optimistic		

Capacity Decisions

Solved Problem 2

TABLE 6.1				
CASH FLOWS FOR TWO-STAGE EXPANSION OF GRANDMOTHER'S CHICKEN RESTAURANT				
Year	Projected Demand (meals/yr)	Projected Capacity (meals/yr)	Calculation of Incremental Cash Flow Compared to Base Case (80,000 meals/yr)	Cash Inflow (outflow)
0	80,000	80,000	Increase kitchen capacity to 105,000 meals =	($80,000)
1	90,000	105,000	90,000 – 80,000 = (10,000 meals)($2/meal) =	$20,000
2	100,000	105,000	100,000 – 80,000 = (20,000 meals)($2/meal) =	$40,000
3	110,000	105,000	105,000 – 80,000 = (25,000 meals)($2/meal) =	$50,000
			Increase total capacity to 130,000 =	($170,000)
				($120,000)
4	120,000	130,000	120,000 – 80,000 = (40,000 meals)($2/meal) =	$80,000
5	130,000	130,000	130,000 – 80,000 = (50,000 meals)($2/meal) =	$100,000

PLANNING HORIZONS

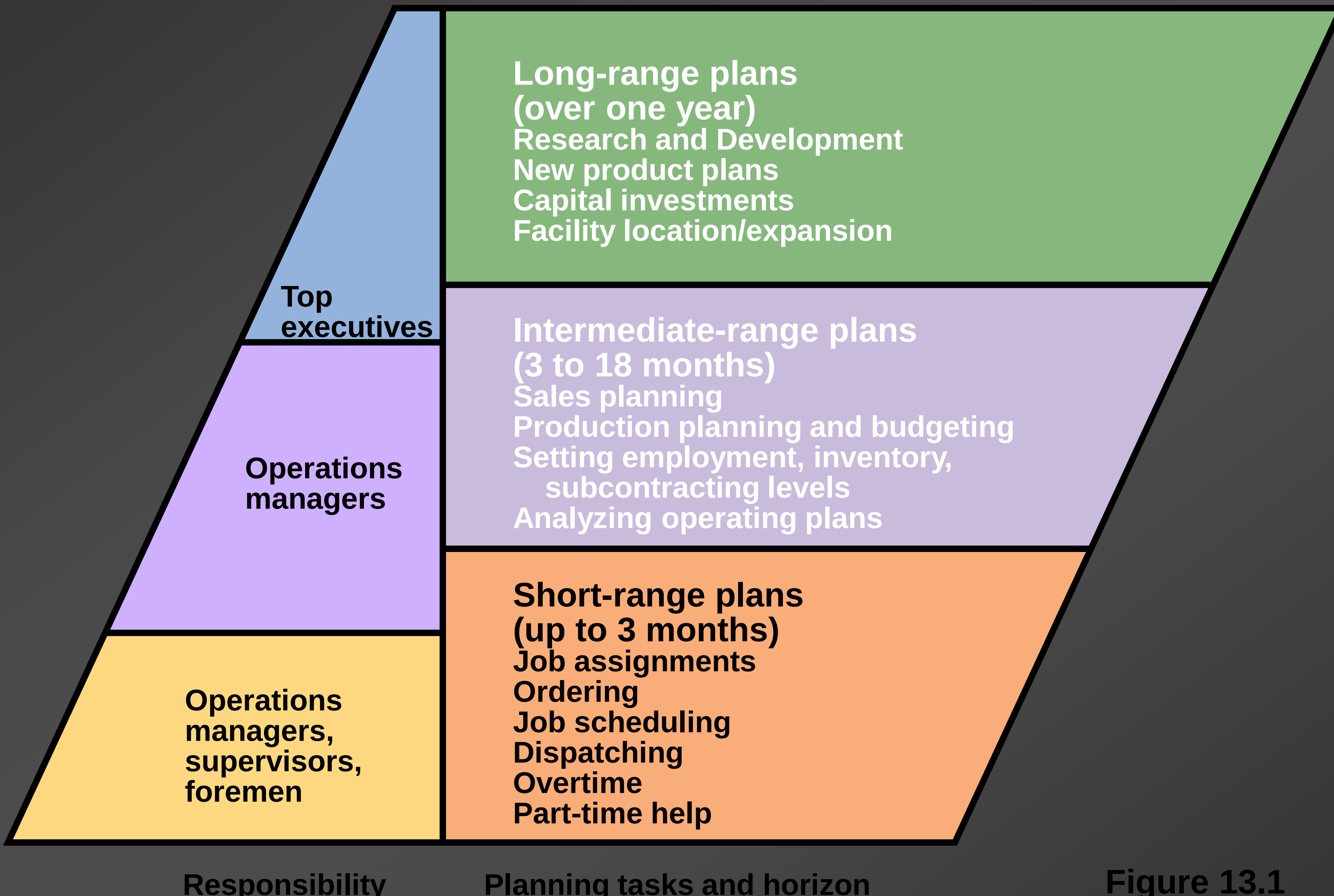


Figure 13.1

Aggregate Planning

Quarter 1		
Jan	Feb	Mar
150,000	120,000	110,000

Quarter 2		
Apr	May	Jun
100,000	130,000	150,000

Quarter 3		
Jul	Aug	Sep
180,000	150,000	140,000

Planning Relationships

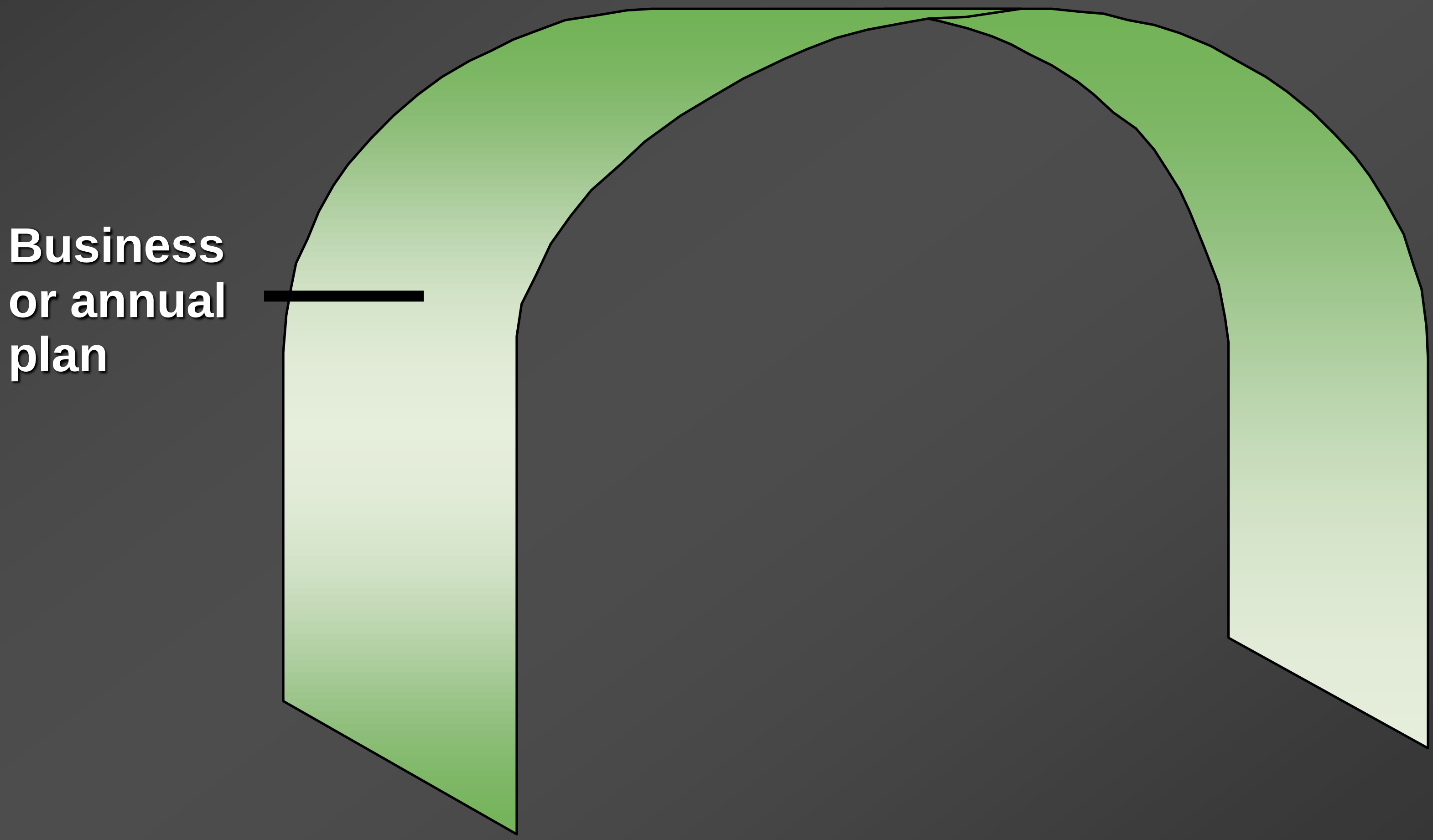


Figure 14.1

Planning Relationships

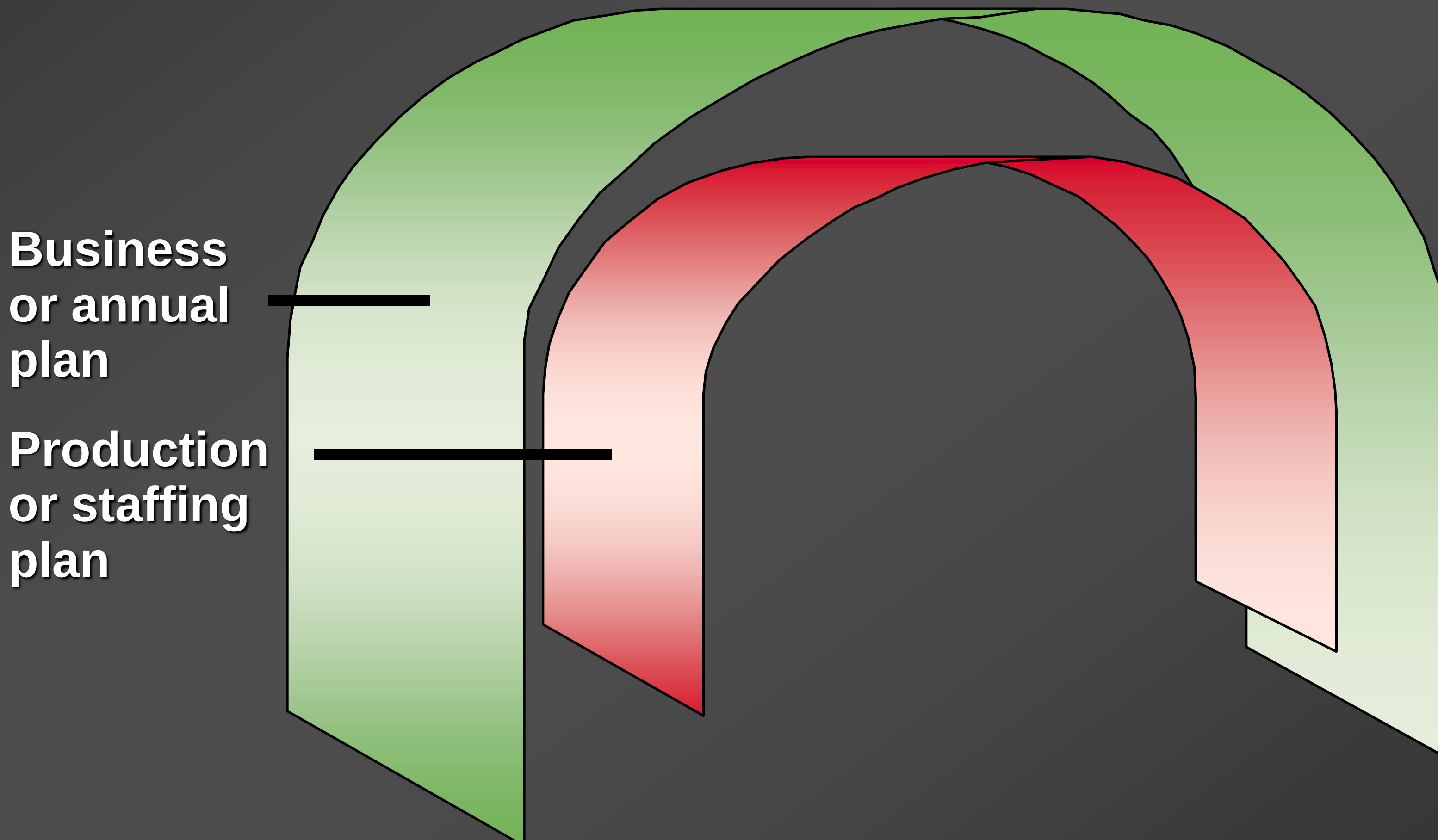
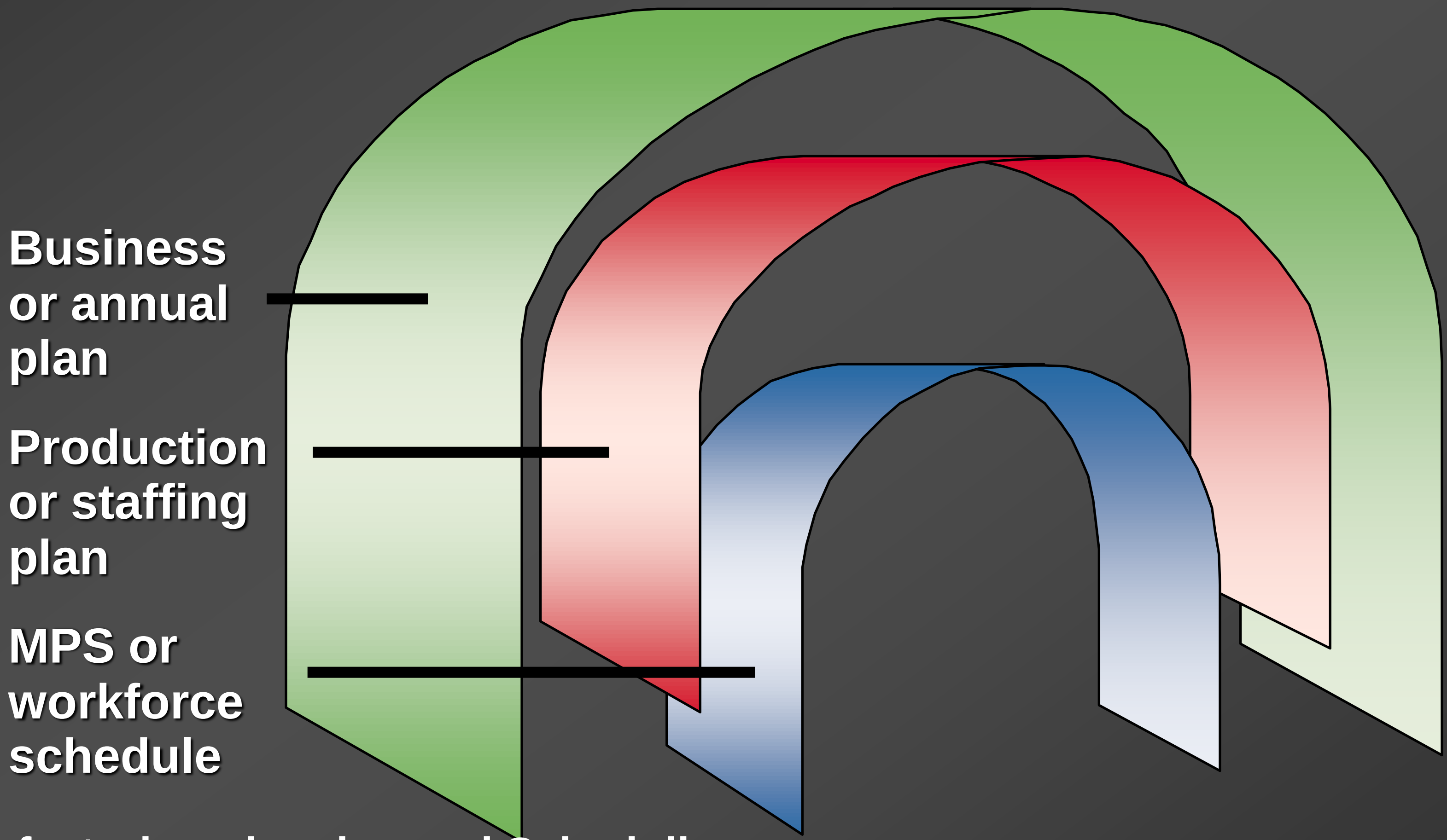


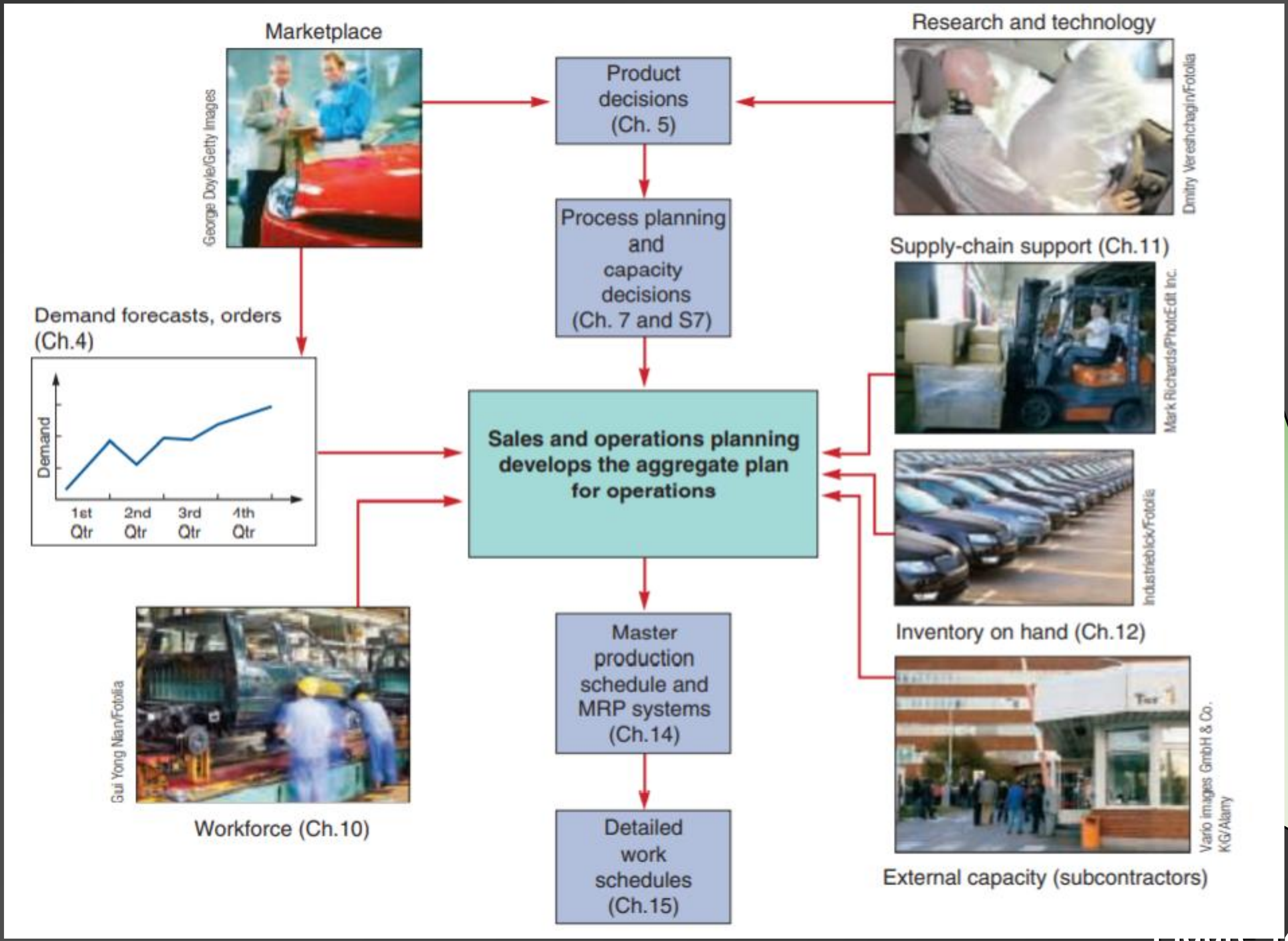
Figure 14.1

Planning Relationships



Manufacturing planning and Scheduling

Figure 14.1



Marketplace
George Doyle/Getty Images
Product decisions (Ch. 5)
Research and technology
Dmitry Vereshchagin/Fotolia
Process planning and capacity decisions (Ch. 7 and S7)
Supply-chain support (Ch.11)
Mark Richards/PhotoEdit Inc.
Demand forecasts, orders (Ch.4)
Demand
1st Qtr
2nd Qtr
3rd Qtr
4th Qtr
Sales and operations planning develops the aggregate plan for operations
Industrieblick/Fotolia
Inventory on hand (Ch.12)
Master production schedule and MRP systems (Ch.14)
Gui Yong Nian/Fotolia
Workforce (Ch.10)
Vario images GmbH & Co. KG/Alamy
Detailed work schedules (Ch.15)
External capacity (subcontractors)

Figure 14.1

Planning Relationships

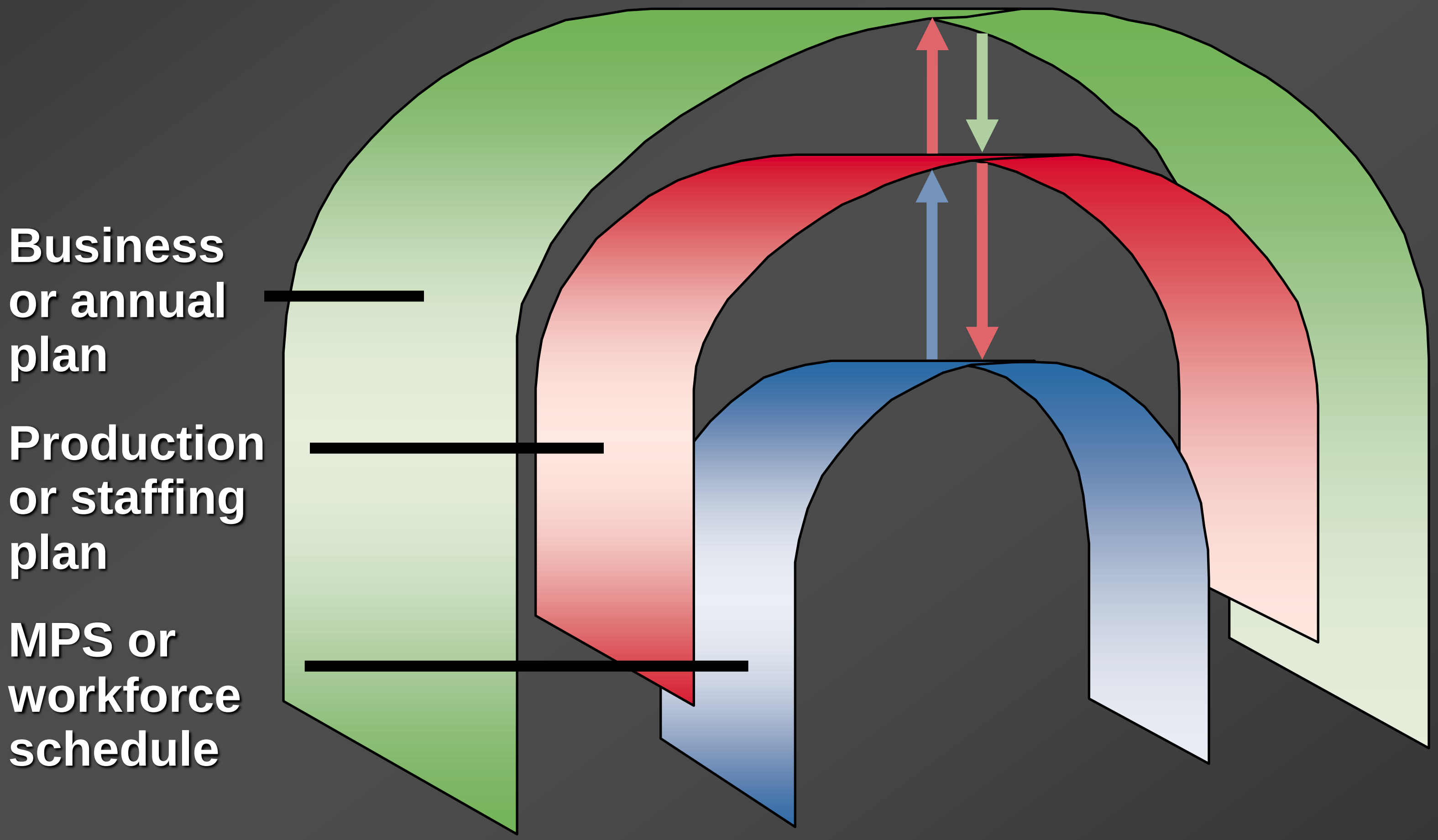


Figure 14.1

Managerial Inputs

Figure 14.2

Managerial Inputs

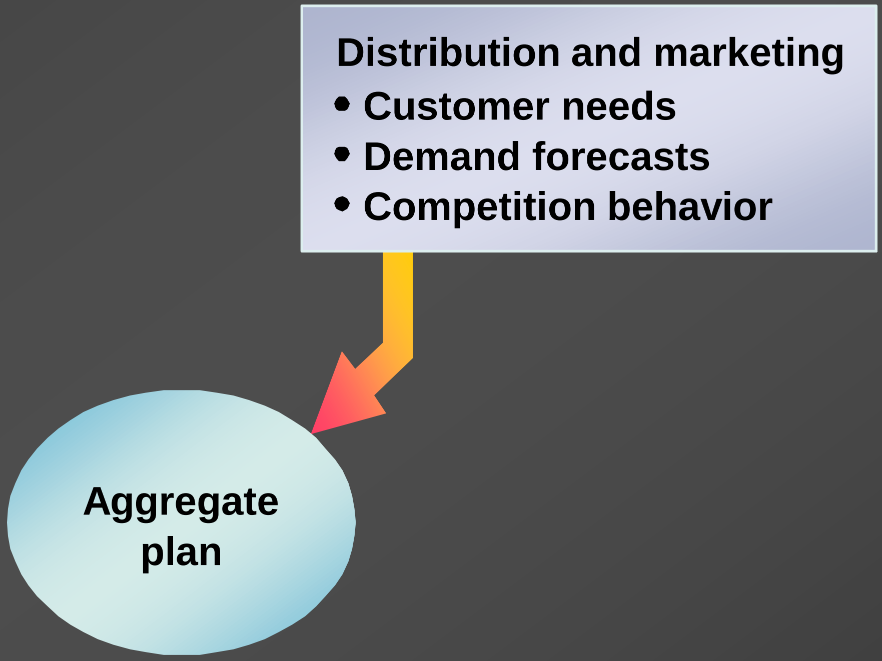


Figure 14.2

Managerial Inputs

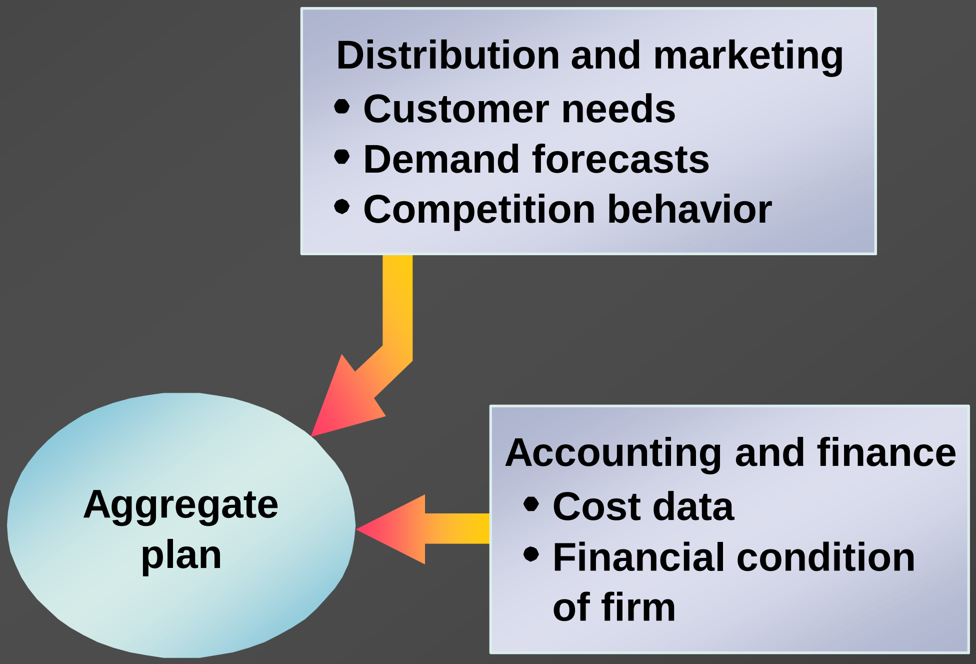


Figure 14.2

Managerial Inputs

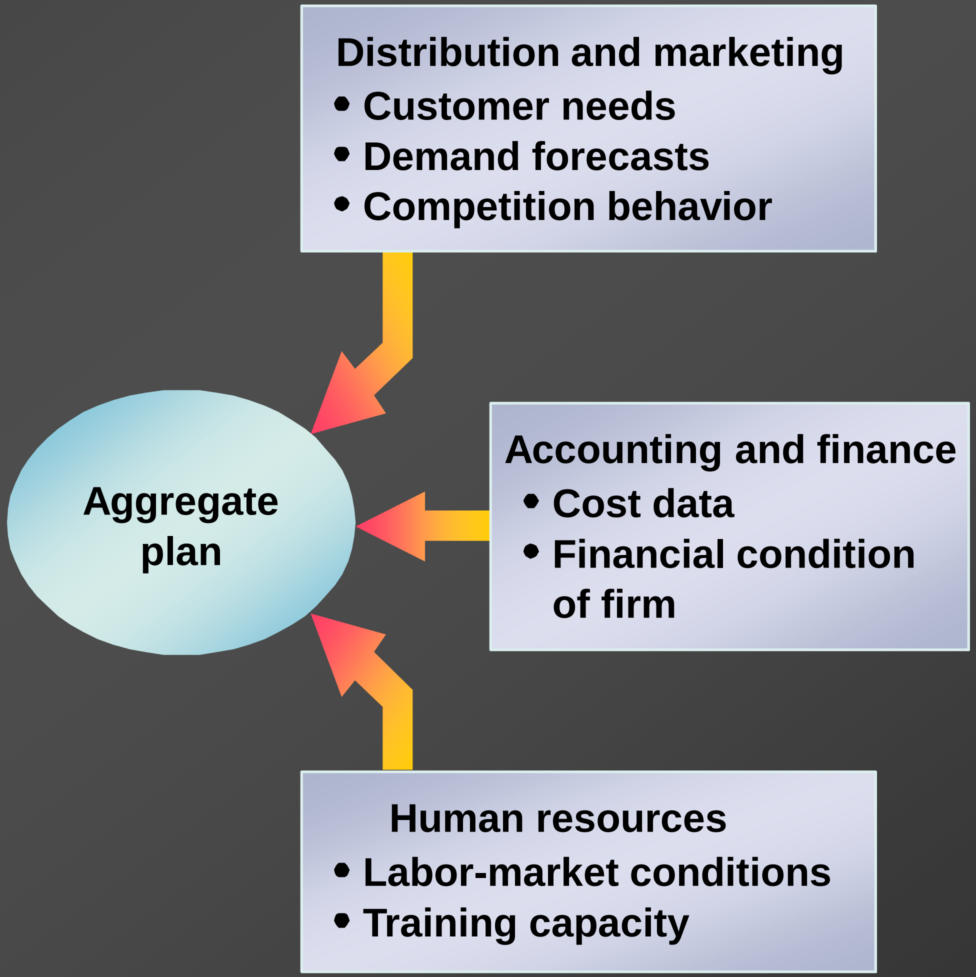


Figure 14.2

Managerial Inputs

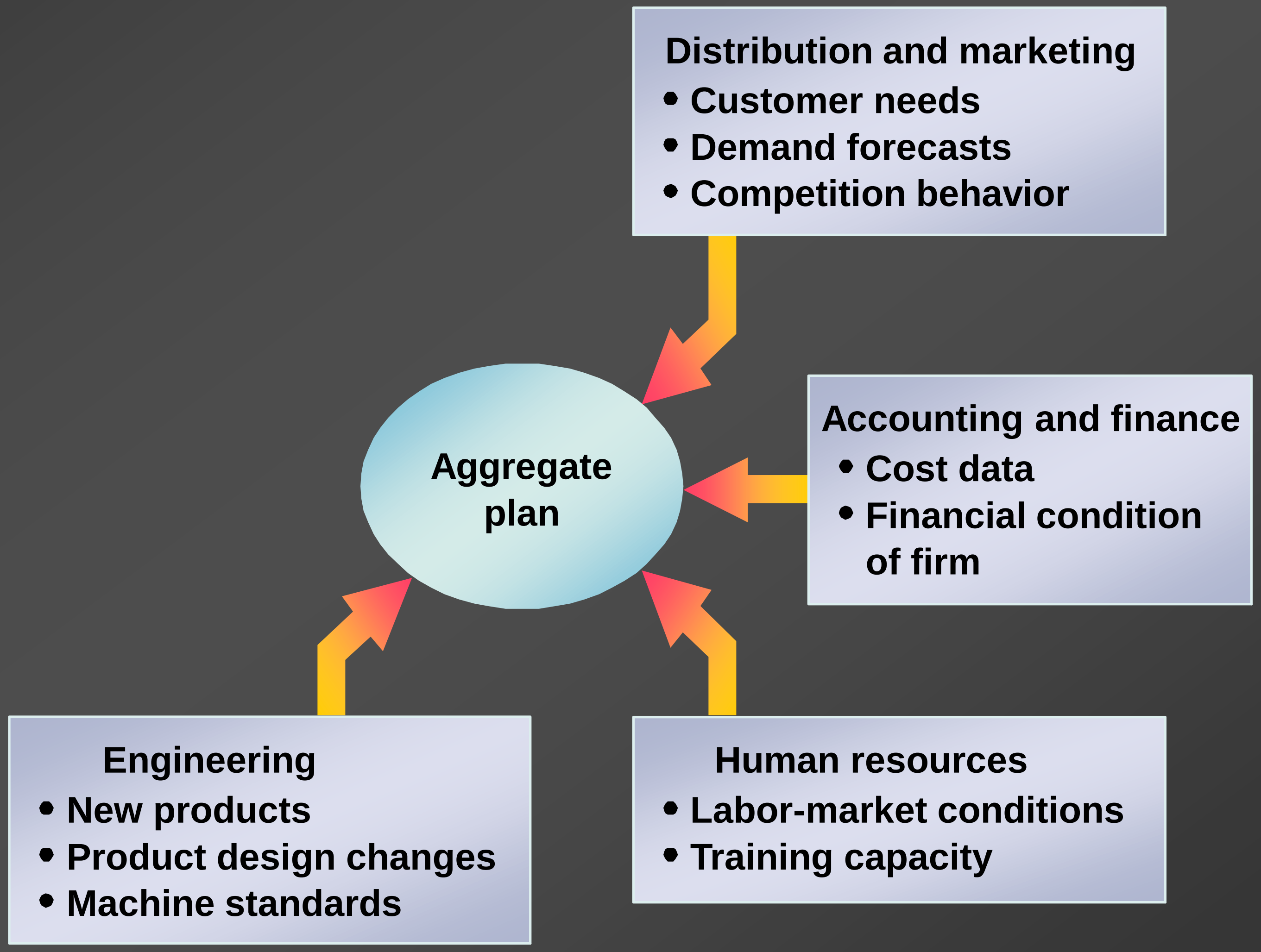


Figure 14.2

Managerial Inputs

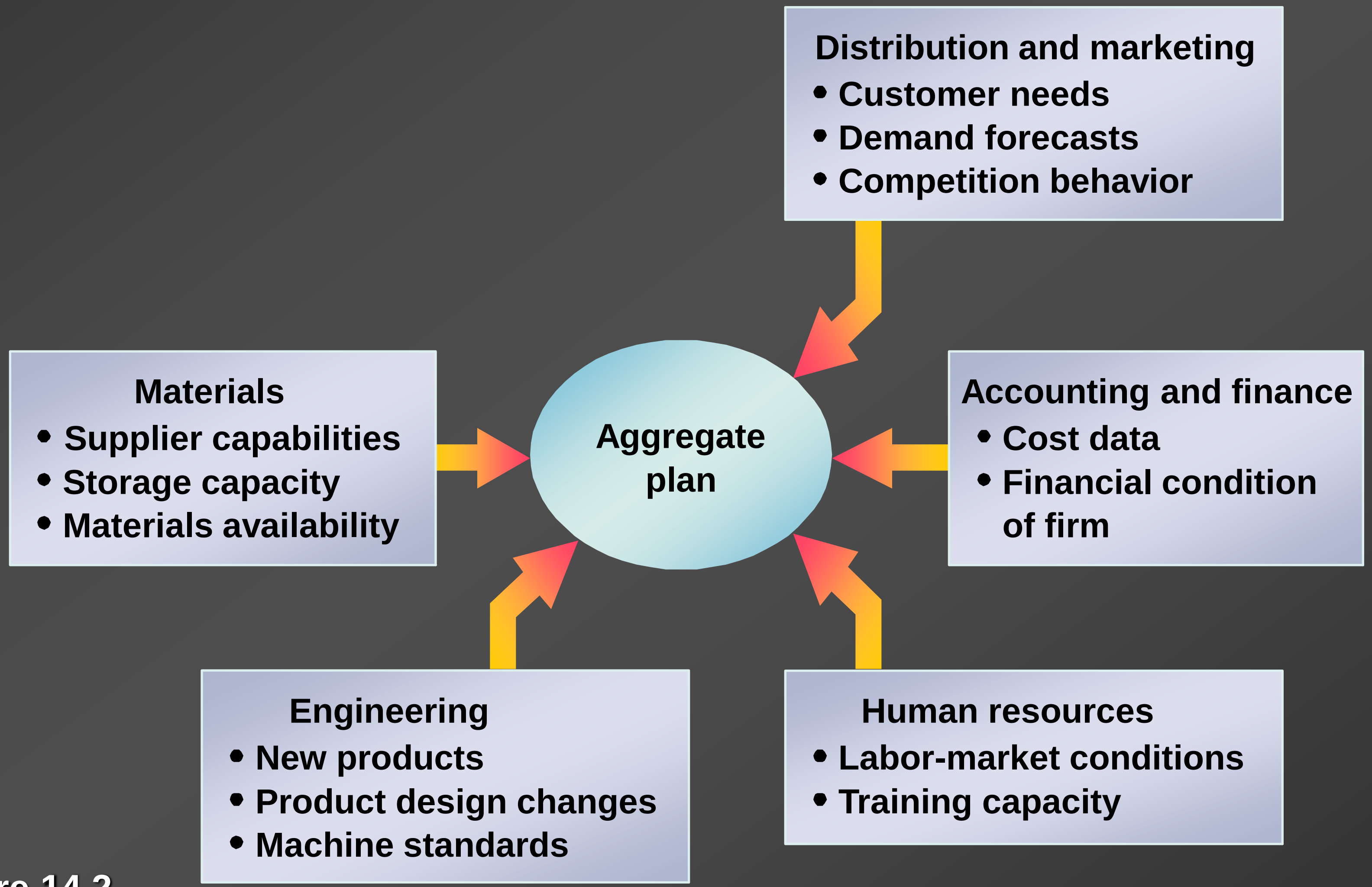


Figure 14.2

Managerial Inputs

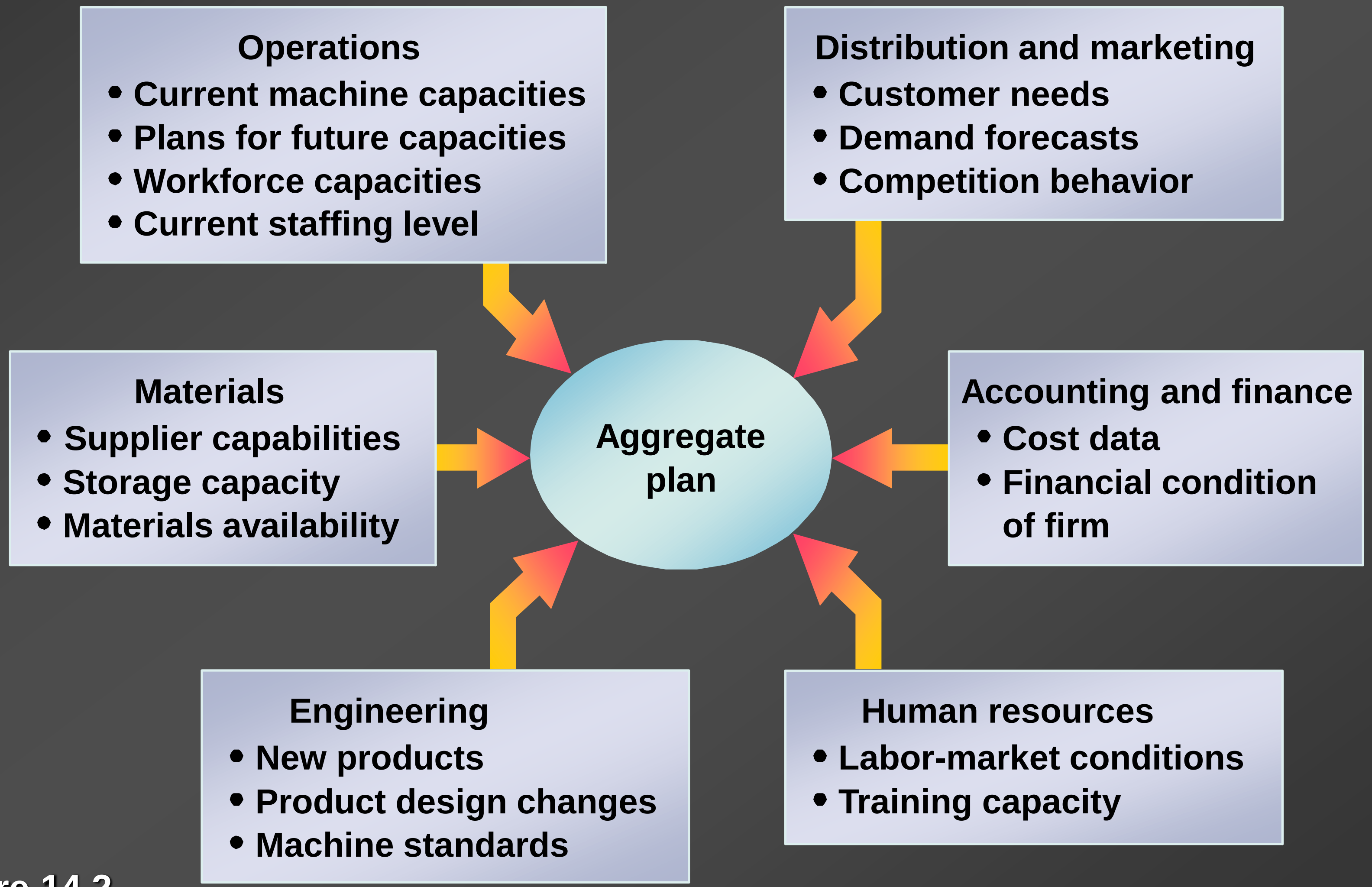
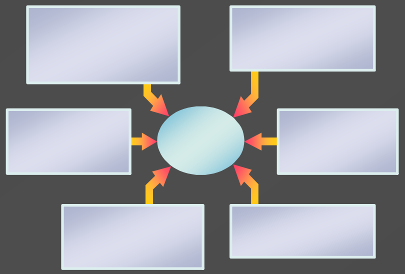


Figure 14.2

Aggregate Planning Objectives



- Minimize Costs/Maximize Profits
- Maximize Customer Service
- Minimize Inventory Investment
- Minimize Changes in Production Rates
- Minimize Changes in Workforce Levels
- Maximize Utilization of Plant and Equipment

Aggregate Planning Strategies

TABLE 14.1 PLANNING STRATEGIES FOR AGGREGATE PLANS

Strategy	Possible Alternatives during Slack Season	Possible Alternatives during Peak Season
1. Chase #1: vary workforce level to match demand	Layoffs	Hiring
2. Chase #2: vary output rate to match demand	Layoffs, undertime, vacations	Hiring, overtime, subcontracting
3. Level #1: constant workforce level	No layoffs, building anticipation inventory, undertime, vacations	No hiring, depleting anticipation inventory, overtime, subcontracting, backorders, stockouts
4. Level #2: constant output rate	Layoffs, building anticipation inventory, undertime, vacations	Hiring, depleting anticipation inventory, overtime, subcontracting, backorders, stockouts

Aggregate Planning Process

Determine requirements for planning horizon

Figure 14.3

Aggregate Planning Process

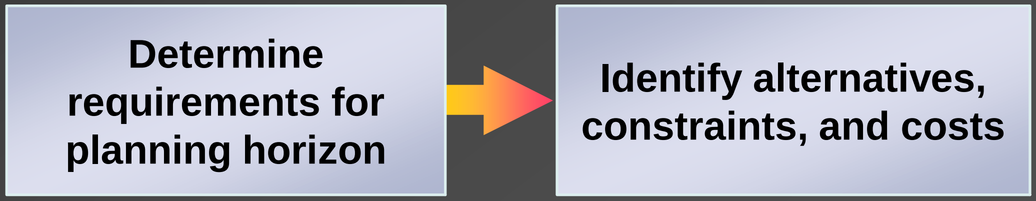


Figure 14.3

Aggregate Planning Process

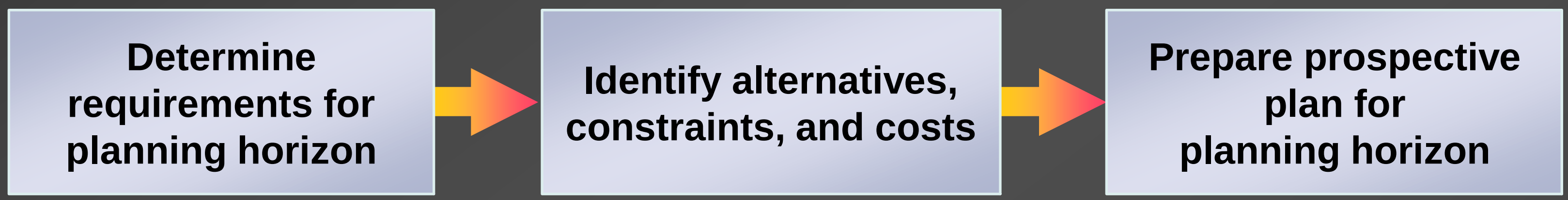


Figure 14.3

Aggregate Planning Process

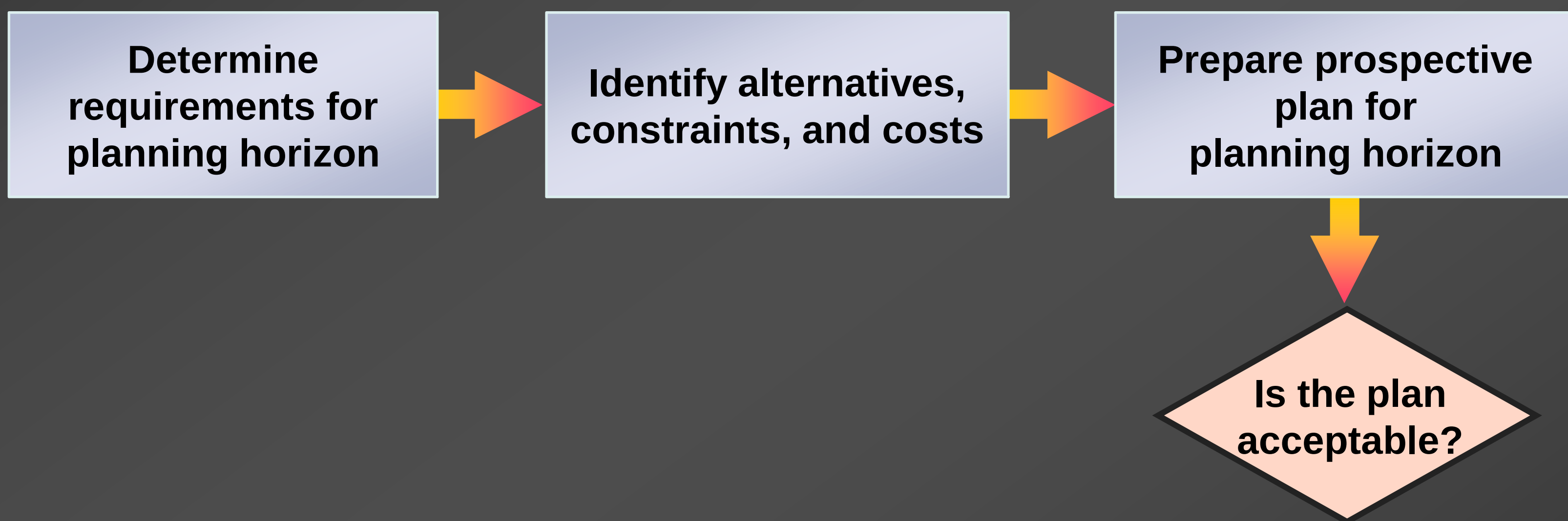


Figure 14.3

Aggregate Planning Process

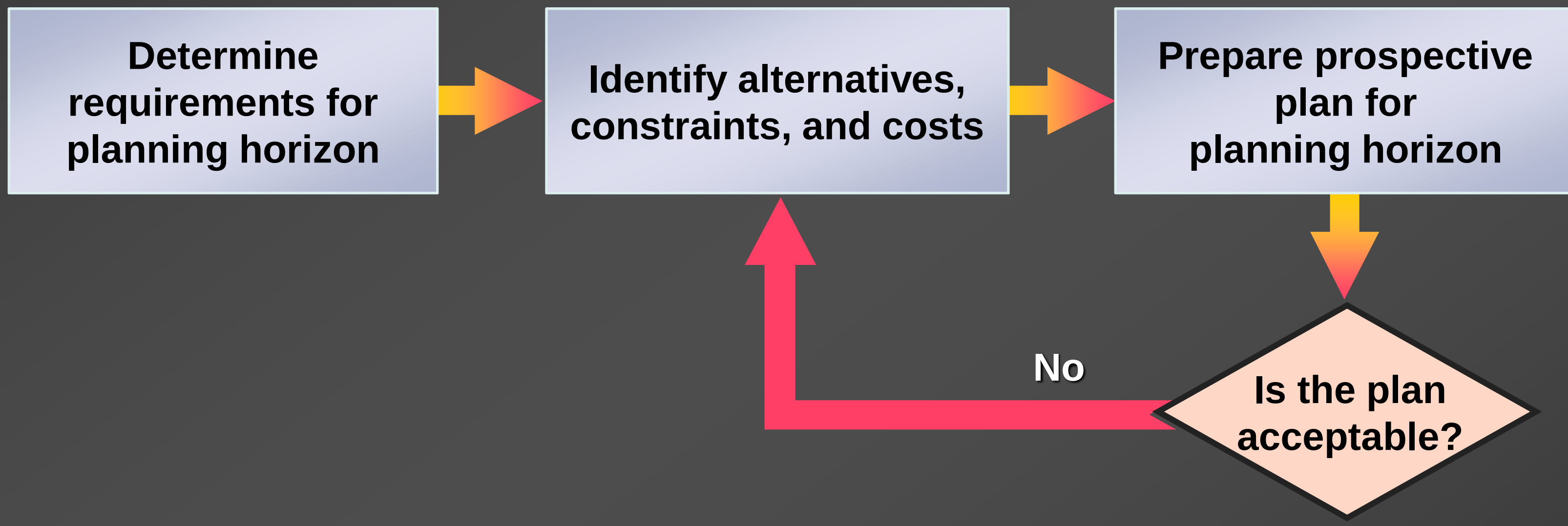


Figure 14.3

Aggregate Planning Process

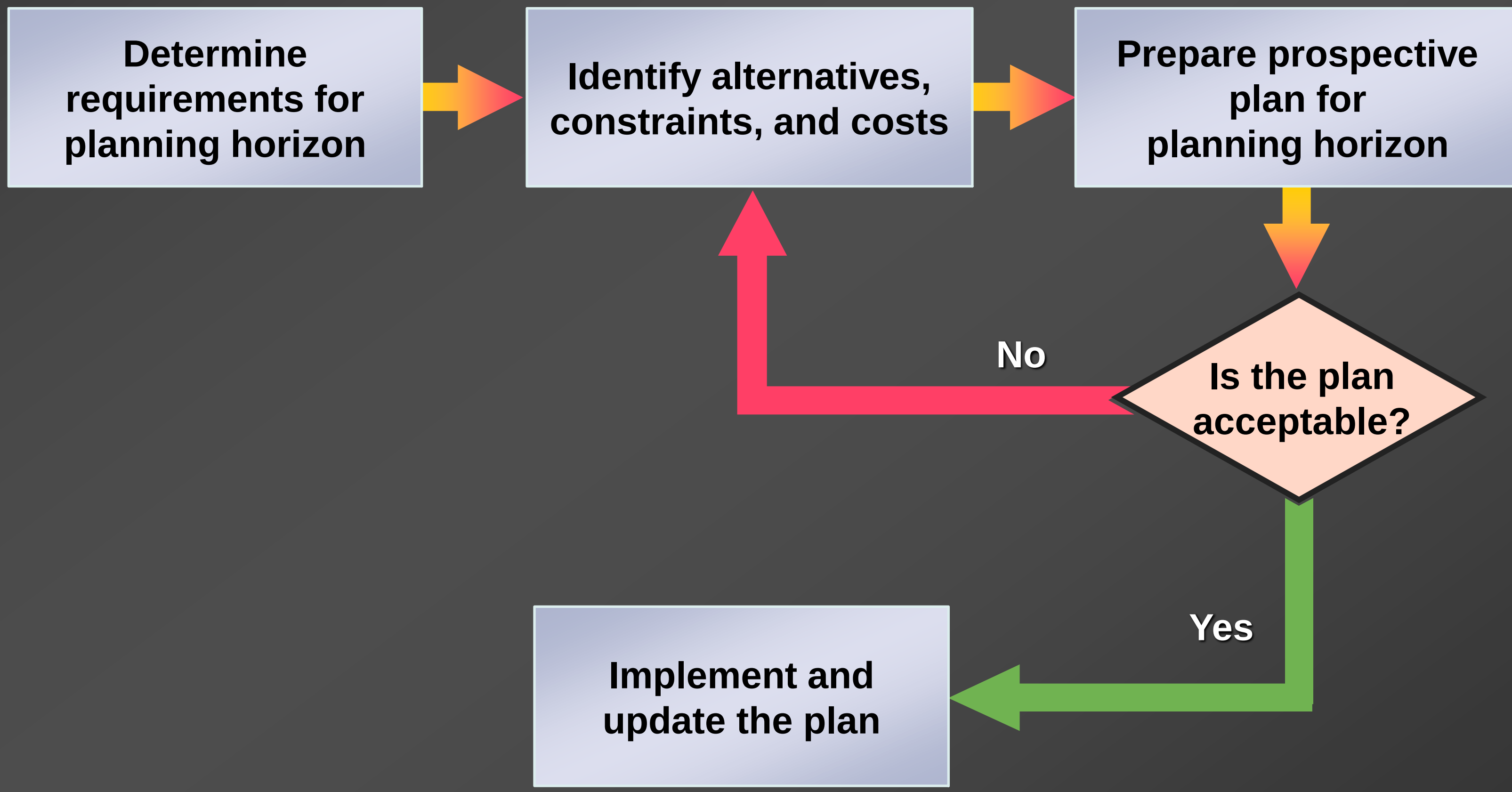


Figure 14.3

Aggregate Planning Process

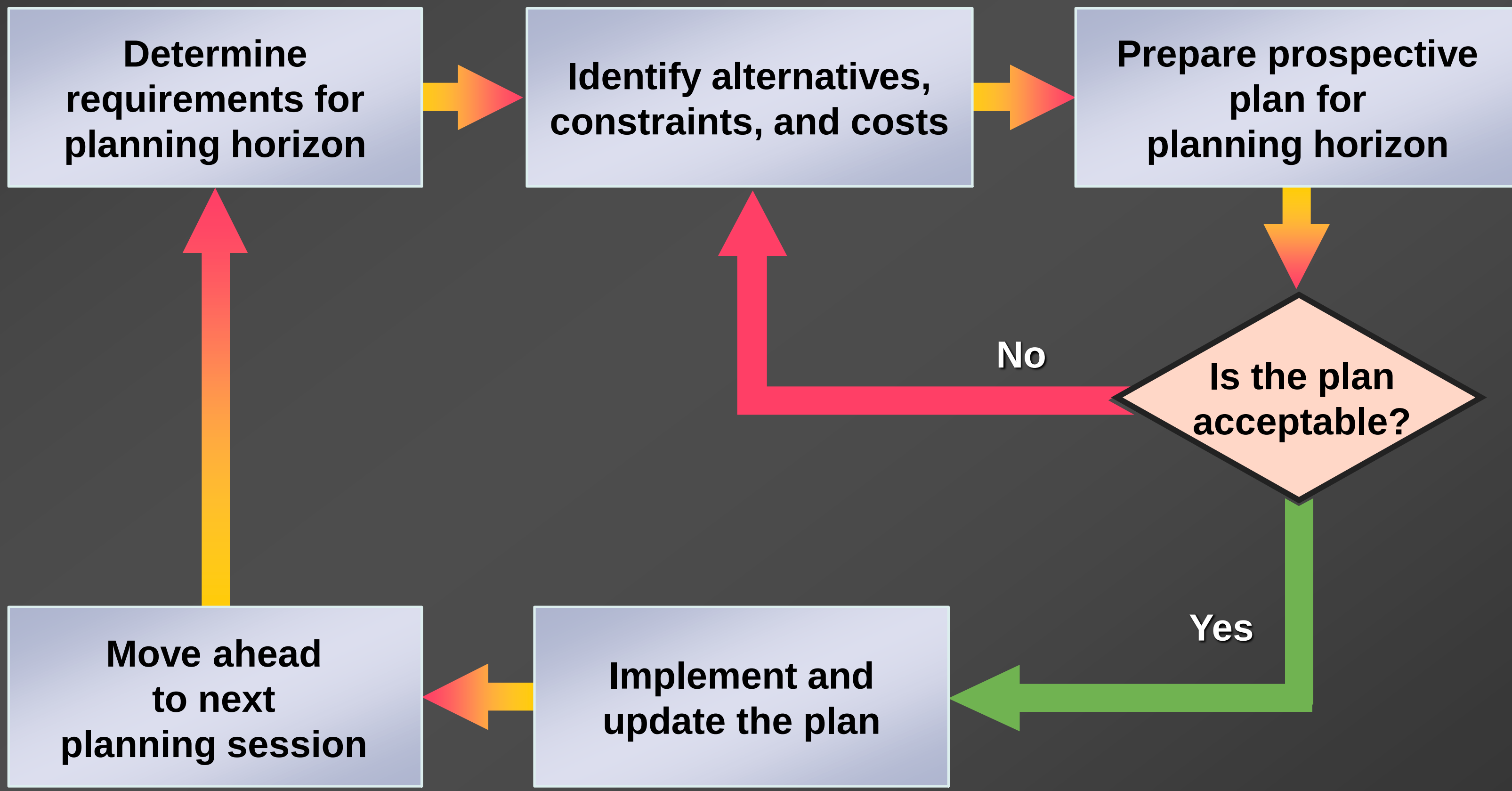


Figure 14.3

Issues

1. Should inventories be used to absorb changes in demand during the planning period?
2. Should changes be accommodated by varying the size of the workforce?
3. Should part-timers be used, or should overtime and idle time absorb fluctuations?
4. Should subcontractors be used on fluctuating orders so a stable workforce can be maintained?
5. Should prices or other factors be changed to influence demand?

TABLE 13.1 Aggregate Planning Options: Advantages and Disadvantages

OPTION	ADVANTAGES	DISADVANTAGES	COMMENTS
Changing inventory levels	Changes in human resources are gradual or none; no abrupt production changes.	Inventory holding costs may increase. Shortages may result in lost sales.	Applies mainly to production, not service, operations.
Varying workforce size by hiring or layoffs	Avoids the costs of other alternatives.	Hiring, layoff, and training costs may be significant.	Used where size of labor pool is large.
Varying production rates through overtime or idle time	Matches seasonal fluctuations without hiring/training costs.	Overtime premiums; tired workers; may not meet demand.	Allows flexibility within the aggregate plan.
Subcontracting	Permits flexibility and smoothing of the firm's output.	Loss of quality control; reduced profits; potential loss of future business.	Applies mainly in production settings.
Using part-time workers	Is less costly and more flexible than full-time workers.	High turnover/training costs; quality suffers; scheduling difficult.	Good for unskilled jobs in areas with large temporary labor pools.
Influencing demand	Tries to use excess capacity. Discounts draw new customers.	Uncertainty in demand. Hard to match demand to supply exactly.	Creates marketing ideas. Overbooking used in some businesses.
Back ordering during high-demand periods	May avoid overtime. Keeps capacity constant.	Customer must be willing to wait, but goodwill is lost.	Many companies back order.
Counterseasonal product and service mixing	Fully utilizes resources; allows stable workforce.	May require skills or equipment outside firm's areas of expertise.	Risky finding products or services with opposite demand patterns.

Sum up

- Identify leverages
- For and counter

What we are going to do

Graphical techniques are popular because they are easy to understand and use. They are trial-and-error approaches that do not guarantee an optimal production plan, but they require only limited computations and can be performed by clerical staff.

1. Determine the **demand** in each period.

2. **Determine capacity** for regular time, overtime, and subcontracting each period.

3. Find labor costs, hiring and layoff costs, and inventory holding costs.

4. Consider **company policy** that may apply to the workers or to stock levels.

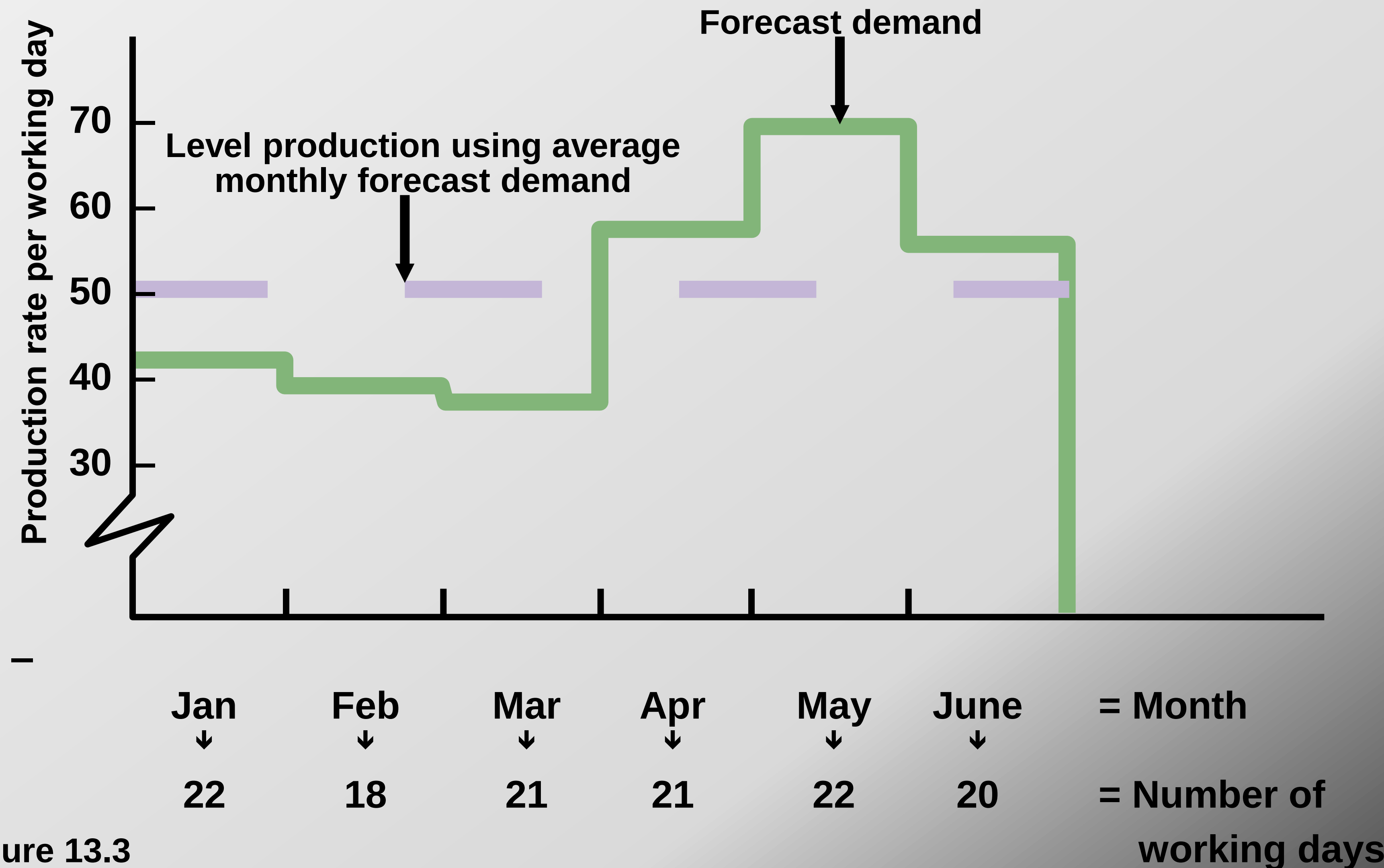
5. Develop **alternative plans** and examine their **total costs.**

ROOFING SUPPLIER EXAMPLE

Month	Expected Demand	Production Days	Demand Per Day (computed)
Jan	900	22	41
Feb	700	18	39
Mar	800	21	38
Apr	1,200	21	57
May	1,500	22	68
June	1,100	20	55
	6,200	124	

Average Total expected demand requirement = Number of production days

$$= \frac{6,200}{124} = 50 \text{ units per day}$$



Forecast demand
Production rate per working day
70
60
50
40
30
Level production using average monthly forecast demand
Jan
Feb
Mar
Apr
May
June
= Month
22
18
21
21
22
20
= Number of working days

Figure 13.3

Cost Information

Inventory carrying cost $ 5 per unit per month Subcontracting cost per unit

$20 per unit

Average pay rate $10 per hour ($80 per day)

Overtime pay rate $17 per hour (above 8 hours per day)

Labor-hours to produce a unit 1.6 hours per unit

Cost of increasing daily production rate $300 per unit (hiring and training)

Roofing Supplier Example 2

Cost Information	
Inventory carrying cost	\$ 5 per unit per month
Subcontracting cost per unit	\$20 per unit
Average pay rate	\$10 per hour (\$80 per day)
Overtime pay rate	\$17 per hour (above 8 hours per day)
Labor-hours to produce a unit	1.6 hours per unit
Cost of increasing daily production rate (hiring and training)	\$300 per unit
Cost of decreasing daily production rate (layoffs)	\$600 per unit

Table 13.3

Plan 1 – constant workforce

Roofing Supplier Example 2

Month	Production Days	Production at 50 Units per Day	Demand Forecast	Monthly Inventory Change	Ending Inventory
Jan	22	1,100	900	+200	200
Feb	18	900	700	+200	400
Mar	21	1,050	800	+250	650
Apr	21	1,050	1,200	-150	500
May	22	1,100	1,500	-400	100
June	20	1,000	1,100	-100	0
					1,850

Total units of inventory carried over from one month to the next = 1,850 units

Workforce required to produce 50 units per day = 10 workers

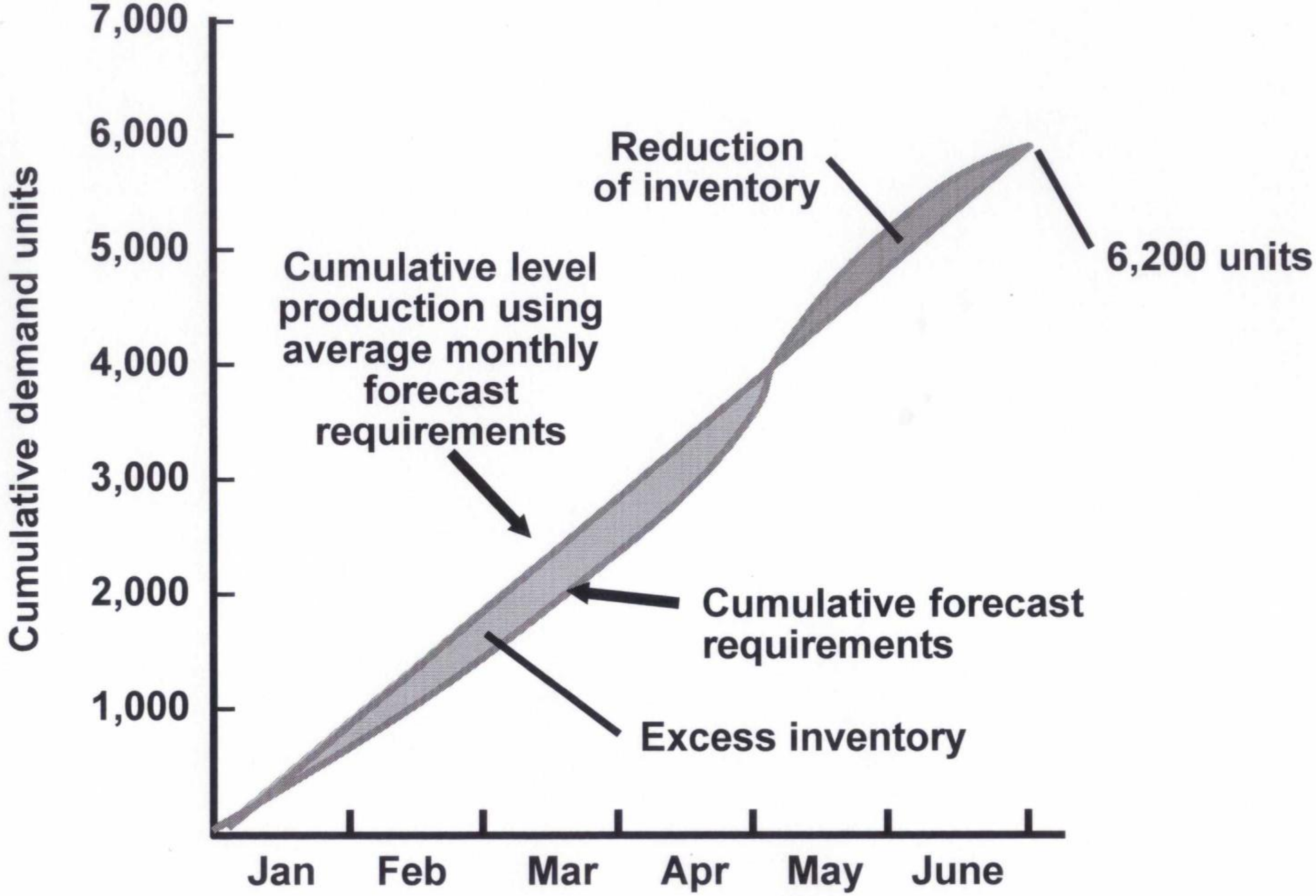
Roofing Supplier Example 2

Costs		Calculations
Inventory carrying	$9,250	(= 1,850 units carried x $5 per unit)
Regular-time labor	99,200	(= 10 workers x $80 per day x 124 days)
Other costs (overtime, hiring, layoffs, subcontracting)	0	
Total cost	$108,450	

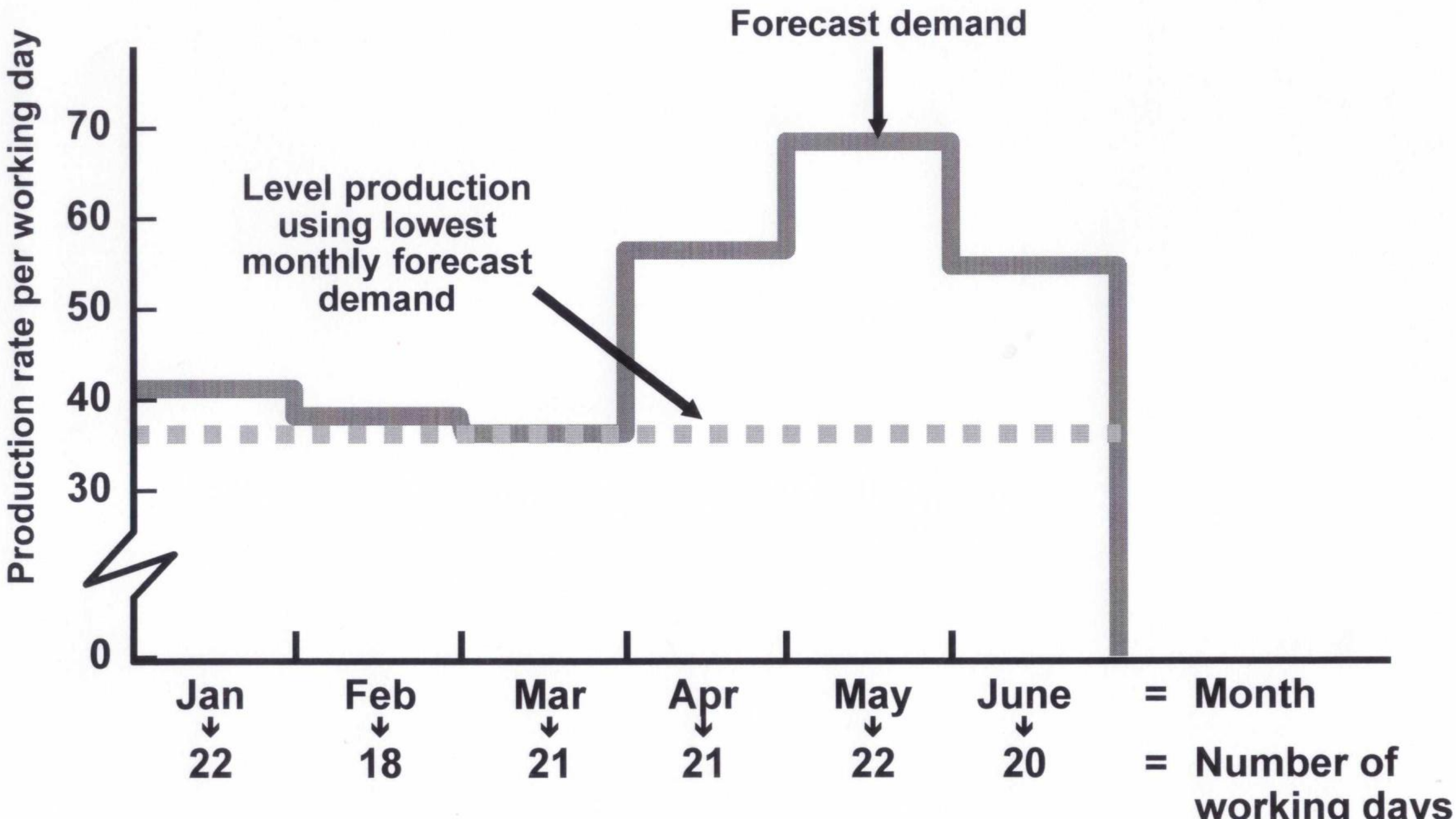
Total units of inventory carried over from one month to the next = 1,850 units

Workforce required to produce 50 units per day = 10 workers

Roofing Supplier Example 2



Roofing Supplier Example 3



Roofing Supplier Example 3

Cost Information	
Inventory carrying cost	$ 5 per unit per month
Subcontracting cost per unit	$20 per unit
Average pay rate	$10 per hour ($80 per day)
Overtime pay rate	$17 per hour (above 8 hours per day)
Labor-hours to produce a unit	1.6 hours per unit
Cost of increasing daily production rate (hiring and training)	$300 per unit
Cost of decreasing daily production rate (layoffs)	$600 per unit

Table 13.3

Roofing Supplier Example 3

In-house production	=	38 units per day
		x 124 days
	=	4,712 units
Subcontract units	=	6,200 - 4,712
	=	1,488 units

(layoffs)

Table 13.3

Roofing Supplier Example 3

In-house production = 38 units per day x 124 days
= 4,712 units

Costs		Calculations
Regular-time labor	$75,392	(= 7.6 workers x $80 per day x 124 days)
Subcontracting	29,760	(= 1,488 units x $20 per unit)
Total cost	$105,152	

Roofing Supplier Example 4

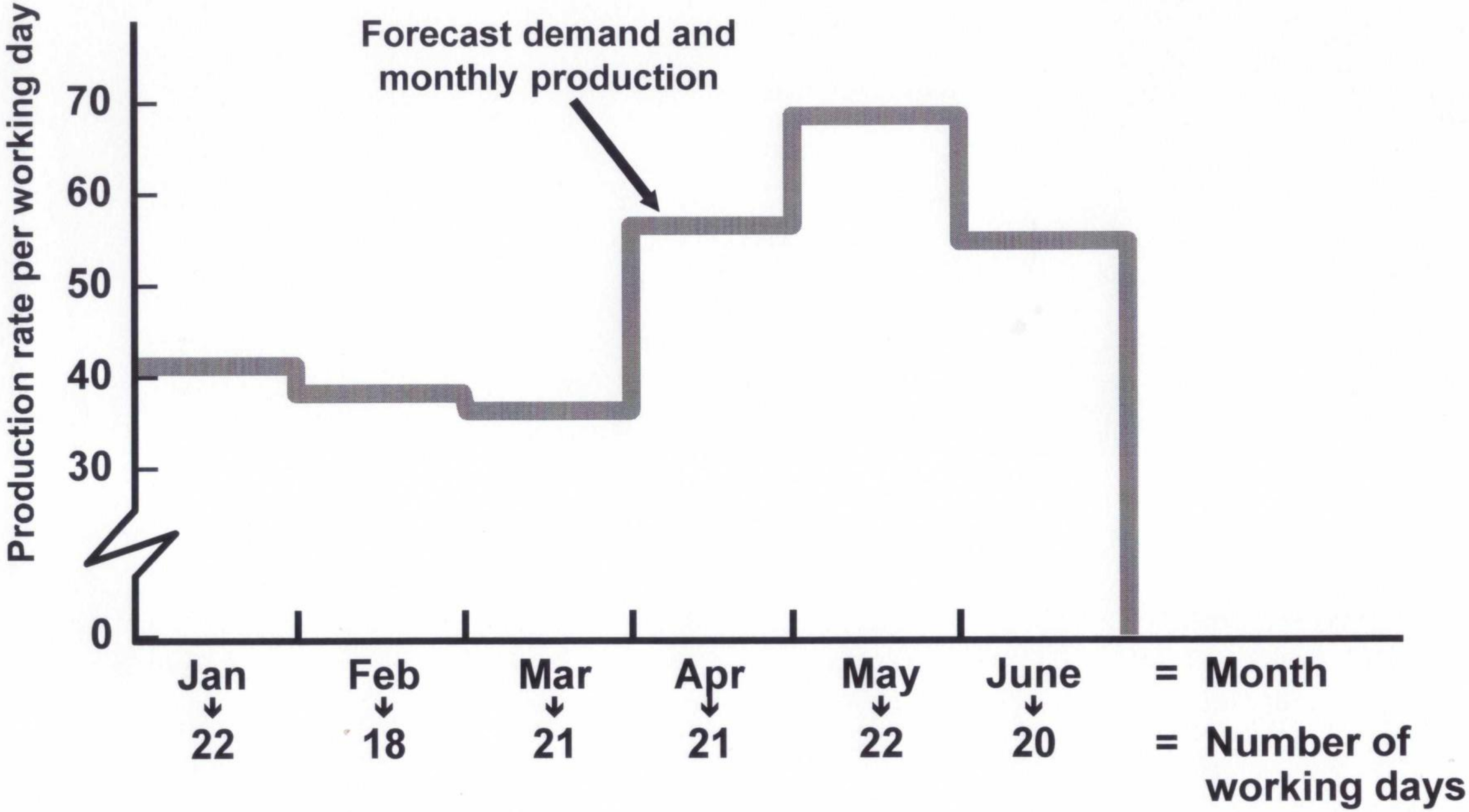
Month	Expected Demand	Production Days	Demand Per Day (computed)
Jan	900	22	41
Feb	700	18	39
Mar	800	21	38
Apr	1,200	21	57
May	1,500	22	68
June	1,100	20	55
	6,200	124	

Table 13.2

Plan 3 – hiring and layoffs

Production = Expected Demand

Roofing Supplier Example 4



Roofing Supplier Example 4

Cost Information	
Inventory carrying cost	$ 5 per unit per month
Subcontracting cost per unit	$20 per unit
Average pay rate	$10 per hour ($80 per day)
Overtime pay rate	$17 per hour (above 8 hours per day)
Labor-hours to produce a unit	1.6 hours per unit
Cost of increasing daily production rate (hiring and training)	$300 per unit
Cost of decreasing daily production rate (layoffs)	$600 per unit

Table 13.3

Roofing Supplier Example 4

Cost Information	
Inventory carrying cost	$ 5 per unit per month
Subcontracting cost per unit	$20 per unit
Average pay rate	$10 per hour ($80 per day)
Overtime pay rate	$17 per hour (above 8 hours per day)
Labor-hours to produce a unit	1.6 hours per unit
Cost of increasing daily production rate (hiring and training)	$300 per unit
Cost of decreasing daily production rate (layoffs)	$600 per unit

Table 13.3

Roofing Supplier Example 4

Month	Forecast (units)	Daily Prod Rate	Basic Production Cost (demand x 1.6 hrs/unit x $10/hr)	Extra Cost of Increasing Production (hiring cost)	Extra Cost of Decreasing Production (layoff cost)	Total Cost
Jan	900	41	$ 14,400	—	—	$ 14,400
Feb	700	39	11,200	—	$1,200 (= 2 x $600)	12,400
Mar	800	38	12,800	—	$600 (= 1 x $600)	13,400
Apr	1,200	57	19,200	$5,700 (= 19 x $300)	—	24,900
May	1,500	68	24,000	$3,300 (= 11 x $300)	—	24,300
June	1,100	55	17,600	—	$7,800 (= 13 x $600)	25,400
			$99,200	$9,000	$9,600	$117,800

Table 13.4

Comparison of Three Plans

Cost	Plan 1	Plan 2	Plan 3
Inventory carrying	$ 9,250	$ 0	$ 0
Regular labor	99,200	75,392	99,200
Overtime labor	0	0	0
Hiring	0	0	9,000
Layoffs	0	0	9,600
Subcontracting	0	29,760	0
Total cost	$108,450	$105,152	$117,800

Plan 2 is the lowest cost option

Table 13.5

To do ....

SOLVED PROBLEM 13.2

A Dover, Delaware, plant has developed the accompanying supply, demand, cost, and inventory data. The firm has a constant workforce and meets all its demand. Allocate production capacity to satisfy demand at a minimum cost. What is the cost of this plan?

Supply Capacity Available (units)

PERIOD	REGULAR TIME	OVERTIME	SUBCONTRACT
1	300	50	200
2	400	50	200
3	450	50	200

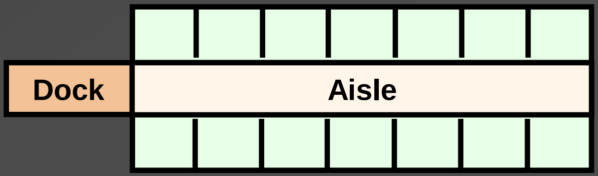
Demand Forecast

PERIOD	DEMAND (UNITS)
1	450
2	550
3	750

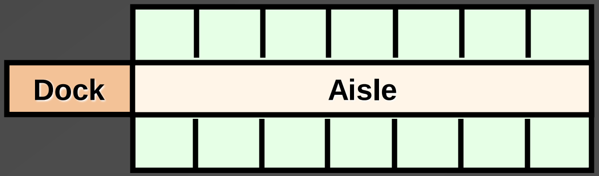
Other data

Initial inventory	50 units
Regular-time cost per unit	$50
Overtime cost per unit	$65
Subcontract cost per unit	$80
Carrying cost per unit per period	$ 1
Back order cost per unit per period	$ 4

Level Strategy for Services



Level Strategy for Services



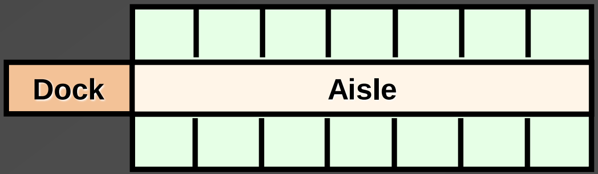
	TIME PERIOD						
	1	2	3	4	5	6	Total
Requirement*	6	12	18	15	13	14	78

Current employment = 10 part-time clerks

* Number of part-time employees

Example 14.1

Level Strategy for Services



	TIME PERIOD						
	1	2	3	4	5	6	Total
Requirement*	6	12	18	15	13	14	78

Current employment = 10 part-time clerks

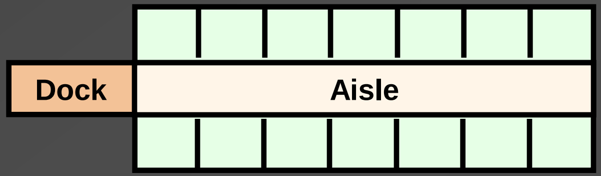
* Number of part-time employees

1. No more than 10 new hires in any period
2. No backorders are permitted
3. Overtime can not exceed 20% of regular-time capacity
4. The following costs can be assigned:

Regular-time wage	$2,000/period at 20 hours/week
Overtime wages	150% of regular-time
Hiring	$1,000/person
Layoffs	$500/person

Example 14.1

Level Strategy for Services



	TIME PERIOD						
	1	2	3	4	5	6	Total
Requirement*	6	12	18	15	13	14	78

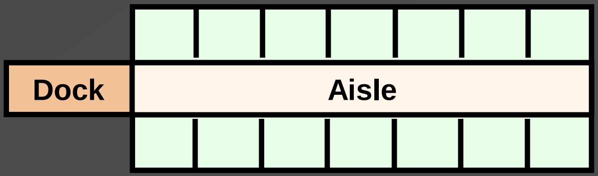
Current employment

1. No more tha
2. No backord
3. Overtime ca
4. The followi
   - Regular-ti
   - Overtime
   - Hiring $1,000/person
   - Layoffs $500/person

Peak Requirement

Example 14.1

Level Strategy for Services



	TIME PERIOD						
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Current employment

1. No more tha
2. No backord
3. Overtime ca
4. The followin

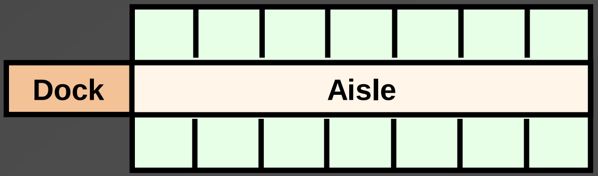
   Regular-ti
   Overtime w
   Hiring $1,000/person
   Layoffs $500/person

Peak Requirement

1.20w = 18 employees in peak period

Example 14.1

Level Strategy for Services



	TIME PERIOD						
	1	2	3	4	5	6	Total
Requirement*	6	12	18	15	13	14	78

Current employment

1. No more tha
2. No backord
3. Overtime ca
4. The followin
   Regular-ti
   Overtime
   Hiring $1,000/person
   Layoffs $500/person

Peak Requirement

$$1.20w = 18 \text{ employees in peak period}$$

$$w = \frac{18}{1.20} = 15 \text{ employees}$$

Example 14.1

Aggregate planning case

- The president of Hill Enterprises, Terri Hill, projects the firm's aggregate demand requirements over the next 8 months as follows

Month	demand	Month	demand
January	1,400	May	2,200
February	1,600	June	2,200
March	1,800	July	1,800
April	1,800	August	1,400

Her operations manager is considering a new plan, which begins in. Stockout cost of lost sales is $100 per unit. Inventory holding cost is $20 per unit per month. Ignore any idle-time costs.

The plan is called plan A.

Plan A : Vary the workforce level to execute a 'chase' strategy by producing the quantity demanded in the prior month. The December demand and rate of production are both 1,600 units per month. The cost of hiring additional workers is $5,000 per 100 units. The cost of laying off workers is $7,500 per 100 units. Evaluate this plan.

Month	demand	Month	demand
January	1,400	May	2,200
February	1,600	June	2,200
March	1,800	July	1,800
April	1,800	August	1,400

Using the information, develop **plan B.**

Produce at a constant rate of 1,400 units per month, which will meet minimum demands. Then use subcontracting, with additional units at a premium price of $75 per unit. Evaluate this plan by computing the costs for January through August.

Hill is now considering **plan C**.

Beginning inventory, stockout costs, and holding costs are provided previously. Keep a stable workforce by maintaining a constant production rate equal to the average requirements and allow varying inventory levels. Hills operations manager is also considering two mixed strategies for January – August

Plan D

Keep the current workforce stable at producing 1,600 units per month. Permit a maximum of 20% overtime at an additional cost of $50 per unit. A warehouse now constraints the maximum allowable inventory on hand to 400 units or less.

Plan E

Keep the current workforce, which is producing 1,600 units per month, and subcontract to meet the rest of the demand. **Evaluate plans D and E and make a recommendation.**

ABOUT QUALITY

Outline

- **Global Company Profile:** *Arnold Palmer Hospital*
- Quality and Strategy
- Defining Quality
- Total Quality Management
- Tools of TQM
- The Role of Inspection
- TQM in Services

Managing Quality Provides a Competitive Advantage

Arnold Palmer Hospital

- Delivers over 14,000 babies annually
- Virtually every type of quality tool is employed
  - Continuous improvement
  - Employee empowerment
  - Benchmarking
  - Just-in-time (JIT)
  - Quality tools

Objectives

Define quality and TQM

Describe the ISO international quality standards

Explain Six Sigma

Explain how benchmarking is used in TQM

Explain quality robust products and Taguchi concepts

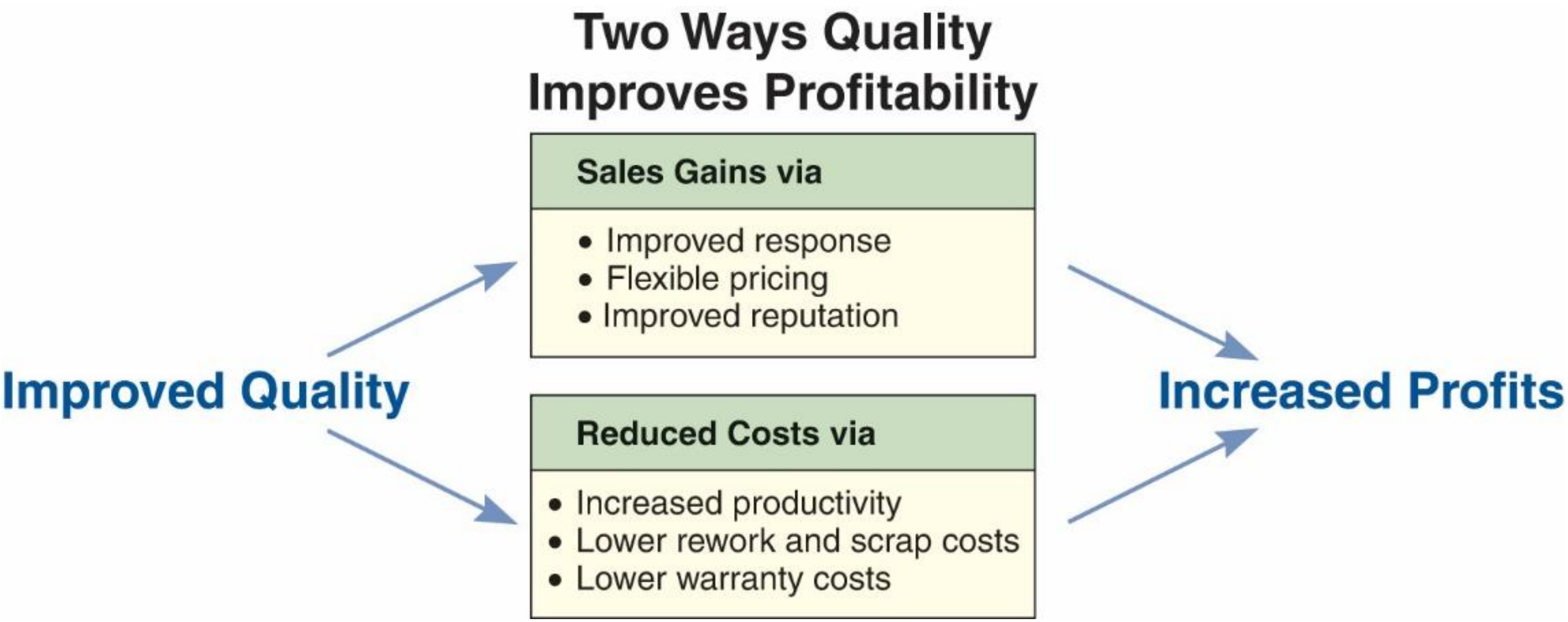
Use the seven tools of TQM

Quality and Strategy

- Managing quality supports *differentiation*, *low cost*, and *response* strategies
- Quality helps firms increase sales and reduce costs
- *Building* a quality organization is a **demanding** task

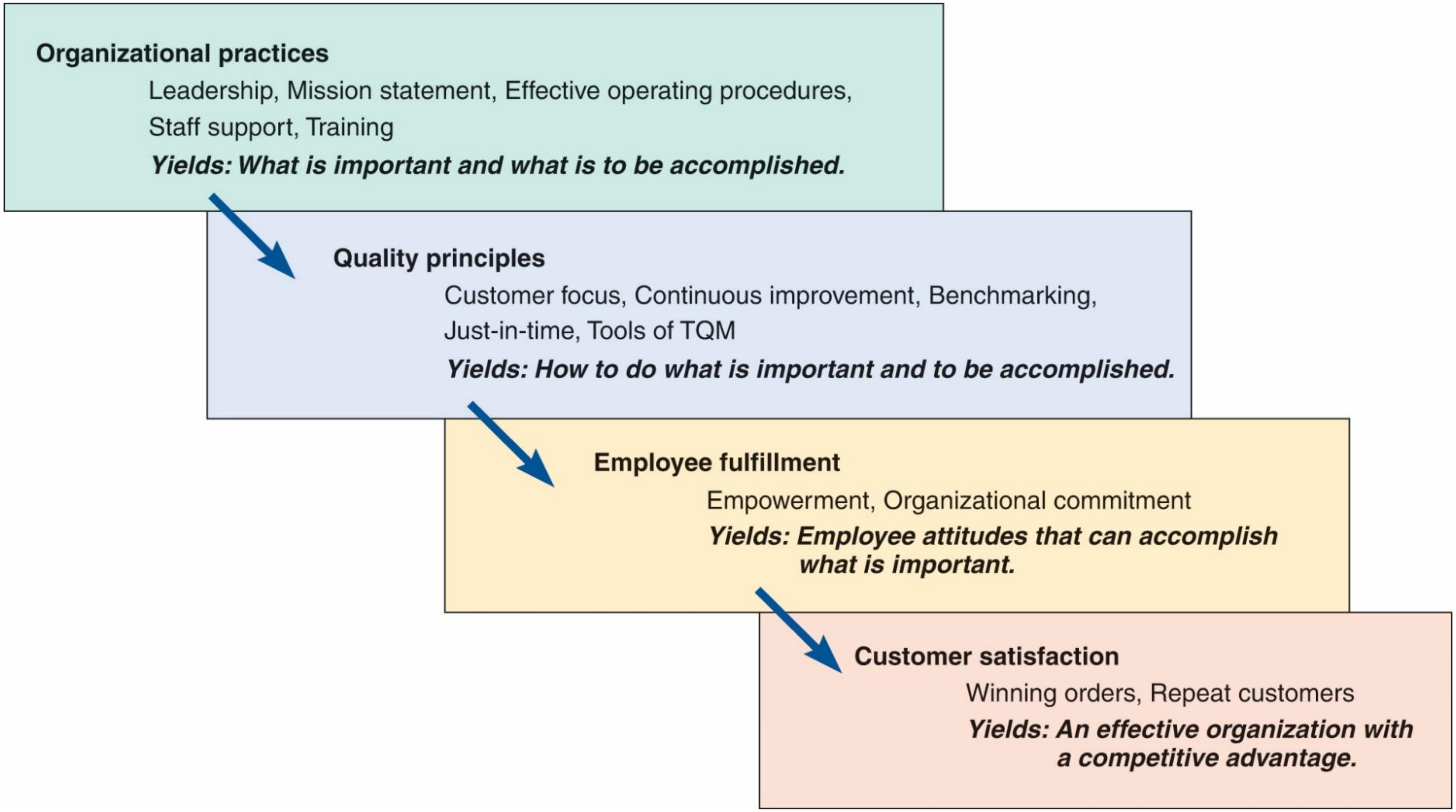
Two Ways Quality Improves Profitability

Figure 6.1



The Flow of Activities

Figure 6.2



Defining Quality (1 of 2)

An operations manager's objective is to build a total quality management system that identifies and satisfies customer needs

Defining Quality (2 of 2)

The totality of features and characteristics of a product or service that bears on its **ability to satisfy** stated or implied needs

American Society for Quality

Different Views

- ***User based:*** better performance, more features
- ***Manufacturing based:*** conformance to standards, making it right the first time
- ***Product based:*** specific and measurable attributes of the product

Pearson

Implications of Quality

1. Company **reputation**
   - Perception of new products
   - Employment practices
   - Supplier relations
2. Product **liability**
   - Reduce risk
3. Global implications
   - Improved ability to compete

Baldrige Criteria

Applicants are evaluated on:

CATEGORIES	POINTS
Leadership	120
Strategic Planning	85
Customer Focus	85
Measurement, Analysis, and Knowledge Management	90
Workforce Focus	85
Operations Focus	85
Results	450

ISO 9000 International Quality Standards (1 of 2)

- International recognition
- **Encourages** quality management procedures, detailed documentation, work instructions, and recordkeeping
- 2015 revision gives greater emphasis to *risk-based thinking*
- *Interconnected departments*
- Over 1.6 million certifications in 201 countries
- Critical for global business

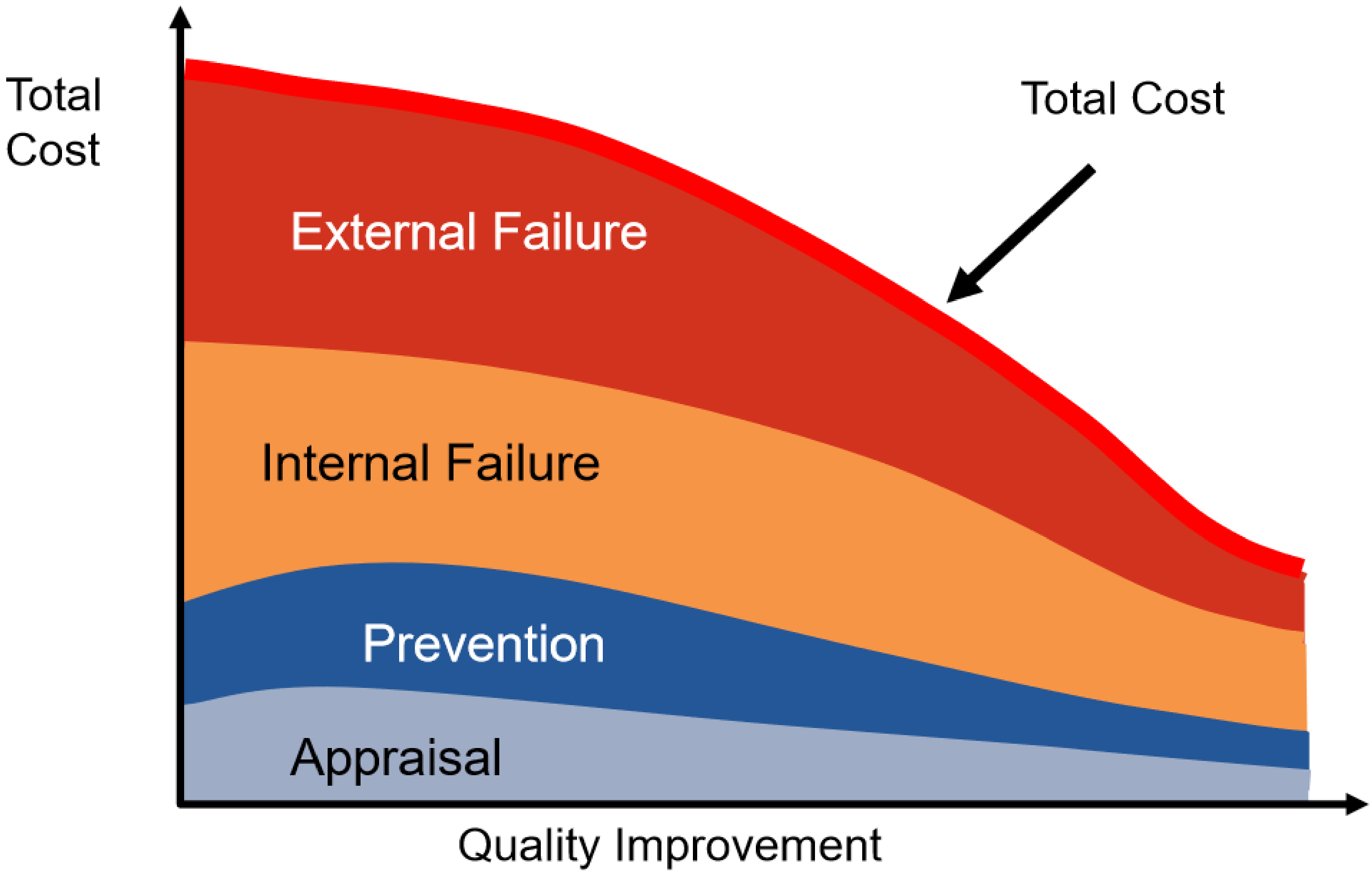
ISO 9000 International Quality Standards (2 of 2)

- Management principles
  1. Top management **leadership**
  2. Customer **satisfaction**
  3. Continual **improvement**
  4. Involvement of people
  5. Process analysis
  6. Use of **data-driven** decision making
  7. A systems approach to management
  8. Mutually beneficial supplier relationships

Costs of Quality (1 of 2)

- *Prevention costs* - reducing the potential for defects
- *Appraisal costs* - **evaluating** products, parts, and services
- *Internal failure costs* - producing defective parts or service before delivery
- *External failure costs* - defects discovered after delivery

Costs of Quality (2 of 2)



Takumi

A Japanese character that symbolizes a **broader** dimension than quality, a deeper process than education, and a **more** perfect method **than** persistence

Leaders in Quality (1 of 2)

Table 6.1 Leaders in the Field of Quality Management

LEADER	PHILOSOPHY/CONTRIBUTION
W. Edwards Deming	Deming insisted management accept **responsibility for building good systems**. The employee cannot produce products that on average exceed the quality of what the process is capable of producing. *His 14 points for implementing quality improvement are presented in this chapter.*
Joseph M. Juran	A pioneer in teaching the Japanese how to improve quality, Juran believed strongly in **top-management commitment**, support, and involvement in the quality effort. He was also a believer **in teams** that continually seek to raise quality standards. Juran varies from Deming somewhat in focusing on the customer and defining quality as fitness for use, **not necessarily the written specifications.**

Leaders in Quality (2 of 2)

Table 6.1 Leaders in the Field of Quality Management

LEADER	PHILOSOPHY/CONTRIBUTION
Armand Feigenbaum	His 1961 book **Total Quality Control** laid out 40 steps to quality improvement processes. He viewed quality not as a set of tools but as **a total field** that integrated the processes of a company. His work in how people learn from each other's successes led to the field of **cross-functional teamwork**.
Philip B. Crosby	Quality Is Free was Crosby's attention-getting book published in 1979. Crosby believed that in the traditional trade-off between the cost of improving quality and the cost of poor quality, **the cost of poor quality is understated**. The cost of poor quality should include all of the things that are involved in not doing the job right the first time. Crosby coined the term **zero defects** and stated, "There is absolutely no reason for having errors or defects in any product or service."

Pearson

Ethics and Quality Management

- Operations managers must **deliver** healthy, safe, quality products and services
- **Poor quality** risks injuries, lawsuits, recalls, and regulation
- **Ethical** conduct must dictate response to problems
- All stakeholders must be considered

Total Quality Management

- Encompasses entire organization from supplier to customer
- **Stresses a commitment by management** to have a continuing companywide drive toward excellence in all aspects of products and services that are important to the customer

Deming's Fourteen Points (1 of 2)

Table 6.2 Deming's 14 Points for Implementing Quality Improvement

1.	Create **consistency** of purpose
2.	Lead to promote change
3.	Build quality into the product; **stop depending on inspections** to catch problems
4.	Build long-term relationships **based on performance** instead of awarding business on price
5.	**Continuously improve** product, quality, and service
6.	Start training
7.	Emphasize leadership

Pearson

Deming's Fourteen Points (2 of 2)

Table 6.2 Deming's 14 Points for Implementing Quality Improvement

8.	Drive out fear
9.	**Break down barriers** between departments
10.	Stop haranguing workers
11.	Support, help, and improve
12.	Remove barriers to pride in work
13.	Institute a vigorous program of **education** and self-improvement
14.	Put **everyone** in the company to work on the transformation

Seven Concepts of TQM

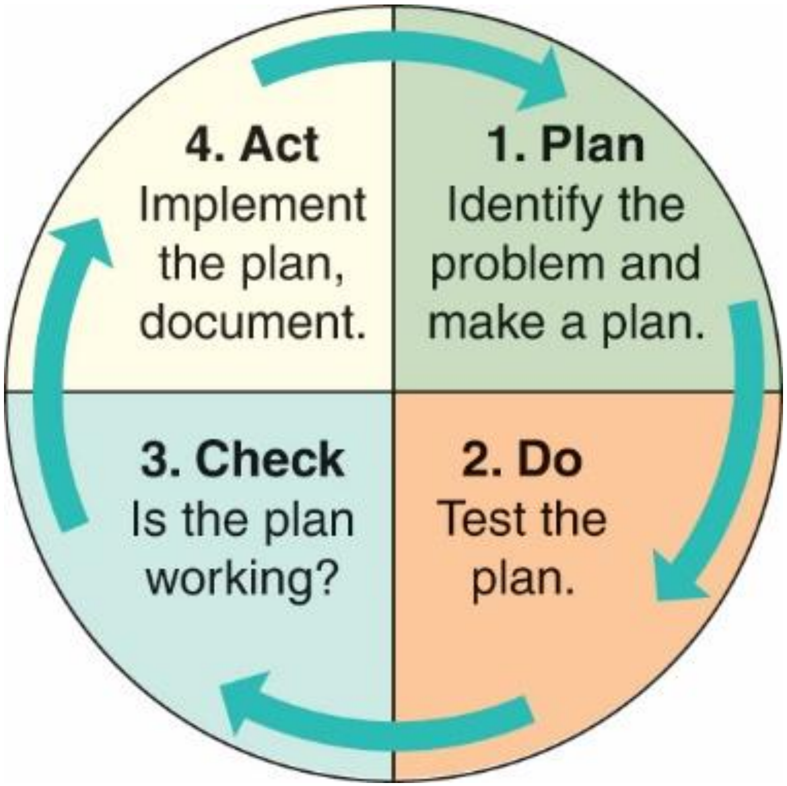
1) Continuous improvement
2) Six Sigma
3) Employee empowerment
4) Benchmarking
5) Just-in-time (JIT)
6) Taguchi concepts
7) Knowledge of TQM tools

Continuous Improvement (1 of 2)

- **Never-ending** process of continuous improvement
- Covers people, equipment, suppliers, materials, procedures
- Every operation can be improved

Shewhart's PDCA Model

Figure 6.3



Continuous Improvement (2 of 2)

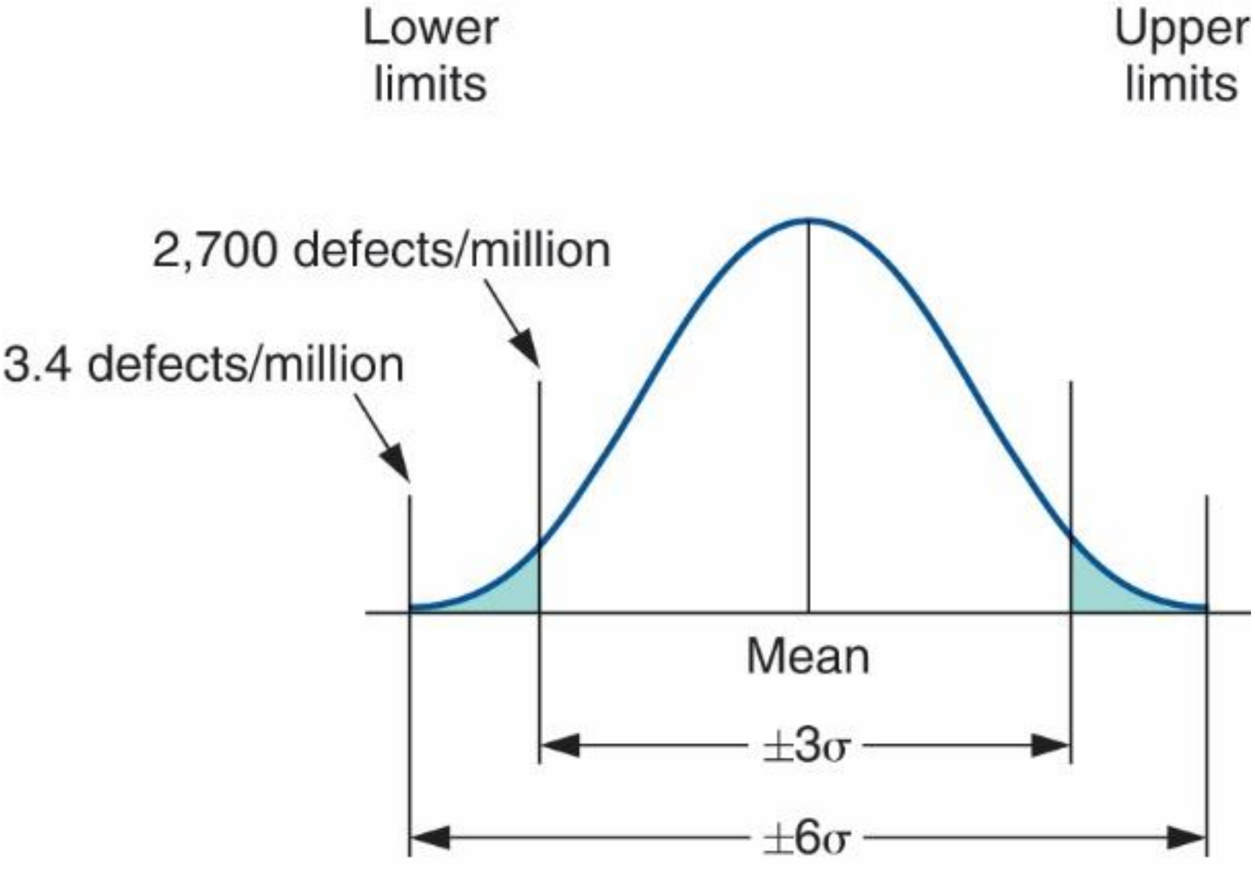
- ***Kaizen*** describes the ongoing process of unending improvement
- *TQM and zero defects* also used to describe continuous improvement

Six Sigma (1 of 3)

- Two meanings
  - *Statistical* definition of a process that is 99.9997% capable, 3.4 **defects per million opportunities** (DPMO)
  - A *program* designed to reduce defects, lower costs, save time, and improve customer satisfaction
- A comprehensive system for achieving and sustaining business success

Six Sigma (2 of 3)

Figure 6.4



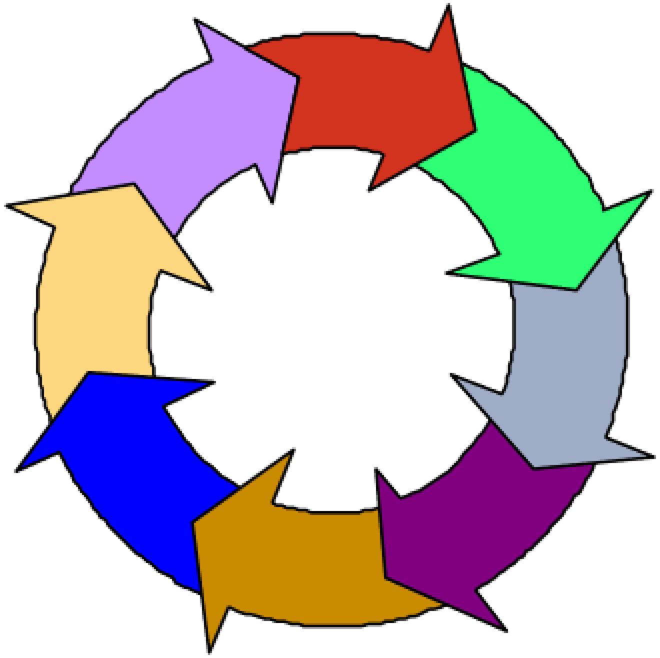
Six Sigma Program

- Originally developed by Motorola, adopted and enhanced by Honeywell and GE
- Highly structured approach to process improvement
- A strategy
- A discipline – DMAIC
- A set of 7 tools

Six Sigma (3 of 3)

- ***Defines*** the project's **purpose, scope, and outputs**, then identifies the required process information keeping in mind the **customer's definition of quality**
- ***Measures*** the process and collects data
- ***Analyzes*** the data, ensuring repeatability and reproducibility
- ***Improves*** by modifying or redesigning existing processes and procedures
- ***Controls*** the new process to make sure performance levels are maintained

DMAIC Approach



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Implementing Six Sigma (1 of 2)

- **Emphasize defects** per million opportunities as a standard metric
- Provide extensive **training**
- Focus on top management leadership (Champion)
- Create qualified process improvement **experts** (Black Belts, Green Belts, etc.)
- Set stretch objectives

Pearson

Implementing Six Sigma (2 of 2)

- Emphasize defects per million opportunities as a standard metric
- Provide extensive training
- Focus on top management leadership (Champion)
- Create qualified process improvement experts (Black Belts, Green Belts, etc.)
- Set stretch objectives

This cannot be accomplished without a major commitment from top level management

Employee Empowerment

- Getting employees involved in product and process improvements
  - 85% of quality problems are **due to materials and process**
- Techniques
  1. Build communication networks that **include employees**
  2. Develop open, supportive supervisors
  3. **Move responsibility** to employees
  4. Build a h**igh-morale** organization
  5. Create formal team structures

Quality Circles

- Group of employees who meet regularly to solve problems
- Trained in planning, problem solving, and statistical methods
- Often **led by a *facilitator***
- *Very effective when done properly*

Benchmarking

Selecting best practices to use as a standard for performance very similar to your own

1. Determine what to benchmark
2. Form a benchmark team
3. Identify benchmarking partners
4. Collect and analyze benchmarking information
5. Take action to match or exceed the benchmark

Best Practices for Resolving Customer Complaints

Table 6.3

BEST PRACTICE	JUSTIFICATION
Make it easy for clients to complain	It is free market research
Respond quickly to complaints	It adds customers and loyalty
Resolve complaints on first contact	It reduces cost
Use computers to manage complaints	Discover trends, share them, and align your services
Recruit the best for customer service jobs	It should be part of formal training and career advancement

Pearson

Internal Benchmarking

- When the organization is large enough
- Data more accessible
- Can and should be established in a variety of areas

Just-in-Time (JIT) (1 of 2)

- **'Pull' system** of production scheduling including supply management
  - Production only when signaled
- Allows **reduced inventory levels**
  - Inventory costs money and hides process and material problems
- Encourages improved process and product quality

Just-in-Time (JIT) (2 of 2)

Relationship to quality:

- JIT cuts the cost of quality
- JIT improves quality
- Better quality means less inventory and better, easier-to-employ JIT system

Taguchi Concepts

- Engineering and experimental design methods to improve product and process design
  - Identify key component and process variables affecting product variation
- Taguchi Concepts
  - *Quality* ***robustness***
  - *Target-oriented quality*
  - *Quality loss function*

Quality Robustness

- Ability to produce products uniformly in adverse manufacturing and environmental conditions
  - Remove the ***effects* of adverse conditions**
  - **Small variations** in materials and process do not destroy product quality

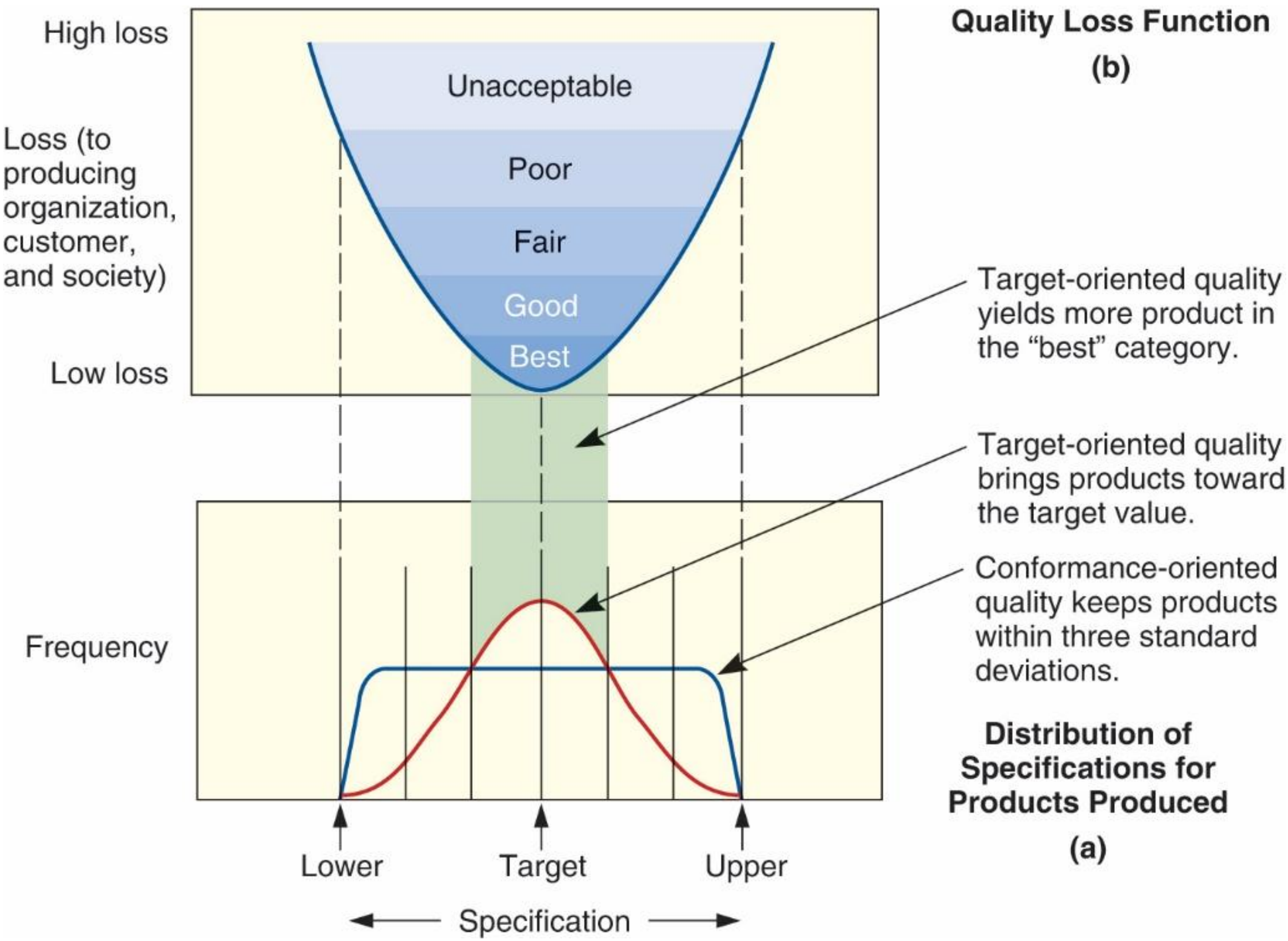
Quality Loss Function (1 of 2)

- Shows that **costs increase** as the product moves away from what the customer wants
- Costs **include** customer dissatisfaction, warranty and service, internal scrap and repair, and costs to society
- Traditional conformance specifications are **too simplistic**

Target-oriented quality

Quality Loss Function (2 of 2)

Figure 6.5



TQM Tools (1 of 2)

- Tools for **Generating Ideas**
  - Check Sheet
  - Scatter Diagram (dispersion)
  - Cause-and-Effect Diagram
- Tools to **Organize the Data**
  - Pareto Chart
  - Flowchart (Process Diagram)

TQM Tools (2 of 2)

- Tools for Identifying Problems
  - Histogram
  - Statistical Process Control Chart

Seven Tools of TQM (1 of 7)

Figure 6.6

(a) *Check Sheet:* An organized method of recording data

Tools for Generating Ideas

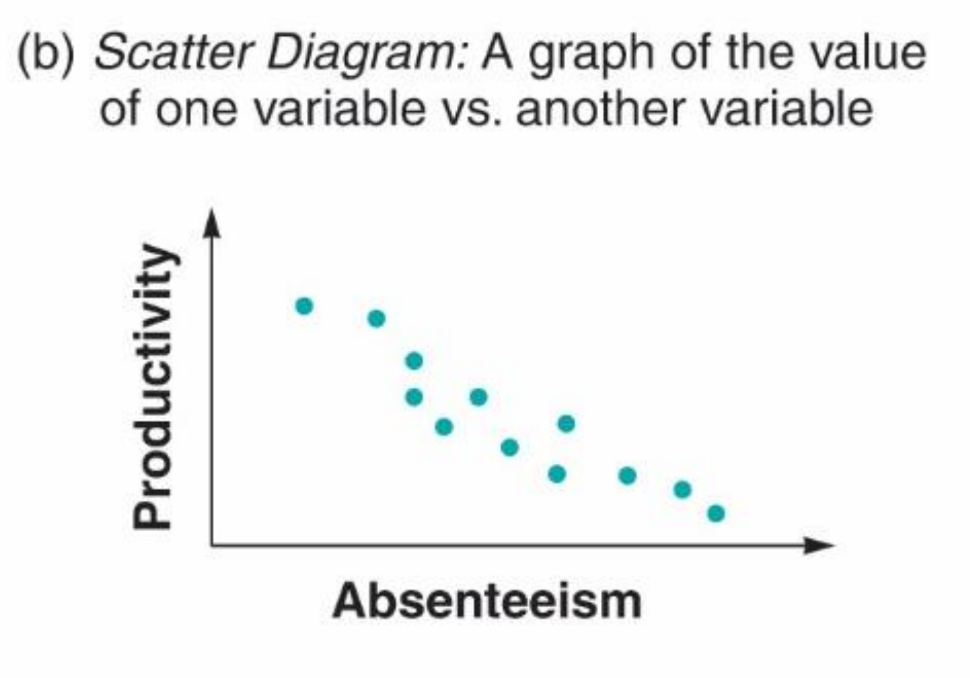
(a) *Check Sheet:* An organized method of recording data

	Hour							
Defect	1	2	3	4	5	6	7	8
A	///	/		/	/	/	///	/
B	//	/	/	/			//	///
C	/	//					//	////

Seven Tools of TQM (2 of 7)

Figure 6.6

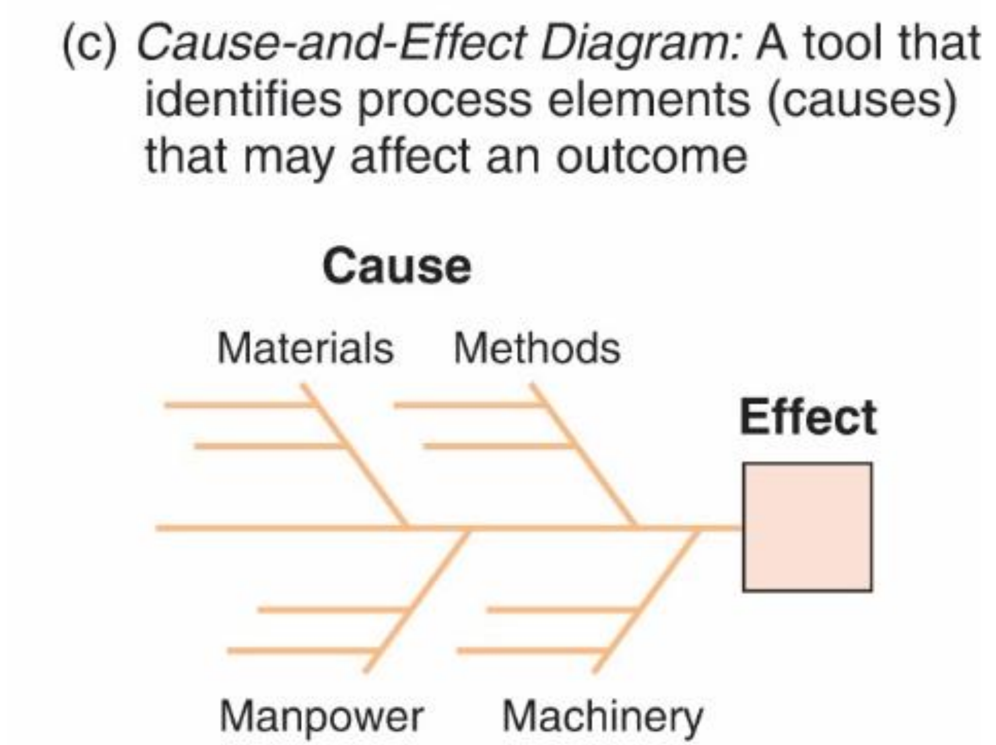
(b) *Scatter Diagram:* A graph of the value of one variable vs. another variable



Seven Tools of TQM (3 of 7)

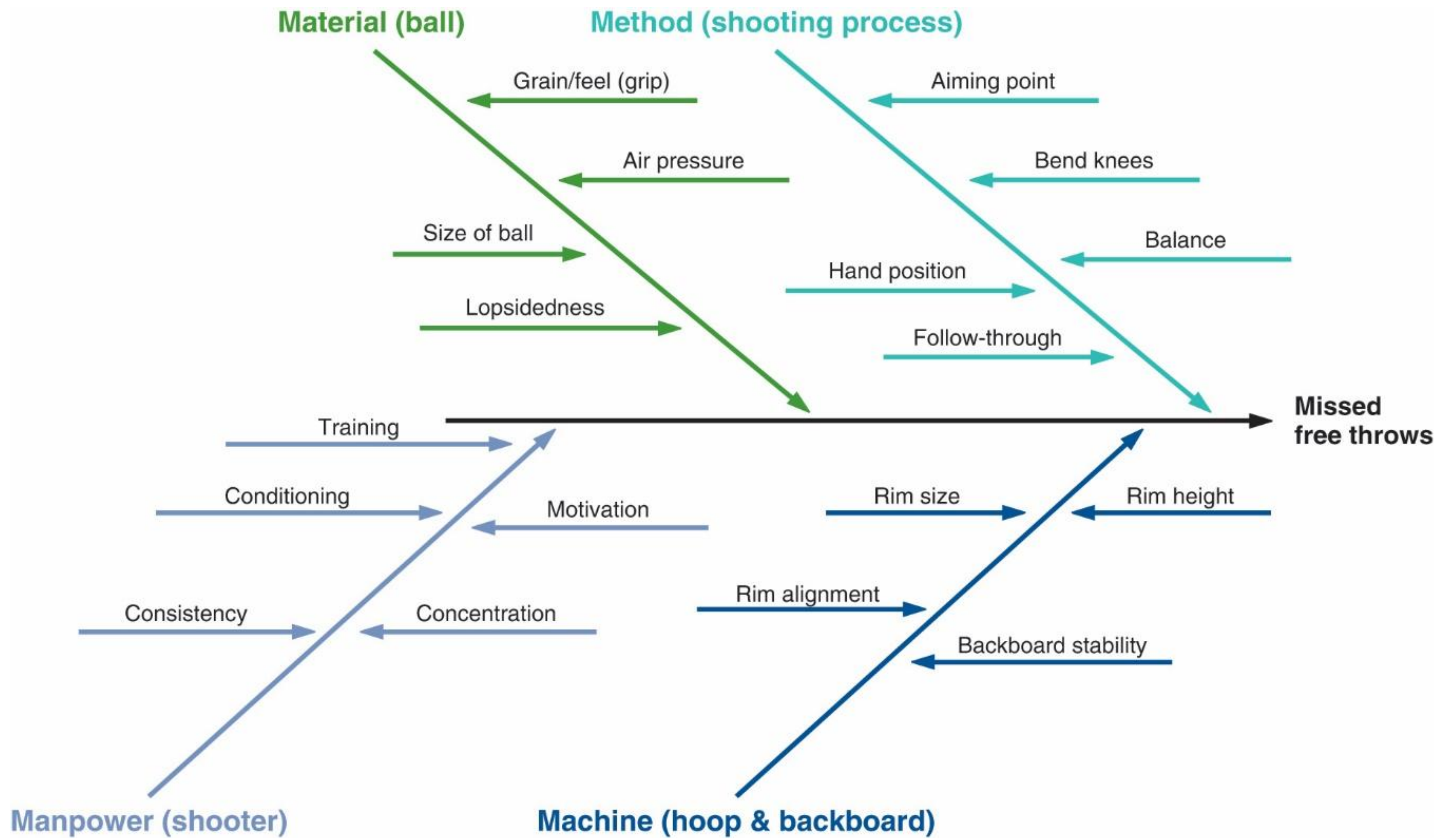
Figure 6.6

(c) *Cause-and-Effect Diagram:* A tool that identifies process elements (causes) that may effect an outcome



Cause-and-Effect Diagrams

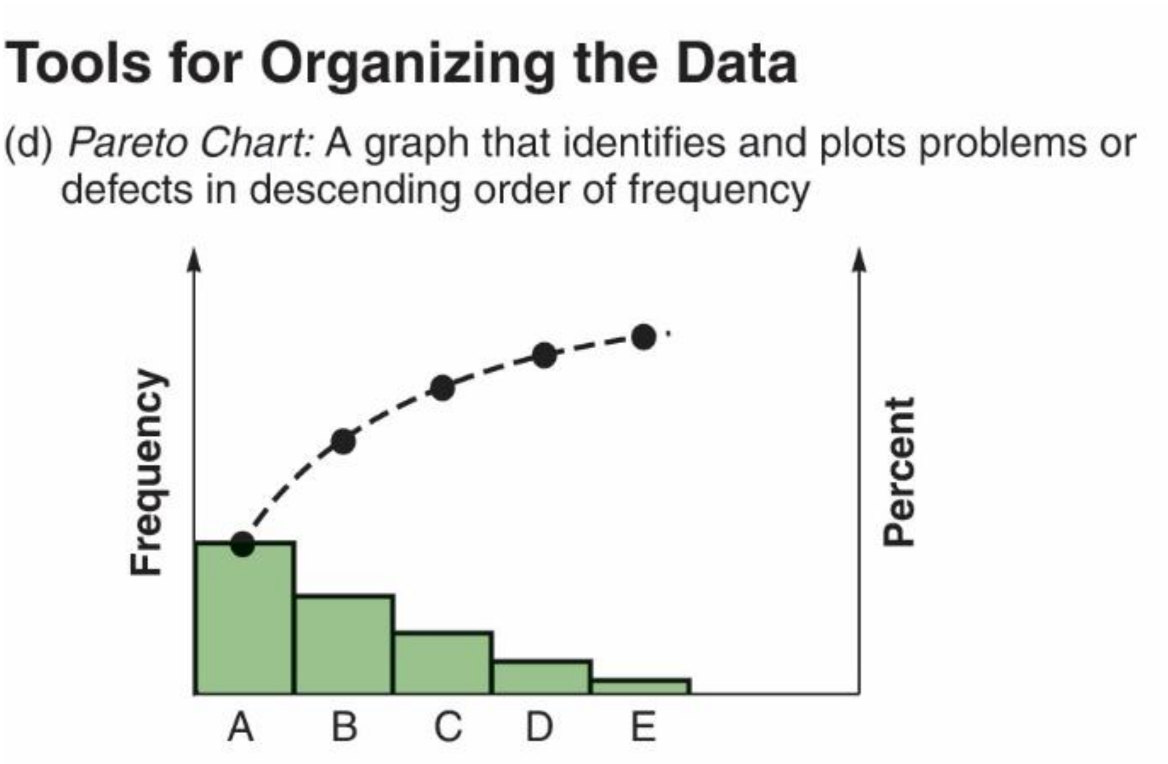
Figure 6.7



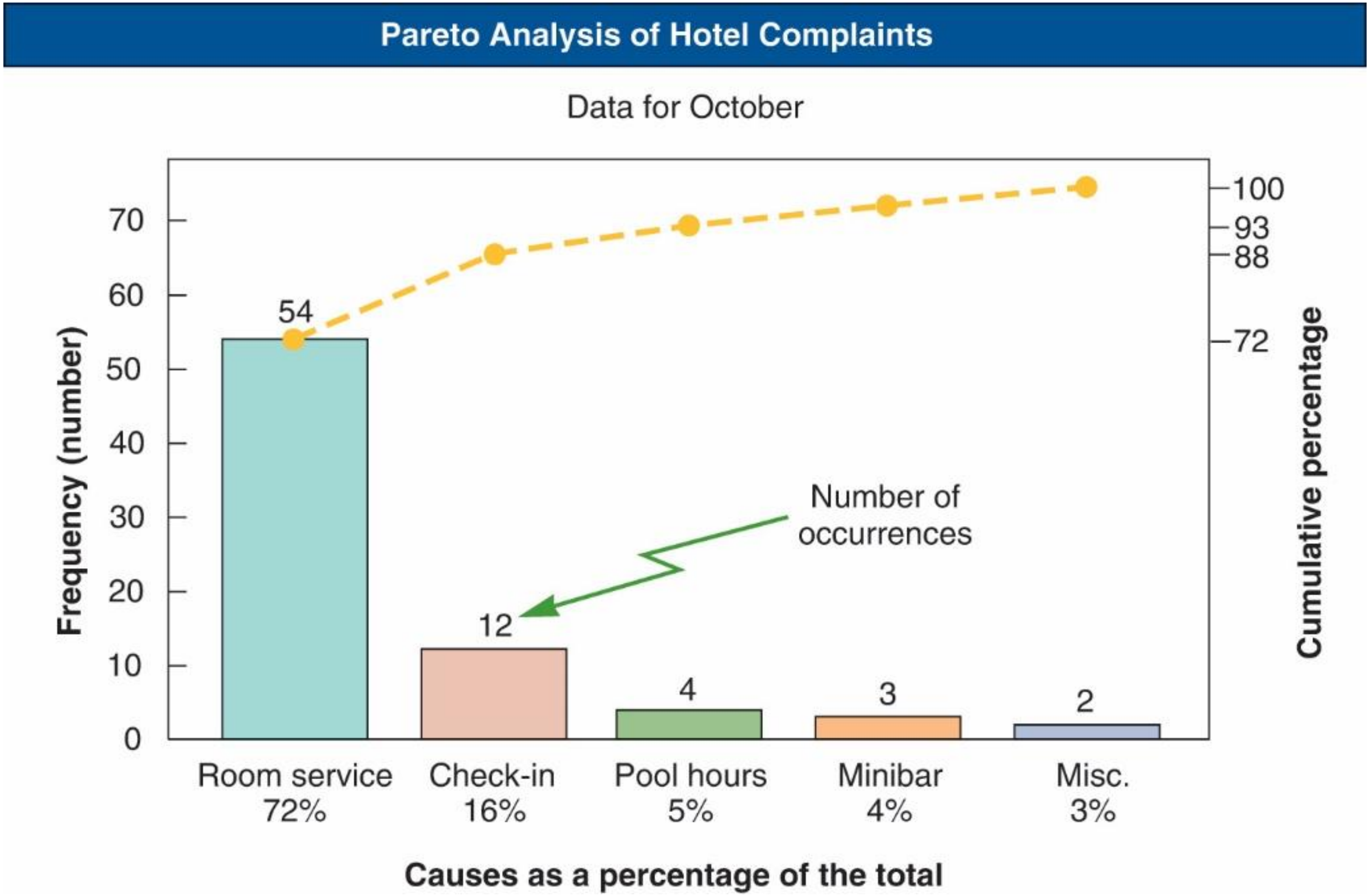
Seven Tools of TQM (4 of 7)

Figure 6.6

(d) *Pareto Chart:* A graph to identify and plot problems or defects in descending order of frequency



Pareto Charts

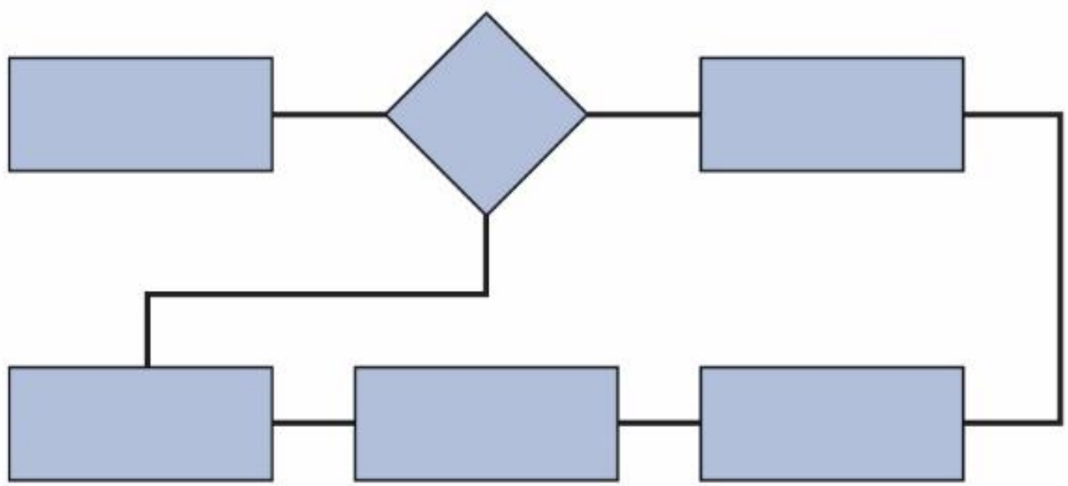


Seven Tools of TQM (5 of 7)

Figure 6.6

(e) *Flowchart (Process Diagram):* A chart that describes the steps in a process

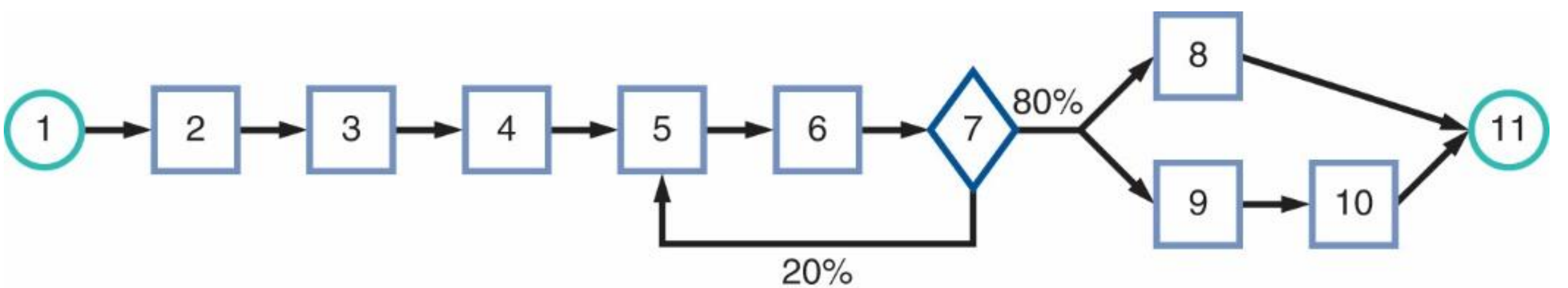
(e) *Flowchart (Process Diagram):* A chart that describes the steps in a process



Flow Charts

MRI Flowchart

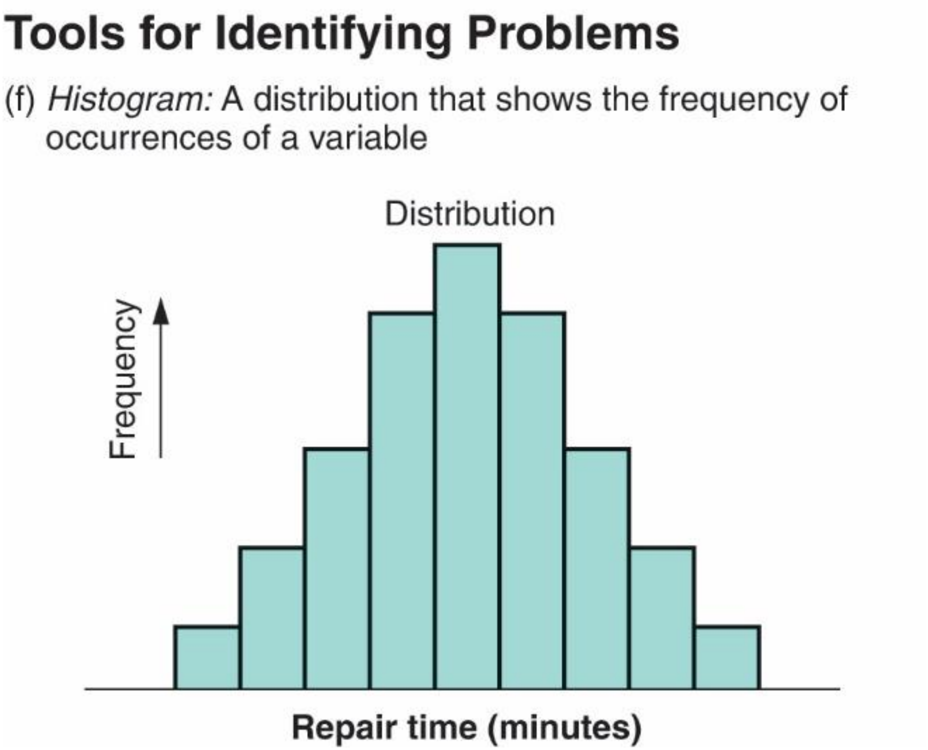
1. Physician schedules MRI
2. Patient taken to MRI
3. Patient signs in
4. Patient is prepped
5. Technician carries out MRI
6. Technician inspects film
7. If unsatisfactory, repeat
8. Patient taken back to room
9. MRI read by radiologist
10. MRI report transferred to physician
11. Patient and physician discuss



Seven Tools of TQM (6 of 7)

Figure 6.6

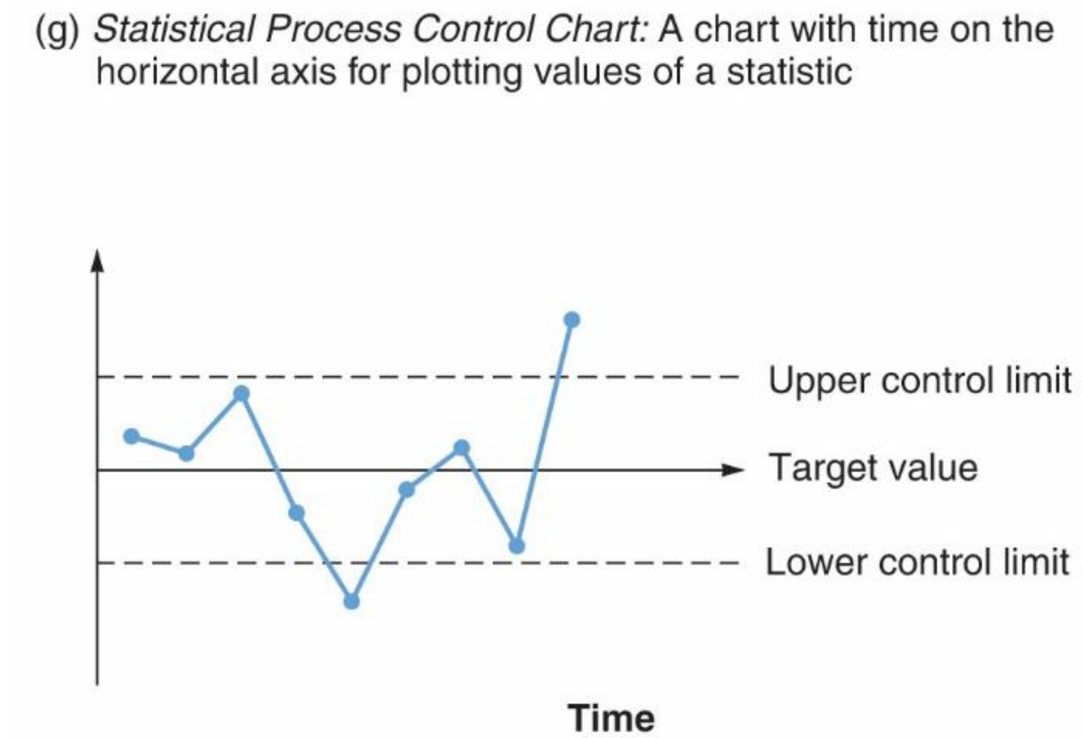
(f) *Histogram:* A distribution showing the frequency of occurrences of a variable



Seven Tools of TQM (7 of 7)

Figure 6.6

(g) *Statistical Process Control Chart:* A chart with time on the horizontal axis to plot values of a statistic

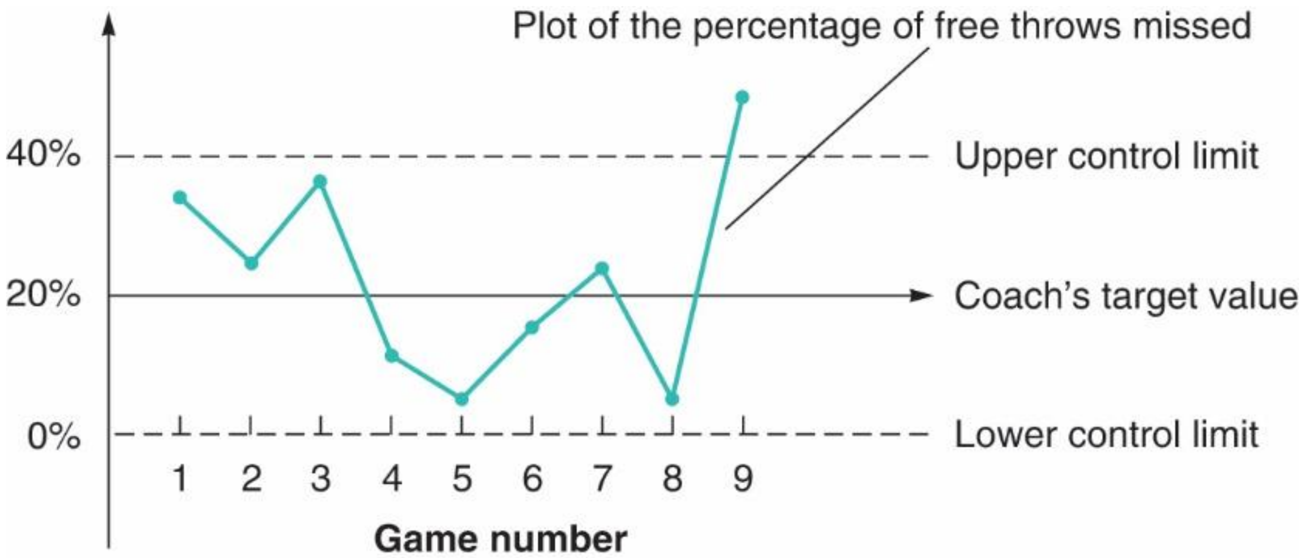


Statistical Process Control (SPC)

- Uses statistics and control charts to tell when to take corrective action
- Drives process improvement
- **Four key steps**
  - Measure the process
  - When a change is indicated, find the assignable cause
  - Eliminate or incorporate the cause
  - Restart the revised process

Control Charts

Figure 6.8



Inspection (1 of 2)

- Involves examining items to see if an item is good or defective
- **Detect a defective product**
  - Does not correct deficiencies in process or product
  - It is expensive
- Issues
  - When to inspect
  - Where in process to inspect

When and Where to Inspect (1 of 2)

1. At the supplier's plant while the supplier is producing
2. At your facility upon receipt of goods from your supplier
3. Before costly or irreversible processes
4. During the step-by-step production process
5. When production or service is complete
6. Before delivery to your customer
7. At the point of customer contact

When and Where to Inspect (2 of 2)

Table 6.4 How Samsung Tests Its Smartphones

Durability	Stress testing with nail punctures, extreme temperatures and overcharging
Visual inspection	Comparing the battery with standardized models
X-ray	Looking for internal abnormalities
Charge and discharge	Power up and down the completed phone
Organic pollution (TVOC)	Looking for battery leakage
Disassembling	Opening the battery cell to inspect tab welding and insulation tape conditions
Accelerated usage	Simulated 2 weeks of real-life use in 5 days
Volatility (OVC)	Checking for change in voltage throughout the manufacturing process

Inspection (2 of 2)

- Many problems
  - Worker **tiredness**
  - Measurement **error**
  - Process **variability**
- Cannot inspect quality into a product
- Robust design, empowered employees, and sound processes are better solutions

Source Inspection (1 of 2)

- Also known as source control
- The next step in the process is your customer
- Ensure perfect product to your customer

Source Inspection (2 of 2)

- **Poka-yoke** is the concept of foolproof devices or techniques designed to pass only acceptable products
- **Checklists** ensure consistency and completeness

Service Industry Inspection (1 of 3)

Table 6.5 Examples of Inspection in Services

ORGANIZATION	WHAT IS INSPECTED	STANDARD
Alaska Airlines	Last bag on carousel Airplane door opened	Less than 20 minutes after arrival at the gate Less than 2 minutes after arrival at the gate
Jones Law Office	Receptionist performance Billing Attorney	Phone answered by the second ring Accurate, timely, and correct format Promptness in returning calls
Hard Rock Hotel	Reception desk Doorman Room Minibar	Use customer’s name Greet guest in less than 30 seconds All lights working, spotless bathroom Restocked and charges accurately posted to bill

Pearson

Service Industry Inspection (2 of 3)

Table 6.5 Examples of Inspection in Services

ORGANIZATION	WHAT IS INSPECTED	STANDARD
Arnold Palmer Hospital	Billing Pharmacy Lab Nurses Admissions	Accurate, timely, and correct format Prescription accuracy, inventory accuracy Audit for lab-test accuracy Charts immediately updated Data entered correctly and completely
Olive Garden Restaurant	Busboy Busboy Waiter	Serves water and bread within 1 minute Clears all entrée items and crumbs prior to dessert Knows and suggests specials, desserts

Pearson

Service Industry Inspection (3 of 3)

Table 6.5 Examples of Inspection in Services

ORGANIZATION	WHAT IS INSPECTED	STANDARD
Nordstrom Department Store	Display areas Stockrooms Salesclerks	Attractive, well-organized, stocked, good lighting Rotation of goods, organized, clean Neat, courteous, very knowledgeable

Pearson

Attributes Versus Variables

- *Attributes*
  - Items are either good or bad, acceptable or unacceptable
  - Does not address degree of failure
- *Variables*
  - Measures dimensions such as weight, speed, height, or strength
  - Falls within an acceptable range
- Use different statistical techniques

Pearson

TQM In Services

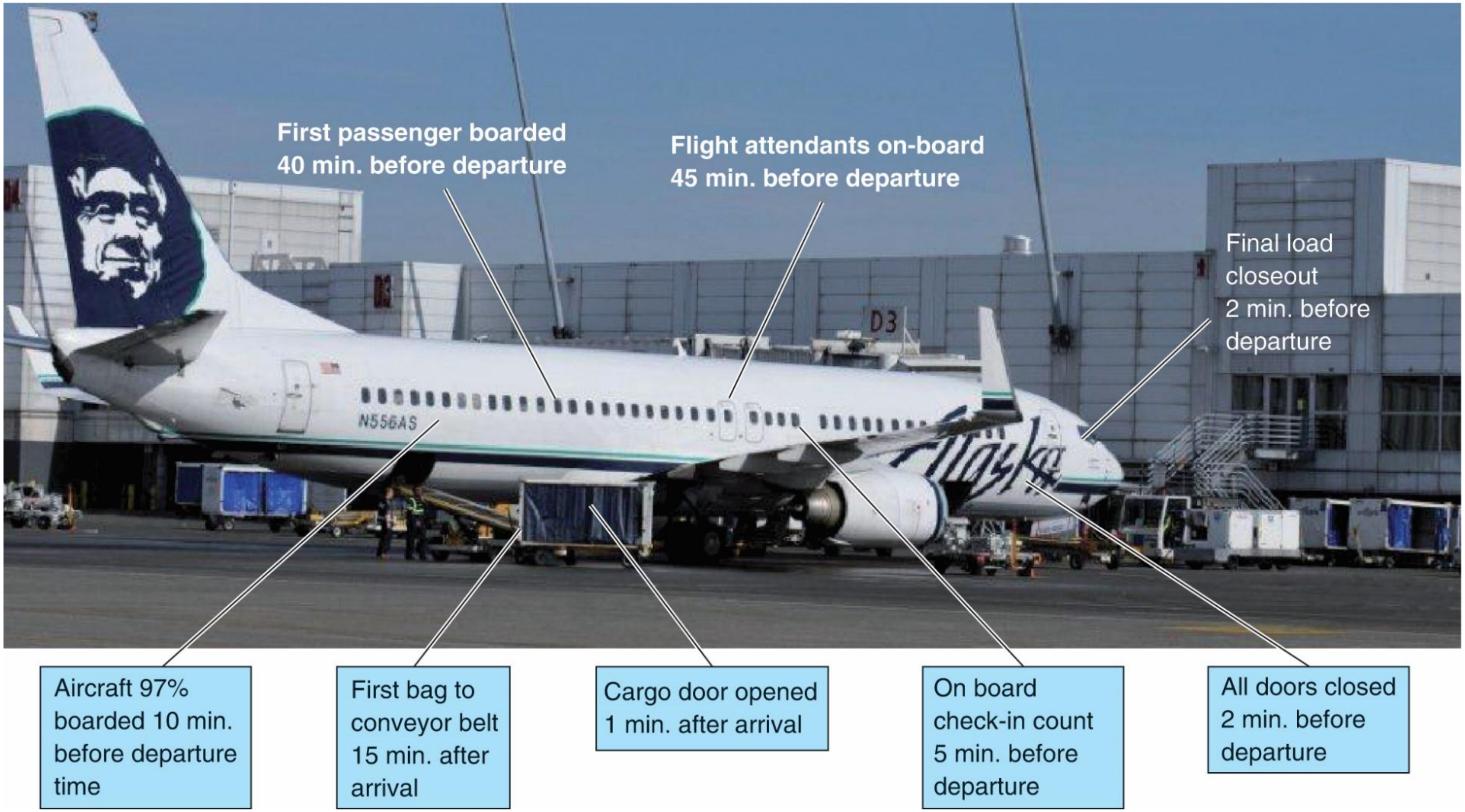
- Service quality is more difficult to measure than the quality of goods
- Service quality perceptions depend on
  1) *Intangible differences between products*
  2) *Intangible expectations customers have of those products*

Service Quality

The operations manager must recognize:

- Selecting best practices to use as a standard for performance
- The tangible component of services is important
- The service process is important
- The service is judged against the customer’s expectations
- Exceptions will occur

Service Specifications



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Determinants of Service Quality

Table 6.6

Reliability involves consistency of performance and dependability
Responsiveness concerns the willingness or readiness of employees to provide service
Competence means possession of the required skills and knowledge to perform the service
Access involves approachability and ease of contact
Courtesy involves politeness, respect, consideration, and friendliness
Communication means keeping customers informed and listening to them
Credibility involves trustworthiness, believability, and honesty
Security is the freedom from danger, risk, or doubt
Understanding/knowing the customer involves making the effort to understand the customer's needs
Tangibles include the physical evidence of the service

Service Recovery Strategy

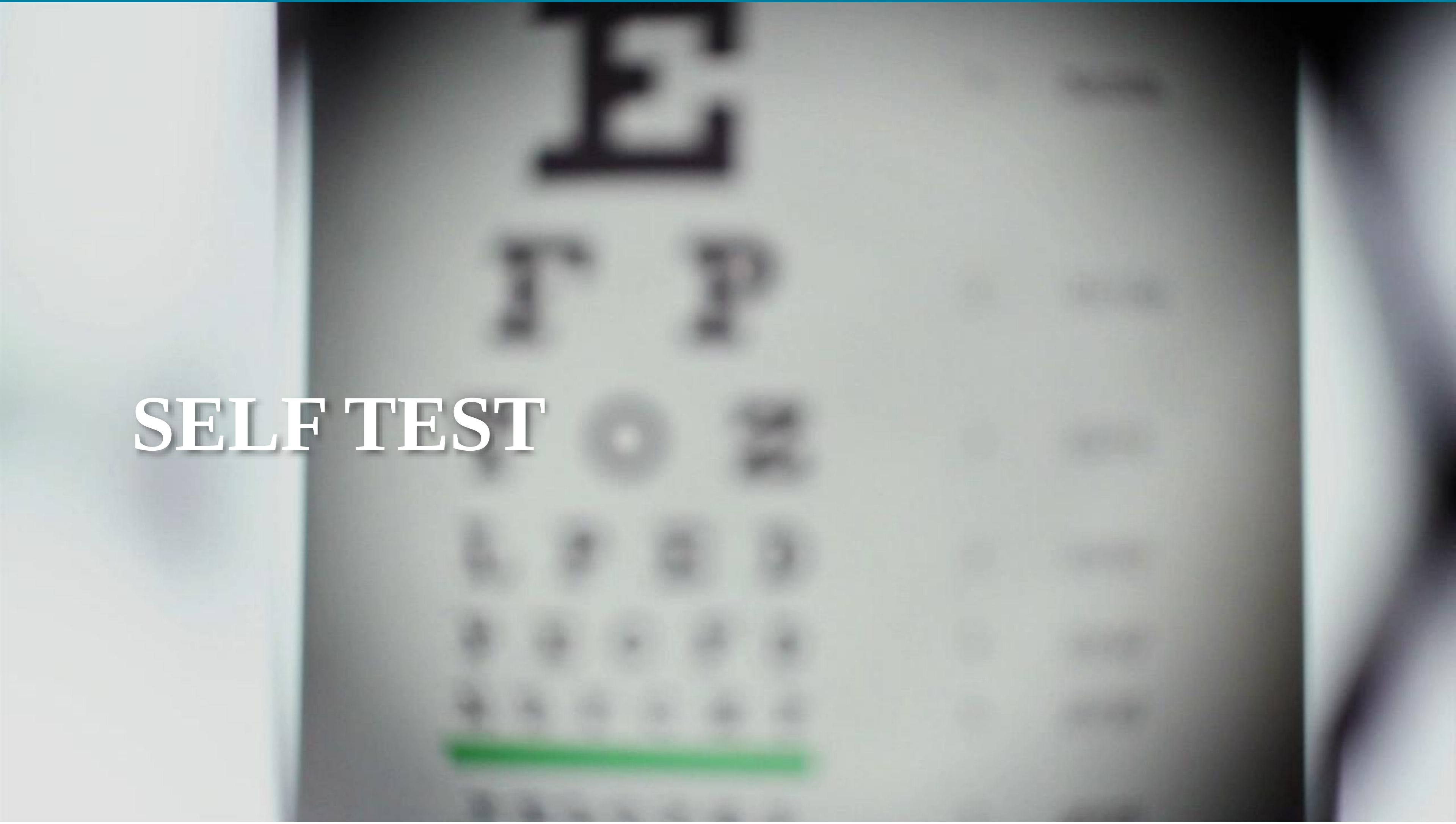
- Managers should have a plan **for when services fail**
- Marriott's **LEARN** routine
  - Listen
  - Empathize
  - Apologize
  - React
  - Notify

Evaluating Performance (1 of 2)

- The SERVQUAL technique
- Direct comparisons **between customer service expectations and actual service provided**
- Focuses on gaps in the 10 service quality determinants

Evaluating Performance (2 of 2)

- Most common version collapses the determinants to
  - Reliability
  - Assurances
  - Tangibles
  - Empathy
  - Responsiveness



SELF TEST

1- Low-volume, high-variety processes are also known as:

a) continuous processes.
b) process focused.
c) repetitive processes.
d) product focused.

2 - A crossover chart for process selection focuses on:

a) labor costs.
b) material cost.
c) both labor and material costs.
d) fixed and variable costs.
e) fixed costs.

3- Tools for process analysis include all of the following except:

a) flowchart.
b) vision systems.
c) service blueprinting.
d) time-function mapping.
e) value-stream mapping

4- Customer feedback in process design is lower as:

a) the degree of customization is increased.

b) the degree of labor is increased.

c) the degree of customization is lowered.

d) both a and b.

e) both b and c.

5- Computer-integrated manufacturing (CIM) includes manufacturing systems that have:

a) computer-aided design, direct numerical control machines, and material-handling equipment controlled by automation.

b) transaction processing, a management information system, and decision support systems.

c) automated guided vehicles, robots, and process control.

d) robots, automated guided vehicles, and transfer equipment.

Quiz

Layout

1- Which of the statements below best describes office layout ?

a) Groups workers, their equipment, and spaces/offices to provide for movement of information.
b) Addresses the layout requirements of large, bulky projects such as ships and buildings.
c) Seeks the best personnel and machine utilization in repetitive or continuous production.
d) Allocates shelf space and responds to customer behavior.
e) Deals with low-volume, high-variety production.

2-Which of the following does not support the retail layout objective of maximizing customer exposure to products?

a) Locate high-draw items around the periphery of the store.
b) Use prominent locations for high-impulse and high-margin items.
c) Maximize exposure to expensive items.
d) Use end-aisle locations.
e) Convey the store's mission with the careful positioning of the lead-off department.

3- The major problem addressed by the warehouse layout strategy is:

a) minimizing difficulties caused by material flow varying with each product.
b) requiring frequent contact close to one another.
c) addressing trade-offs between space and material handling or balancing product flow from one workstation to the next.
d) none of the above.

4- A fixed-position layout:

a) groups workers to provide for movement of information.
b) addresses the layout requirements of large, bulky projects such as ships and buildings.
c) seeks the best machine utilization in continuous production.
d) allocates shelf space based on customer behavior. e) deals with low-volume, high-variety production.

5 -A process-oriented layout:

a) groups workers to provide for movement of information.
b) addresses the layout requirements of large, bulky projects such as ships and buildings.
c) seeks the best machine utilization in continuous production.
d) allocates shelf space based on customer behavior.
e) deals with low-volume, high-variety production.

6-For a focused work center or focused factory to be appropriate, the following three factors are required:

a)
b)
c)

7- Before considering a product-oriented layout, it is important to be certain of:

a)
b)
c)
d)

8- An assembly line is to be designed for a product whose completion requires 21 minutes of work. The factory works 400 minutes per day. Can a production line with five workstations make 100 units per day?

a) Yes, with exactly 100 minutes to spare.
b) No, but four workstations would be sufficient.
c) No, it will fall short even with a perfectly balanced line.
d) Yes, but the line's efficiency is very low.
e) Cannot be determined from the information given.

SELF TEST

- **Which of the following is not one of the graphical method steps?**

a) Determine the demand in each period.

b) Determine capacity for regular time, overtime, and subcontracting each period.

c) Find labor costs, hiring and layoff costs, and inventory holding costs.

d) Construct the transportation table.

e) Consider company policy that may apply to the workers or stock levels.

f) Develop alternative plans and examine their total costs.

- **The outputs from an S&OP process are:**

a) long-run plans.
b) detail schedules.
c) aggregate plans.
d) revenue management plans.
e) short-run plans.