Operations Management

William J. Stevenson

8th edition

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CHAPTER 1

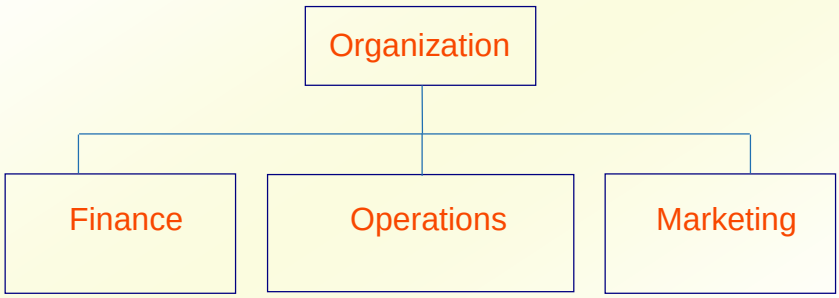
Introduction to Operations Management

McGraw-Hill/Irwin

Operations Management

Figure 1.1

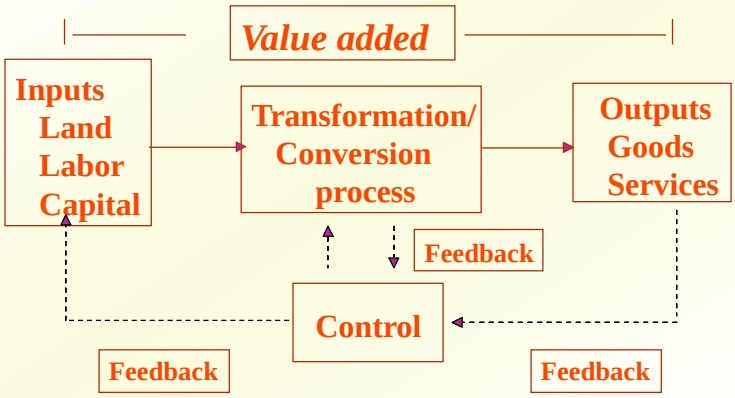
The management of systems or processes that *create goods and/or provide services*



Value-Added

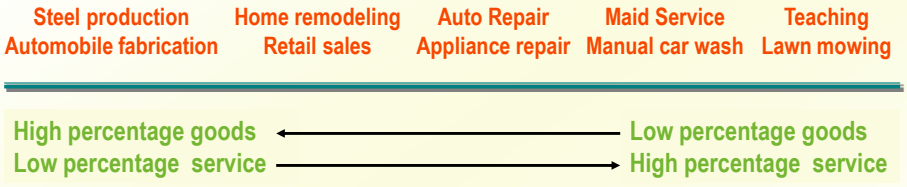
Figure 1.2

The difference between the cost of inputs and the value or price of outputs.



Goods-service Continuum

Figure 1.3



Food Processor

Table 1.2

Inputs	Processing	Outputs
Raw Vegetables	Cleaning	Canned vegetables
Metal Sheets	Making cans	
Water	Cutting	
Energy	Cooking	
Labor	Packing	
Building	Labeling	
Equipment		

Hospital Process

Table 1.2

Inputs	Processing	Outputs
Doctors, nurses	Examination	Healthy patients
Hospital	Surgery	
Medical Supplies	Monitoring	
Equipment	Medication	
Laboratories	Therapy	

Manufacturing or Service?

Production of Goods vs. Delivery of Services

- Production of goods – tangible output
- Delivery of services – an act
- Service job categories
  - Government
  - Wholesale/retail
  - Financial services
  - Healthcare
  - Personal services
  - Business services
  - Education

Key Differences

1. Customer contact
2. Uniformity of input
3. Labor content of jobs
4. Uniformity of output
5. Measurement of productivity
6. Production and delivery
7. Quality assurance
8. Amount of inventory

Manufacturing vs Service

Characteristic	Manufacturing	Service
Output	Tangible	Intangible
Customer contact	Low	High
Uniformity of input	High	Low
Labor content	Low	High
Uniformity of output	High	Low
Measurement of productivity	Easy	Difficult
Opportunity to correct quality problems	High	Low

Scope of Operations Management

- Operations Management includes:
  - Forecasting
  - Capacity planning
  - Scheduling
  - Managing inventories
  - Assuring quality
  - Motivating employees
  - Deciding where to locate facilities
  - And more . . .

- The operations function
  - Consists of all activities directly related to producing goods or providing services

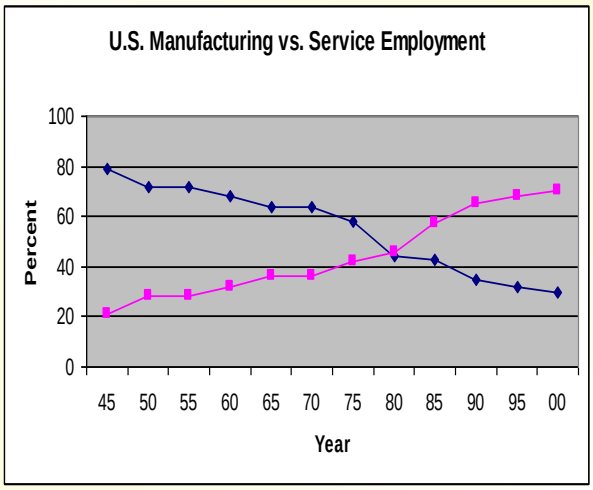
Types of Operations

Table 1.4

Operations	Examples
Goods Producing	Farming, mining, construction, manufacturing, power generation
Storage/Transportation	Warehousing, trucking, mail service, moving, taxis, buses, hotels, airlines
Exchange	Retailing, wholesaling, banking, renting, leasing, library, loans
Entertainment	Films, radio and television, concerts, recording
Communication	Newspapers, radio and television newscasts, telephone, satellites

Figure 1.4

Year	Mfg.	Service
45	79	21
50	72	28
55	72	28
60	68	32
65	64	36
70	64	36
75	58	42
80	44	46
85	43	57
90	35	65
95	32	68
00	30	70



Key Decisions of Operations Managers

- What
  - What resources/what amounts
- When
  - Needed/scheduled/ordered
- Where
  - Work to be done
- How
  - Designed
- Who
  - To do the work

Pareto Phenomenon

- A few factors account for a high percentage of the occurrence of some event(s).
- 80/20 Rule - 80% of problems are caused by 20% of the activities.

How do we identify the vital few?

Historical Evolution of Operations Management

Table 1.7

- Industrial revolution (1770's)
- Scientific management (1911)
  - Mass production
  - Interchangeable parts
  - Division of labor
- Human relations movement (1920-60)
- Decision models (1915, 1960-70's)
- Influence of Japanese manufacturers

Trends in Business

- Major trends
  - The Internet, e-commerce, e-business
  - Management technology
  - Globalization
  - Management of supply chains
  - Agility

Simple Product Supply Chain

Figure 1.7

Supply Chain: A sequence of activities
And organizations involved in producing
And delivering a good or service

A Supply Chain for Bread

Stage of Production	Value Added	Value of Product
Farmer produces and harvests wheat	$0.15	$0.15
Wheat transported to mill	$0.08	$0.23
Mill produces flour	$0.15	$0.38
Flour transported to baker	$0.08	$0.46
Baker produces bread	$0.54	$1.00
Bread transported to grocery store	$0.08	$1.08
Grocery store displays and sells bread	$0.21	$1.29
Total Value-Added	**$1.29**	

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CHAPTER 2

Competitiveness, Strategy, and Productivity

McGraw-Hill/Irwin

Competitiveness:

How effectively an organization meets the wants and needs of customers relative to others that offer similar goods or services

Businesses Compete Using Marketing

- Identifying consumer wants and needs
- Pricing
- Advertising and promotion

Businesses Compete Using Operations

- Product and service design
- Cost
- Location
- Quality
- Quick response

Businesses Compete Using Operations

- Flexibility
- Inventory management
- Supply chain management
- Service

Mission/Strategy/Tactics

How does mission, strategies and tactics relate to decision making and distinctive competencies?

Strategy

- Strategies
  - Plans for achieving organizational goals
- Mission
  - The reason for existence for an organization
- Mission Statement
  - Answers the question “What business are we in?”
- Goals
  - Provide detail and scope of mission
- Tactics
  - The methods and actions taken to accomplish strategies

Planning and Decision Making

Figure 2.1

Strategy Example

Example 1

Rita is a high school student. She would like to have a career in business, have a good job, and earn enough income to live comfortably

Mission:	Live a good life
• Goal:	Successful career, good income
• Strategy:	Obtain a college education
• Tactics:	Select a college and a major
• Operations:	Register, buy books, take courses, study, graduate, get job

Strategy and Tactics

- Distinctive Competencies

  The special attributes or abilities that give an organization a competitive edge.

  - Price
  - Quality
  - Time
  - Flexibility
  - Service
  - Location

Examples of Distinctive Competencies

Table 2.2

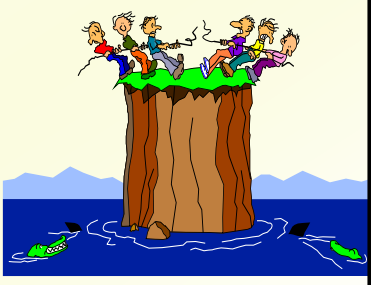
Price	Low Cost	U.S. first-class postage Motel-6, Red Roof Inns
Quality	High-performance design or high quality Consistent quality	Sony TV Lexus, Cadillac Pepsi, Kodak, Motorola
Time	Rapid delivery On-time delivery	Express Mail, Fedex, One-hour photo, UPS
Flexibility	Variety Volume	Burger King Supermarkets
Service	Superior customer service	Disneyland Nordstroms
Location	Convenience	Banks, ATMs

Operations Strategy

- Operations strategy – The approach, consistent with organization strategy, that is used to guide the operations function.

Quality and Time Strategies

- Quality-based strategies
  - Focuses on maintaining or improving the quality of an organization's products or services
  - Quality at the source
- Time-based strategies
  - Focuses on reduction of time needed to accomplish tasks



Productivity

- Productivity
  - A measure of the effective use of resources, usually expressed as the ratio of output to input
- Productivity ratios are used for
  - Planning workforce requirements
  - Scheduling equipment
  - Financial analysis

Productivity

- Partial measures
  - output/(single input)
- Multi-factor measures
  - output/(multiple inputs)
- Total measure
  - output/(total inputs)

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

Productivity Growth

Productivity Growth =

$$\frac{\text{Current Period Productivity} - \text{Previous Period Productivity}}{\text{Previous Period Productivity}}$$

Measures of Productivity

Table 2.4

Partial measures	$\frac{\text{Output}}{\text{Labor}}$	$\frac{\text{Output}}{\text{Machine}}$	$\frac{\text{Output}}{\text{Capital}}$	$\frac{\text{Output}}{\text{Energy}}$
Multifactor measures	$\frac{\text{Output}}{\text{Labor + Machine}}$		$\frac{\text{Output}}{\text{Labor + Capital + Energy}}$	
Total measure	$\frac{\text{Goods or Services Produced}}{\text{All inputs used to produce them}}$			

Examples of Partial Productivity Measures

Table 2.5

Labor Productivity	Units of output per labor hour Units of output per shift Value-added per labor hour
Machine Productivity	Units of output per machine hour machine hour
Capital Productivity	Units of output per dollar input Dollar value of output per dollar input
Energy Productivity	Units of output per kilowatt-hour Dollar value of output per kilowatt-hour

Example 3

7040 Units Produced

Sold for $1.10/unit

Cost of labor of $1,000

Cost of materials: $520

Cost of overhead: $2000

What is the multifactor productivity?

Ans. 2.20

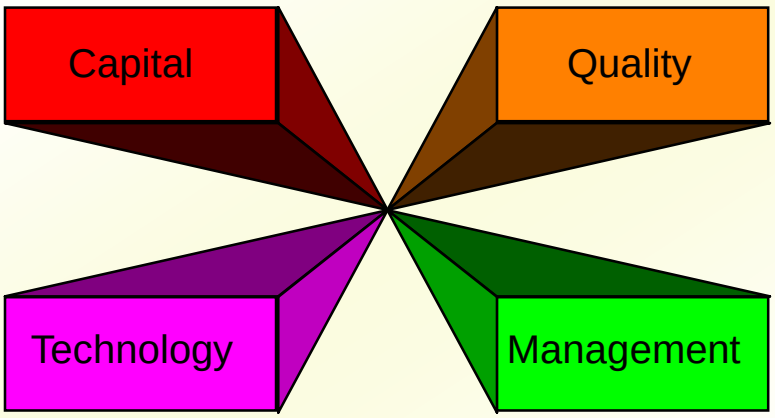
Example 3 Solution

$$MFP = \frac{\text{Output}}{\text{Labor + Materials + Overhead}}$$

$$MFP = \frac{(7040 \text{ units})*(\$1.10)}{\$1000 + \$520 + \$2000}$$

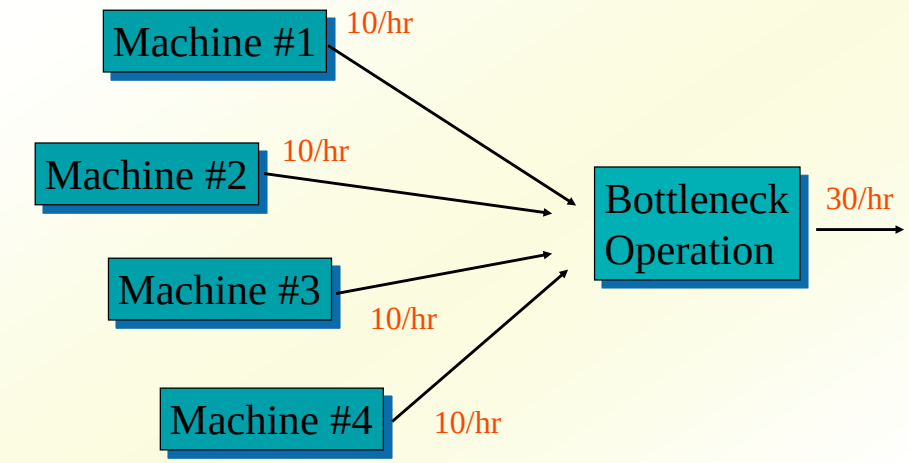
$$MFP = 2.20$$

Factors Affecting Productivity



Bottleneck Operation

Figure 2.3



Improving Productivity

- Develop productivity measures
- Determine critical (bottleneck) operations
- Develop methods for productivity improvements
- Establish reasonable goals
- Get management support
- Measure and publicize improvements
- Don’t confuse productivity with efficiency

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CHAPTER 3

Forecasting

FORECAST:

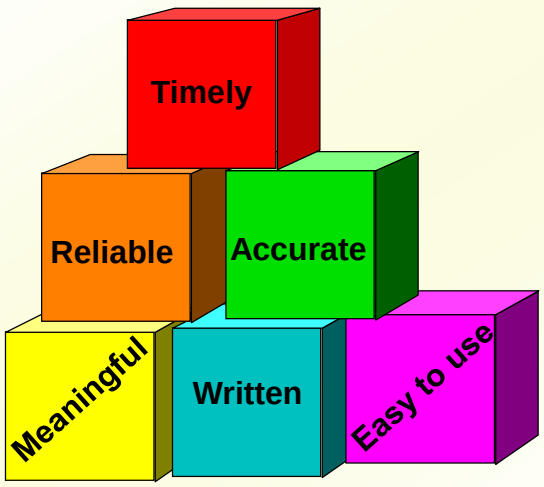
- A statement about the future value of a variable of interest such as demand.
- Forecasts affect decisions and activities throughout an organization
  - Accounting, finance
  - Human resources
  - Marketing
  - MIS
  - Operations
  - Product / service design

Uses of Forecasts

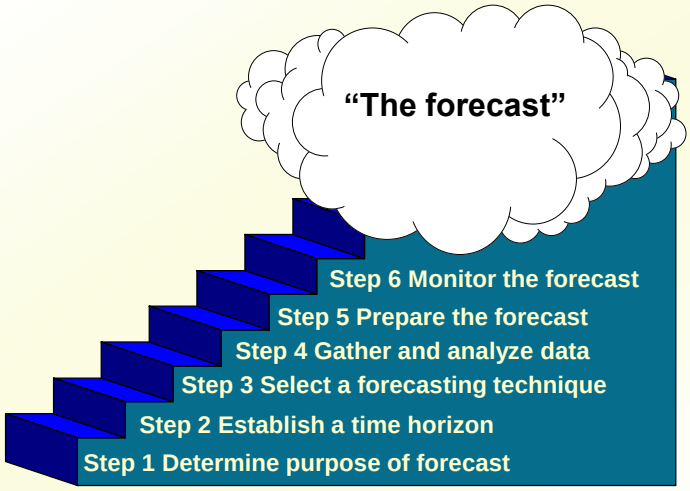
Accounting	Cost/profit estimates
Finance	Cash flow and funding
Human Resources	Hiring/recruiting/training
Marketing	Pricing, promotion, strategy
MIS	IT/IS systems, services
Operations	Schedules, MRP, workloads
Product/service design	New products and services

- Assumes causal system
  past ==> future
- Forecasts rarely perfect because of randomness
- Forecasts more accurate for groups vs. individuals
- Forecast accuracy decreases as time horizon increases

Elements of a Good Forecast



Steps in the Forecasting Process



Types of Forecasts

- *Judgmental* - uses subjective inputs
- *Time series* - uses historical data assuming the future will be like the past
- *Associative models* - uses explanatory variables to predict the future

Judgmental Forecasts

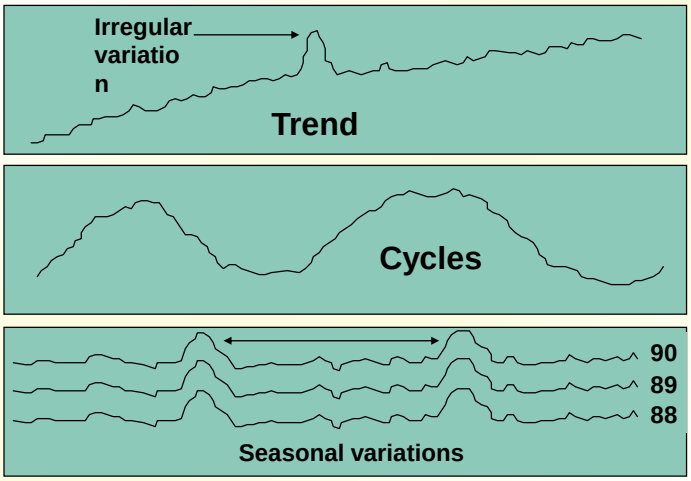
- Executive opinions
- Sales force opinions
- Consumer surveys
- Outside opinion (8-12)
- Delphi method (12-18)
  - Opinions of managers and staff
  - Achieves a consensus forecast

Time Series Forecasts

- *Trend* - long-term movement in data
- *Seasonality* - short-term regular variations in data
- Cycle – wavelike variations of more than one year's duration
- *Irregular variations* - caused by unusual circumstances
- *Random variations* - caused by chance

Forecast Variations

Figure 3.1



Naive Forecasts

Uh, give me a minute.... We sold 250 wheels last week.... Now, next week we should sell....

The forecast for any period equals the previous period's actual value.

Naïve Forecasts

- Simple to use
- Virtually no cost
- Quick and easy to prepare
- Data analysis is nonexistent
- Easily understandable
- Cannot provide high accuracy
- Can be a standard for accuracy

Uses for Naïve Forecasts

- Stable time series data
  - $F(t) = A(t-1)$
- Seasonal variations
  - $F(t) = A(t-n)$
- Data with trends
  - $F(t) = A(t-1) + (A(t-1) – A(t-2))$

Techniques for Averaging

- Moving average
- Weighted moving average
- Exponential smoothing

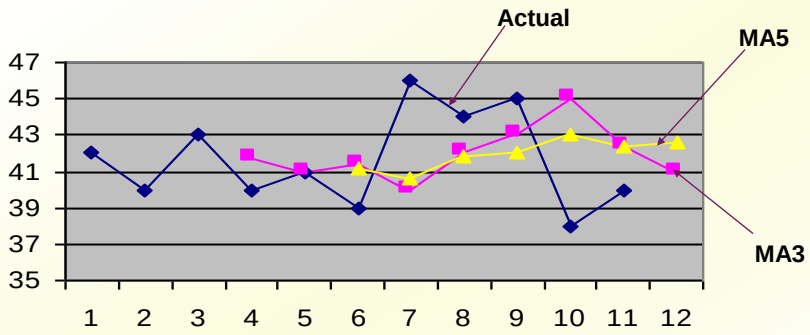
Moving Averages

- *Moving average* – A technique that averages a number of recent actual values, updated as new values become available.

$$MA_n = \frac{\sum_{i=1}^{n} A_i}{n}$$

- *Weighted moving average* – More recent values in a series are given more weight in computing the forecast.

Simple Moving Average



$$MA_n = \frac{\sum_{i=1}^{n} A_i}{n}$$

Exponential Smoothing

$$F_t = F_{t-1} + \alpha(A_{t-1} - F_{t-1})$$

- *Premise*--The most recent observations might have the highest predictive value.
  - Therefore, we should give more weight to the more recent time periods when forecasting.

Exponential Smoothing

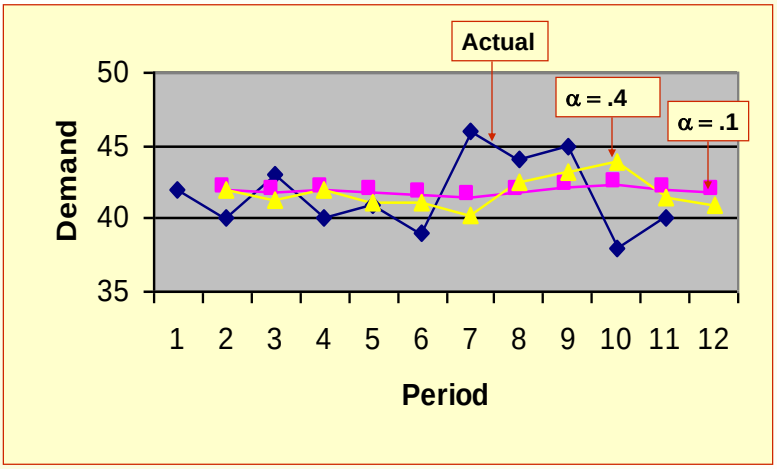
$$F_t = F_{t-1} + \alpha(A_{t-1} - F_{t-1})$$

- Weighted averaging method based on previous forecast plus a percentage of the forecast error
- A-F is the error term, α is the % feedback

Example 3 - Exponential Smoothing

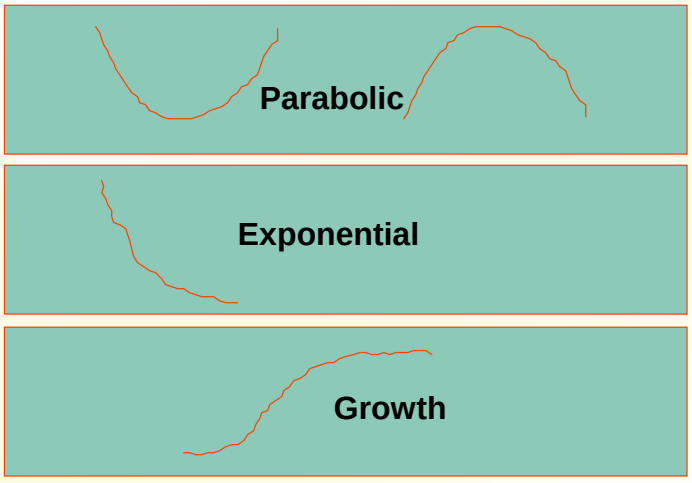
Period	Actual	Alpha = 0.1	Error	Alpha = 0.4	Error
1	42				
2	40	42	-2.00	42	-2
3	43	41.8	1.20	41.2	1.8
4	40	41.92	-1.92	41.92	-1.92
5	41	41.73	-0.73	41.15	-0.15
6	39	41.66	-2.66	41.09	-2.09
7	46	41.39	4.61	40.25	5.75
8	44	41.85	2.15	42.55	1.45
9	45	42.07	2.93	43.13	1.87
10	38	42.36	-4.36	43.88	-5.88
11	40	41.92	-1.92	41.53	-1.53
12		41.73		40.92	

Picking a Smoothing Constant



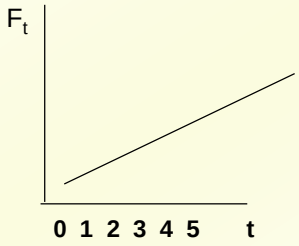
Common Nonlinear Trends

Figure 3.5



Linear Trend Equation

$$F_t = a + bt$$



- F_t = Forecast for period t
- t = Specified number of time periods
- a = Value of F_t at t = 0
- b = Slope of the line

Calculating a and b

$$b = \frac{n\sum(ty) - \sum t\sum y}{n\sum t^2 - (\sum t)^2}$$

$$a = \frac{\sum y - b\sum t}{n}$$

Linear Trend Equation Example

t Week	t^2	y Sales	ty
1	1	150	150
2	4	157	314
3	9	162	486
4	16	166	664
5	25	177	885
$\Sigma t = 15$ $(\Sigma t)^2 = 225$	$\Sigma t^2 = 55$	$\Sigma y = 812$	$\Sigma ty = 2499$

Linear Trend Calculation

$$b = \frac{5(2499) - 15(812)}{5(55) - 225} = \frac{12495 - 12180}{275 - 225} = 6.3$$

$$a = \frac{812 - 6.3(15)}{5} = 143.5$$

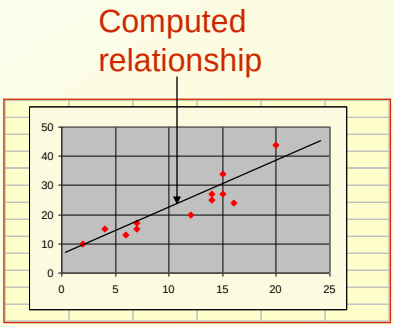
$$y = 143.5 + 6.3t$$

Associative Forecasting

- *Predictor variables* - used to predict values of variable interest
- *Regression* - technique for fitting a line to a set of points
- *Least squares line* - minimizes sum of squared deviations around the line

Linear Model Seems Reasonable

X	Y
7	15
2	10
6	13
4	15
14	25
15	27
16	24
12	20
14	27
20	44
15	34
7	17



A straight line is fitted to a set of sample points.

Forecast Accuracy

- Error - difference between actual value and predicted value
- Mean Absolute Deviation (MAD)
  - Average absolute error
- Mean Squared Error (MSE)
  - Average of squared error
- Mean Absolute Percent Error (MAPE)
  - Average absolute percent error

MAD, MSE, and MAPE

$$MAD = \frac{\sum \left| Actual - forecast \right|}{n}$$

$$MSE = \frac{\sum (Actual - forecast)^2}{n - 1}$$

$$MAPE = \frac{\sum \left(\left| Actual - forecast_t \right| / Actual * 100 \right)}{n}$$

Example 10

Period	Actual	Forecast	(A-F)	|A-F|	(A-F)^2	(|A-F|/Actual)*100
1	217	215	2	2	4	0.92
2	213	216	-3	3	9	1.41
3	216	215	1	1	1	0.46
4	210	214	-4	4	16	1.90
5	213	211	2	2	4	0.94
6	219	214	5	5	25	2.28
7	216	217	-1	1	1	0.46
8	212	216	-4	4	16	1.89
			-2	22	76	10.26
MAD=	2.75					
MSE=	10.86					
MAPE=	1.28					

Controlling the Forecast

- Control chart
  - A visual tool for monitoring forecast errors
  - Used to detect non-randomness in errors
- Forecasting errors are in control if
  - All errors are within the control limits
  - No patterns, such as trends or cycles, are present

Sources of Forecast errors

- Model may be inadequate
- Irregular variations
- Incorrect use of forecasting technique

Tracking Signal

- Tracking signal
  - –Ratio of cumulative error to MAD

$$\text{Tracking signal} = \frac{\sum(\text{Actual-forecast})}{\text{MAD}}$$

Bias **– Persistent tendency for forecasts to be Greater or less than actual values.**

Choosing a Forecasting Technique

- No single technique works in every situation
- Two most important factors
  - Cost
  - Accuracy
- Other factors include the availability of:
  - Historical data
  - Computers
  - Time needed to gather and analyze the data
  - Forecast horizon

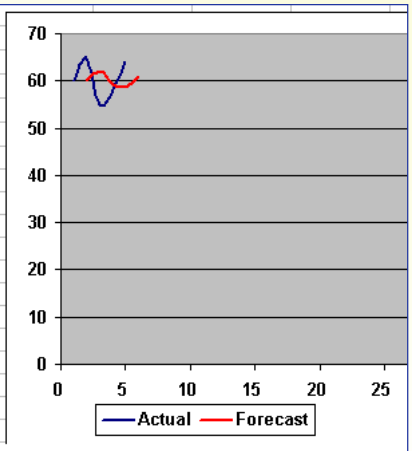
Exponential Smoothing

Exponential Smoothing

Clear

α =	0.4	MAD =	4.62
Δα =	0.1	MSE =	34.44

Period	Actual	Forecast	Error
1	60		
2	65	60	5
3	55	62	-7
4	58	59.2	-1.2
5	64	58.72	5.28
6		60.832	

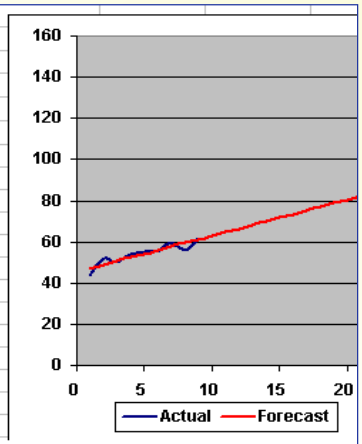


Linear Trend Equation

Linear Trend Equation Clear

Slope =	1.7500	MAD =	1.86
Intercept =	45.472222	MSE =	5.23

Period	Actual	Forecast	Error
1	44	47.222222	-3.2222222
2	52	48.972222	3.0277778
3	50	50.722222	-0.7222222
4	54	52.472222	1.5277778
5	55	54.222222	0.7777778
6	55	55.972222	-0.9722222
7	60	57.722222	2.2777778
8	56	59.472222	-3.4722222
9	62	61.222222	0.7777778

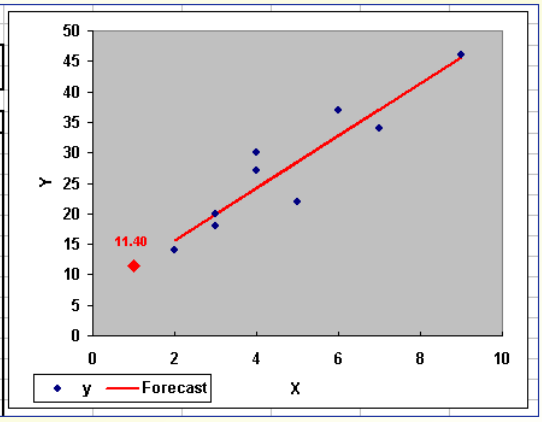


Simple Linear Regression

Simple Linear Regression Clear

Slope =	4.2753	r =	0.9276226
Intercept =	7.1292135	r^2 =	0.8604837

x	y	Forecast	Error
9	46	45.606742	0.3932584
3	18	19.955056	-1.9550562
3	20	19.955056	0.0449438
5	22	28.505618	-6.505618
4	27	24.230337	2.7696629
7	34	37.05618	-3.0561798
2	14	15.679775	-1.6797753
6	37	32.780899	4.2191011
4	30	24.230337	5.7696629



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CHAPTER 4

Product and Service Design

McGraw-Hill/Irwin

Product and Service Design

- Major factors in design strategy
  - Cost
  - Quality
  - Time-to-market
  - Customer satisfaction
  - Competitive advantage

Product and service design – or redesign – should be closely tied to an organization's strategy

Product or Service Design Activities

- Translate customer wants and needs into product and service requirements
- Refine existing products and services
- Develop new products and services
- Formulate quality goals
- Formulate cost targets
- Construct and test prototypes
- Document specifications

Reasons for Product or Service Design

- Economic
- Social and demographic
- Political, liability, or legal
- Competitive
- Technological

Objectives of Product and Service Design

- Main focus
  - Customer satisfaction
- Secondary focus
  - Function of product/service
  - Cost/profit
  - Quality
  - Appearance
  - Ease of production/assembly
  - Ease of maintenance/service

Designing For Operations

- Taking into account the capabilities of the organization in designing goods and services

Legal, Ethical, and Environmental Issues

- Legal
  - FDA, OSHA, IRS
  - Product liability
  - Uniform commercial code
- Ethical
  - Releasing products with defects
- Environmental
  - EPA

Regulations & Legal Considerations

- *Product Liability* - A manufacturer is liable for any injuries or damages caused by a faulty product.
- *Uniform Commercial Code* - Products carry an implication of merchantability and fitness.

Designers Adhere to Guidelines

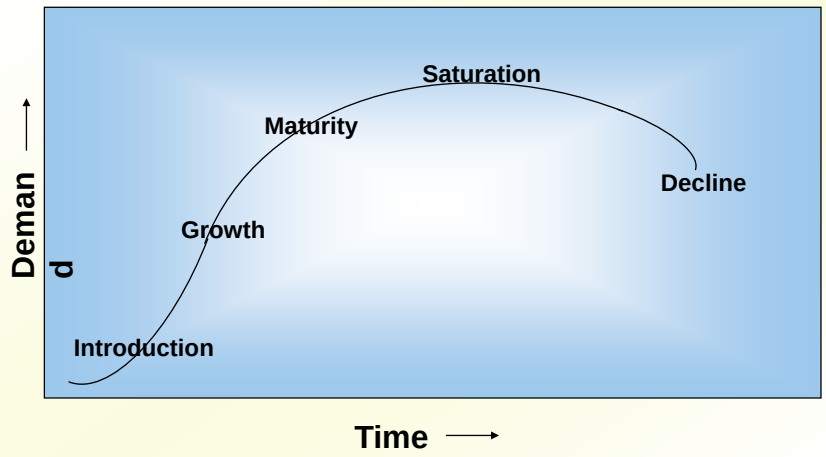
- Produce designs that are consistant with the goals of the company
- Give customers the value they expect
- Make health and safety a primary concern
- Consider potential harm to the environment

Other Issues in Product and Service Design

- Product/service life cycles
- How much standardization
- Product/service reliability
- Range of operating conditions

Life Cycles of Products or Services

Figure 4.1



Standardization

- Standardization
  - Extent to which there is an absence of variety in a product, service or process
- Standardized products are immediately available to customers

Advantages of Standardization

- Fewer parts to deal with in inventory & manufacturing
- Design costs are generally lower
- Reduced training costs and time
- More routine purchasing, handling, and inspection procedures

Advantages of Standardization (Cont'd)

- Orders fillable from inventory
- Opportunities for long production runs and automation
- Need for fewer parts justifies increased expenditures on perfecting designs and improving quality control procedures.

Disadvantages of Standardization

- Designs may be frozen with too many imperfections remaining.
- High cost of design changes increases resistance to improvements.
- Decreased variety results in less consumer appeal.

Mass Customization

- Mass customization:
  - A strategy of producing standardized goods or services, but incorporating some degree degree of customization
  - Delayed differentiation
  - Modular design

Delayed Differentiation

- Delayed differentiation is a postponement tactic
  - Producing but not quite completing a product or service until customer preferences or specifications are known

Modular Design

Modular design is a form of standardization in which component parts are subdivided into modules that are easily replaced or interchanged. It allows:

- easier diagnosis and remedy of failures
- easier repair and replacement
- simplification of manufacturing and assembly

Reliability

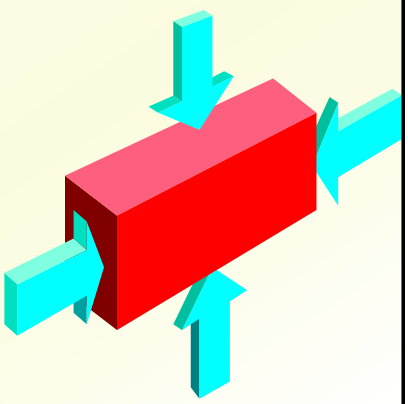
- *Reliability*: The ability of a product, part, or system to perform its intended function under a prescribed set of conditions
- *Failure*: Situation in which a product, part, or system does not perform as intended
- *Normal operating conditions*: The set of conditions under which an item's reliability is specified

Improving Reliability

- Component design
- Production/assembly techniques
- Testing
- Redundancy/backup
- Preventive maintenance procedures
- User education
- System design

Product Design

- Product Life Cycles
- Robust Design
- Concurrent Engineering
- Computer-Aided Design
- Modular Design



Robust Design

Robust Design: Design that results in products or services that can function over a broad range of conditions

Taguchi Approach Robust Design

- Design a robust product
  - Insensitive to environmental factors either in manufacturing or in use.
- Central feature is *Parameter Design*.
- Determines:
  - factors that are controllable and those not controllable
  - their optimal levels relative to major product advances

Degree of Newness

1. Modification of an existing product/service
2. Expansion of an existing product/service
3. Clone of a competitor's product/service
4. New product/service

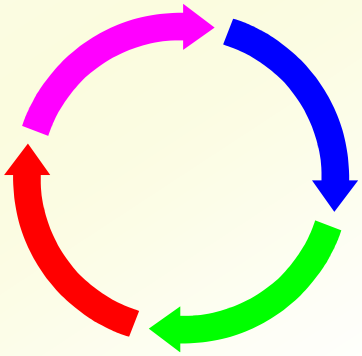
Degree of Design Change

Table 4.3

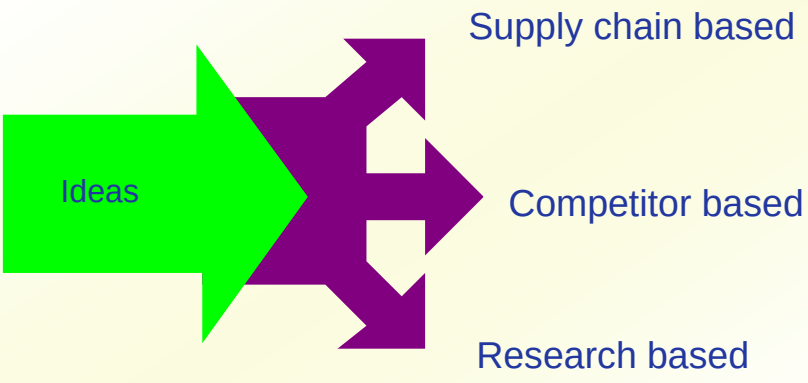
Type of Design Change	Newness of the organization	Newness to the market
Modification	Low	Low
Expansion	Low	Low
Clone	High	Low
New	High	High

Phases in Product Development Process

1. Idea generation
2. Feasibility analysis
3. Product specifications
4. Process specifications
5. Prototype development
6. Design review
7. Market test
8. Product introduction
9. Follow-up evaluation



Idea Generation



Reverse Engineering

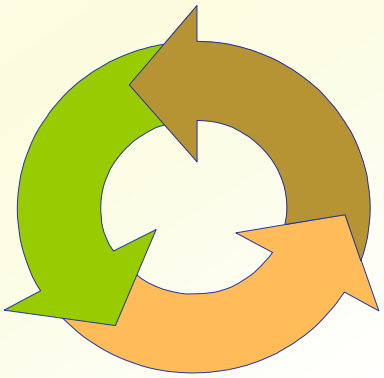
Reverse engineering **is the dismantling and inspecting of a competitor's product to discover product improvements.**

Research & Development (R&D)

- Organized efforts to increase scientific knowledge or product innovation & may involve:
  - *Basic Research* advances knowledge about a subject without near-term expectations of commercial applications.
  - *Applied Research* achieves commercial applications.
  - *Development* converts results of applied research into commercial applications.

Manufacturability

- Manufacturability **is the ease of fabrication and/or assembly which is important for:**
  - Cost
  - Productivity
  - Quality



Designing for Manufacturing

Beyond the overall objective to achieve customer satisfaction while making a reasonable profit is:

Design for Manufacturing(DFM)

The designers' consideration of the organization's manufacturing capabilities when designing a product.

The more general term *design for operations* encompasses services as well as manufacturing

Concurrent Engineering

Concurrent engineering
is the bringing together of engineering design and manufacturing personnel early in the design phase.

Computer-Aided Design

- *Computer-Aided Design (CAD)* is product design using computer graphics.
  - increases productivity of designers, 3 to 10 times
  - creates a database for manufacturing information on product specifications
  - provides possibility of engineering and cost analysis on proposed designs

Product design

- Design for manufacturing (DFM)
- Design for assembly (DFA)
- Design for recycling (DFR)
- Remanufacturing
- Design for disassembly (DFD)
- Robust design

Recycling

- Recycling: recovering materials for future use
- Recycling reasons
  - Cost savings
  - Environment concerns
  - Environment regulations

Service Design

- Service is an act
- Service delivery system
  - Facilities
  - Processes
  - Skills
- Many services are bundled with products

Service Design

- Service design involves
  - The physical resources needed
  - The goods that are purchased or consumed by the customer
  - Explicit services
  - Implicit services

Service Design

- Service
  - Something that is done to or for a customer
- Service delivery system
  - The facilities, processes, and skills needed to provide a service
- Product bundle
  - The combination of goods and services provided to a customer
- Service package
  - The physical resources needed to perform the service

Differences Between Product and Service Design

- Tangible – intangible
- Services created and delivered at the same time
- Services cannot be inventoried
- Services highly visible to customers
- Services have low barrier to entry
- Location important to service

Phases in Service Design

1. Conceptualize
2. Identify service package components
3. Determine performance specifications
4. Translate performance specifications into design specifications
5. Translate design specifications into delivery specifications

Service Blueprinting

- Service blueprinting
  - A method used in service design to describe and analyze a proposed service
- A useful tool for conceptualizing a service delivery system

Major Steps in Service Blueprinting

1. Establish boundaries
2. Identify steps involved
3. Prepare a flowchart
4. Identify potential failure points
5. Establish a time frame
6. Analyze profitability

Characteristics of Well Designed Service Systems

1. Consistent with the organization mission
2. User friendly
3. Robust
4. Easy to sustain
5. Cost effective
6. Value to customers
7. Effective linkages between back operations
8. Single unifying theme
9. Ensure reliability and high quality

Challenges of Service Design

- Variable requirements
- Difficult to describe
- High customer contact
- Service – customer encounter

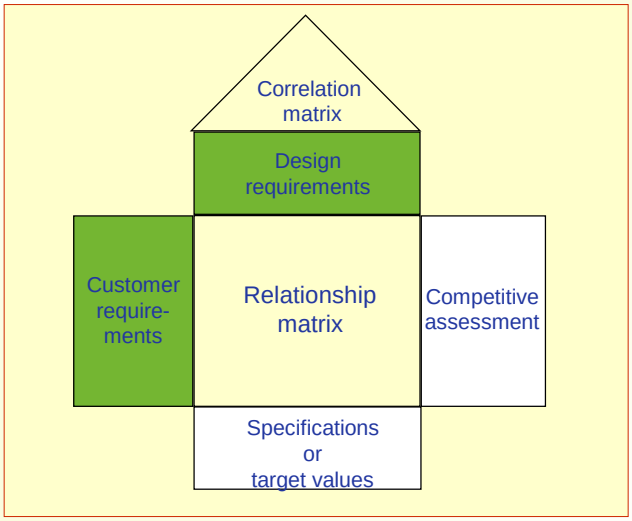
Quality Function Deployment

- Quality Function Deployment
  - Voice of the customer
  - House of quality

QFD: **An approach that integrates the "voice of the customer" into the product and service development process.**

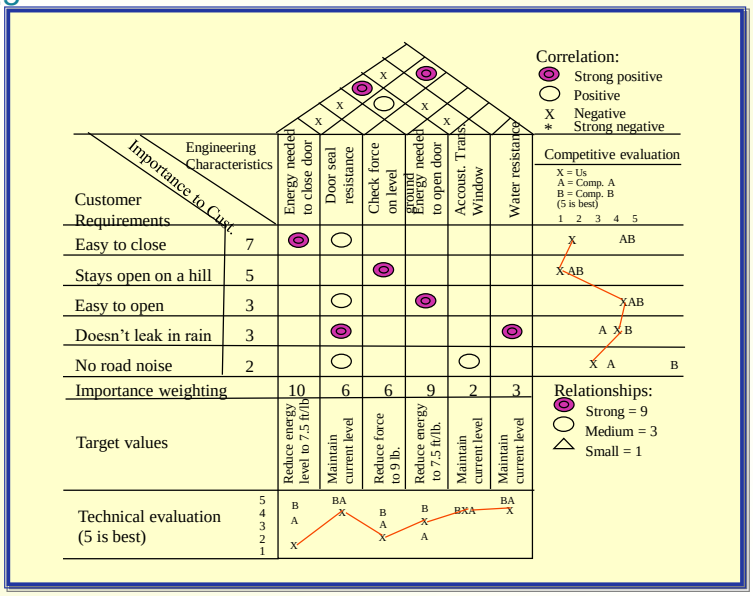
The House of Quality

Figure 4.4



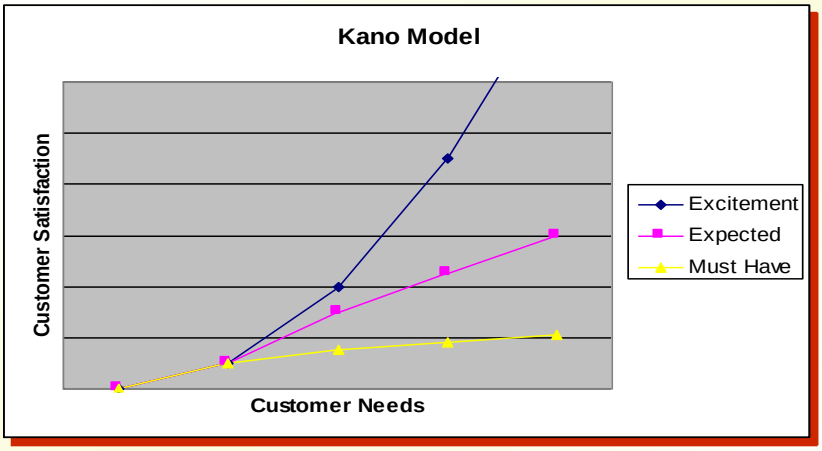
House of Quality Example

Figure 4.5



The Kano Model

Figure 4.6



Operations Strategy

1. Increase emphasis on component commonality
2. Package products and services
3. Use multiple-use platforms
4. Consider tactics for mass customization
5. Look for continual improvement
6. Shorten time to market

Shorten Time to Market

1. Use standardized components
2. Use technology
3. Use concurrent engineering

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CHAPTER 5

Capacity Planning For Products and Services

Capacity Planning

- Capacity is the upper limit or ceiling on the load that an operating unit can handle.
- The basic questions in capacity handling are:
  - What kind of capacity is needed?
  - How much is needed?
  - When is it needed?

Capacity

- Design capacity
  - maximum output rate or service capacity an operation, process, or facility is designed for
- Effective capacity
  - Design capacity minus allowances such as personal time, maintenance, and scrap
- Actual output
  - rate of output actually achieved--cannot exceed effective capacity.

Efficiency and Utilization

$$\text{Efficiency} = \frac{\text{Actual output}}{\text{Effective capacity}}$$

$$\text{Utilization} = \frac{\text{Actual output}}{\text{Design capacity}}$$

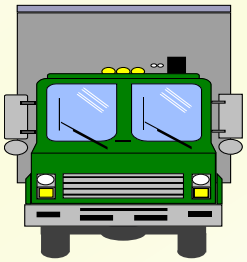
Both measures expressed as percentages

Efficiency/Utilization Example

Design capacity = 50 trucks/day

Effective capacity = 40 trucks/day

Actual output = 36 units/day



$$\text{Efficiency} = \frac{\text{Actual output}}{\text{Effective capacity}} = \frac{36 \text{ units/day}}{40 \text{ units/ day}} = 90\%$$

$$\text{Utilization} = \frac{\text{Actual output}}{\text{Design capacity}} = \frac{36 \text{ units/day}}{50 \text{ units/day}} = 72\%$$

Determinants of Effective Capacity

- Facilities
- Product and service factors
- Process factors
- Human factors
- Operational factors
- Supply chain factors
- External factors

Key Decisions of Capacity Planning

1. Amount of capacity needed
2. Timing of changes
3. Need to maintain balance
4. Extent of flexibility of facilities

Capacity cushion – extra demand intended to offset uncertainty

Make or Buy

1. Available capacity
2. Expertise
3. Quality considerations
4. Nature of demand
5. Cost
6. Risk

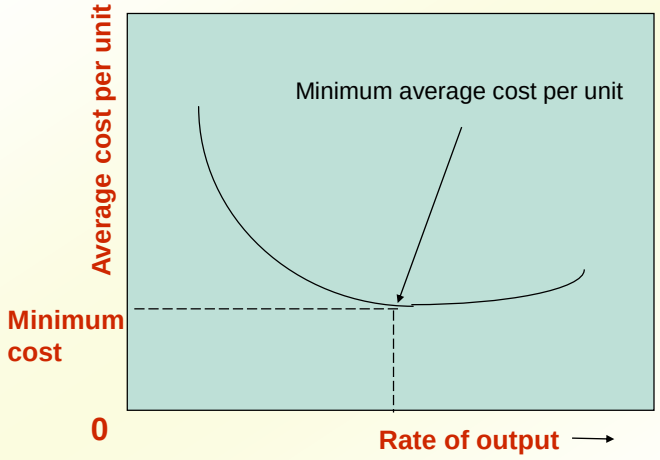
Economies of Scale

- Economies of scale
  - If the output rate is less than the optimal level, increasing output rate results in decreasing average unit costs
- Diseconomies of scale
  - If the output rate is more than the optimal level, increasing the output rate results in increasing average unit costs

Evaluating Alternatives

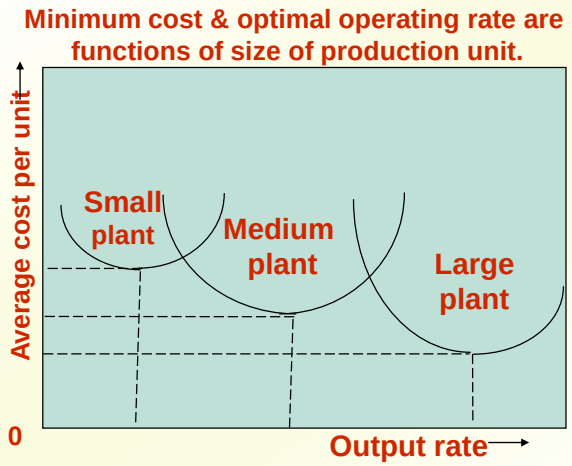
Figure 5.3

Production units have an optimal rate of output for minimal cost.



Evaluating Alternatives

Figure 5.4

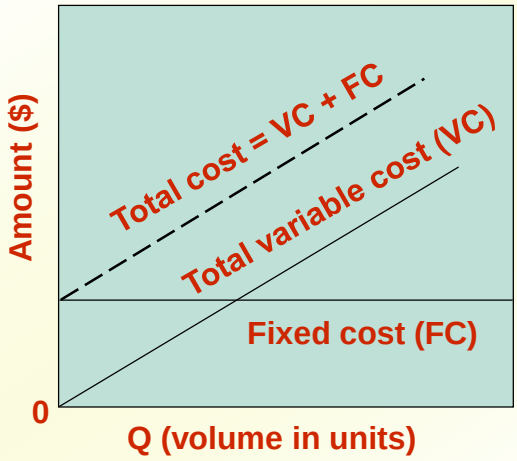


Planning Service Capacity

- Need to be near customers
  - Capacity and location are closely tied
- Inability to store services
  - Capacity must be matched with timing of demand
- Degree of volatility of demand
  - Peak demand periods

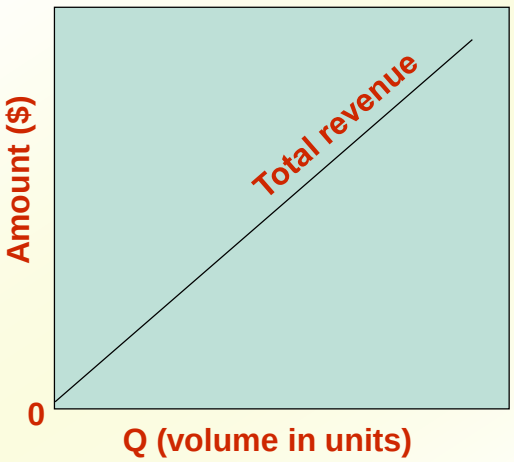
Cost-Volume Relationships

Figure 5.5a



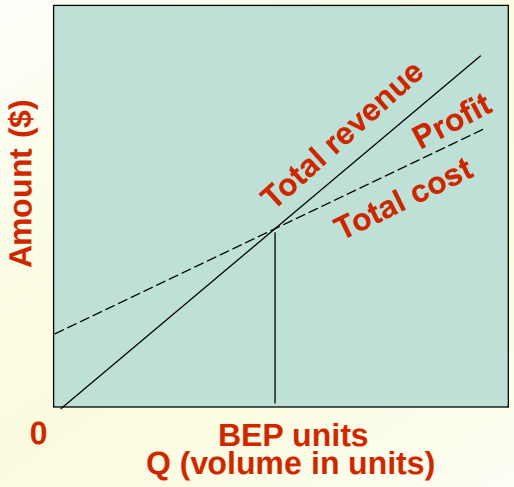
Cost-Volume Relationships

Figure 5.5b



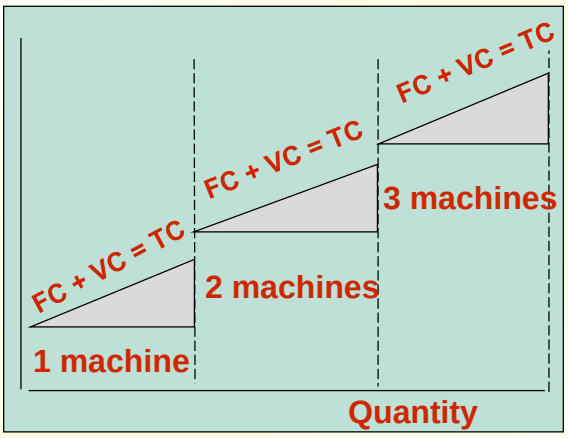
Cost-Volume Relationships

Figure 5.5c



Break-Even Problem with Step Fixed Costs

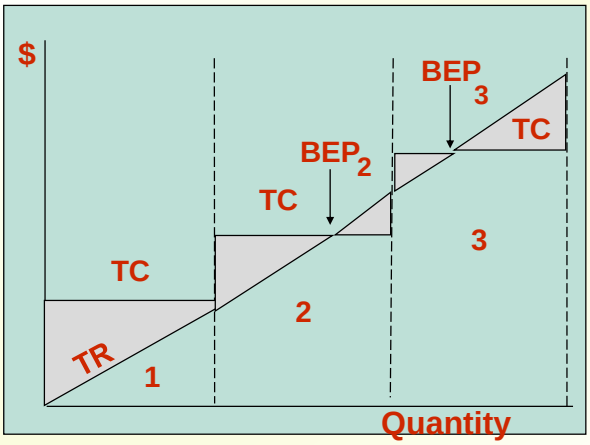
Figure 5.6a



Step fixed costs and variable costs.

Break-Even Problem with Step Fixed Costs

Figure 5.6b



Multiple break-even points

Assumptions of Cost-Volume Analysis

1. One product is involved
2. Everything produced can be sold
3. Variable cost per unit is the same regardless of volume
4. Fixed costs do not change with volume
5. Revenue per unit constant with volume
6. Revenue per unit exceeds variable cost per unit

Financial Analysis

- Cash Flow - the difference between cash received from sales and other sources, and cash outflow for labor, material, overhead, and taxes.
- Present Value - the sum, in current value, of all future cash flows of an investment proposal.

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CHAPTER
6

Process Selection and Facility Layout

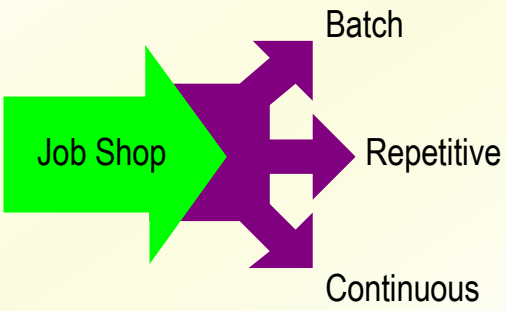
McGraw-Hill/Irwin

Introduction

- Process selection
  - Deciding on the way production of goods or services will be organized
- Major implications
  - Capacity planning
  - Layout of facilities
  - Equipment
  - Design of work systems

Process Selection

- Variety
  - How much
- Flexibility
  - What degree
- Volume
  - Expected output



Process Types

- Job shop
  - Small scale
- Batch
  - Moderate volume
- Repetitive/assembly line
  - High volumes of standardized goods or services
- Continuous
  - Very high volumes of non-discrete goods

Product – Process Matrix

Figure 6.2

Process Type				
Job Shop	Appliance repair Emergency room			Not feasible
Batch		Commercial bakery Classroom Lecture		
Repetitive			Automotive assembly Automatic carwash	
Continuous (flow)	Not feasible			Oil refinery Water purification

Product – Process Matrix

Figure 6.2 (cont'd)

Dimension	Job Shop	Batch	Repetitive	Continuous
Job variety	Very High	Moderate	Low	Very low
Process flexibility	Very High	Moderate	Low	Very low
Unit cost	Very High	Moderate	Low	Very low
Volume of output	Very High	Low	High	Very low

Automation

- *Automation*: Machinery that has sensing and control devices that enables it to operate
  - Fixed automation
  - Programmable automation

Automation

- Computer-aided design and manufacturing systems (CAD/CAM)
- Numerically controlled (NC) machines
- Robot
- Manufacturing cell
- Flexible manufacturing systems(FMS)
- Computer-integrated manufacturing (CIM)

Facilities Layout

- *Layout*: the configuration of departments, work centers, and equipment, with particular emphasis on movement of work (customers or materials) through the system

Importance of Layout Decisions

- Requires substantial investments of money and effort
- Involves long-term commitments
- Has significant impact on cost and efficiency of short-term operations

The Need for Layout Decisions

Inefficient operations

For Example:
High Cost Bottlenecks

Changes in the design of products or services

The introduction of new products or services

Accidents

Safety hazards

The Need for Layout Design (Cont'd)

Changes in environmental or other legal requirements

Changes in volume of output or mix of products

Changes in methods and equipment

Morale problems

Basic Layout Types

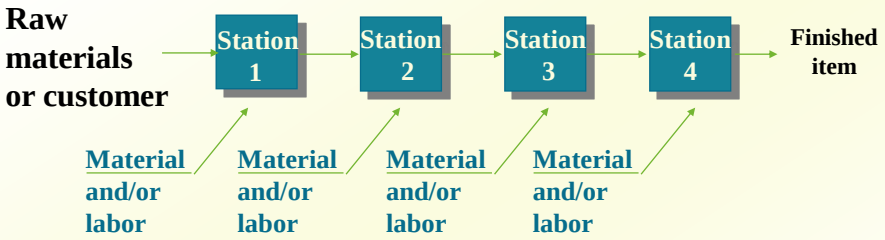
- Product layouts
- Process layouts
- Fixed-Position layout
- Combination layouts

Basic Layout Types

- Product layout
  - Layout that uses standardized processing operations to achieve smooth, rapid, high-volume flow
- Process layout
  - Layout that can handle varied processing requirements
- Fixed Position layout
  - Layout in which the product or project remains stationary, and workers, materials, and equipment are moved as needed

Product Layout

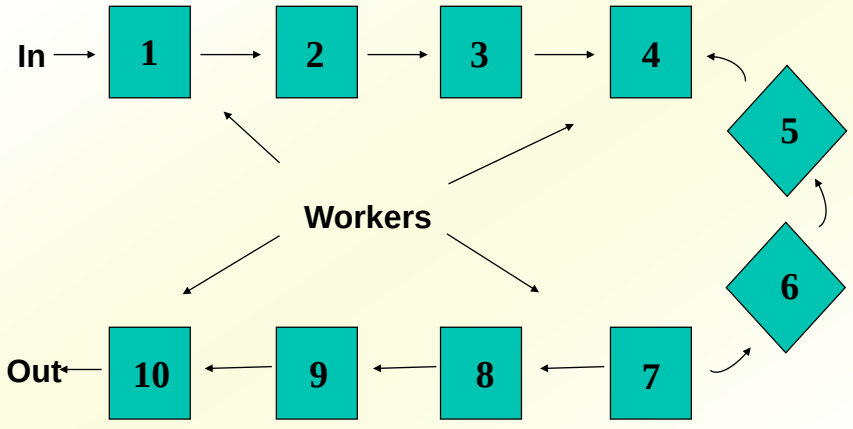
Figure 6.4



Used for Repetitive or Continuous Processing

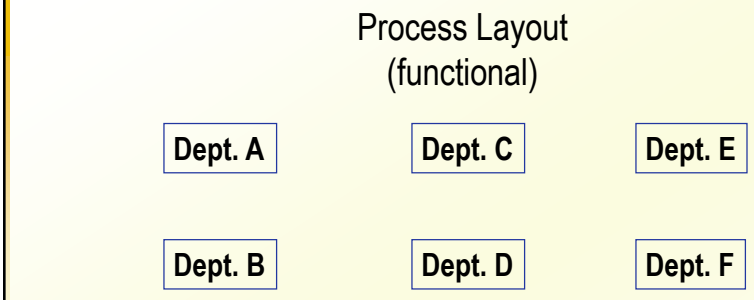
A U-Shaped Production Line

Figure 6.6



Process Layout

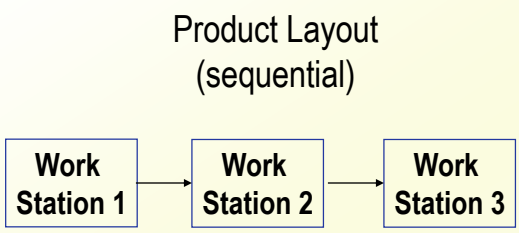
Figure 6.7



Used for Intermittent processing
Job Shop or Batch

Product Layout

Figure 6.7 (cont'd)

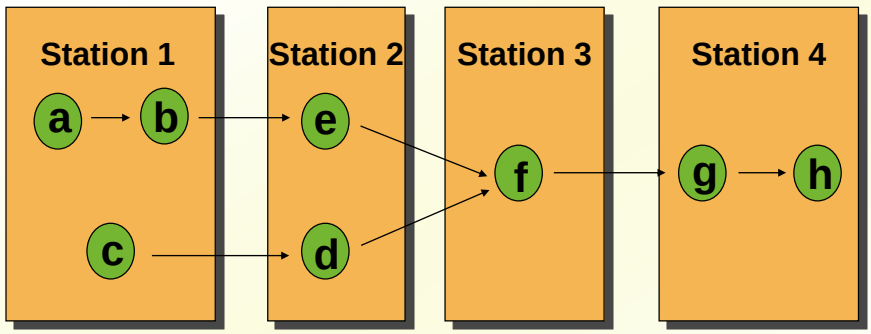


Used for Repetitive Processing
Repetitive or Continuous

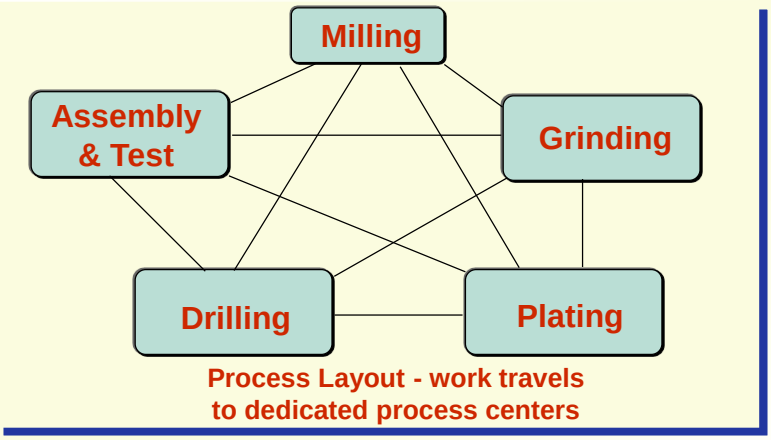
Cellular Layouts

- Cellular Production
  - Layout in which machines are grouped into a cell that can process items that have similar processing requirements
- Group Technology
  - The grouping into part families of items with similar design or manufacturing characteristics

Solution to Example 2



Process Layout



Process Layout - work travels to dedicated process centers

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CHAPTER 7

Design of Work Systems

McGraw-Hill/Irwin

Job Design

- *Job design* involves specifying the content and methods of job
  - What will be done
  - Who will do the job
  - How the job will bob will be done
  - Where the job will be done
  - Ergonomics

Job Design Success

Successful Job Design must be:

- Carried out by experienced personnel with the necessary training and background
- Consistent with the goals of the organization
- In written form
- Understood and agreed to by both management and employees

Specialization in Business: Advantages

Table 7.1

For *Management:*	For *Labor:*
1. Simplifies training	1. Low education and skill requirements
2. High productivity	2. Minimum responsibilities
3. Low wage costs	3. Little mental effort needed

Disadvantages

Table 7.1

For *Management:*	For *Labor:*
1. Difficult to motivate quality	1. Monotonous work
2. Worker dissatisfaction, possibly resulting in absenteeism, high turnover, disruptive tactics, poor attention to quality	2. Limited opportunities for advancement
	3. Little control over work
	4. Little opportunity for self-fulfillment

Behavioral Approaches to Job Design

- Job Enlargement
  - Giving a worker a larger portion of the total task by horizontal loading
- Job Rotation
  - Workers periodically exchange jobs
- Job Enrichment
  - Increasing responsibility for planning and coordination tasks, by vertical loading

Teams

- Benefits of teams
  - Higher quality
  - Higher productivity
  - Greater worker satisfaction
- Self-directed teams
  - Groups of empowered to make certain changes in their work process

Analyzing the Job

- Flow process chart
  - Chart used to examine the overall sequence of an operation by focusing on movements of the operator or flow of materials
- Worker-machine chart
  - Chart used to determine portions of a work cycle during which an operator and equipment are busy or idle

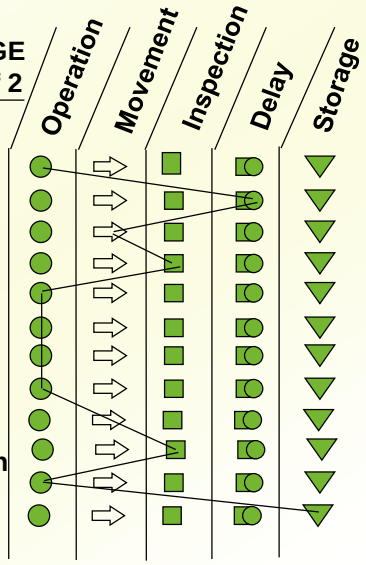
Figure 7-2

FLOW PROCESS CHART
Job Requisition of petty cash

ANALYST	PAGE
D. Kolb	1 of 2

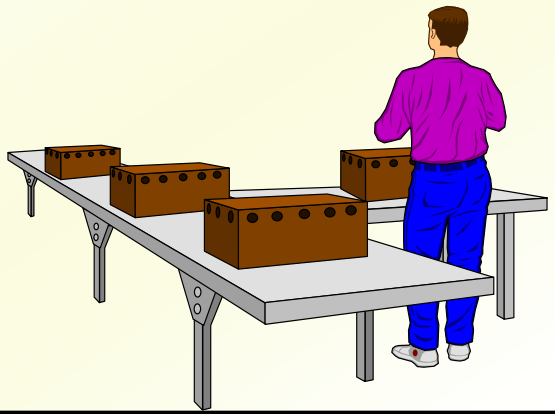
Details of Method

- Requisition made by department head
- Put in "pick-up" basket
- To accounting department
- Account and signature verified
- Amount approved by treasurer
- Amount counted by cashier
- Amount recorded by bookkeeper
- Petty cash sealed in envelope
- Petty cash carried to department
- Petty cash checked against requisition
- Receipt signed
- Petty cash stored in safety box



Motion Study

Motion study is the systematic study of the human motions used to perform an operation.

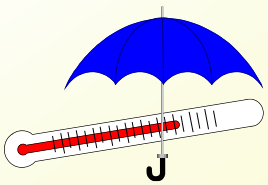


Developing Work Methods

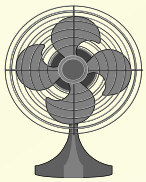
1. Eliminate unnecessary motions
2. Combine activities
3. Reduce fatigue
4. Improve the arrangement of the workplace
5. Improve the design of tools and equipment

Working Conditions

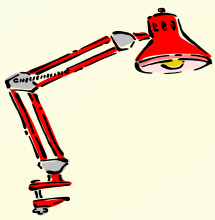
Temperature & Humidity

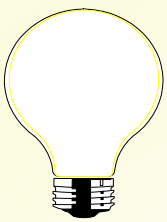


Ventilation

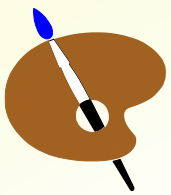


Illumination



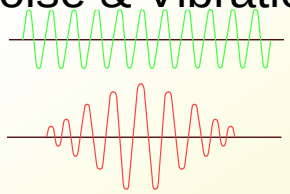


Color



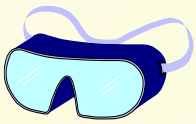
Working Conditions (cont'd)

Noise & Vibration



Work Breaks

Safety



Causes of Accidents

Work Measurement

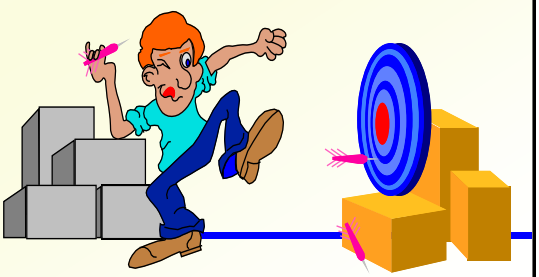
- Standard time
- Stopwatch time study
- Historical times
- Predetermined data
- Work Sampling

Compensation

- Time-based system
  - Compensation based on time an employee has worked during a pay period
- Output-based (incentive) system
  - Compensation based on the amount of output an employee produces during a pay period

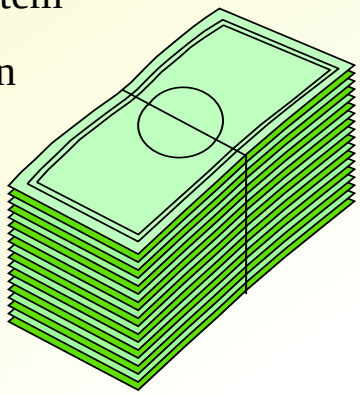
Form of Incentive Plan

- Accurate
- Easy to apply
- Consistent
- Easy to understand
- Fair



Compensation

- Individual Incentive Plans
- Group Incentive Plans
- Knowledge-Based Pay System
- Management Compensation



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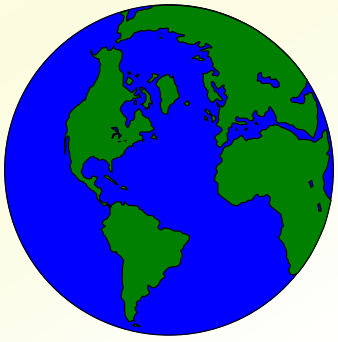
CHAPTER
8

Location Planning and Analysis

McGraw-Hill/Irwin

Need for Location Decisions

- Marketing Strategy
- Cost of Doing Business
- Growth
- Depletion of Resources



Nature of Location Decisions

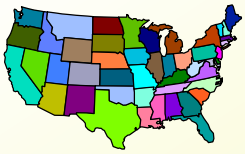
- Strategic Importance
  - Long term commitment/costs
  - Impact on investments, revenues, and operations
  - Supply chains
- Objectives
  - Profit potential
  - No single location may be better than others
  - Identify several locations from which to choose
- Options
  - Expand existing facilities
  - Add new facilities
  - Move

Making Location Decisions

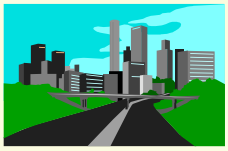
- Decide on the criteria
- Identify the important factors
- Develop location alternatives
- Evaluate the alternatives
- Make selection

Location Decision Factors

Regional Factors

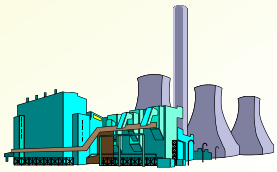


Community Considerations



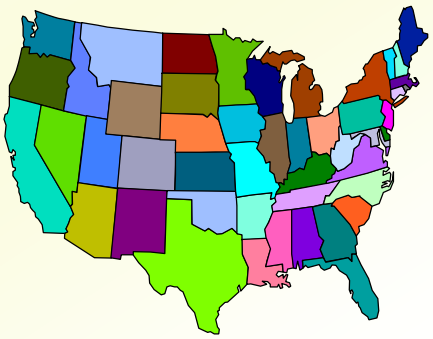
Multiple Plant Strategies

Site-related Factors



Regional Factors

- Location of raw materials
- Location of markets
- Labor factors
- Climate and taxes

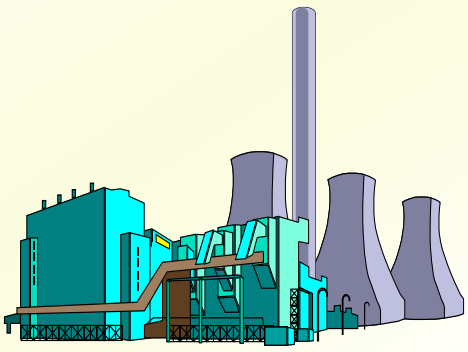


Community Considerations

- Quality of life
- Services
- Attitudes
- Taxes
- Environmental regulations
- Utilities
- Developer support

Site Related Factors

- Land
- Transportation
- Environmental
- Legal



Multiple Plant Strategies

- Product plant strategy
- Market area plant strategy
- Process plant strategy

Comparison of Service and Manufacturing Considerations

Table 8.2

Manufacturing/Distribution	Service/Retail
Cost Focus	**Revenue focus**
Transportation modes/costs	Demographics: age,income,etc
Energy availability, costs	Population/drawing area
Labor cost/availability/skills	Competition
Building/leasing costs	Traffic volume/patterns
	Customer access/parking

Trends in Locations

- Foreign producers locating in U.S.
  - "Made in USA"
  - Currency fluctuations
- Just-in-time manufacturing techniques
- Microfactories
- Information Technology

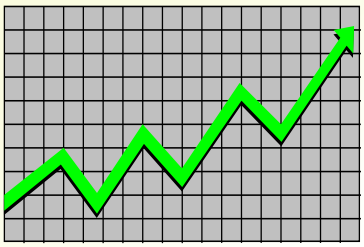
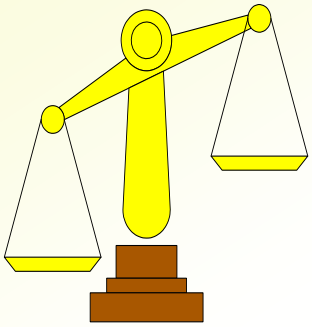


Table 8.3

Foreign Government	a. Policies on foreign ownership of production facilities Local Content Import restrictions Currency restrictions Environmental regulations Local product standards b. Stability issues
Cultural Differences	Living circumstances for foreign workers / dependents Religious holidays/traditions
Customer Preferences	Possible buy locally sentiment
Labor	Level of training and education of workers Work practices Possible regulations limiting number of foreign employees Language differences
Resources	Availability and quality of raw materials, energy, transportation

Evaluating Locations

- Cost-Profit-Volume Analysis
  - Determine fixed and variable costs
  - Plot total costs
  - Determine lowest total costs



Location Cost-Volume Analysis

- Assumptions
  - Fixed costs are constant
  - Variable costs are linear
  - Output can be closely estimated
  - Only one product involved

Example 1: Cost-Volume Analysis

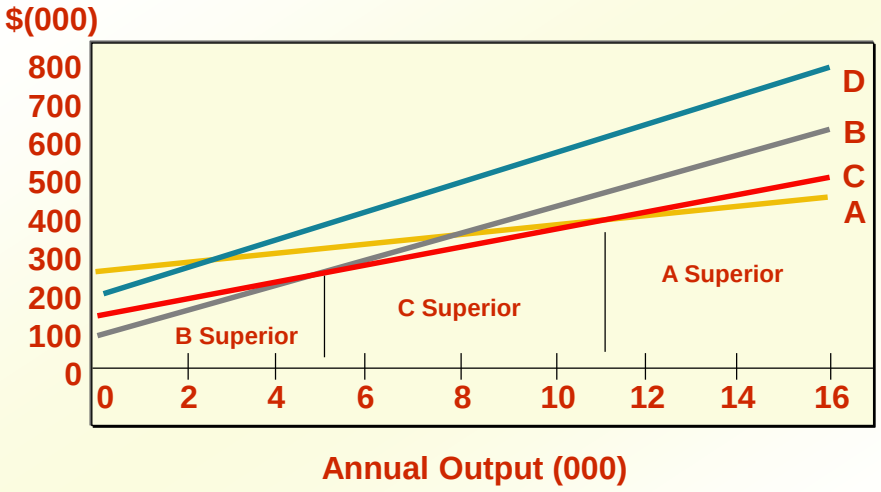
Fixed and variable costs for four potential locations

Location	Fixed Cost	Variable Cost
A	$250,000	$11
B	100,000	30
C	150,000	20
D	200,000	35

Example 1: Solution

	Fixed Costs	Variable Costs	Total Costs
A	$250,000	$11(10,000)	$360,000
B	100,000	30(10,000)	400,000
C	150,000	20(10,000)	350,000
D	200,000	35(10,000)	550,000

Example 1: Solution



Evaluating Locations

- Transportation Model
  - Decision based on movement costs of raw materials or finished goods
- Factor Rating
  - Decision based on quantitative and qualitative inputs
- Center of Gravity Method
  - Decision based on minimum distribution costs

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CHAPTER 9

Management of Quality

Quality Management

- What does the term *quality* mean?
- *Quality* is the ability of a product or service to consistently meet or exceed customer expectations.

Quality Assurance vs. Strategic Approach

- Quality Assurance
  - Emphasis on finding and correcting defects before reaching market
- Strategic Approach
  - Proactive, focusing on preventing mistakes from occurring
  - Greater emphasis on customer satisfaction

The Quality Gurus

- Walter Shewhart
  - "Father of statistical quality control"
- W. Edwards Deming
- Joseph M. Juran
- Armand Feignbaum
- Philip B. Crosby
- Kaoru Ishikawa
- Genichi Taguchi

Dimensions of Quality

- *Performance* - main characteristics of the product/service
- *Aesthetics* - appearance, feel, smell, taste
- *Special Features* - extra characteristics
- *Conformance* - how well product/service conforms to customer's expectations
- *Reliability* - consistency of performance

Dimensions of Quality (Cont'd)

- *Durability* - useful life of the product/service
- *Perceived Quality* - indirect evaluation of quality (e.g. reputation)
- *Serviceability* - *service after sale*

Examples of Quality Dimensions

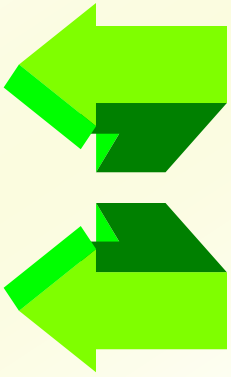
Dimension	(Product) Automobile	(Service) Auto Repair
1. Performance	Everything works, fit & finish	All work done, at agreed price
	Ride, handling, grade of materials used	Friendliness, courtesy, Competency, quickness
2. Aesthetics	Interior design, soft touch	Clean work/waiting area
3. Special features	Gauge/control placement	Location, call when ready
	Cellular phone, CD player	Computer diagnostics

Examples of Quality Dimensions (Cont'd)

Dimension	(Product) Automobile	(Service) Auto Repair
5. Reliability	Infrequency of breakdowns	Work done correctly, ready when promised
6. Durability	Useful life in miles, resistance to rust & corrosion	Work holds up over time
7. Perceived quality	Top-rated car	Award-winning service department
8. Serviceability	Handling of complaints and/or requests for information	Handling of complaints

Service Quality

- Tangibles
- Convenience
- Reliability
- Responsiveness
- Time
- Assurance
- Courtesy



Examples of Service Quality

Table 9.4

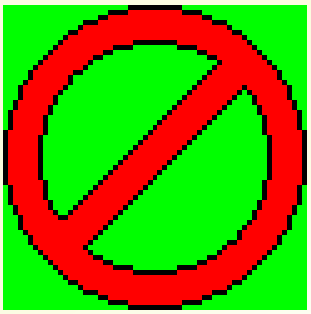
Dimension	Examples
1. Tangibles	Were the facilities clean, personnel neat?
2. Convenience	Was the service center conveniently located?
3. Reliability	Was the problem fixed?
4. Responsiveness	Were customer service personnel willing and able to answer questions?
5. Time	How long did the customer wait?
6. Assurance	Did the customer service personnel seem knowledgeable about the repair?
7. Courtesy	Were customer service personnel and the cashierfriendly and courteous?

Determinants of Quality (cont'd)

- Quality of design
  - Intension of designers to include or exclude features in a product or service
- Quality of conformance
  - The degree to which goods or services conform to the intent of the designers

The Consequences of Poor Quality

- Loss of business
- Liability
- Productivity
- Costs



Responsibility for Quality

- Top management
- Design
- Procurement
- Production/operations
- Quality assurance
- Packaging and shipping
- Marketing and sales
- Customer service

Costs of Quality

- Failure Costs - costs incurred by defective parts/products or faulty services.
- Internal Failure Costs
  - Costs incurred to fix problems that are detected before the product/service is delivered to the customer.
- External Failure Costs
  - All costs incurred to fix problems that are detected after the product/service is delivered to the customer.

Costs of Quality (continued)

- Appraisal Costs
  - Costs of activities designed to ensure quality or uncover defects
- Prevention Costs
  - All TQ training, TQ planning, customer assessment, process control, and quality improvement costs to prevent defects from occurring

Ethics and Quality

- Substandard work
  - Defective products
  - Substandard service
  - Poor designs
  - Shoddy workmanship
  - Substandard parts and materials

Having knowledge of this and failing to correct and report it in a timely manner is unethical.

Quality Certification

- ISO 9000
  - Set of international standards on quality management and quality assurance, critical to international business
- ISO 14000
  - A set of international standards for assessing a company's environmental performance

ISO 14000

- ISO 14000 - A set of international standards for assessing a company's environmental performance
- Standards in three major areas
  - Management systems
  - Operations
  - Environmental systems

Total Quality Management

A philosophy that involves everyone in an organization in a continual effort to improve quality and achieve customer satisfaction.

The TQM Approach

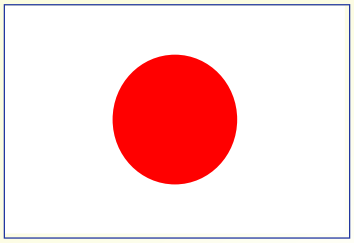
1. Find out what the customer wants
2. Design a product or service that meets or exceeds customer wants
3. Design processes that facilitates doing the job right the first time
4. Keep track of results
5. Extend these concepts to suppliers

Elements of TQM

- Continual improvement
- Competitive benchmarking
- Employee empowerment
- Team approach
- Decisions based on facts
- Knowledge of tools
- Supplier quality
- Champion
- Quality at the source
- Suppliers

Continuous Improvement

- Philosophy that seeks to make never-ending improvements to the process of converting inputs into outputs.
- Kaizen: Japanese word for continuous improvement.

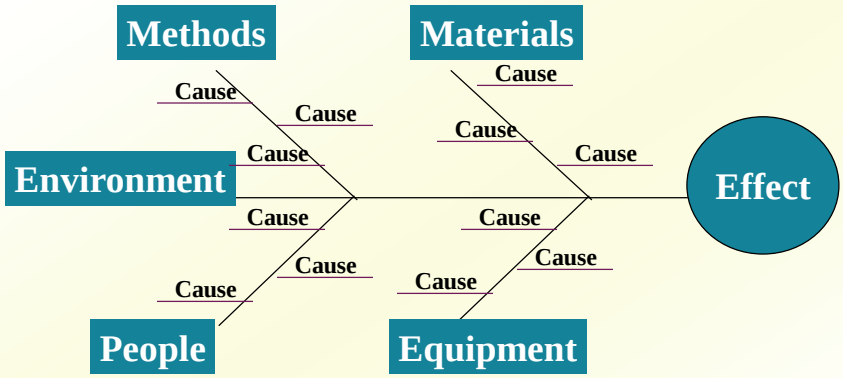


Six Sigma

- Statistically
  - Having no more than 3.4 defects per million
- Conceptually
  - Program designed to reduce defects
  - Requires the use of certain tools and techniques

Cause-and-Effect Diagram

Figure 9.12



Methods for Generating Ideas

- Brainstorming
- Quality circles
- Interviewing
- Benchmarking
- 5W2H