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Production & Operations Management: Study Guide for Management 318

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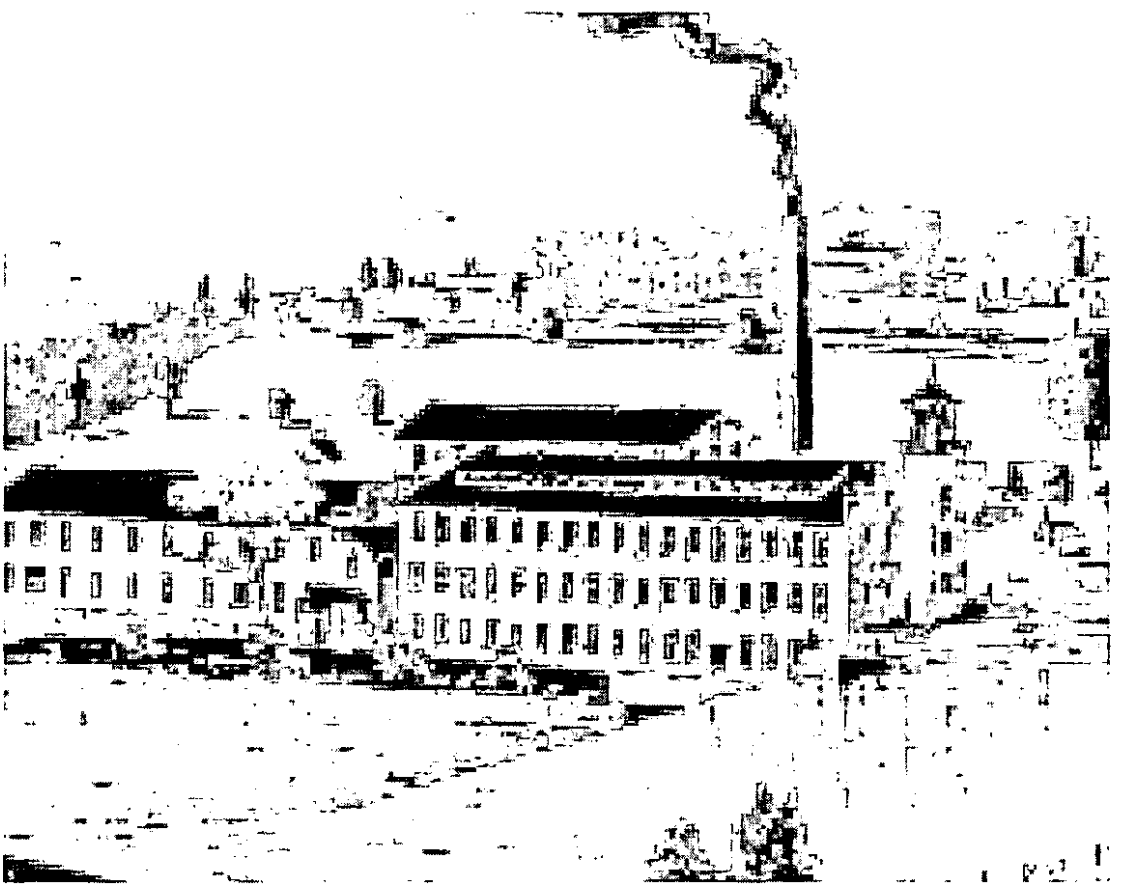
PRODUCTION & OPERATIONS MANAGEMENT

STUDY GUIDE FOR MANAGEMENT 318



DAVID J. BOLLING

NOTES FROM THE AUTHOR

Fellow students, I am neither a professor, nor an assistant professor in management. I am a student who recently took Management 318 as part of my core requirement. In the process I developed this study guide. I shared my study guide with some of my friends in the class and their exam results improved greatly. This study guide is not meant to replace attendance in lecture, nor the replacement of required text reading. This study guide is merely a supplemental guide that I hope will aid you in your studies. **At the end of the book I have included Dr. White's lecture guides and old sample tests.** I would appreciate any comments or recommendations on improving the guide that you may have. Please give your comments to Dr. White or catch me on campus. Good luck and I hope my study guide assists you in obtaining the grade you desire.

Acknowledgment

Any success that this guide has for the student is a direct result of the brilliance of Dr. White's lectures. Dr. White's easy going mannerism and methodical step-by-step presentations are the creator of this text. I am merely the tool he used in the study guide development.

I would also like to acknowledge the patience and tolerance of my family. Thank you, Beth, Jay, Kelly, Kyle, Jill, and Angela, for tolerating my cigarette smoke and attitude while developing this study guide. Maybe I'll quit smoking before I attempt such an undertaking in the future. I doubt it!!

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Chapter 1
Operations Management

List the inputs and outputs of the operation's conversion process

Conversion process is the process of changing inputs of labor, capital, land, and management into outputs of goods and services.

E.G. A farmer's inputs (land, equipment, labor, etc.) are converted into such outputs as corn, wheat, or milk.

Explain the concept of "value added"

The general goal of all operations systems are to create some kind of value-added, so that the outputs are worth more to consumers than just the sum of the individual inputs. If you just can't wait, later in Chapter 15 a much more in-depth analysis is provided.

List the differences between manufacturing and service operations.

	Manufacturing	Services
products	tangible	intangible
consumption's	later	immediate
work (job)	equipment intensive	labor intensive
consumer contact	low	high
consumer participation	usually none	high
measures	sophisticated	elementary

Operations management - Decision making involving the design, planning, and control of the processes that produce goods and services.

Calculate efficiency

The basis of scientific management is a focus on economic efficiency at the production core of the organization.

$$\text{Efficiency} = \frac{\text{output}}{\text{inputs}} = (100\%)$$

EG A dentist has established the standard that her office should treat 40 patients per day. However, on a particular day the office treats only 30 patients. Her office efficiency that day is?

$$\frac{30}{40} = (100\%) = 75\%$$

Describe how the companies in the video shown in class have implemented TQM?
(answers from video in class)

How is quality defined?
Meeting or exceeding customer expectations.

When is quality good enough?
Never ending cycle.

Who is responsible for quality?
All employees are responsible for quality, not just quality control department. If DR. White has decided not to use the video, just imagine questions and answers were provided by a video you've seen.

(Helpful hint)
When using old tests in your studies, I found it beneficial to ask myself, how would I change the question if I were making up the exam? Old test in back of study guide.

Chapter 2
Operations Strategies For Competitive Advantage

Strategic planning
A process of thinking through the organization's current mission and environment and then setting forth a guide for tomorrow's decisions and results.

List the steps in the forced choice model of strategic planning

- access the environment, government, technology, competitors
- access organization, mission, strengths and weaknesses
- develop options
- determine requirements
- develop contingencies
- a more informative illustration is provided on page 41,figure 2.1 of the text.

Differentiate between strategy process and strategy content.

- strategy process - the procedure used to develop strategy.
- strategy content - the actual strategy itself.

Explain the relations between productivity and quality

Productivity - Efficiency; a ratio of outputs to inputs.

Quality - The degree to which the design specifications for a product or services are appropriate to its function and use, and the degree to which a product or service conforms to its specifications.

For the overly zealous student; Checkout Chapter 15, and see how the Japanese approach of JIT uses quality and productivity as a mutually beneficial approach to business in the nineties and beyond.

Calculate labor productivity

$$\text{labor productivity} = \frac{\text{output}}{\text{labor input}}$$

EG Assume for a moment that you owned a local pub in Carbondale. How would you determine the productivity of your beautiful young waitresses? If your 3 waitresses, Bunny, Snuggles, and Bambi, served an average 2240 customers each day. Hours 8:00pm to 4:00am, (like Diamonds (local late night bar) I'm sure that all of you are studying Management 318 much too hard to know of such places) what would there labor productivity be?

$$\text{Labor productivity} = \frac{\text{Output}}{\text{labor input}} = \frac{\text{2240 customers served}}{\text{3 employees X 8 hr./employee}} = 81 \text{ customers/ hr.}$$

Calculate total factor productivity

The ratio of outputs to the total inputs of labor, capital, materials, and energy.

Indicate differences in competitive strategies (priorities) between various global producers.

Europe	N America	Japan
quality	quality	cost
delivery reliability	delivery reliability	speed
speed	cost	quality

Maquiladors

"Twin plants," which refers to production plants in 2 different places. Automated, parts fabrication in US, then shipped to Mexico for manual assembly into finished products. Products are then shipped back to US for distribution . Escalating direct labor in US have forced some companies to use this approach to remain competitive in the nineties and beyond.

Explain why the competitive capabilities, technology, and International business are challenging to operations managers.

- competitive priorities, must be able to compete
- increasingly more technologies - offers opportunity for competitive capabilities but repaired some changes in organizations
- international business - many competitors, regional advantage (EG, DL in Mexico)

Chapter 3
Forecasting

Forecasting - use of past data to determine future events: an objective computation

Explain why forecasting is important to operations
Forecasts are necessary for planning, scheduling, and controlling the system to facilitate effective and efficient output of goods and services.

Differentiate between independent and dependent demand
When demand for one product is linked to demand for another product, the demand is termed **dependent**.
EG The number of kegs required is **dependent** upon the amount of beer to be consumed.
Independent demand - demand for an item that occurs separately of demand for any other item.
EG Amount of beer consumed on Friday night is independent of tests on Monday. Only kidding! But if this were true it would exemplify an independent demand.

Only independent demand needs forecasting, dependent demand can be derived from the independent demand to which it is linked.

Forecast error - The numeric difference of forecast demand and actual demand.

EG 100 people are invited to a party and a six pack per person is the forecast demand to provide more than adequate refreshment for the party. The 600 cans of beer was

expected to last 3 hours, but the boys from lambda lambda lambda were much thirstier than anyone expected. The beer lasted one hour and another 600 cans were purchased. What would the forecast error be? Answer on next page.

Forecast demand (600 cans of beer) - actual demand (1200 cans of beer) = forecast error of 600 cans. Most forecast demands are much closer to actual demand but hopefully this will provide a memorable illustration of the definition.

MAD (Mean absolute deviation) - A forecast error measure that is the average forecast error ***without regard to direction***; calculated as the sum of the absolute value of forecast error for all periods divided by the total number of periods evaluated.

$$\text{MAD} = \frac{\textbf{Sum of the absolute value of forecast error for all periods}}{\textbf{number of periods}}$$

Bias - A forecast error measure that is the average of forecast error ***with regard to direction*** and shows any tendency consistently to over- or underforecast; calculated as the sum of the actual forecast error for all periods divided by the total number of periods evaluated.

$$\textbf{Bias} = \frac{\text{Sum of all forecasts errors}}{\text{\# of periods}}$$

Forecast using **simple average** - Average of demands occurring in all previous periods; the demands of all periods are equally weighted.

$$\text{SA} = \frac{\text{Sum of demands for all periods}}{\text{\# of periods}}$$

EG Suppose that the people who gave the party in the previous example used 700 & 500 cans of beer in their next two parties respectively. There simple average would be 600 cans from the first party + 700 + 500/ 3 parties = 600 simple average. Therefore, applying the simple average, they would order 600 cans of beer for their next party.

Simple moving average - Average of demands occurring in several of the most recent periods; most recent periods are added and old ones dropped to keep calculations current.

$$\text{MA} = \frac{\text{Sum of demands for periods}}{\text{chosen number of periods}}$$

EG Suppose the people who gave the party in the previous example gave parties once a month for 8 months. Using a simple moving average to determine the demand for beer for the party next month **using the past six months in our calculation**.

Month	Cans of beer demanded	Month	Cans of beer demanded
January	600	**June**	**700**
February	700	**July**	**800**
March	**800**	**August**	**600**
April	**500**		

May **800**

Simple moving average for September's party = 800+500+800+700+800+600/6= 700

Note: only the most recent periods are considered when using simple moving average.

Weighted moving average - An averaging method that allows for varying weighting of old demands.

WMA = Each period's demand times a weight, summed over all periods in the moving average.

EG If demand for cans of beer were determined using weighted moving average in our previous example and 3 periods were used. Weighting the most recent period twice as heavily as the previous 2, the resulting weighted moving average would be;

June (700).25 + July(800).25 + August (600).5 = September's demand using WMA

175 + 200 + 300 = **WMA** = 675

An advantage of this model is that is allows you to compensate for some trend or seasonality by carefully fitting the coefficients. Of course, the modeler or manager still has to choose the coefficients, and this choice is critical to model success or failure of the party.

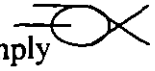
Exponential smoothing - an averaging method that exponentially decreases the weighting of old demands. **Exponential smoothing** is distinguishable by the special way it weighs each past demand. The pattern of weights is exponential in form. Demand for the most recent period is weighted most heavily; The weights placed on successively older periods decrease exponentially. The weights decrease in magnitude, the further back in time, the data are weighted; the decrease is nonlinear (exponentially).

First order exponential smoothing

To begin, lets examine the computational aspects of first order exponential smoothing. The equation for creating a new or updated forecast uses two pieces of information: actual demand for the most recent period and the most recent demand forecast. As each time period expires, a new forecast is made.

Forecast of next period's demand = alpha (actual demand for most recent period) + (1-alpha) (demand forecast for most recent period)

F_t = alpha (D_{t-1}) + (1 - alpha) F_{t-1}, where $0 \leq \text{alpha} \leq 1$, and t is the period.

OK, now that we have went through the texts informative illustrative techniques, let's apply a much simpler approach and see if some of the fog lifts. DR. White will provide a much simpler and more easily understandable technique. But for those of you who might have missed that class, let's go back to our ongoing party example. Alpha has a symbol but unfortunately my computer does not. Alpha looks something like  that, unfortunately it took me 10 minutes to create it so I will continue to simply call it alpha. DR. White will provide the formula on the exam. Finally to our example:

If August actual demand for cans of beer was 600 and the forecast was 500 the forecast for September using exponential smoothing would be. Using a value of alpha = .2.

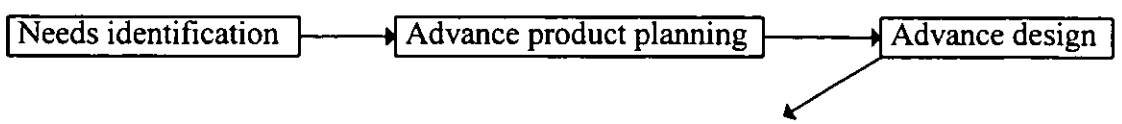
September's forecast = alpha (.2) X Actual demand of August (600)+(1-.2)forecasted demand for August (500) = .2(600)+(1-.2)500= 120+400 =520 cans of beer for September.
If this same technique was used for October with the following information provided the formula would be. If the actual demand for September was 500 then the formula for October's demand using exponential smoothing to forecast would be:
Using September's forecast of 520 and alpha = .2, the formula would be.

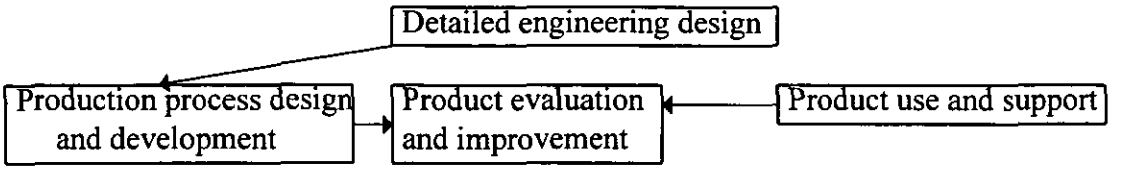
Forecast for October = alpha(actual demand for September)+(1-alpa) forecasted demand
= .2(500) + (1-.2)520 = 516 cans of beer forecasted for October
See question 15 on sample test to have an idea of how it may be worded on the test.

Explain the effect of different smoothing coefficients.
If demand is very stable and believed to be representative of the future, the forecaster wants to select a low alpha value to smooth out any sudden noise that might have occurred. The forecasting procedure, then, does not overreact to the most recent demand. Under these stable conditions, an appropriate smoothing coefficient might be .1,.2, or .3. When demand is slightly unstable, smoothing coefficients of .4, .5, or .6 might provide the most accurate forecasts. A high smoothing coefficient could be more appropriate for new products or items for which the underlying demand is shifting about (dynamic or unstable). An alpha of .7, .8, or.9 may be more appropriate.
Regression analysis - A causal forecasting model in which, from historical data, a functional relationship is established between variables and then used to forecast dependent variable values. One variable is known or assumed, and used to forecast the value of an unknown variable. Past data establishes a functional relationship between the two variables. Our forecast of the period's demand, F_t, is expressed by
$F_t = a + bX_t$, where F_t is the forecast for period t, given we know the value of the variable X in period t. The coefficients a and b are constants; a is the intercept value for the vertical (F) axis and b is the slope of the line. Often this equation is expressed in the more familiar form, $Y = a + bX$
Actual application and use with or without the STORM Forecasting module can most easily be understood by examples in the text on pages 100-102. DR. White gives a very comprehensive and step by step analysis of Regression Analysis and use of the Storm Forecasting module. My suggestion would be to ***attend these classes***. Once classes have been attended a good idea of possible test questions can be developed from old test provided in the study guide.

CHAPTER 4
DESIGNING PRODUCTS, SERVICES, AND PROCESSES

List the steps in the product development process.





Define concurrent engineering and list its advantages.

Concurrent engineering - Different parts of a company (engineering, marketing, operations) working together with suppliers to develop a new product. The result is that these companies get new products into the marketplace twice as fast as companies who do not use this process.

Define the terms product reliability, modular design, and standardization

Product reliability - The probability that a product will perform as intended for a prescribed lifetime under specified operating conditions.

Modular design - The creation of products from some combination of basic, preexisting subsystems.

Standardization - Make uniform, adopt a standard, regulate, gauge, control - In designing new products, standardization can bolster productivity by avoiding unnecessary engineering design when a suitable component already exists; simplifying materials planning and control during production because fewer components are in the system; reducing components production (if the components are produced in-house) or reducing purchasing requirements and limiting the number of vendors (if components are purchased).

Define each type of process

Process technology - Equipment, people, and systems used to produce a firm's products and services.

Project technology - A process technology suitable for producing one-of-a-kind products

Job shop technology - A process technology suitable for a variety of custom-designed products in small volumes.

Batch technology - A process technology suitable for a variety of products in varying volumes.

Assembly line technology - A process technology suitable for a narrow range of standardized products in high volumes.

Continuous flow technology - A process technology suitable for producing a continuous flow of products.

Given a set of product characteristics, use the product-process matrix to determine which type of process would probably be most appropriate.

	low customer contact	**high customer contact**
capital intensive	**Quasi- manufacturing** postal services, check processing, automated warehousing	**custom-shop Services** charter travel services, long-distance telephone services medical treatment
labor intensive	**mass services** Teaching, live entertainment,	**Professional Services** legal counseling, medical diagnosis,

cafeteria	tutoring
Rigid process technology	Flexible process technology

Lets look at how a possible test question might look on service process matrix.
24. According to the service process matrix, a quasi-manufacturing service is one that has
(a.) low customer contact and is capital intensive. Question 24 on sample test #1.

Define an FMS and give its characteristics.
Flexible manufacturing system (FMS) - A computer-controlled process technology suitable for producing a moderate variety of products in moderate volumes, and can do so quickly and with high quality. Operating costs, too, can be reduced with an FMS; lower direct labor costs lead to lower manufacturing costs. These benefits, however, are not free; an FMS requires very large capital investments in equipment, planning and control systems, and human resources. **An FMS is generally appropriate when**:

1. All products are variations of a stable basic design;
2. All products utilize the same family of components;
3. the number of components is only moderate (10 to 50);
4. The volume of each component is moderate (1,000 to 30,000 units annually), but in lot sizes as small as one unit.

Define CIM and list some of its functions.
Computer-integrated manufacturing (CIM) - Computer information systems utilizing a shared manufacturing database for engineering design, manufacturing engineering, factory production, and information management.
CIM centers around a shared database for four primary manufacturing functions: engineering design, manufacturing engineering, factory production, and information management.
Define CAD, robotics, and group technology.
Computer-aided design (CAD) - computer software programs that allow a designer to carry out geometric transformations rapidly.
Robot - A programmable machine capable of moving materials and performing routine, repetitive tasks.
Robotics - The science of selecting robots for various applications.
Group technology - A way of organizing and using data for components that have similar properties and manufacturing requirements.

Chapter 5
Operations Capacity

Capacity - Capacity is the rate of productive capability of a facility.

Explain why capacity is important

Operations managers are concerned with capacity for several reasons. First, they want sufficient capacity to meet customer demand in a timely manner. Second, capacity affects the cost efficiency of operations, the ease or difficulty of scheduling output, and the costs of maintaining the facility. Finally, capacity requires an investment. Since managers seek a good return on investment, both the costs and revenues of a capacity planning decision must be carefully evaluated.

Indicate some possible capacity measures for manufacturing and services

Capacity may be measured in terms of the inputs or the outputs of the conversion process. Refer to page 165 for some common examples of capacity measures.

EG **output** - automobile manufacturer - **measure** - # of autos
input - airline - **measure** -number of seats

List some short-term and long-term strategies for modifying capacity

- **Short-term** Responses - for short-term periods of up to one year, fundamental capacity is fixed.
- Adjustments to make depend on whether the conversion process is primarily labor- or capital-intensive and whether the product is one that can be stored in inventory.
- **Capital- intensive processes** rely heavily on physical facilities, plant, and equipment. Short-term capacity can be modified by operating these facilities more or less intensively than normal.
- **Labor-intensive processes**, short-term capacity can be changed by laying off or hiring people or by having employees work overtime or be idle.
- Strategies for changing capacity also depend upon how long the product can be stored in **inventory**. Instead of storing output in inventory, input can be expanded or shrunk temporarily in anticipation of demand.
- **Long-term Responses:**
- If a firm anticipates that demand will be **permanently higher**, it could expand the facility and reap the benefits of economies of scale.
- **Capacity contraction and constant capacity**
- **Capacity contraction** most often involves selling off existing facilities, equipment, and inventories, and firing employees. Permanent capacity reduction or shutdown

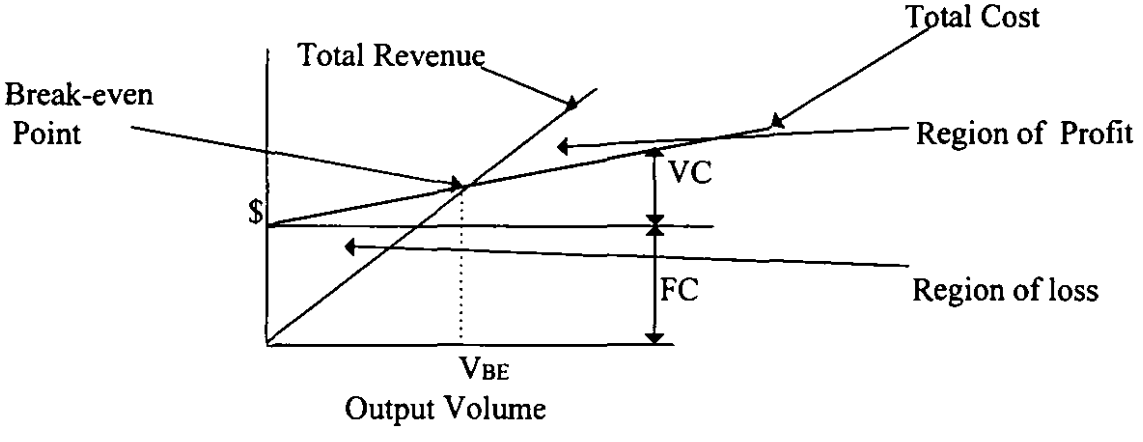
occurs only as a last resort. Instead, new ways are sought to maintain and use existing capacity.

- Phasing in and out of new and old products is not by accident. Staff for product research and development and market research engage in long-range planning to determine how existing capacity can be used and adapted to meet future product demand.

Chapter 6
Locating Production and Service Facilities

Recognize the factors that should be considered in location decisions
Revenues and costs are both affected by facility location. A technique called break-even analysis helps relate costs and revenues to facility location.

Use break-even analysis to calculate volume required to produce a profit
A graphical and algebraic representation of the relationships among volume of output, costs, and revenues. Costs can generally be divided into two categories: fixed and variable.
Fixed costs (FC) - costs that are incurred regardless of output volume. Costs that are incurred by the organization even if no products or services were produced. EG heating, lighting, and administrative expenses that are the same whether one or one thousand units of output are produced.
Variable costs (VC)- costs that fluctuate directly with volume of output: higher output results in higher total variable costs; lower outputs results in lower variable costs. Typically they are the costs of direct labor and material.
Break-even point(V_{BE}) - The level of output volume for which total costs equal total revenues.
First lets look at a simple illustration involving one location.



Refer to page 213 of the text for a comprehensive view of a break-even chart for operating one facility, two facilities, and two facilities on double shifts.

The overall operations will not be profitable until a volume of V_{BE} is reached. Information from the break-even chart can be used for managerial decisions. Once the desired level of profitability for the year has been stated, we can show the volume of output required to achieve it. We can also identify how many facilities and shifts will be needed, and we can estimate operating costs and working capital requirements.

Use the simple median model to determine facility location

Let's begin by defining what a **simple median model** is:

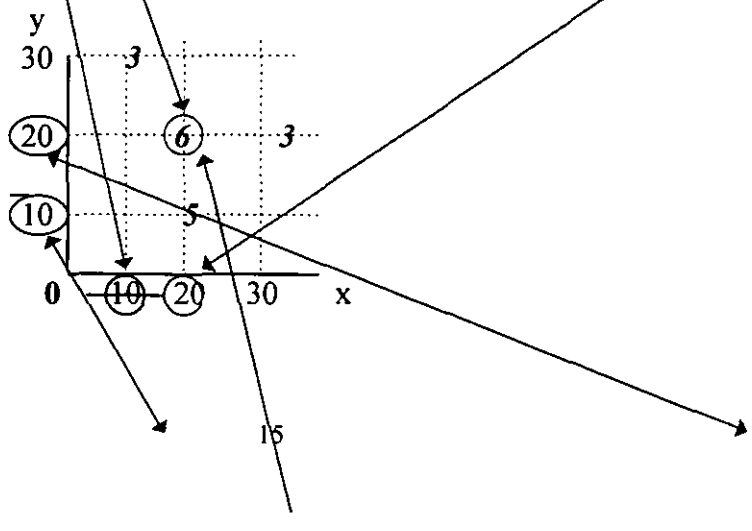
A quantitative method for choosing an optimal facility location, minimizing costs of transportation and based on the median load. Our goal is simple, we want to minimize our costs by constructing our plant in a central location based on load and customer location. Test #2 problem #5 provides a simple but typical illustration.

5. An office-supply store is considering a new location. The store has three major customers that are located as shown below. Use the simple median model to determine where the new store should be. Cost per load is the same for all three customers.

Customer	**Coordinates (x,y)**	**Loads per week**
A	(20,10)	5
B	(10,30)	3
C	(30,20)	3

Our goal is to find values for x_o and y_o (new store) that result in minimum transportation costs. We follow three steps:

1. **Identify the median value of the loads L_i moved**. The total number of loads moved to and from the new store will be (5+3+3) 11. If we think of each load individually and number them from 1 to 11, then the median load number is the middle number – that is, the number for which the same number of loads fall above and below. Median load is 11+1 = 6. Total # of loads + 1 Rational for adding 1 escapes me
   2 2 just use it as part of formula!!!
2. Find the x-coordinate of the existing facility that sends (or receives) the median load. First we consider movement of loads in the x-direction. Beginning at the origin and moving to the right along the x-axis, observe the number of loads moved to or from existing customers. Loads 1-3 are shipped to location x = 10. Loads 4-8 are shipped to from location x = 20. Since the median load (6) falls in the interval 4-8, x = 20 is the desired x-coordinated location for the new plant.



3. Find y-coordinate of the median load. Now consider the y-direction of load movements. Begin at the origin and move upward along the y-axis. Movements in the y direction begin with loads 1- 5 are shipped to location y = 10. Loads 6 - 9 are shipped to location y = 20. Since the median load falls, in the interval 6-9, Y = 20 is the desired y-coordinate for the new store.
4. The optimal plant location x = 20 and y = 20, results in minimizing annual transportation costs for this store. I placed the 6 in the optimal plant location to represent the median load.

Set up a transportation problem in the table format

I find it simpler to understand simple transportation by using a graph to find the optimal location of plant. Information can also be obtained using a table and formulas to find the optimal plant location. Either approach can be used or a combination of the two to find desired location. Lets go back to our previous example and set it up in a table format to find our solution. I will paste the problem here to avoid having to glance back at example on previous page.

An office-supply store is considering a new location. The store has three major customers that are located as shown below. Use the simple median model to determine where the new store should be. Cost per load is the same for all three customers.

Customer	Coordinates (x,y)	Loads per week	Weekly Load L_i New Store for x	Weekly Load L_i New Store for y	median load
A	(20,10)	5	1-3 @10	1-5@10	
B	(10,30)	3	4-8@20	5-8@20	6
C	(30,20)	3	9-11 @30	9-11 @30	

Our goal is to find values for x_o and y_o (new store) that result in minimum transportation costs. Since all loads must be on rectangular paths, distance between each existing facility and the new plant will be measured by the difference in the x-coordinates and the difference in they-coordinates. If we let (x_o,y_o) be the coordinates of a proposed new plant, then: $D_i = |x_o-x_i| + |y_o-y_i|$ Notice we calculate the absolute value of the differences, because distance is always positive. Notice too we could have reversed the values within the equation without changing the results. $D_i = |x_i-x_d| + |y_i-y_o|$

Looking at the table format we can see that the location of store should be (20,20).

I could have restated the steps involved, but I think the process is apparent. If you find it necessary to do so, glance back at previous example.

Compare two sites based on qualitative factors

Factor Ratings are frequently used to evaluate location alternatives because their simplicity facilitates communication about why one site is better than another; they enable managers to bring diverse locational considerations into the evaluation process; and they foster consistency of judgment about location alternatives.

Typically, the first step in using factor ratings is to list the most relevant factors in the location decision. Next, each factor is rated, say from 1(very low) to 5(very high), according to its relative importance. Then, each location is rated, say from 1(very low) to 10(very high), according to its merits on each characteristic. Finally, the factor rating is multiplied by the location rating for each factor, and the sum of the products yields the

total rating score for that location. The total scores indicate which alternative locations are most promising, considering of all the various location factors. Obviously, all that I have done is reproduced the text on page 219 to illustrate this approach. *I was getting tired and the procedure is relatively simple.* Factor rating are multiplied by location rating and their products are added together and whichever sight has the most points is the most desirable location for the new facility.

Storm Transportation Module simplifies the procedure for application of facility location. DR. White illustration's in class will provide a step by step procedure of entering the necessary data for it's application and how to interpret the data obtained.

Chapter 7
Layout planning

Briefly describe each of the layout types

A layout is the physical configuration of departments, work stations, and equipment in the conversion process. It is the spatial arrangement of physical resources used to create the product. The three basic layouts: **process-oriented, product-oriented**, and **fixed-position.**

Process-oriented layout The arrangement of a facility so that work centers or departments are grouped together according to their functional type.

Product-oriented layout. The arrangement of a facility so that work centers or equipment are in a line to afford a specialized sequence of tasks.

Fixed-position layout. The arrangement of a facility so that the product stays in one location; tools, equipment, and workers are brought to it as needed.

Explain how the load-distance model is used for a process layout

All movement costs money. People and equipment must be on hand, and space must be available for storing the product in between work centers. Since transporting adds no value to the product, managers seek layouts that minimize unnecessary flow among work centers.

We begin by estimating the number of loads we expect to move between each pair of work centers, say annually.

The next step is to determine the distance between each pair of work centers. These distances depend on the locations fixed by the layout. So propose an initial layout assigning space to each work center. Using the Equation below, calculate the cost of the initial layout. Finally, modify the initial layout to reduce costs. Repeat this process until you can improve no further.

$$C = \left(\sum_{i=1}^{n} \sum_{j=1}^{n} L_{ij} D_{ij} \right) K$$

n = the number of work centers
L_{ij} = the numbers of loads moved between work centers i and j
D_{ij} = the distance between work centers i and j
K = cost to move on load one distance unit

The cost effectiveness of each possible layout need not be fully calculated. Although many different layouts are possible, many of them are equivalent, or nearly so, cost-wise, and their costs need not be calculated separately.

Assembly-line production

Lets begin by defining ***Cycle Time***

Time elapsing between completed units coming off an assembly line. EG When I worked at Chrysler Car Plant, every 57 seconds a finished car came off the assembly line. This also meant that each automobile spent 57 seconds at each work station along assembly line. This also means that a work station which takes the longest time (**bottle neck operation**) defined the **maximum cycle time** for the assembly-line (**Maximum** cycle time).

An assembly-line has a good design if the sequence and assignment meet the following 3 criteria.

1. They produce the desired output capacity.
2. They are feasible.
3. They are efficient.

Lets use the table 7.5 example on page 267 of your text. I've restated the table below;

Work Station	Preceding Work Station	Task Assigned	Task's Required Predecessor	Task Time/Unit (in seconds)
1	--	A: Assemble frame	none	70
2	1	B: Install rubber molding	A	80
3	2	C: Insert frame screws	A	40
		D: Install frame latch	A	20
4	3	E: Install frame handle	A	40
		F: Install glass pane	B,C	30
5	4	G: Cover frame screws	C	50
6	5	H: Pack window unit	D, E, F, G	50
			Total	380

Lets begin by finding the bottleneck. Since Station 2 has the longest time and every units passes through each workstation the **Cycle Time** will be 80 seconds if the maximum daily output will be obtained. If the operation runs for an 8-hour shift each day we can establish the maximum daily output by the formula given below.

$$\text{Maximum daily output} = \frac{\text{available time}}{\text{cycle time per unit}} = \frac{28{,}800 \text{ Seconds}}{80 \text{ seconds per unit}} = 360 \text{units/day}$$

Calculate cycle time given a desired production rate

Sometimes cycle time is established by a desired output rather than maximum daily output. EG If 320 units were the desired production rate in an eight hour shift. Cycle time would be:

$$\text{Max. allowable cycle time} = \frac{\text{Time Available}}{} = \frac{\text{8 hours a day}}{}$$

to produce desired daily output Desired number of units 320 units per day

Max. allowable cycle time = 8 hrs. 60 min. 60 sec. = 28,800 90sec./unit
to **produce desired daily output** 1 hr 1 min. 320units/day
320 units per day

The second criteria is feasibility. Lets assume for the moment that it is feasible, but we will come back to this later.

The 3rd criteria is the line's efficiency. In our example we had a maximum daily output of 360 units and a desired daily output of 320 units. Obviously, the maximum daily output is more efficient but for illustrative purposes lets compare their efficiency. In this simplistic example, lets define idleness of worker as inefficient time and time spent working as efficient time in comparing the 2 output levels.

Calculate efficiency (balance delay) for an assembly line

Lets compare the 6 workers(8hrs. per day) at each production rate.

90 second cycle time = $\frac{\text{Production time}}{\text{Total Possible production time}} = \frac{(70+80+60+70+50+50)}{6 \text{ workers X } 90\text{sec.X } 100\%} = 70.4\%$

80 second cycle time = $\frac{(70+80+60+70+50+50)}{6 \text{ workers X } 80 \text{ sec.per workstation X } 100\%} = 79.2\%$ efficiency

As we earlier presumed the 80 second cycle time is more efficient than the 90 sec.

Determine the theoretical minimum number of work stations required given cycle times and task times

Once the desired output is specified, we can calculate the theoretical minimum number of stations required, the third step in our solution. We do so by contrasting the time required to produce one unit with the time we can allow, given the daily output requirements. We have already calculated the time required, as the sum of the task times in Table 7.5: 380 seconds. And we have calculated the time allowable, as the maximum allowable, as the maximum allowable cycle time: 90 seconds. Since just 90 seconds are allowed to produce one unit, 4022 stations must operate simultaneously, each contributing 90 seconds, so that the required 380 seconds are made available, as required (90)(4.22) = 380, or 4.22 = 380 divided by 90 seconds/unit. Since only whole stations are possible, at least five stations are needed. The actual layout may use more than the minimum number of stations, depening on the precedence requirements.

Use the longest operation time (LOT) rule to balance an assembly line

Longest-operation time (LOT) rule. A line-balancing heuristic that gives top assignment priority to the task that has the longest operation time. The fourth step

assigns tasks to each station. The designer must assign eight tasks to five or more stations. Several assignment combinations are possible.

The steps in the longest-operation-time (LOT) rule are:

1. Assign first the task that takes the most time to the first station. Maintain precedence requirements.
2. After assigning a task, determine how much time the station has left to contribute (time-task times).
3. If the station can contribute more time, assign it a task requiring as much time as possible. Maintain precedence relationships. Otherwise, return to LOT 1. Continue until all tasks have been assigned to stations.

The longest-operation-time procedure when used on a very simplistic assembly line(such as the classic red wagon example) we can determine the best possible method through trial and error. It doesn't take much imagination to realize that a real world application would be vastly more complicated. EG I mentioned earlier that I worked on the assembly line at Chrysler Car Plant. My job was to put 9 screws in the trim of the car at my workstation every 57 seconds. Again it doesn't take much imagination to realize that it takes thousands of workstations to complete a finished car. It also doesn't take much imagination to understand why I QUIT. But that's another story that would bore you as much as it bored me. Anyway back to the point. The industry use to use a heuristic (a procedure in which a set of rules is systematically applied; an algorithm) approach that was very time consuming. Today we use the computer to aid in its adaptation. DR. White will demonstrate how to use the Storm system to simplify the process. Pay close attention on where to place the inputs and how to read the outputs to learn the Storm process when taking the test. The accompanying past test will give you a good idea of how your test questions may be worded. The best method in learning the Storm system or any other system is practicing the programs.

Briefly describe a cellular layout and list its advantages

Cellular layout. The arrangement of a facility so that equipment used to make similar parts or families of parts is grouped together. In order for a cell to be economical and practical in the long term, the machines must be closely grouped, and the cell must be closely grouped, and the cell must be flexible in its mix of capacity and must be big enough so any one absent employee does not shut it down, yet small enough for employees to identify with the cell and understand the products and equipment. Cellular layouts can be configured in many ways - in a line as in Figure 7.10, in a U as the Japanese have demonstrated, or in a C. Employees are often placed along U and C cells in such a way that they can attend several machines at one time.

Advantages

1. Lower work-in-process inventories
2. Reduced materials handling costs
3. Shorter flow times in production
4. Simplified production planning (material and labor)
5. Increased operator responsibilities
6. Improved visual control

7. Fewer tooling changes (therefore quicker set-ups)
8. Overall performance often increases by lowering production costs
9. Improving on time delivery
10. Quality should increase as well

Disadvantages

1. Redused manufacturing flexibility
2. Potentially increased machine downtime cells that become out-of-date as products and process change
3. The disruption and cost of changing to cells

I don't think you need to memorize the advantages and disadvantages of the cellular layouts. A little common horsesense should provide you with an adaquate foundation to the test questions. Glance over old test questions and you will understand my assumption. But if you find it necessary to memorize, to obtain your desired test results, feel free to do so.

Chapter 8
Job Design, Production and Operations Standards, and Work Measurement

Before we begin the study questions for Chapter 8, lets look over some basic terminology

Job - A group of related tasks or activities that needs to be performed to meet organizational objectives.

Job design - Activities that specify the content of each job and determine how work is distributed within the organization.

Specialization of labor - Breaking apart jobs into tasks and assigning tasks to different workers according to their special skills, talents, and tools.

Job rotation - Moving employees into a job for a short period of time and then out again.

Job enlargement - Redesigning jobs to provide greater variety, autonomy, task identity, and feedback for the employee.

Job enrichment - Redesigning jobs to give more meaning and enjoyment to the job by involving employees in planning, organizing, and controlling their work.

Briefly explain the purpose of each chart used in methods analysis

Operation chart - A graphic tool to analyze and time elementary motions of the right and left hand in performing a routine, repetitive task.

Activity chart - A graphic tool to analyze and time the small, physical actions of worker and machine in performing a routine, repetitive, worker-machine tasks so that idle time can be identified.

Flow process chart - A graphic tool to analyze and categorize interstation activities so that the flow of the product throughout the overall production process is represented.

Gang process chart - A graphic tool to trace the interaction of several workers with one machine.

Any waste is anti-productive and therefore unnessary and adds cost to final product which is reflected in the final selling price. In order to remain competitive in the global

market today's manufacturers have to cut cost wherever possible. Production and Industrial enginneers have made a science of determining ways to make each and every phase of manufacturing more productive. Included in the charts above the engineers use the **Principles of Motion Economy**. - A broad set of guidelines focusing on work arrangements, the use of human **hands (both hands)** and body, and the use of tools.

Production and Operations Standards

Standard - A quantitative criterion established as a basis for comparison in measuring or judging output.

Labor standard - A quantitative criterion reflecting the output expected from an average worker under average conditions for a given time period.

Uses of Standards

As a basis for making operating decisions, labor time standards are used to **evaluate** the **performance of workers** and **facilities** and for **predicting, planning, and controlling operations.**

Standard usage - An established industrial engineering time standard. The standard labor rate is the accepted wage rate for the labor force that will be performing the work. Standard costs are compared with actual costs, giving a labor efficiency variance where

Actual costs = Actual usage X Standard labor rate
and
labor efficiency variance = Standard costs - Actual costs
Key decisions are based on labor efficiency variances, so it is important that the data used to calculate the variance be correct. Lets look at the example on page 305 of your text for a better understanding.

EG A manufacturing firm introducing a new product set a preliminary labor standard at 10 units/hour. The standard labor rate was $8/hour. During the third month of production, 800 units were produced using 90 labor hours. The labor efficiency variance is calculated as:

Standard cost = (.10 hours/unit) (800 units) ($8/hour) = $640
Actual cost = (90 hours) ($8/hour) = $720
Labor efficiency variance = $640 - $720 = -$80

Management was somewhat concerned about the negative variance, indicating actual costs are greater than standard costs, but decided to have industrial engineering thoroughly check the labor standard before taking corrective action. Engineering recommended the standard be established at 12 units/hour, and the labor efficiency variance was recalculated as
Standard cost = (0.0833 hour/unit) (800 units) ($8/hour) = $533.12
Labor efficiency variance = $533.12 - $720 = -$186.88

The preliminary labor standard was in error by 20% (from 10 to 12units/hour), and the corrected labor standard resulted in more than doubling the negative variance (from $-80 to -$186.88). Management now set out to find causes for the unfavorable variance.
Additional definitions needed for further applications.

Work Measurement - The determination of the degree and quantity of labor in performing tasks.

Direct time study - A work measurement technique that involves observing the job, determining the job cycle, stopwatch-timing the job cycle, and calculating a performance standard.

Normal time - The average cycle time for a job, adjusted by a worker rating to account for variations in "normal" performance.

Allowance fraction - The fraction of time lost on a job because of workers' personal needs, fatigue, and other unavoidable delays; the remaining fraction of time is the available fraction.

Standard time - The ratio of normal time to the available fraction of time.

Work sampling - A work measurement technique that involves defining the state of "working," observing the job over time, and computing the portion of time the worker is "working."

Predetermined time study - A work measurement technique that involves observing or thinking through a job, recording job elements, recording pre-established motion units, and calculating a performance standard.

Time measurement unit (TMU) A unit of time, equivalent to 0.00001 hours, used as a basis for **methods time measurement** (MTM), a widely accepted form of predetermined time study.

Great, we have a group of new definitions to learn, but why bother. Probably, as a manager, an accountant, or someone in personal, you won't have much to do with time study. Except you will be responsible for cutting costs wherever possible and you will be working with engineers to find ways to cut costs. Without some basic knowledge of how engineers determine amount of work to be performed, you will not understand any proposal they might submit. To eliminate future embarrassment and to do well on your next exam, lets take a look at a couple of practical examples.

22 on sample test #2

A stopwatch time study is done of a certain task. The average **cycle time is .50 minutes, rating factor is 120%,** and **the allowance fraction is 20%.** The **standard time** for this task (accurate to two decimal places should be:

(helpful hint: notice that all important information needed to solve this problem & all other problems on sample tests and actual tests are in bold)

$$\frac{\text{cycle time (rating factor)}}{\text{allowance fraction}} = \frac{.5(1.20)}{.20} = .6 \text{ normal time}$$

$$\frac{\text{normal time}}{\text{rating factor}} = \frac{.6}{1.20} = .75 \text{ minutes the standard time for this task}$$

lets try #25 on sample test # 2

A company has a set of tasks that must be completed to assemble a product. The total time for these tasks is 96 minutes. The cycle time is 3 minutes and the company has

found that 40 work stations are required to balance the line. What is the efficiency (or utilization) for this assembly line?

$\frac{40(3) - 96}{40(3)} = .2$ efficiency = 1-.2 = 80%

You will also be responsible for storm applications that apply to this chapter.

CHAPTER 9
PROJECT MANAGEMENT

Before we begin applicable questions within the study guide, lets review some basic definitions.

Project - A one-time only set of activities that has a definite beginning and ending point in time.

Project planning - Activities that establish a course of action for a project.

Project scheduling - Activities that establish the times and the sequence of project tasks.

Explain a Gantt chart

A bar chart showing the relationship of project activities in time.

An open bracket indicates the scheduled start of the activity, and a closing bracket indicates the scheduled completion. A heavy line indicates the currently completed portion of the activity. A caret ($\vee$) at the top of the chart indicates current time. Pages 334 & 335 of your text provide an informative example of how to use the Gantt chart.

A Gantt chart is a simplistic method of evaluating an activity at a certain time and determining if you have progressed to the expected amount of work. Network modeling allows us to address project scheduling a little more formally than we can with the Gantt chart. Before we can understand the more complex Pert chart and its applications we have to understand some basic terminology's.

Network modeling - Analyzing the precedence relationships of project activities and depicting them graphically.

Arc - In network modeling, an arrowed line segment; the symbol for a project activity.

Node - In network modeling, a circle at one end of an arc; the symbol for the beginning or ending of a project activity.

Program Evaluation and Review Technique *(PERT)* - An application of network modeling originally designed for planning and controlling the U.S. Navy's Polaris nuclear submarine project.

Activity - A project work needed to be accomplished, symbolized with an arc

Dummy activity - A fictitious activity consuming no time, symbolized by a node

Network - The sequence of all activities, symbolized by nodes connected by arcs.

Path - A portion of the network, including the first and last activities, for which each activity has a single immediate successor .

Critical path - A path whose activities are expected to consume the most time.

Logic of PERT How does PERT work? It works by following these steps:

1. Clearly identify all activities in the project.
2. Identify the precedence requirements of the activities.
3. Diagram the precedence requirements of the activities.
4. Diagram the precedence requirements as a sequence of activities.
5. Estimate the time each activity will take.
6. Calculate the critical path and other project performance criteria, creating the schedule and plan for subsequent control.
7. Reevaluate and revise as experience dictates.

Additional PERT language:

Optimistic time (t_o) is the least amount of time an activity is expected to consume.
Pessimistic time (t_p) is the greatest amount of time an activity is expected to consume.
Most likely time t_m is the single best guess of the amount of time an activity is expected to consume.
Expected time (t_e) is the amount of time an activity is expected to consume.

Time estimates are obtained from either past data or from people experienced in a particular activity. Optimistic t_o, pessimistic t_p, and most likely t_m times must be estimated so that the expected (average) time t_e can be calculated from the following equation.

$$T_e = \frac{(t_o + 4t_m + t_p)}{6}$$

***Given three time estimates, calculate expected activity time**
#4 on Test #3

It has been estimated an activity in a project might be completed in **as little as 1 day** or **as long as 9 days**. However, **most often the activity takes 2 days**. What is the **expected (mean) time** for this activity?

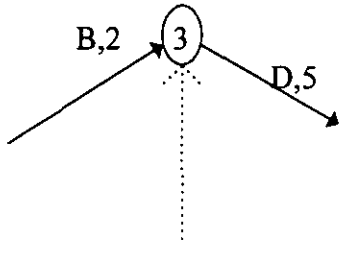
$$T_e = \frac{(t_o + 4t_m + t_p)}{6} \qquad \frac{1+4(2)+9}{6} = 3 \text{ days}$$

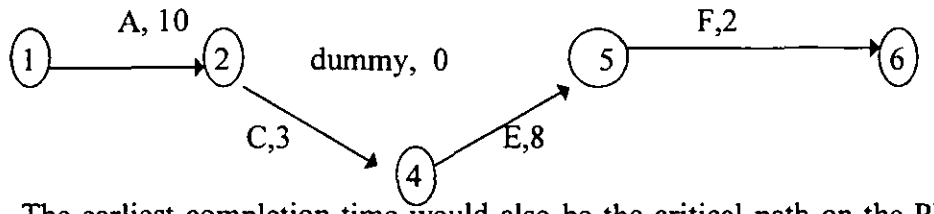
Explain the purpose of a dummy activity in a PERT diagram.

A fictitious activity consuming no time; necessary to preserve the unique identification of activities. DR. White's explanation in class will clarify the rational for using a dummy activity. EG If you were manufacturing little red wagons, you could not place the wheels on the wagon before the wagon was assembled. If you were diagramming the manufacturing of the wagon on a PERT diagram you might have a dummy activity to illustrate that the wheels can not be assembled on wagon until the wagon is completed. Therefore even though the manufacturing of the wheels were completed the PERT chart would have a dummy activity to consume the time to complete the wagon.

Calculate the earliest and latest times for an event: lets look at problem 16 on sample test #3.

For the following project, what is the earliest possible completion time?





The earliest completion time would also be the critical path on the PERT diagram. The critical path is the path whose activities are expected to consume the most time. Obviously, no project can be completed until all jobs are performed, the critical path is designated by a ACEF. The earliest completion time would be 23 the critical path of ACEF. On your exam the critical path will not be given, I provided the critical path for illustrative purposes. If we had taken ABDF path the time would have been 20, which is less than the critical path. I suppose that someone has added up ABDF and got 19 and wondered where I came up with 20. Remember you have to include the dummy activity which means D's earliest starting time is 13 because it cannot begin until event 4 is completed which is 13 instead of 12.

Suppose the preceding project has a desired completion time of 27. What is the slack for event (node) 4?

Slack time - The amount of leeway time an activity can consume and still allow the project to be completed on time. The difference of the latest beginning time and the expected beginning time. $T_S = T_L - T_E$

In order to determine the slack for event (node) 4, we first have to determine the slack for the ending node 6. $T_S = T_L(27) - T_E(23) = 4$ which is the slack time for all nodes in the critical path. Therefore the slack for node 4 is also 4.

Suppose the STORM Project Management module is to be used for the Project shown above in problem 16. What should be entered as the Start node and End node for Activity C?

The **start node** is simply the node preceding the activity C which is (2) The **End node** is simply the node following the activity C which is (4).

Time/Cost Tradeoffs. - Managers often want to reduce critical path times, even if it costs extra money to make the reductions. The essence of the time/cost tradeoff is allocating resources (spending money) to reduce project time only so far as further direct costs do not exceed indirect project cost savings. Beyond this point, the cost of expediting exceeds the benefit of reduced indirect project costs.

PERT procedures for analyzing time/cost tradeoffs are useful and straightforward.

1. Estimate costs. For each activity, determine indirect project costs and expediting costs per time period.
2. Estimate crash times. For each activity, determine the shortest possible activity time.
3. Identify activities on the critical path.
4. Evaluate the PERT network. Reduce the critical (CP) activity times by observing these restrictions: Expedite the CP activity that has the least expediting cost, continuing to the second least costly, and so on to the most costly, or until one of the following occurs:
   (a) The target expedited time has been reached.
   (b) The resources for expediting ($) have been exhausted.

(c) The indirect project costs are less than the expediting costs for each activity on the critical path.

In this procedure, you must be careful to keep an eye on the critical path. As the path time of the original CP is reduced, other paths may become critical. Should two or more paths have to be expedited simultaneously, the procedure may become too costly. We look at an example to illustrate this procedure.

Lets look at problem 21 on sample test # 3 for a better understanding. Restated on next page

A project has the activities listed on the next page. Those in ***bold italic type*** are on the **critical path**. The expected time, crash time, and cost to expedite are indicated on next page.

Activity	Expected Time	Crash Time	Cost to expedite ($/day)
A	5	3	$ 20
B	***10***	***9***	***100***
C	***5***	***4***	***120***
D	15	12	75
E	***9***	***8***	***50***

If the project completion time must be reduced by one day, which activity should be shortened?

Just before the problem, I identified the text's step by step procedure for analyzing time/cost tradeoffs. In the problem the steps have been completed to the point of identifying the critical path. The critical path is BCE. The problem illustrates that all activities may be reduced. If we can reduce all activities we naturally want to reduce the activity at the least cost. B can be reduced by one day at a cost of $100, C @$120, and E@$50. We would chose activity E because the cost of reduction of one day is less. **Suppose we were asked to reduce completion time by two days**. We would choose activity E first because @$50/day it would cost the least. We still have to reduce the activity by another day, what do we do? Upon a quick glance we might choose to reduce activity E for the second day also. Unfortunately, activity E can only be reduced by one day. Why? Because there is only a one day reduction that is possible. Expected time - Crash time, 10-9=1. Therefore, we would choose activity B for the second day reduction. Why? Because it is on the critical path and its cost of $100/day is less than cost of activity C@$120. The reduction would be activity E and activity B.

CHAPTER 10
SCHEDULING PRODUCTION AND SERVICE SYSTEMS

Business plan - A statement of an organization's overall level of business activity for the coming six to 18 months, usually expressed in terms of dollar volume of sales for its various product groups.

Product group (family) A set of individual products that share or consume common blocks of capacity in the manufacturing process.

Aggregate output planning - The process of determining output levels (units) of product groups over the coming 6 to 18 months on a weekly or monthly basis; the plan identifies the overall level of outputs in support of the business plan. Planning at this level ignores such details as how many of each individual product, style, color option, or model to produce.

Explain the purposes of aggregate planning

The plan recognizes the division's existing fixed capacity and the company's overall policies for maintaining inventories and backlogs, employment, stability, and subcontracting.

Aggregate capacity planning - The process of testing the **feasibility** of aggregate output plans and evaluating overall **capacity utilization.**

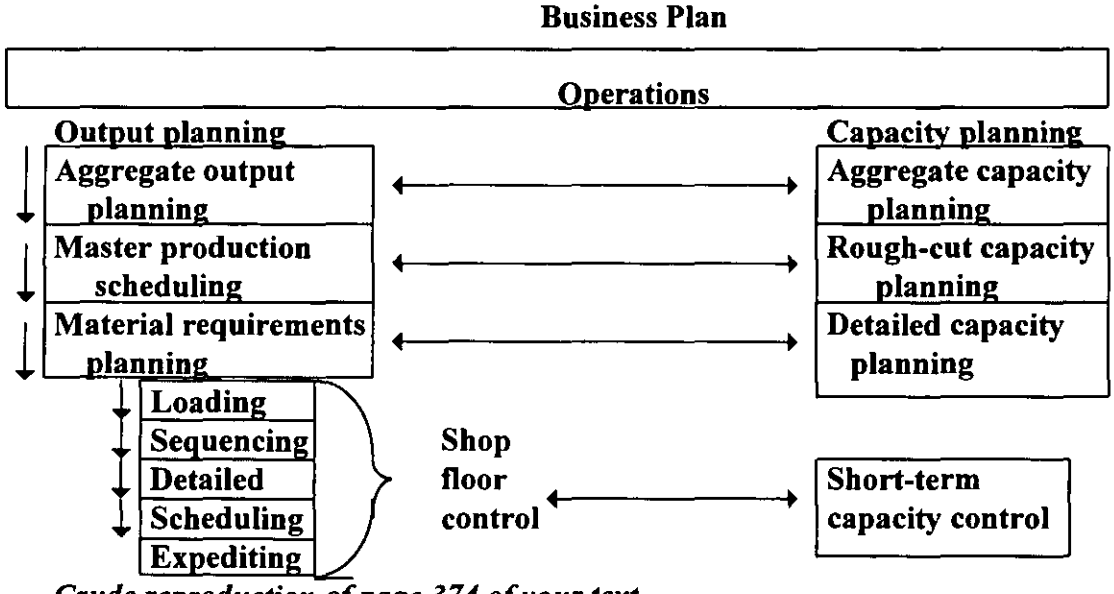
Role of aggregate capacity planning - to keep capacity utilization at desired levels and to test the feasibility of planned output against existing capacity.

Master production scheduling (MPS) - A schedule showing week by week how many of each product must be produced according to customer orders and demand forecasts.

Rough-cut capacity planning - the process of testing the feasibility of master production schedules in terms of capacity.

Shop floor control - Activities that execute and control shop operations; includes loading, sequencing, detailed scheduling, and expediting jobs in production.

The operations planning and scheduling system



Crude reproduction of page 374 of your text

Given a company's competitive strategy, indicate which pure strategy of aggregate planning would be most appropriate.

Pure Strategy - Aggregate planning strategy using just one of several possible means to respond to demand fluctuations.

Three Pure Planning Strategies

Strategy 1: Vary the Number of Productive Employees in Response to Varying Requirements.

From historical data, management can estimate the average productivity per employee and thus determine the number of employees needed to meet each month's output requirement. When required monthly output declines, employees can be laid off. As it increases, the work force can be increased accordingly.

Strategy 2: Maintain a Constant Work Force Size but Vary the Utilization of the Work Force.

During the lean months, the work would be scheduled to produce only the amount forecasted, resulting in some idle working hours. During high demand months, overtime operations would be needed to meet demand. The work force would therefore be intensely utilized during some months and underutilized in other months.

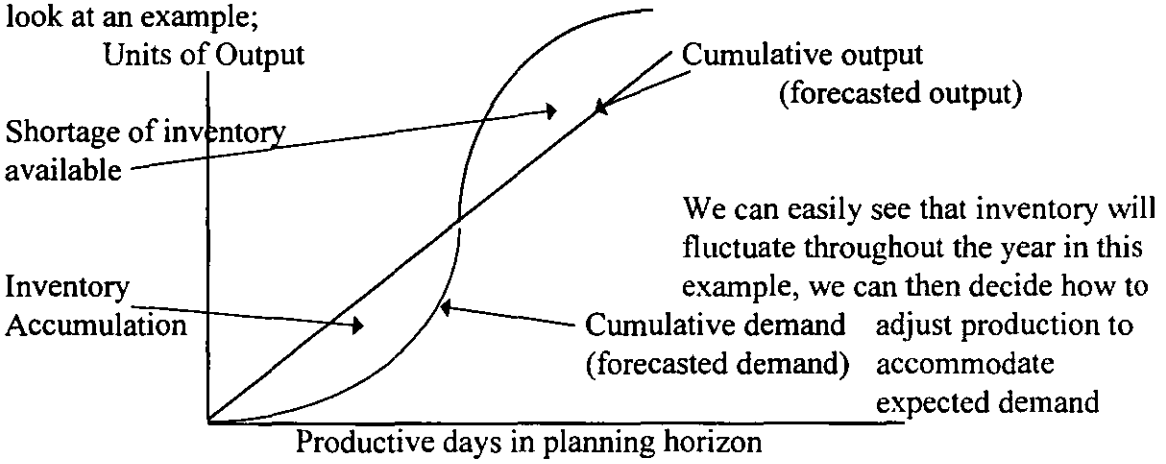
Strategy 3: Vary the Size of Inventory in Response to Varying Demand

Finished goods inventories in make to stock companies can be used as a cushion against fluctuating demand. Obvious advantage would be stable employment, no idle time, and no overtime. Disadvantage would be that inventory is not cost free. Strategy 3 uses backorders (outstanding or unfilled customer orders).

All the strategies have advantage and disadvantages, a company must decide for themselves which is best for their own needs. Some companies have a combination strategy. **Mixed strategy** - Aggregate planning strategy the incorporates or combines some elements from each of the pure aggregate planning strategies.

Explain what is indicated in the graphical method of aggregate planning

Two dimensional model relating cumulative demand to cumulative output capacity. The graphical method is convenient, relatively simple to understand, and requires only minimal computational effort. The entire planning horizon is on the horizontal axis, and cumulative units of output on the vertical axis. That is, the horizontal axis is the total productive days available and the vertical is the total amount of product produced. Lets look at an example;



Given an aggregate plan, calculate the costs of payroll, hiring and layoff, overtime, subcontracting, inventory, and total cost.

Variable output rate (chase) plan - An aggregate plan that changes period to period output to correspond with the demand fluctuation.

An intermediate plan - Excessive inventory and changes in output rates can be costly. The intermediate plan changes output rates only occasionally instead of every month.

Production smoothing - Production planning that reduces drastic period to period changes in levels of output or work force.

Total costs in production can be divided into variable and fixed costs. In the long run all costs are considered variable, that is, they vary with the total production in an operation. The aggregate plan that a company chooses will determine how the costs of payroll, hiring and layoffs, overtime, subcontracting, inventory, and total costs will be in the future. All possible costs must be considered when deciding which plan works best for each individual company. These costs will vary with the plan which is finally used. Computer software, such as STORM, will help determine the cost of each plan. With the aid of computers the cost of choosing a plan has been lessened considerably. Like all decisions in business the benefits must outweigh the cost. DR. White will explain the values which should be entered and how to interpret the output from the STORM production scheduling module for aggregate planning.

Explain the differences and relationships between the aggregate plan and the master production schedule.

Master production scheduling (MPS) - A schedule showing week by week how many of each product must be produced according to customer orders and demand forecasts.

This more detailed level of planning dis-**aggregates** the product groups into **individual products** and indicates when they will be produced. Whereas, the aggregate plan determines output levels of **product groups**. The master plan is developed from the aggregate plan.

Explain the purpose of rough-cut capacity planning.

Rough-cut capacity planning - The process of testing the feasibility of master production schedules in terms of capacity.

The purpose of rough-cut capacity planning is done in conjunction with the tentative master production schedule to test its feasibility in terms of capacity before the MPS is finally settled. This step ensures that a proposed MPS does not inadvertently overload any key department, work center, or machine, making the MPS unworkable.

Calculate rough-cut capacity requirements for a given master schedule.

Lets look at problem 12 on Test #3.

The master production schedule calls for production of **1000 units of product X** in a given week. If **2.5 standard hours** are required per unit and **drill department time has historically been 30% of the total time**, use **rough-cut capacity planning** to determine how many hours of capacity will be required in the drill department to meet this master schedule?

If total standard hours required per unit is 2.5 and the drill department time has historically been 30% of the total time, then the drill department time/unit is determined (2.5(30%)) = .75. The total capacity required in the drill department would be:

1000 units **X** .75/unit = **750 total standard hours required**

Chapter 11
OPERATIONS SCHEDULING

Define the terms loading, routing, sequencing, detailed scheduling, and expediting.

Loading - The cumulative amount of work currently assigned to a work center for future processing.
Routing - The processing steps or stages needed to create a product or to do a job.
Sequencing - This stage establishes the priorities for jobs in the queues (waiting lines) at the work centers. Priority sequencing specifies the order in which the waiting jobs are processed.
Detailed scheduling - Determining start times, finish times, and work assignments for all jobs at each work center.
Expediting - Tracking a job's progress and taking special actions to move it through the facility.
Refer to page 415 in the text for an illustration of the operations planning and scheduling system, or glance back 3 pages in the study guide for my reproduction of Figure 11.1.

Explain how the Gantt load Chart is used.
Gantt load chart - A graph showing work loads on a time scale.
The Gantt chart signals the need for reassigning resources when the load at one work center becomes too large. Employees from a low load center may be temporarily shifted to high load centers, or, alternately , temporary employees can be hired. Multipurpose equipment can be shifted among work centers. If the waiting jobs can be processed at any of several work centers, some of the jobs at high load centers can be reassigned to low load centers.
Define infinite loading and finite loading.
Infinite loading - Assigning jobs to work centers **without considering** the work center's capacity (as if the capacity were infinite).
Finite loading - A scheduling procedure that assigns jobs into work centers and determines their starting and completion dates by **considering** the work centers' capacities.
Use the priority sequencing rules to schedule a set of jobs.
Priority sequencing rule - A systematic procedure for assigning priorities to waiting jobs, thereby determining the sequence in which jobs will be processed.
First-come-first-served rule (FCFS) - Priority rule that gives top priority to the waiting job that arrived earliest in the production system. Page 422 & 423 provides an example of FCFS.
Earliest-due-date rule - EDD - Priority rule that gives top priority to the waiting job whose due date is earliest.
Shortest-processing-time rule - SPT - A priority rule that gives top priority to the waiting job whose operation time at a work center is shortest.
Least slack rule - (LS) - a priority rule that gives top priority to the waiting job whose slack time is least; slack time is the difference between the length of time remaining until the job is due and the length of its operation time.
Flow time - The total time that a job is in the system; the sum of waiting time and processing time.
Lets look at a few examples for better understanding of the processes involved.
Problem 15 on Test # 3

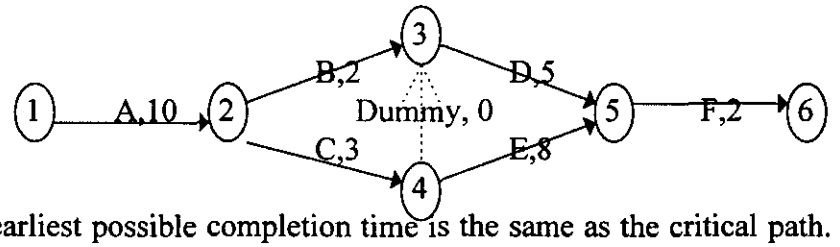
Four jobs are awaiting their last processing step. Information about those jobs is given below.

Job	Processing Time (days)	Days Until Due
A	2	10
B	3	12
C	1	3
D	4	8

If the **least slack rule** is used, what should be the sequence of jobs?1st **find the slack time for each job**, job A(10-2)= 8, job B = 9, job C =2, and job C = 4.2nd **Sequence the jobs in ascending order** of slack time, C(2), D(4), A(8), B(9)Answer: CDAB

Now that were having fun lets look at a couple more sample test questions,16, 17, & 18.

16. For the following project, what is the earliest possible completion time?



The earliest possible completion time is the same as the critical path. The critical path is ACEF. 10+3+8+2 = 23

17. Suppose the preceding project has a desired completion time of 27. What is the slack for event (node) 4?

Slack time - The amount of leeway time an activity can consume and still allow the project to be completed on time. The difference of the latest beginning time and the expected beginning time. $T_S = T_L - T_E$

In order to determine the slack for event (node) 4, we first have to determine the slack for the ending node 6. $T_S = T_L(27) - T_E(23) = 4$ which is the slack time for all nodes in the **critical path**. Therefore the slack for node 4 is also 4.

18. Suppose the STORM Project management module is to be used for the project shown above in problem 16. What is the slack for event (node) 4?

The **start node** is simply the node preceding the activity C which is (2). The **End node** is simply the node following the activity C which is (4).

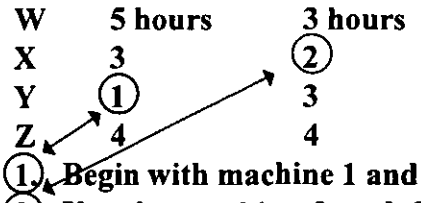
Yea, I know, I've already used these problems earlier in the study guide. Some people need to see a problem over and over to remember it for a test. Actually, I did the earlier part on a different day and its easier to keep it than to figure out how to take it out.

Schedule jobs on two work centers to minimize last-job flow time.

Lets apply the Johnson's Rule: see question 3 on test #3.

Four jobs are waiting to be processed **on two machines**. All jobs must go through machine A first then machine B. **Use Johnson's Rule** to sequence the four jobs so that last-job flow time is minimized.

	Processing Times	
Job	**machine A**	**machine B**



1. Begin with machine 1 and find the least processing time. Job Y is the first job.

2. Use the machine 2 and find the least processing time, you cannot use Job Y because you already used it in the first step. Job X has the least processing time therefore it is the last step in the sequence. You now have Y _ _X determined at this point. That is, Y is the first step and X is the fourth step in the sequence. This process is followed in the next 2 steps. now go back to machine A and find the next sequence. Job Z is the next job in the sequence because it is lower than Job W and you have already used y &x. The only job left is W therefore your ending sequence would be YZWX.

Define forward and backward scheduling.

Forward scheduling -Determining the start and finish times for waiting jobs by assigning them to the earliest available time slots at the work center.

Backward scheduling - Determining the start and finish times for waiting jobs by assigning them to the latest available time slot that will enable each job to be completed just when it is due, but not before.

CHAPTER 12
INVENTORY CONTROL FUNDAMENTALS

Explain the differences between independent and dependent demand.
Independent demand - Demand for an item that occurs separately of demand for any other item
Dependent demand - Demand for an item that can be linked to the demand for another item.

List the uses of inventory.
The fundamental reason for carrying inventories is that it is physically impossible and economically impractical for each stock item to arrive exactly where it is needed exactly when it is needed.

Explain the differences between Q/R and periodic inventory systems.
Q/R inventory system - An operating doctrine for which an optimal reorder point R - the trigger level - and an optimal order quantity Q - the economic order quantity (EOC - are fixed. Economic order quantity in the Q/R system and base stock levels in the periodic system determine how much to order; reorder point in the Q/R system and time between orders in the periodic system determine when to order.
Periodic inventory system - An operating doctrine for which reorder points and order quantities vary; stocks are replenished up to fixed base stock level after a fixed time period has passed. With this method, the order quantity will be whatever is needed to bring the amount of inventory back up to some pre-established base stock level. The base stock level and the time between orders are set by operations management and comprise the inventory system's operating doctrine.

Basic terminology

Cost of the item - or value, of the item is usually its purchase price: the amount paid to the supplier for the item.
Procurement costs - Costs of placing an order, or setup costs if ordered items are manufactured by the firm.
Carrying (holding) costs - Costs of maintaining the inventory warehouse and protecting the inventoried items.
Stockout costs - Costs associated with demand when stocks have been depleted; generally lost sales or backorder costs.
Total annual relevant costs = Cost of the items + Procurement costs + carrying cost +Stockout cost

Variables in Inventory Models
D = Total annual demand (in units)
Q = Quantity ordered (in units); order quantity
Q* = Optimal order quantity (in units)
R = Reorder point (in units)
R* = Optimal reorder point (in units)
L = Lead time (in time units)
S = Setup or procurement cost (per order)
C = Cost of the individual item; cost per unit
I = Carrying cost per unit carried, expressed as a percentage of unit cost C
K = Stockout cost per unit out of stock
P = Production rate; output per time unit (in units); or delivery rate
dL = Demand per time unit during lead time (in units)
DL = Total demand during lead time (in units)
TC = Total annual relevant costs
TC* = Minimum total annual relevant costs

Simple Lot Size Formula
The situation is characterized thusly:
Inventory has one stock point.
Annual demand is constant.
No stockouts are allowed
lead time is constant and independent of demand
Cost per unit is constant.
To simplify the case even further, lead time is assumed to be zero: that is, delivery is instantaneous. What is the total annual relevant cost (TC) equation?
Total annual relevant costs = Procurement cost + Carrying cost
Stockouts are not allowed, and the cost of the items is excluded, since the cost per unit is constant. Only those costs that can be affected by our choice of Q are included.
TC = (Order procurement cost)(# of orders per yr.)+(Cost of carrying 1 unit)(ave.#per/yr.)
TC = S(# of orders per yr.) + IC(aver # of units carried per year)
The number of orders per year can be expressed in terms of annual demand and order quantity.
Annual demand = (order quantity)(number of orders per year) then,

Number of orders per year = Annual demand (D)/ Ordered quantity (Q)

How can we determine the average number of units carried in inventory per year?

1. What is the maximum inventory, the highest that inventory will ever be?
2. It is the order quantity, Q
3. What is the lowest inventory?
4. Since we reorder when the stock is fully depleted, the lowest is zero. This pattern, in which inventories vary from maximum to minimum and then back to maximum, is called a cycle. For any one cycle, the average inventory is the average of the maximum inventory and the minimum inventory.
5. Average inventory per cycle = Maximum inventory + Minimum inventory /2
6. For the constant usage situation, then, average annual inventory per cycle is Average in inventory per cycle = Q + 0/2 = Q/2
7. The average for any time during any cycle, the average is Q/2, for any time at all during the year, the average is Q/2. Average inventory is time independent, as long as cycles during the year are the same.

Substituting our expressions for the number of orders per year and average inventory, our total cost equation is.

$TC = (S)(D/Q) + IC(Q/2)$

From this total cost equation evolves the formula for the optimal order quantity Q*, the quantity at the low point of the total cost curve.

$Q^* = \sqrt{2DS/IC}$ When inventory reaches R= 0 units

We can compare the sensitivity of total costs (TC) for any operating system with the system's minimum total costs TC* with the ratio TC/TC*. Recall that to find Q* we chose Q* that yielded the minimum TC, TC*. Thus TC* is computed by using Q* as the value of Q in the equation for TC.

$TC/TC^* = S(D/Q) + IC(Q/2)/S(D/Q^*)+IC(Q^*/2)$

$TC/TC^* = ½(Q^*/Q+Q/Q^*)$

Note that the total cost ratio in this equation is expressed solely in terms of Q and Q*. If our existing order quantity Q is very close to the optimal Q*, the ratio TC/TC8 is slightly larger than one. As Q departs farther from Q*, we expect TC/TC*also to grow. If Q is either twice or half as much as Q*, costs increase only 25 percent. This has important practical implications. For cases that fit the assumptions of the simple lot size model, changing order quantities will not save much money.

Gradual replacement model - A deterministic inventory model characterized by demand Being withdrawn while production is underway; no stockouts, constant and known demand, lead time, and unit cost.

Sometimes, part of the order is delivered instantaneously, but the rest of the order is sent little by little over time. When the order is placed, the supplier begins producing units, which are supplied continuously to the purchaser. While these units are being added to inventory (causing it to grow), other units are being taken out of inventory (causing it to diminish). Consider the case in which replenishment rate (P) exceeds withdrawal rate (D). After some time, the order quantity has been produced, and net

inventories have increased. The inventory level, however, never reaches the same high level as the simple lot size model, the order quantity. During time Tp, the slope of inventory accumulation is not vertical, as it was in the simple lot size model. This is the case because the entire order is not received at one time. Since P>D, during the time Tp inventory is consumed as well as built up, and this situation continues until the initial order quantity, Q, has been produced and delivered. At that point, inventory, is at its maximum Qmax. Thereafter, during time TD units are being taken out of inventory but other units are not being added to it. The slope of inventory depletion corresponds to the withdrawal rate. At the end of time TD, another order for Q is placed, partial delivery is instantaneous, and the cycle repeats. The entire order is filled continually over time, not immediately as was the case with the simple lot size model.

Still applying the other assumptions of the lot size model, the total annual cost equation for this model is the same.

Total annual relevant costs = Procurement cost + Carrying cost

TC = S(D/Q)+IC(average number of units carried per year)

As we have noted, maximum inventory Qmax never reaches Q but is always somewhat less. Therefore average inventory carried will not be Q/2. Realizing that the positive slope of the graph is P-D and negative slope is -D, we can find the maximum inventory, Qmax from

Slope = Rise/Run

P-D -Qmax/Tp

But the time Tp required to produce a lot Q is

Tp = Q/P

Substituting

Qmax = (P-D)Q/P = Q(P-D/P)

Average inventory is then

Average inventory = Maximum inventory +Minimum inventory/2

Q/2(P-D/P)

The total cost equation to be minimized in the gradual replacement correction model is

TC = S(D/Q)+IC(Q/2(P-D/P))

or Q* = 2DS/IC(P/P-D)

Lead time in determining models

Deterministic models can be adjusted for lead times known with certainty. The reorder point is calculated:

R* = Buffer stock + Demand during lead time

= 0+ DL

= 0+ (lead time)(Demand / unit time)

= LdL

The reorder point is now set and order will be placed for Q* units, which will arrive L units of time later. During the time between ordering and arrival, dL units per time unit, DL in total will be demanded, and inventory will be reduced accordingly.

Chapter 13
Quantity Discount

A policy of allowing item cost to vary with the volume ordered; usually the item cost decreases as volume increases due to economies of scale in production and distribution. As volume ordered Q increases, the supplier can often produce and shop more economically. To encourage volume purchases, the supplier shares the economies of scale with the customer.

In the operating doctrine for quantity discounts, reorder point is still at zero inventory, since delivery is assumed to be instantaneous. The general procedure for determining the order quantity starts by checking the lowest cost curve for an optimal Q. If that is unsuccessful, each higher cost curve is systematically checked until optimal is found. Follow these steps:

1. Calculate the economic order quantity (EOQ) for the lowest unit price using the simple lot size formula.
2. Determine if the EOQ in step 1 is feasible by determining whether it is in the quantity range for that price.
3. If the EOQ in step 1 is not feasible, compute the total cost for the smallest feasible quantity at the lowest unit price.
4. If the EOQ for the lowest unit price is feasible, compute the total cost for the this quantity at the lowest unit price, compute the total costs for the smallest feasible quantity at each unit price, and choose the quantity yielding the lowest total cost. Skip the remaining steps.
5. Repeat steps 1 through 4 for the remaining unit prices until a feasible EOC is found or all unit prices are evaluated. If the EOC for each unit price is not feasible, choose the price break with the lowest total cost.

Essentially, this procedure finds the quantity yielding the lowest cost on the lowest cost curve, checks its feasibility, and if it is not feasible, computes a cost at the price break that allows a feasible solution. Then we move to the next highest cost curve and repeat the procedures. In this way all minimum cost EOQ's will be calculated, and all price breaks will eventually be checked, provided an optimal feasible solution is not discovered earlier. As in all inventory operating doctrines, the optimal order quantity is the quantity that offers the lowest total cost.

EG Consider an inventory situation in a medical center where disposable sanitary packs are ordered in boxes of 5 dozen/box. Annual demand is 400 boxes; the cost of placing an order is \$12; and the inventory carrying charge is 20%. There are two price breaks: price per box is \$29 for 1 to 49 boxes, \$28.50 for 50 to 99 boxes, and \$28 for100 or more boxes.

To determine the optimal quantity, we begin on the lowest cost curve and compute Q* for a price of \$28 per box.

$$Q^* = \sqrt{2DS/IC} = \sqrt{2(400)12/.2(28)} = 41.40 = 41 \text{ boxes}$$

Since 100 or more boxes must be ordered to get a price of $28 per box, our Q* = 41 is not feasible. Computing the total cost for the lowest feasible quantity (100) at this unit price, we get

$TC = CD + S(D/Q) + IC(Q/2) = \$11,528$

Moving to the next highest curve

$Q^*_2 = \sqrt{2DS/IC} = 41$ boxes

The price of $28.50 applies to orders of 50 to 99 boxes, so $Q^*_2 = 41$ is not feasible. Computing the total cost at the lowest feasible quantity (50) at this unit price, we get,

$TC = CD + S(D/Q) + IC\ (Q/2) = \$11,638.50$

Moving to the next highest and last cost curve,

$Q^*_3 = \sqrt{2DS/IC} = 40.68$

This is a feasible quantity, since $29 is the price for an order of 1-49 boxes. Now we must compute the total cost for Q* = 41:

$TC^* = CD + S(D/Q^*) + IC(Q^*/2) = \$11,835.97$

Comparing all total costs, we see that the lowest total cost is $11,528 for an order quantity of 100. Therefore the operating doctrine for disposable sanitary packs is

$Q^* = 100, R^* = 0, TC^* = \$11,528$

For the disposable sanitary packs, the quantity discount overcame higher carrying costs. The sum of ordering and carrying costs were $328 for Q = 100, $238.50 for Q = 50, and $235.97 for Q = 41. However, the quantity discount of $1 per box for 400 boxes (comparing Q = 100 with Q =41) overcame the additional $92.03 in ordering and carrying costs, making Q = 100 the more attractive choice.

Variable Demand

The most common way to estimate demand is to collect data about past experiences and forecast future demand based on that data.

Lead Time Demand

Units of stock demanded during lead time; can be described by a probability distribution in stochastic situations. The two sources of demand variation during lead time, the length of lead time itself, and the demand per time period of lead time interact to determine demand during lead time. EG We can determine expected demand during lead time (average demand).

Expected demand during lead time = (300units/day)(3 days) = 900 units

If we had the lowest demand for each day (100) of the shortest lead time (2), we would have a low demand during lead time of 200 units. Likewise, is he most demanding condition prevailed, highest demand per day (700) and longest lead time (4), demand during lead time would be 2,800 units.

Between these extreme points, there can be various levels of demand. We can calculate all possible combinations of lead time and daily demand and see what values are possible for demand during lead time. We can also calculate the probabilities of these demand and use them to construct a probability distribution of demand during lead time, hand calculations become tedious. An alternative method for generating the distribution of demand during lead time is to simulate the operation of the inventory system over time on the computer. By randomly selecting a lead time and a demand, computing a demand

during lead time, and repeating the process dozens of times, we could classify the data into a distribution of lead-time demands and compute a mean and standard deviation to describe that distribution.

A model for variable demand and constant lead time, with specified service level

We now examine a moderately complex quantity/reorder point model in which lead time does not vary, but demand does. In this model, we want to find an operating doctrine that takes into account the possibility of a stockout. We want to establish buffer stocks that adequately protect service to customers when demand is uncertain.

Definition

μ= demand during lead time, a random variable
σ_μ = standard deviation of demand during lead time
$\overline{\mu}$ = expected demand during lead time
$\overline{d}$ = expected average daily demand
$\overline{\sigma_d}$ = standard deviation of expected daily demand
$\overline{D}$ = expected annual demand
B = buffer stock
z = number of standard deviations needed for a specified confidence level

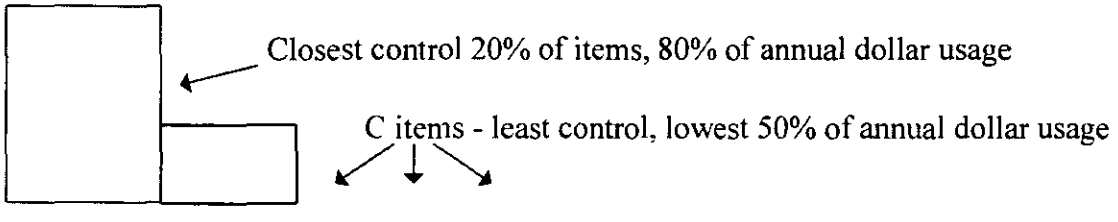
Daily demand for product EPD101 is normally distributed with a mean of 50 units and a standard deviation of 5. Supply is virtually certain with a lead time of six days. The cost of placing an order is $8, and annual carrying costs are 20% of the unit price of $1.20. A 95% service level is desired for the customers who place orders dusiog!uie!seosees!qesioe/Cackoseess!as

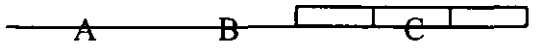
Determining the operating doctrine, we calculate order quantity as follows;
$Q^* = \sqrt{2DS/IC} = 1{,}103$
From the normal distribution, a 0.95 confidence level gives z = 1.645. Thus
$R^* = \overline{d}L + z\sigma_\mu = 1.64\ \sigma_\mu$
$R^* = 50(6) + 1.645(12.2) = 320$ units, our operating doctrine is to order 1,103 units when we reach an order point of 320.

Classify items using ABC analysis

Classification of inventory into three groups: An **A** group comprising items with a large dollar volume: a B group comprising items with moderate volume and moderate dollar volume; and a C group comprising items with a large volume and small dollar volume.

ABC Analysis Independent demand percent inventory value percent of items
A items - monitor closest control
C items - least control





Item	Annual Usage	% of total annual $ usage
2704	$125,000	46.18% A Item
1511	90,000	33.25% A Item
0012	32,000	11.82% B Item
ETC. ETC. ETC.		.24% C item

CHAPTER 14
MATERIAL REQUIREMENTS PLANNING

MATERIAL REQUIREMENT PLANNING (MRP)

A system of planning and scheduling the time-phased materials requirements for production operations. As such, it is geared toward meeting the end item outputs prescribed in the master production schedule. MRP also provides information such as due dates for components that are subsequently used for shop floor control. Once this MRP information is available, it enables managers to estimate the detailed capacity requirements for each work center. MRP's role in coordinating these activities becomes evident as we examine its objectives and methods in greater detail.

MRP Objectives and Methods

1. Inventory reduction. MRP determines how many of a component are needed and when, in order to meet the master schedule. MRP enables the manager to procure that component as it is needed, thereby avoiding costs of excessive inventory.
2. Reduction in production and delivery lead times. MRP identifies materials and components quantities, timings, availability's, and procurement and production actions required to meet delivery deadlines. By coordinating inventories, procurement, and production decisions, MRP helps avoid delays in production. It prioritizes production activities by putting due dates on customer job orders.
3. Realistic commitments. Realistic delivery promises can enhance customer satisfaction. By using MRP, production can give marketing timely information about likely delivery times to prospective customers. Potential new customer orders can be added to the system to show the manager how the revised total load can be handled with existing capacity. The result can be a more realistic delivery date.
4. Increased efficiency. MRP provides close coordination among various work centers as products progress through them. Consequently, production can proceed with fewer indirect personnel, such as materials expeditors, and components available at

appropriately scheduled times. The information provided by MRP encourages production efficiencies.

The major sources of information are mandatory in the MRP system; a master production schedule, and inventory status file, and a bill of materials file.

Master Production Schedule

The MPS is initially developed from firm customer orders or from forecasts of demand before the MRP system begins to operate. The MPS is an input to the MRP system. Designed to meet market demand, the MPS identifies the quantity of each end product (end item) and when it needs to be produced during each future period in the production planning horizon. Orders for replacement (service) components for customers are also entered as end items in the MPS. The MPS ultimately governs the MRP system's recommended actions on the timing of procuring materials and producing sub-components, which are geared to meeting the MPS output schedule.

The MRP Processing Logic

The MRP processing logic accepts the master schedule and determines the components schedules for successively lower level items of the product structures. It calculates for each item in each product structure and for each time period (typically one week) in the planning horizon how many of that item are needed (gross requirements), how many units from inventory are already available, the net quantity that must be planned on receiving in new shipments (planned order receipts), and when orders for the new shipments must be placed (planned order releases) determined the requirements for all items used to meet the master production schedule.

Selected terminology of MRP component records

1. **Allocated quantity** - The quantity of an item in inventory that has been committed for use and is not available to meet future requirements.
2. **Gross requirements** - The overall quantity of an item needed at the end of a period to meet planned output levels. Planned output for end items is obtained from the MPS. Planned output for end items is obtained from the MPS. Planned output for lower-level items is obtained from the MRP system.
3. **Scheduled receipts** - The quantity of an item that will be received at the beginning of a time period from suppliers as a result of orders that have already been placed (open orders).
4. **Available quantity** - The quantity of an item expected to be available at the end of a time period for meeting requirements in succeeding periods. It is calculated as scheduled receipts plus planned order receipts minus gross requirements for the period, plus amounts available from the previous period.

5. **Net requirements** - The net quantity of an item that must be acquired to meet the scheduled output for the period. It is calculated as gross requirements minus scheduled receipts for the period minus amounts available from the previous period.
6. **Planned order receipts** - The quantity of an item that is planned to be ordered so that it will be received at the beginning of the period to meet net requirements for the period. The order has not yet been placed.
7. **Planned order release** - The quantity of an item that is planned to be ordered and the planned time period for releasing this order that will result in the order being received when this order is placed (released), it becomes a scheduled receipt and is deleted from planned order receipts and planned order releases.

More definitions

lead time offsetting - The process of determining the timing of a planned order release; backing off from the timing of a planned order receipt by the length of lead time.

Product explosion - The process of determining from the product structure and planned order releases the gross requirements for components

Pegging - The process of tracing through the MRP records and all levels in the product structure to identify how changes in the records of one component will affect the records of other components.

Cycle counting - Counting on hand inventories at regular intervals to verify inventory quantities shown in the MRP.

Time fence - A designated length of time that must pass without changing the MPS, to stabilize the MRP system; afterward, the MPS is allowed to change.

Firm planned order - A planned order release scheduled within the MRP time fence.

Lot for lot ordering - A lot sizing policy in which order quantity equals net requirements for the period.

Route sheet - A document that shows the routing of a component, including the work centers and operation times, through its production processes.

Bill of Materials - A document describing the details of an item's product buildup, including all component items, their buildup sequence, the quantity needed for each, and the work centers that perform the buildup sequence.

Product structure - The levels of components to produce of an item in the product structure; end items are upper-level; preliminary items in the product structure are lower-level.

Inventory status file - The complete documentation of the inventory status of each item in the product structure, including item identification, on-hand quantity, safety stock level, quantity allocated and lead time.

Allocated Quantity - The quantity of an item in inventory that has been committed for use and is not available to meet future requirements.

Gross requirements - The overall quantity of an item needed during a time period to meet planned output levels. Planned output for end items is obtained from the MPS. Planned output for lower-level items is obtained from the MRP.

Available quantity - The quantity of an item expected to be available at the end of a time period to meet requirements in succeeding periods. Calculated as scheduled receipts plus

planned order receipts minus gross requirements for the period, plus amounts available from the previous period.

That's all for the information on Test # 4 that I'm going to provide for this section. I know the format is different than on the other sections. Let me know if it worked better or worse. That way I can make an adjustment in my revised version of the study guide for next semester. I will still spend as much time working on this part of the study guide, but I'm going to go through every question on the sample test. I will tell you why I answered each question the way I did and go through a step by step analysis on how I used the sample test to study for the 4th exam. You can now look at the sample exam and only look at the problems that are giving you problems or you can follow me through each question on the sample exam. Again, I'm not suggesting that you not read the material in the text or attend the lecture. I am simply applying a different format to your supplemental material. I don't know how many students will need information on each question individually, that's why I need your input. The material provided for test #5 in the study guide will go back to the format I have used previously. Good Luck on exam #4.

MGMT 318/BA 420 -Test #4

1. A company makes toy automobiles. Each toy automobile requires **4 wheels** that are assembled directly onto the automobile. Based on the following information, how many units would be in the planned order release of **wheels for week 2?** Use lot-for- lot ordering with a **lead time of 1 week.** ***Information in italic is the information I used to answer the problem.***

Master Schedule - Toy Automobiles

Week	1	2	3	4	5	6
	50	60	75	50	60	75

Wheels - (4 per automobile)

Week	1	2	3	4	5	6
Gross Requirements						
Scheduled Receipts	300					
Available for next period (50)						
net Requirements						
Planned Receipts						
Planned order releases						

For this question and all following questions, the first thing I do is to make sure I know what the question is asking. I know this is a very simple concept but most questions I miss on exams are because I have read the problem wrong. I will leave the above question blank so you can work it out on your own. I will provide an answer key below after I have discussed how I worked the problem. Lets begin. The question asks how many units would be in the planned order release of wheels for week 2?

1. I noticed that 4 wheels are needed for each automobile. That tells me that the gross requirement for week 1 is 200 not 50 as shown in the master schedule. I place the 200 **in the box** for gross requirements for week 1. No I won't say that each time!!
2. I see that the available for next period has 50 units in it. That is the same as beginning inventory for week 1. I also see that Scheduled receipts has 300 units in it, which is the inventory scheduled for the beginning of week to be added to the available for next period. (300+50 = 350) If the gross requirement for week 1 is 200 then the available for next period balance would be 150. (350 - 200)
3. I then determine the gross requirement for week 2. Master Schedule needs 60 and four are required for each automobile therefore 240 are needed for week 2.
4. I can now determine the plan order release for week 1. Available for next period (beginning inventory) is 150 and there are no scheduled receipts. 240 are needed, therefore 90 planned order releases are needed. (240-150)
5. I now need to determine the gross requirement for week 3. 75X4=300
6. There is 0 available for next period, because we used up all of our inventory. Therefore the planned order release for week 2 is 300 gross requirement. Our answer.

I realize that all students will not need such an in-debt analysis for each question. That is why I didn't apply this format before. Here is the completed answer.

	1	2	3	4	5	6
Wheels - (4 per automobile)	50	60	75	50	60	75
Week	1	2	3	4	5	6
Gross Requirements	***200***	***240***	***300***			
Scheduled Receipts	300					
Available for next period 50	***150***	***0***				
net Requirements		***90***	***300***			
Planned Receipts		***90***	***300***			
Planned order releases	***90***	***300***				

After I have completed a problem, I ask myself how would I change the question. Dr. White could have asked for any information in any blank box. I then look at important information that I could possibly miss. The key information in this problem are all in bold print. Overlooking any of this information would provide you with a different answer.

You can now see why I didn't provide this kind of information earlier. If you think iu!iscosiog!uo!seae

c. It is a finished product sold directly to consumers.
d. Its demand depends on the production schedule for another item.
e. Its level of inventory depends on amount of customer demand.

Remember there are dependent and independent demand. Look for key words in these types of questions. By the way, did you notice that all the other answers are for independent demand. Food for thought, the next exam may ask, which is independent.

3. Which of the following IS NOT a use of inventory?
   c. Buffer against uncertainty
   d. Allow for large variations in production
   e. De-couple different processes.
   f. Allow for smooth production

Answer is the only one not a use of inventory. Don't ya just love these kinds of problems I'm going to skip #4 and go to #5, because I don't have enough room to put the whole problem on the page.

5. A material is ordered from a supplier. The **demand during the reorder lead time averages 60 units per day** with **standard deviation of 10 units per day**. If the company wants a **service rate of at least 98.5%,** what should be the **reorder point with *safety stock*** for this material if lead time is **4 days**?

If you were taking the exam and find the formula. The key is to find the formula for the reorder point ***with safety stock***. $R^* = dL + z\sigma_\mu = 60(4) + z(\sqrt{4})(10)$
$z = .985/2 = .4850$ find .4850 in columns on chart where formulas are provided. To get a z value of 2.17. Add z value to formula. $R^* = dL + z\sigma_\mu = 240 + 2.17(20) = 284$

	Week		1	2	3	4	5
Product A:	Master Schedule		100	120	150	120	130
Assembly B	Gross Requirements		100	120	150	120	130
	Scheduled Receipts		300				
	Available for next period	30	230	110	0	0	0
	Net Requirements				40	120	130
	Planned Receipts				40	120	130
	Planned order Releases		40	120	130		

Use this information to determine planned order releases for part C in week 1 using the information provided below. Lead time for Part C is 1 week. Use lot-for-lot ordering

	Week		1	2	3	4	5
Part C (2 per B)	Gross Requirements		**80**	**240**	**260**		
	Scheduled Receipts		300				
	Available for next period	30	**250**	**10**			
	net Requirements				**250**		
	Planned Receipts				**250**		
	Planned order Releases		**0**	**250**			

The method to find solution to this problem is the same as problem 1. Except instead of getting information for gross requirement from the Master Schedule, it is obtained from the planned order Releases of Assembly B. Again the easy way to make a mistake on this problem is to not realize that info for Part C gross requirements is obtained from assembly B. The only other thing that may give you a problem on a similar problem is not seeing that Part C requires 2 per B. Since the problem is so similar I will just fill in the information I think is required and information you may be wondering about to answer the question. ***The planned order releases for part C in week 1 is 0***

6. MRP II differs from MRP in that
   f. only MRP is concerned with requirements for parts
   (g.) MRP II includes requirements for **other** resources
   h. MRP II is just a computerized version of MRP
   i. MRP does not consider requirements for parts or raw materials

Manufacturing resource planning (MRPII) - An **integrated information system** that **shares data** among and **synchronizes** the activities of production and the **other** functional areas of the business.

Material requirements planning (MRP) - A **system of planning and scheduling** the **time-phased materials requirements** for production operations.

Look at both definitions carefully and notice the differences. Just for **fun** (OK maybe **fun** is not the word I would use either) try to find ways of stating the differences if you were making up the problem. This would be a good way to prepare for any change you might see on a similar problem on the exam.

7. In a periodic inventory system, the inventory level is:
   (g.) Checked only periodically.
   h. Continuously monitored.
   i. Held constant.
   j. Always close to zero.

OK, I don't think you have to be a rocket scientist to guess this one. To prepare for any changes you might see on the exam you might glance back at your notes and see some possible differences. Notice in the question, that B & D are conditions that are desired in JIT inventory system.

8. **The planned order releases for part X** are shown below. Also, information from the **routing sheet and labor standards** is given. How many standard hours will be required **for the lathe in week 2?**

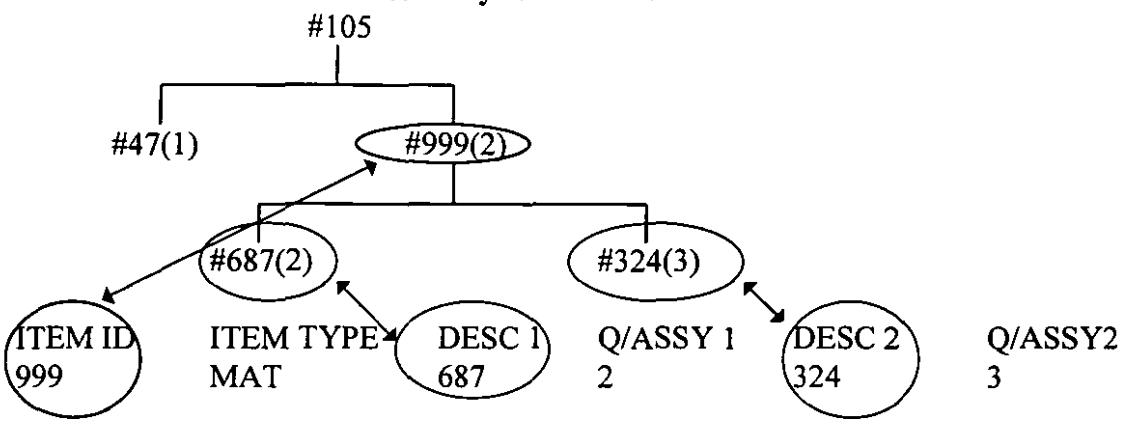
			Week			
			1	2	3	4
Part Z:	Planned Order Releases		200	150	300	200
			Lead			
		Operation	Time	Setup		Run
	Routing	#1 Drill	1 week	.2 hr.		.1 hr./unit
		#2 Lathe	1 week	.5 hr.		.3 hr./unit
		#3 Grind	1 week	.1 hr.		.05 hr./unit

Answer: 200(.3) +.5hr = 60.5

When I first did this problem my answer was 150(.3) + .5hr. = 45.5. The key phrase is **routing sheet**. What this means is that all the operations are not done at the same time.

With a lead time of one week, the product begins in the drill department for one week. The next week the product is in the lathe department for a week. Therefore the planned order releases (200) for the lathe department will not begin until week 2. It will begin in the grind department in week 3.

9. The following product structure tree diagram shows the subassemblies and component parts that are used in making product #105. Numbers in parentheses indicate the number of each part required. Based on this, input to the **STORM Bill of Materials File for Subassembly #999** should be:



Look at the question, it asks for the input for the bill of materials file for sub-assembly #999. The graph shows us that the 1st DESC is #687 for 2 and the 2nd DESC is #324 for 3. The alternative answers do not include #687 or #324.

Output from the STORM MRP Module is shown below.

EXPLOSION REPORT

Planning Period	Gross Reqts	Scheduled Receipts	Projected On hand	---Planned Orders--- Lot for Lot	Lot sized

C 3 Level 2 LT = 2 Lot size FQ
Annual demand = 0 Scrap % = 0.00
Order/Setup Cost =0.00 Total order/setup cost = 0.00 Unit Value = 0.00
total carrying cost = 0.00
Safety stock = 0 Fixed Quantity = 1000

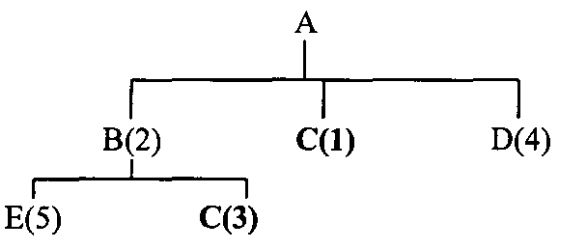
	GR	SR	OH	LFL	PO
PAST DUE	0		1000		
WEEK 1	250	0	750	0	0
WEEK 2	**275**	**0**	**475**	**50**	**1000**
WEEK 3	195	0	280	385	0
WEEK 4	330	0	950	240	0
WEEK 5	385	0	565	0	0
WEEK 6	240	0	325	0	0

Based on this information, how many units will be **ordered in Week 2?**

a. 50 1st we look at week 2 and check column for Planned Orders (PO).

b. 475 This tells us that the planned order for week 2 is 1000.
c. 0 If we were entering the data from the information provided, we
(d. 1000) would enter 1000 in the PO because you have to order at least 1000, because there is a fixed quantity of 1000.

11. Given the master schedule for part A, the planned order releases for part B, and the product structure tree, **what is the Gross Requirements for part C in week 4?**



Master Schedule (A):

week:	1	2	3	**4**
quantity:	100	100	125	**300**

Planned Order Releases (B):

week:	1	2	3	**4**
quantity:	50	50	50	**50**

a. 100 The key to solving the problem is determining the gross
b. 250 requirements for part c in week 4. Gross requirement for
c. 300 week 4 is 300 units from the Master Schedule (A) +
(d. 450) gross requirement from planned order releases (B) of 50(3)=150. Gives the answer of 300 + 150 = 450

12. Which of the following is an **independent demand** inventory item?
l. a component part used in an assembled product.
m. a raw material used to make a component part.
(n.) a finished product sold to consumers.
o. a component part purchased from a supplier.

C is the only independent demand for inventory item, all the rest are dependent. Dr. White may ask which is the dependent demand on the exam.

13. A retailer stocks a certain product that is sold at the rate of **10,000 units per year.** Each replenishment **order from the outside supplier costs $50**. The price is **$40 per unit** and **inventory carrying cost per year is 10% of unit price**, how many units should be **ordered each time to minimize total annual cost?**

m. 100 Dr. White provides the formula needed on the last page of sample test #4.
n. 250 The only thing you have to do is recognize which formula to use.
(o.) 500 formula needed: $Q = \sqrt{\frac{2DS}{IC}} = \sqrt{\frac{2(10{,}000)50}{.10(40)}} = 500$
p. 1000

14. Referring to the preceding problem, suppose the supplier requires that orders be placed for 2,000 units at a time. What would be the total annual variable cost of ordering and carrying inventory?
n. $2,000 The formula needed is not included on the sample test #4.
o. $2,500 $TC = \frac{10{,}000}{2{,}000}(50) + \frac{2000}{2}(.10)(40) = \$4{,}250$
(p. $4,250)

q. $8,000

The total cost = cost of placing each order (#of orders)+cost /unit(# of units)

15. Which of the following is a **component of an MRP system**?

o. The aggregate plan.
p. Economic order quantity
q. Forward scheduling.
(r.) Bill of materials file.

My only suggestion is to look at all the components of the MRP system and to be prepared for any component you may find on a similar question.

16. Suppose a company finds that scheduled receipt of a certain component part will be delayed. If the company wants to find **which customer orders will be affected by this delay**, its MRP system should have:

p. cycle counting
q. updating
(r.) pegging
s. backward scheduling

Definition of pegging, I would also learn the other 3 definitions.

1. A company that uses MRP **counts its inventory at regular intervals** to verify that its inventory status file has the correct amount for each item. This is called:

q. pegging
(r.) cycle counting.
s. A Q/R inventory system.
t. Safety stock.

I told you to learn all the definitions.

1. In MRP **a time fence** is:

(r.) a time within which no changes can be made in the master schedule.
s. The time period represented by each block of the MRP table.
t. the time between when an order is placed and it is received.
u. the length of time for which planning is done.

The last three questions were definition questions. HINT!!!

19. Which of the following is used in MRP to generate all gross requirements of level 1 items?

s. The aggregate plan.
t. The capacity requirements plan.
u. Rough-cut capacity planning.
(v.) The master production schedule.

I believe I would try to get a good grasp on the components and uses of all 4 of MC answers

1. A certain item is subject to **quantity discounts** s shown below:

Quantity Purchased	Price Per Unit
1-49	$ 2.50
50-999	$ 2.00
1000 or more	$1.80

If **1,000 units are used per year** and it **costs $450 to place an order** due to high shipping costs, how many should be ordered at a time to minimize variable costs if **carrying cost per unit per year is 50% of unit value?**

a. 1000
a. 500
b. 100
c. 50

As long as you can see which formula to use, this problem is simply plugging in numbers for symbols.

$$Q^* = \sqrt{\frac{2DS}{IC}} = \sqrt{\frac{2(1000)\$450}{.5(1.80)}} = 1000 \text{ units ordered at a time.}$$

21. A particular item is used at the rate of **10 units per day** and the reorder **lead time is 8 days**. What should the **reorder point** be with **no safety stock**?
    u. 8 10 units/day X 8 days = 80units is the reorder point with no safety stock.
    v. 10
    w. 18
    (x) 80

1. A company has 100 inventory items with total annual dollar usage of $3,000,000. Which of the following is most likely a C inventory based on ABC analysis?

	Part #	Annual $ Usage	
a.	1078	$500,000	Remember that C items have lowest of total annual $
b.	2365	$250,000	usage . a & b would be A items.
c.	1287	$ 52,000	c would be a B item.
(d.)	7864	$ 1,000	

1. The term **updating** in MRP refers to:
    (w) performing MRP calculations to reflect the impact of changes.
    x. obtaining the latest copy of MRP computer software.
    y. moving from MRP to MRPII
    z. tying a particular customer order to each planned order

Again just another definition to learn. I really do think you can expect several definitions on this exam.

24. A company manufactures repair parts. These parts are used **at the rate of 5,000 units per year.** It costs **$100 every time more are produced**. The cost of holding these parts in **inventory is 20% of unit price, which is $25 per unit.!!Uie!qasus!cao!ceqsoeucee!au!u**

    time to minimize total annual cost?
    x. 500
    (y.) 1000
    z. 1500
    aa. 2000

Again it's just a matter of knowing which formula to use when. The formula will be given on the exam. You may want to review what formula to use.

$$\mathbf{Q^* = \sqrt{\frac{2DS}{IC}\frac{P}{P-D}} = \sqrt{\frac{2(5000)\$100}{20\%(25)}\frac{6250}{6250-5000}} = 1000}$$

25. **A particular pamust be ordered in multiples of 1000 units**. In the **STORM MRP module, the item Master File** would have which of the following?

	ITEM ID	CLASS	LOT SIZE	MULTIPLE
a.	3		FQ	1
b.	3		1000	FQ
c.	3		FQ	1000
d.	3		LFL	1000

Lot size is fixed quantity (FQ) and the multiple is 1000.

Chapter 15
Japanese Contribution (JIT

List and define the seven wastes
Over production - Producing more than is needed immediately
Waiting - Work waiting to be processed or employees waiting for work.
Transportation- unnecessary movement does not add value
Processing - Unnecessary operations are a waste
Stock - Inventory not needed immediately
motion - motion can waste time
Defects - Defective parts or products or products not meeting customer needs

Value Added Manufacturing - All parts of process add value for the customer. There is no waste.

Fundamental Concepts of JIT
- produce what the customer wants
- Perfect quality
- Produce at the rate of demand
- Produce with minimum lead time
- No waste

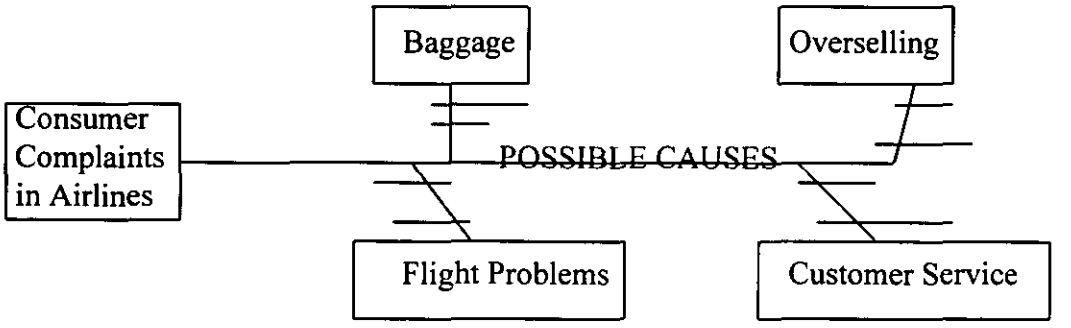
- Allow people to develop

Explain the difference between a pull system and a push system
Push System - Materials are started into production based on a schedule or plan (MRP)
Pull System - Materials are started into production based on their need at other operations

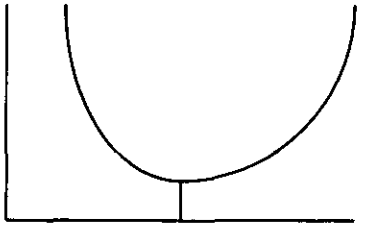
Describe how a kanban system works
kanban system - (Marker or card in Japanese) Signal for more material
EG Work Station (WS#4) needs material form WS#3, WS#4 puts card in box when inventory is getting low, this signals WS3 the need for parts, When WS#3 gets card they send inventory to WS#4.

Define the terms "visible control," "andon,""poka-yoke" and quality circle."
Visible control - Making it easy to identify problems, waste, progress, or improvements made.
Andon - lights that indicate problem
Poka-yoke -Making it impossible to produce defects (defect prevention)
EG. Manufacturing transmission in such a way that individual components can only fit together one way. (Idiot proof)
Quality circle - A group of workers who meet to discuss quality, resolve quality problem

Explain the purpose and structure of a "fishbone diagram.
Identifies the problem to be solved and possible causes. EG Consumer airlines complaint

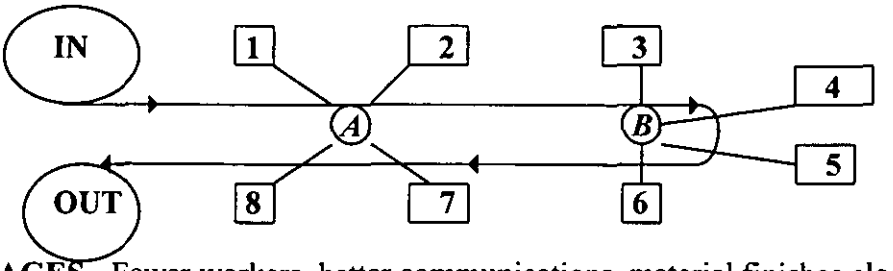


Explain the meaning of the Taguchi loss Function
Loss to society increases exponentially, once we move away from targeted specification there is an additional cost to society.



Target Specifications

Give some reasons why U-shaped manufacturing cells are desirable. A reproduction of figure 15.2 of two workers in a U-shaped manufacturing cells may help.



ADVANTAGES - Fewer workers, better communications, material finishes close to where it goes in, better material handling.

Uniform load scheduling - Produce each product in small quantities that match demand rate.

Explain why uniform load scheduling is important

- ties production to demand
- reduces inventory
- smoothes flow of materials
- levels demand for resources

List ways that JIT purchasing differs from traditional purchasing

	JIT Purchasing	Traditional Purchasing
Lot Size	small	large
# of suppliers	one for each part	several for each part
Supplier selection	Quality, delivery	Price
Inspection	None	Inspect all deliveries
Negotiation	L/T contracts	Cutting prices
Paperwork	Minimal	Formal, detailed
Packaging	Small, standard Containers, reusable	Regular Packaging

CHAPTER 16
MANAGING FOR QUALITY

List and define the categories of quality costs.

Internal failure costs (Cost incurred, poor quality)

- costs of defects discovered before delivery to customer (scrap, rework)

External failure costs (Cost incurred, poor quality)

- costs of defects discovered after delivery to the customer (service warranty, lost sales)

Prevention Costs (preventable, poor quality)

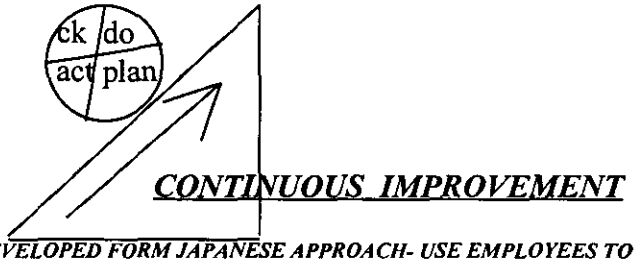
- Costs of preventing defects (training, maintenance, vendor certification)

Appraisal Costs (preventable, poor quality)

- cost of evaluating quality (inspection, testing)

List the elements of company-wide quality control (TQM)

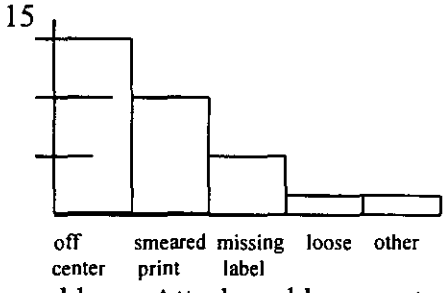
- consider quality first
- design quality into new products
- customer orientation
- customer is the next step of process
- use plan-do-check-act cycle
- EG - accounting, management, commercial customer



RESPECT PEOPLE - DEVELOPED FORM JAPANESE APPROACH- USE EMPLOYEES TO FULLEST EXTINCT

Discuss how Pareto analysis is used in problem solving.

# of defects
Bar chart main idea
of pareto chart
EG. printing



Pareto chart - identifies problem - Attack problem most common (most frequent)

Explain briefly some differences between the Deming Prize and the Baldrige Award.

Deming Prize

- Responsibility for teaching Japanese quality, at request of Japanese companies. Japanese gives Demings prize that focuses on activities over a specified period of time
- Senior management
- Florida power & light, AT&T, American co. who have won prize
- Customer satisfaction

- Employee involvement
- Training

Baldrige Award (only US firms)

- Former Secretary of commerce

Breakdown of points

- leadership (10%)
- information & analysis (7%)
- strategic quality planning (6%)
- human resource utilization (15%)
- quality assurance of products & services (14%)
- quality results (18%)
- customer satisfaction (30%)

The Deming Prize is awarded in Japan and the Baldrige Award is given in the US. Most companies that apply for the Deming Prize win the award but few win the Baldrige Award. The Baldrige Award focuses on outcomes while the Deming Prize emphasizes activities.

Define the terms "competitive benchmarking,""employee involvement," and "leadership through quality.

Competitive Benchmarking - Comparing procedures and performance against either competitions or against companies recognized as outstanding for certain activities.

Employees Involvement - giving employees authority and responsibility for solving problems, making decision, and improving processes

Leadership through Quality - Top management must set the tone by "living quality" (if it comes down to increased costs or improvement of quality, need to go for quality)

Chapter 17
QUALITY ANALYSIS AND CONTROL

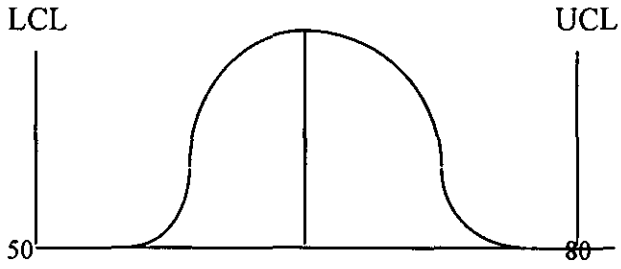
List the sources of variation in a process and define each

Statistical process control

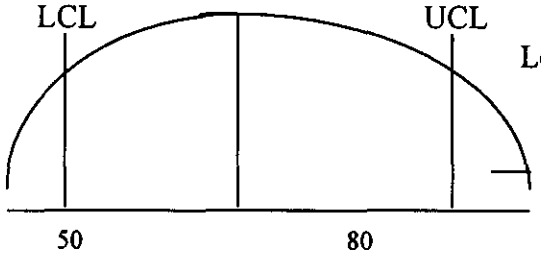
1. **Random** (Chance or common) sources or variations, sources that are difficult or expensive to control -EG (air humidity, line voltage, moisture content of material)
2. **Assignable** sources of variations - we can effectively eliminate, but we have to be able to identify - sources we can **Identify & Control** - EG (tool wear, employee error, different material)

Statistical Process Control Illustration of rubber seals.

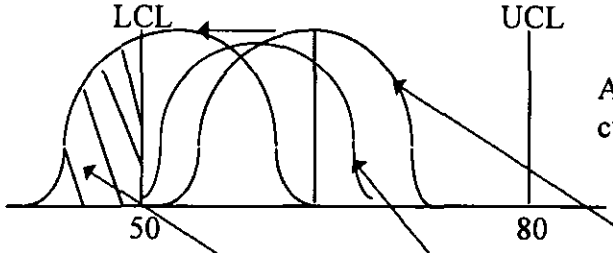
- identify when assignable sources of variations are influencing a process, fig 17.1, measure of hardness of rubber seals
- lower specifications 50, lower that 50 is defective (LCL)
- upper limit is 80, higher than 80 is defective (UCL)



High Process Capacity (Random)



Low process capability (Random)



Assignable variation of variations cause curve to shift Defective Units

Need way to detect variations. Is it due to random or assignable variations? Set control limits - based on random variations. Set upper & lower control limits, 3 standard deviations from mean. What is SD for process? 99.7%, should be within range if effected by random variation. Shift falls outside control limits, ideally we would detect shift before defective units are produced. By detecting shift early we can make adjustments before defective units are produced.

Discuss what is meant by process capability

1st step toward control is to document the process's capability - its performance under chronic conditions in which sporadic variations do not exist.

2nd step begins with sampling, the process of selecting and measuring representative units of outputs called sample units.

3rd step define the processes natural limit. Three standard deviations above and below the average of sample unit measurements. Random limitations

4th step define the specification limit (SL) Upper (USL) and lower(LSL) boundaries defining the limits of variation in a product characteristic such that the product is fit for use; output measuring outside these limits is unacceptable. Assignable variations.

Lets begin by defining some basic concepts needed in Statistical Process Control.

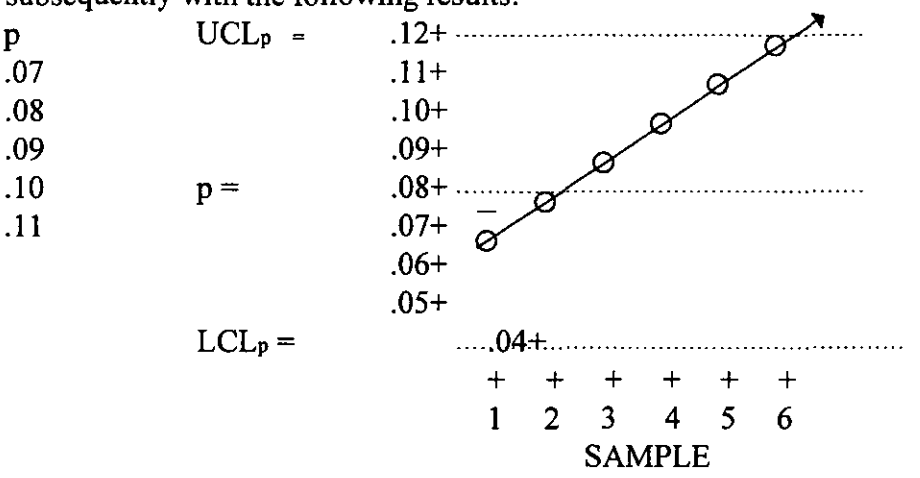
Statistical process control (SPC) - The use of sample statistics to detect and eliminate nonrandom (sporadic) variations in the conversion process.

In-control process - A process for which all variations are random; if some variations are nonrandom (sporadic), the process is termed an out-of-control process.

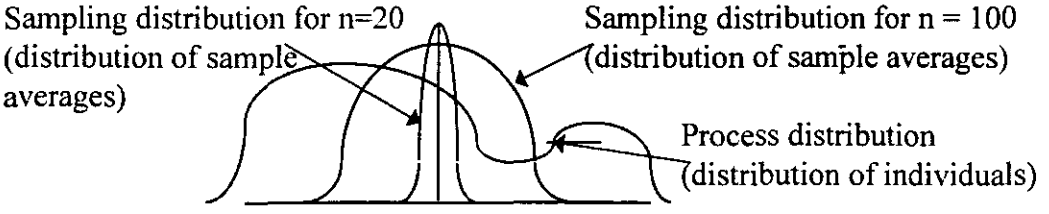
Control chart - A chart of sampling data used to make inferences about the control status of a conversion process.
Variable characteristic - A product characteristic that can be measured on a continuum.
Attribute characteristic - A product characteristic that can be measured by a rating of good or bad. Assignable variations
These definitions need not be memorized, but you probably should understand these terms in case they are used in a problem on your exam.
X-chart - A control chart using sample averages.
P chart - A control chart using sample fractions defective.
To get a better understanding, lets try a sample question on test # 5.

20. The p chart shown below was developed while a process was in control and uses control limits that are three standard deviations from the mean. Five samples have been taken subsequently with the following results:

Sample	p
1	.07
2	.08
3	.09
4	.10
5	.11



Based on this information, should the process be checked for possible assignable causes of variation?
Answer: Yes, because non-random behavior is indicated by the arrow. On your test you will have to plot samples to determine the behavior.
Page 648 in your text has an informative illustration on how to decide what is normal behavior and what is not. I would suggest that you glance at illustration for a better understanding of control chart behavior.
Central limit theorem - A statistical hypothesis that the sampling distribution approaches normality as the size of the samples increases, regardless of the distribution of the measurements of individual sample units.



Explain the differences between specification limits and control limits.
Specification limits (SL) - upper and lower boundaries defining the limits of variation in a product characteristic such that the product **is fit for use**; output measuring outside these limits is unacceptable.

Control limits (CL) - upper and lower boundaries defining the range of variation in a product characteristic such that the conversion process **is in control**.

A product may be fit for use but not be in control, that is, even though the output is within the acceptable limits, closer examination would indicate a tendency of unacceptable limits in the near future.

Alas, this Chapter is not without it's formulas. I could confuse those who are confused further with my own understanding of the formulas by restating the text. Let me suggest that you attend the lectures and read your text first. DR. White will give you the bulk of the formulas you will need for the test. Whatever formulas you will need to memorize, he will tell you before the test. Lets work some of the problems on the sample test and I will tell you how I approached the problems when I took the exam. Please, if my approach confuses you more than it helps, don't pitch the guide in the trash. Bring your questions to DR. White and he will be more than happy to answer your questions. Remember bring your questions to DR. White not me!

21. A process is in control and 25 samples of **size n = 100** are taken. The following is calculated: $\bar{p} = .2$

Based on this, what should be the **lower control limit for a p chart**?

Remember all the important stuff is in bold on the test. If you will carefully read what the question is asking, I think you can look at the formulas provided and make an educated guess at which formula is applicable. The question asks for the **lower control limit for a p chart**. Look at sample test included in the study guide to have an idea of how the formulas will be given on the test. $\mathbf{LCL_p} = p - 3S_p$, once you have determined the correct formula to use, look back at the question to see if enough information is provided to answer the question. Without too much sole searching, I think it becomes apparent that the S_p is not given within the problem. Now look for the formula to obtain the S_p. $S_p = \sqrt{p(1-p)/n}$, now lets work the problem.

$S_p = \sqrt{p(1-p)/n} = \sqrt{.2(1-.2)/100} = .04$

$LCL_p = p - 3S_p = .2 - 3(.08) = .08$ The process seemed to work for myself and my friends last semester, more dedicated students may want to learn the formulas.

Lets try the same process for a couple more examples.

23. A company plans to use statistical process control. **Samples of size 9** are taken from the process and it is found that **$\bar{X} = 15$, $\bar{R} = 2$**

    Based on this, calculate the **Lower control limit for an X-bar chart.**

Steps I would take to answer problem.

1. What does the question ask? (Lower control limit for an X-bar chart)
2. Find applicable formula. ($LCL_{\bar{x}} = \bar{\bar{X}} - A_2\bar{R}$)
3. Is there enough information to solve the problem, if so solve that problem, if not find additional information or formula(s) to solve the problem. (In this case we have to use the chart on page 6 on test #5 to find the A_2 value. I will not reproduce the entire chart, but I will tell you the process I took in finding the value. 1st find the # of units in Sampling *n* that correspond to the problem. Then find the corresponding column to find the A_2 value.

Number of units in _____R Chart_____

Sampling n	A_2 for $\bar{X}$ Chart	D_3 for LCL	D_4 for UCL
9	0.34	0.18	1.82

4. Solve the problem. A_2 =.34 found by using the chart
5. $$LCL_{\bar{X}} = \bar{\bar{X}} - A_2 \bar{R} = 15 - 0.34(2) = 14.32$$

24. For the preceding problem, what is the lower control limit for an R chart.

$LCL_R = D_3 \bar{R} = (.18)\ 2 = .36$ Note that D_3 was found on same line as in problem 23 and R was given in the problem.

CHAPTER 18
THE CONVERSION PROCESS IN CHANGE

List the three areas of the conversion process that can be modified as part of the change process.

- **Technology** - robots, computers, information technology.
- **Structure (of organizations)** - downsizing, outsourcing (component parts bought from other companies), teams
- **Behavior** - management - employee relations, employee attitude

List and explain the five procedures for over coming resistance to change

1. Peer group influences, teams influence individuals
2. Group discussions
3. Employee, suggestions
4. Manager's job security, manager may resist employee involvement. Way to avoid resistance - Assure managers of job security.
5. Terminology - "Change" can be threatening use other terms.

List and explain some trends in production/operations management.

- Strategy - operations as an important part of competitive strategy
- Services - More emphasis on understanding, improving.
- International (Economy)
- Quality

MGMT 318
Test #1

Chapter 1

- List the inputs and outputs of the operations conversion process.
- Explain the concept of "value added."
- List the differences between manufacturing and service operations.
- Define operations management.
- Calculate efficiency.
- List the "competitive priorities" that form a competitive basis.
- describe how the companies in the video shown in class have implemented TQM

Suggested homework problems: 1,2.

Chapter 2

- List the steps in the forced choice model of strategic planning.
- Differentiate between strategy process and strategy content.
- Explain the relation between productivity and quality.
- Calculate labor productivity.
- Calculate total factor productivity.
- Indicate differences in competitive strategy between various global producers.
- Define the term "maquiladora."
- Explain why the competetive capabilities, technology, and international business are challenging to operations managers.
- explain how the company in the video shown in class uses operations for competitive advantage

Suggested homework problems: 1,2.

Chapter 3

- Explain why forecasting is important to operations.
- Differentiate between independent and dependent demand.
- Calculate MAD.
- Calculate bias.
- Forecast using simple average, simple moving average, or weighted moving average.
- Forecast using first-order exponential smoothing.
- Explain the effect of different smoothing coefficients.
- Given values of *a* and *b*, calculate a forecast using regression.
- select the best forecasting method based on a forecast error measure.
- given characteristics of a time series, suggest an appropriate forecasting method.
- Know what values to input and how to interpret output for the STORM statistics module.
- Know what values to input and how to interpret output for the STORM forecasting module.

Suggested homework problems: 3, 8, 20 (use STORM)

Chapter 4

- List the steps in the product development process.
- Define concurrent engineering and list its advantages.
- Define the terms product reliability, modular design, and standardization.
- Define each type of process.
- Given a set of product characteristics, use the product-process matrix to determine which type of process would probably be most appropriate.
- Define an FMS and give its characteristics.
- Define CIM and list some of its functions.
- Define CAD, robotics, and group technology.
- Use the service process matrix to define various types of services.

MGMT 318 Test #1

Name _____

I.D. # _____

Jan.

1. Operations management is:

   a. decision making involving the design, planning, and control of the processes that produce goods and services.
   b. decision making involving accounting, engineering, marketing, and strategy formulation that affect operations.
   c. decision making involving operations productivity and the reliability, durability, and manufacturability of products.
   d. decision making involving analyzing the competitive environment, appraising the organizations skills and resources, and examining the limitations of economics and technology on operations.

2. Inputs to the **transformation process** of operations include:

   a. Labor, capital, management, and material.
   b. Product design, materials planning, production planning, and product distribution.
   c. Strategic planning, marketing, engineering, and purchasing.
   d. Steel, plastics, fibers, food crops, or other raw materials.

3. Identify the organization which is NOT classified as a producer of **services**.

   a. Airline
   b. Hotel
   c. Hospital
   d. Automobile manufacturer

4. Some characteristics of **services** that differentiate them from goods (manufactured products) are:

   a. intangible, immediate consumption, high customer contact
   b. inventory, immediate consumption, options available
   c. delayed consumption, intangible, customer contact
   d. immediate consumption, options available, inventory

5. Which of the following is **NOT**a competitive priority?

   a. quality
   b. productivity
   c. flexibility
   d. innovativeness

6. According to the video shown in class, companies that have won the Malcolm Baldrige National Quality Award **define quality as**:

   a. selling a product with high cost.
   b. a point at which they can stop improving.
   c. meeting the needs of the customer.
   d. something determined only by company management.

7. An important step in developing a **strategic plan** is:

   a. short-range forecasting
   b. measuring productivity
   c. working with suppliers on product design
   d. assessing the organization's strengths and weaknesses

8. The concept of **value added** means

   a. the customer must add value to a product by paying for it
   b. machines add value to the production process because of their low cost
   c. only service operations add value for the customer
   d. outputs of a process are worth more to customers than the sum of inputs

9. A dentist has established the standard that her office should treat 40 patients per day. However, on a particular day the office treats only 30 patients. Her office's **efficiency** that day is:

   a. 133
   b. 100%
   c. 30%
   d. 75%

10. The term **maquiladora** refers to:

    a. any factory located in Mexico
    b. a factory that produces women's makeup
    c. an operation in which parts are made in the U.S. but assembled in Mexico
    d. an operation designed to use illegal Mexican labor to make products in the U.S.

11. **Computer-integrated manufacturing (CIM)** differs from a flexible manufacturing system (FMS) in that:

    a. CIM usually includes one or more FMSs as components.
    b. An FMS does not use computers at all.
    c. CIM is only one component of an FMS.
    d. CIM is concerned only with data while FMS involves production processes.

12. In the video of Allen-Bradley's computer-integrated manufacturing (CIM) system, the company emphasized all of the following to improve its competitiveness **EXCEPT**:

a. rapid turnaround of customer orders.
b. producing overseas to reduce labor costs.
c. extensive emphasis on quality control.
d. use of flexible automation to produce many product variations.

13. The following data were collected from a company's historical records

Year	Demand
1988	4,500
1989	5,000
1990	4,300
1991	5,200
1992	4,600

Based on this, a **three-year simple moving average forecast** of demand for **1993** would be:

a. 4,700
b. 4,600
c. 4,720
d. 4,500

14. Suppose a company uses exponential smoothing to forecast. If the **smoothing coefficient, α, is set to .1** this means:

a. The weight on the second most recent time period must be .2.
b. The forecast is weighted less on the current time period than on previous ones.
c. The forecast for next period will be half as much as this period's forecast.
d. Demand is increasing by 10% every time period.

15. Use **exponential smoothing** to forecast demand for **June** given the following information. Use a value of $\alpha = .2$.

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

Month	Actual Demand	Forecast
April	500	550
May	600	
June		

a. 540
b. 542
c. 550
d. 552

16. The following indicates actual sales (D) and forecasts (F) for each of five months.

Month	F_t	D_t
Jan.	100	90
Feb.	97	92
Mar.	83	93
Apr.	106	91
May	99	94

Use the preceding information to calculate MAD.
a. 95
b. 9.75
c. 475
d. 9

17. Referring to the preceding data, what is the forecast bias?

a. 9
b. 9.75
c. -4.75
d. 5

18. A company notices that its sales have been increasing during the past few years. The product it sells is not a seasonal product. Which forecasting method would probably be most appropriate?

a. simple moving average
b. weighted moving average
c. regression
d. exponential smoothing adjusted for seasonality

19. A company is comparing four different methods of forecasting, labelled as methods A, B, C, and D. The Mean Absolute Deviation (MAD) for each on a set of test data are shown below.

Method	MAD
A	4,238
B	1,238
C	375
D	5,642

Based on this, which forecasting method gives the best forecasts?

a. A
b. B
c. C
d. D

20. Suppose a company wants to forecast using regression analysis in the STORM statistics module. The company has four years of monthly data for actual demand. What should be entered as the value for "Maximal number of cases for any variable"?

a. 4
b. 48
c. 2
d. 12

21. The STORM Forecasting module provided the following output. Based on the error measures, which model gives the best forecasts?

MODEL FITTING / VALIDATION ERROR STATISTICS FOR SERIES 1

Statistic	Level Model	Trend Model	Seasonal Model	Trend-Seas Model
Model Fitting Error Statistics for 5 periods from PERIOD 8				
Mean Err	3.2000	0.2000	4.2000	0.8000
Mean % Err	11.1010	0.8363	14.3668	2.8994
Mean Absolute Err	3.2000	1.0000	5.4000	1.6000
Mean Abs % Err	11.1010	3.5060	18.2378	5.4801
Root Mean Sq Err	4.4272	1.1832	6.6182	1.8974

Model selected was Trend

a. Level
b. Trend
c. Seasonal
d. Trend-Seasonal

22. **Concurrent engineering** is defined as:

a. the engineering department designing several different products at the same time.
b. the engineering department works out all design details of a product then dictates those requirements to both marketing and operations at the same time.
c. a company works out the "bugs" in a new product at the same time the product is being sold to the customers.
d. different parts of a company (engineering, marketing, operations) working together with suppliers to develop a new product.

23. The term **"reliability"** refers to:

a. The probability of a product not failing before a certain time.
b. The ability of a product to withstand hard or frequent use.
c. The ability to change products or customers easily.
d. The ease with which a product can be produced.

24. According to the service process matrix, a quasi-manufacturing service is one that has

a. low customer contact and is capital intensive
b. low customer contact and is labor intensive
c. high customer contact and is capital intensive
d. high customer contact and is labor intensive

25. A company is planning to produce a product that will compete in a high-volume market that is very price-competitive. What type of process would be most appropriate?

a. project
b. job shop
c. batch
d. continuous

Before turning in your test, please be sure:

- **your name and I.D. # are on both the questions and answer sheet**
- **you have indicated the version of your test (jan., feb., etc.) in the "BIRTH DATE" column on your answer sheet**

MGMT 318
Test #2

You should be able to:

Chapter 5

- explain why capacity is important
- indicate some possible capacity measures for manufacturing and services
- list some short-term and long-term strategies for modifying capacity

Chapter 6

- recognize the factors that should be considered in location decisions
- use breakeven analysis to calculate volume required to produce a profit
- compare two sites based on qualitative factors
- use the simple median model to determine facility location
- set up a transportation problem in the table format
- input a transportation problem to the STORM program
- interpret the output from the STORM transportation module

Suggested homework problems: #4, 6, 9 (use STORM)

Chapter 7

- briefly describe each of the layout types
- explain how the load-distance model is used for a process layout
- calculate cycle time given a desired production rate
- determine the theoretical minimum number of work stations required given cycle times and task times
- use the longest operation time (LOT) rule to balance an assembly line
- calculate efficiency (balance delay) for an assembly line
- briefly describe a cellular layout and list its advantages
- input information to the STORM layout module
- interpret output from the STORM layout module
- input information to the STORM assembly line balancing module
- interpret the output from the STORM assembly line balancing module

Suggested homework problems: #5 (use STORM), 10, 17(use STORM)

Chapter 8

- briefly explain the purpose of each chart used in methods analysis
- list the principles of motion economy
- define job specialization, job enlargement, and job enrichment
- list the uses of standards
- given total time, number of cycles, rating factor, and allowance, calculate normal time and standard time for an activity
- explain the use of predetermined time studies
- describe when work sampling is most appropriately used

Suggested homework problem: #3

MGMT 318/BA 420 – Test #2

Name _____

I.D. # _____

Jan.

1. Which of the following **IS NOT** a reason why a company's capacity is important?

   a. it affects the cost efficiency of operations.
   b. it requires an investment.
   c. it is always measured the same way for different companies
   d. it indicates ability to meet demand in a timely manner

2. Which of the following is a possible capacity measure **based on output?**

   a. Number of seats in a classroom.
   b. Tons of steel produced.
   c. Number of employees.
   d. Hours of machine time available.

3. Which of the following **IS** a long-term strategy for modifying capacity?

   a. subcontracting.
   b. use of overtime.
   c. discontinuing maintenance.
   d. building a new facility.

4. Which of the following includes **only cost** factors that should be considered in facility location decisions.

   a. workforce quality, labor skills, utilities
   b. construction, equipment, taxes
   c. community receptivity, operating, equipment
   d. labor skills, quality of life, utilities

5. An office-supply store is considering a new location. The store has three major customers that are located as shown below. Use the **simple median model** to determine where the new store should be. Cost per load is the same for all three customers.

Customer	Coordinates (x,y)	Loads per week
A	(20,10)	5
B	(10,30)	3
C	(30,20)	3

   a. (20,20)
   b. (10,20)
   c. (20,10)
   d. (15,20)

6. Two different locations are being evaluated using qualitative criteria. Based on the following information, which site should be selected to **maximize value and what is that value?**

		Location Ratings	
Factor	Factor Rating	Minneapolis	Miami
Climate	50	3	8
Educational facilities	80	9	4
Labor availability	60	7	6
Quality of life	40	8	3
Research facilities	50	7	5
Banking facilities	60	4	8

a. Minneapolis; 38
b. Miami; 34
c. Minneapolis; 2200
d. Miami; 1930

7. A company is planning to manufacture a product that has a **revenue of $20 per unit and variable cost of $12 per unit. Annual fixed costs are $48,000 per year. How many units must be produced per year** to break even?

a. 6,000
b. 10,000
c. 12,000
d. 15,000

8. Each **row in the table format** of a transportation problem corresponds to:

a. A destination to which material is shipped.
b. The cost of shipping from a source to a destination.
c. The demand at each destination.
d. A source from which material may be shipped.

9. A company has **four factories that ship to five warehouses.** To set this up as a transportation problem and use the STORM Transportation Module to solve it, what value should be entered for **"Number of Columns"?**

a. 3
b. 4
c. 5
d. 8

10. The following output was obtained from the STORM Transportation Module:

TRANSPORTATION - OPTIMAL SOLUTION - SUMMARY REPORT

Cell		Unit	Cell	
Row	Column	Amount	Cost	Cost
REFINERY 1	TERMINAL 1	5	2.0000	10.0000
REFINERY 1	TERMINAL 2	45	2.8000	126.0000
REFINERY 1 Subtotal = 136.0000				
REFINERY 2	TERMINAL 1	20	3.0000	60.0000
REFINERY 2	TERMINAL 3	10	4.2000	42.0000
REFINERY 2	Dummy	20	0.0000	0.0000
REFINERY 2 Subtotal = 102.0000				
Total Cost = 238.0000				

Based on this, how many units are to be shipped from **Refinery 2 to Terminal 3**?

a. 0
b. 5
c. 10
d. 42

11. Which of the following **IS NOT** a characteristic of a **product layout**?

a. standard product.
b. high volume production.
c. same sequence of operations for each unit.
d. each order may require a unique sequence of operations.

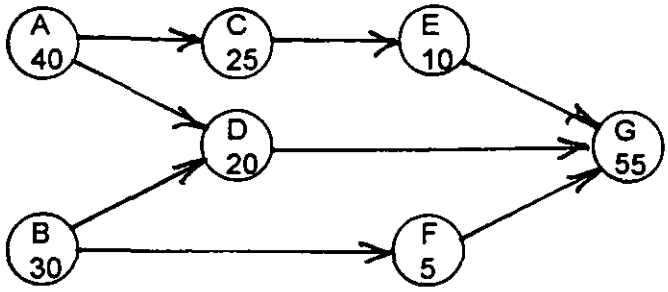
12. For a **process layout**, different possible layouts are evaluated by:

a. the balance delay.
b. the dominant flow pattern.
c. the work stations required to balance task times given cycle time.
d. the cost of transporting materials between departments.

13. The desired production rate for an assembly line is 120 units per hour. What would be the **cycle time**?

a. 30 seconds per unit
b. 40 seconds per unit
c. .0083 minutes per unit
d. 2 minutes per unit

The precedence diagram below applies to problems **14, 15 and 16.**



14. Using the **longest operation time (LOT) rule**, which tasks would be assigned to **work station number 2** if **cycle time is 60?**

a. A, D
b. B, C, F
c. B, C
d. A

15. What is the **theoretical minimum number of work stations** for the precedence diagram above if **cycle time is 60?**

a. 2
b. 2.5
c. 4
d. 3

16. For the precedence diagram above, the **Maximal Number of Predecessors** value input to the **STORM Assembly Line Balancing Module** should be:

a. 7
b. 4
c. 2
d. 3

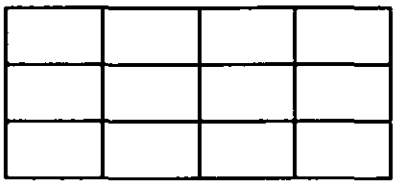
17. Which of the following is an **advantage** of a **cellular layout?**

a. higher volume than an assembly line.
b. greater flexibility than a job shop.
c. reduced material handling.
d. use of more employees.

18. **Job specialization** involves:

a. giving a person only one specific job to perform.
b. giving a person more autonomy and responsibility.
c. moving a person from one job to another.
d. Enriching a person by paying him or her more money for the same work.

19. The following diagram shows the departments that are being arranged for a **process layout**. Using the STORM Facility Layout module, what value would be entered for "Number of depts down"?



a. 2
b. 3
c. 4
d. 12

20. The following output was generated by the STORM Assembly Line Balancing Module.

Assembly Line Balancing Problem
OPTIMAL SOLUTION
Cycle Time = 60.0000

Work Station	Number of Operators	Tasks Assigned	Task Time	Idle Time	% Idle
1	1	A	20.0000	0.0000	0.00
		B	30.0000		
		C	10.0000		
		Total Time:	60.0000		
2	1	D	15.0000	10.0000	16.67
		E	35.0000		
		Total Time:	50.0000		
3	1	F	20.0000	0.0000	0.00
		G	15.0000		
		H	25.0000		
		Total Time:	60.0000		

According to this, **which tasks are assigned to work station #2?**

a. A, B, and C
b. D and E
c. F, G, and H
d. no tasks

21. The **Operator-Machine chart** is used primarily to:

    a. identify idle time for machines or workers.
    b. analyze the movements of a worker.
    c. indicate how an employee's hands are used in doing a job.
    d. indicate percentage of time spent on different activities.

22. A stopwatch time study is done of a certain task. The average **cycle time is .50 minutes, rating factor is 120%**, and **the allowance fraction is 20%**. The **standard time** for this task (accurate to two decimal places) should be:

    a. .50 minutes
    b. .60 minutes
    c. .70 minutes
    d. .75 minutes

23. For which of the following jobs would **work sampling be <u>most</u> appropriate?**

    a. An assembly line worker
    b. A secretary
    c. A grocery store checkout clerk
    d. A telephone information operator

24. Which of the following **IS NOT** a principle of motion economy?

    a. Use only one hand at a time.
    b. The body's full capabilities should be used.
    c. Arrange the workplace to assist performance.
    d. Use mechanical devices to reduce effort.

25. A company has a set of tasks that must be completed to assemble a product. The **total time for these tasks is 96 minutes**. The **cycle time is 3 minutes** and the company has found that **40 work stations** are required to balance the line. What is the **efficiency (or utilization)** for this assembly line?

    a. 95%
    b. 90%
    c. 85%
    d. 80%

MGMT 318 – STUDY GUIDE -- TEST #3

You should be able to:

Chapter 9

- Explain a Gantt chart.
- Given three time estimates, calculate expected activity time.
- Explain the purpose of a dummy activity in a PERT diagram.
- Calculate the earliest and latest times for an event.
- Calculate slack time for each event.
- Identify the critical path of a project.
- Use time/cost tradeoffs to reduce completion time for a project.
- input information to the STORM project management module
- interpret output from the STORM project management module

Suggested homework problems: #4, 9, 16 (use STORM)

Chapter 10

- Explain the purpose of aggregate planning.
- Given a company's competitive strategy, indicate which pure strategy of aggregate planning would be most appropriate.
- Explain what is indicated in the graphical method of aggregate planning.
- Given an aggregate plan, calculate the costs of payroll, hiring and layoff, overtime, subcontracting, inventory, and total cost.
- Explain the differences and relationships between the aggregate plan and the master production schedule.
- Explain the purpose of rough-cut capacity planning.
- Calculate rough-cut capacity requirements for a given master schedule.
- Explain what values should be entered when using the STORM production scheduling module for aggregate planning.
- Interpret the output from the STORM production scheduling module for aggregate planning.

Suggested homework problems: #8 (by hand and use STORM), #16

Chapter 11

- Define the terms loading, routing, sequencing, detailed scheduling, and expediting.
- Explain how the Gantt Load Chart is used.
- Define infinite loading and finite loading.
- Use the priority sequencing rules to schedule a set of jobs.
- Schedule jobs on two work centers to minimize last-job flow time.
- Define forward and backward scheduling.
- Calculate actual backlog for an input-output report.

Suggested homework problems: #7, 8, 10

Name_____

Jan . I.D. # _____

1. In **graphical aggregate planning**, if the **cumulative demand line is above the cumulative production line**, this indicates:

   a. Inventory will be available
   b. Subcontracting has been used
   c. Overtime has been used
   (d.) There will be a shortage of product available

2. The following is part of the output from the STORM Project Management module.

Activity Name	Symb	Mean Time /Std Dev	Earliest Start/Fin	Latest Start/Fin	Slack
ACT 2	STDY	6.0000 0.1333	0.0000 6.0000	0.0000 6.0000	0.0000 c

   The information indicates that this activity:

   a. is probably the last activity of the project
   b. is not on the critical path
   c. has slack of .1333
   (d.) is on the critical path

3. Four jobs are waiting to be processed **on two machines**. All jobs must go through machine A first then machine B. Use **Johnson's Rule** to sequence the four jobs so that last-job flow time is minimized.

	Processing Times	
Job	Machine A	Machine B
W	5 hours	3 hours
X	3	2
Y	1	3
Z	4	4

   (a.) YZWX
   b. ZWXY
   c. ZXYW
   d. YXWZ

4. It has been estimated an activity in a project might be completed in as **little as 1 day** or as **long as 9 days**. However, **most often the activity takes 2 days**. What is the **expected (mean) time** for this activity?

   a. 2 days
   (b.) 3 days
   c. 4 days
   d. 5 days

5. The primary purpose of a **Gantt Load Chart** is to show:

   a. The production schedule for a given job.
   b. The work load at a work center
   c. The amount of time a job has to wait for moving and queuing
   d. The time it will take to complete a particular job.

6. The **purpose of aggregate planning** is to:

   a. determine approximate work-force levels, overtime production, inventory, etc. needed to meet monthly demand for a product group.
   b. determine accurate work-force levels, overtime production, inventory, etc. needed to meet weekly demand for a particular product.
   c. determine planned order releases for component parts that are needed to meet the master production schedule.
   d. determine whether the master production schedule is doable.

7. The term **loading** refers to:

   a. Assigning specific jobs to each work center for the planning period.
   b. Determining the sequence of processing for all jobs at each workplace.
   c. Establishing start and finish times of all jobs at each work center.
   d. Deviating from plans; taking special actions for special conditions.

8. A company uses a **low-skilled workforce** to make a product that has **seasonal variations in demand**. New employees are readily available and the company's objective is to keep costs low. Storage costs are quite expensive. Which **pure strategy of aggregate planning** would most likely be used?

   a. they could not use a pure strategy.
   b. vary workforce size by hiring and layoffs.
   c. use inventory to absorb demand fluctuations.
   d. use overtime and subcontracting to meet peak demand.

9. In scheduling with **infinite loading**, we

   a. Always start from job due date and work backward.
   b. Do not consider machine or work center capacity.
   c. Always start from the present and work forward.
   d. Avoid exceeding machine or work center capacity.

10. **Backward scheduling**

    a. must always be used with finite loading.
    b. is used to balance an assembly line.
    c. schedules jobs by starting from their due dates.
    d. schedules jobs by starting from the present time.

11. Suppose you are going to use the **STORM software for aggregate planning** for a company that **uses either regular time or subcontracting. At the beginning of the planning horizon, 1000 units are in inventory.** In the STORM module, the value you should enter for "Number of Methods " is:

a. 1
(b) 2
c. 3
d. 4

12. The master production schedule calls for production of **1000 units of product X** in a given week. **If 2.5 standard hours** are required per unit and **drill department time has historically been 30% of the total time**, use **rough-cut capacity planning** to determine how many hours of capacity will be required in the drill department to meet this master schedule?

a. 2500
b. 1000
(c.) 750
d. 250

13. Output from the STORM Production Scheduling Module is shown below.

THE CHARLESVILLE FURNITURE COMPANY CASE
PRODUCT REPORT

	PERIOD 1	PERIOD 2	PERIOD 3	PERIOD 4
Beg Inventory	23.00	48.00	48.00	48.00
Production				
REGULAR	105.00	93.00	89.00	97.00
OVERTIME	0.00	0.00	0.00	0.00
Demand	80.00	93.00	89.00	97.00
End Inventory	48.00	48.00	48.00	48.00
Lost Sales	0.00	0.00	0.00	0.00

Based on this, how much did inventory **increase** from the beginning of period 1 to the end of that same period?

a. 23
(b.) 25
c. 2
d. 103

14. The relationship between the **aggregate plan and the master schedule** is:

a. There is no relationship between the two.
(b.) The master schedule is developed from the aggregate plan.
c. The aggregate plan is developed after the master schedule.
d. The aggregate plan is for individual products but the master schedule is for product groups.

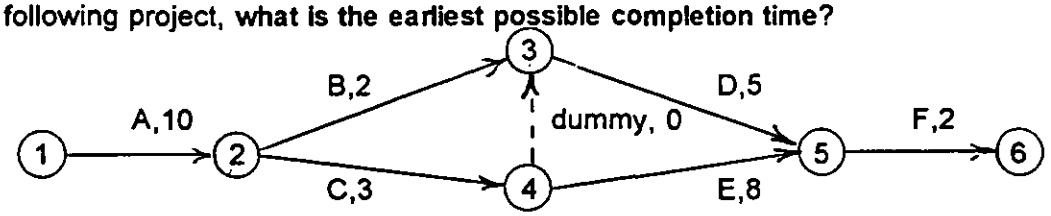
15. Four jobs are awaiting their last processing step. Information about those jobs is given below.

Job	Processing Time (days)	Days Until Due
A	2	10
B	3	12
C	1	3
D	4	8

If the **least slack rule** is used, what should be the sequence of jobs?

a. DCBA
b. CABD
c. CDAB
d. DBAC

16. For the following project, **what is the earliest possible completion time?**



a. 19
b. 20
c. 23
d. 30

17. Suppose the preceding project has a **desired completion time of 27.** What is the **slack for event (node) 4?**

a. -3
b. 4
c. 7
d. 8

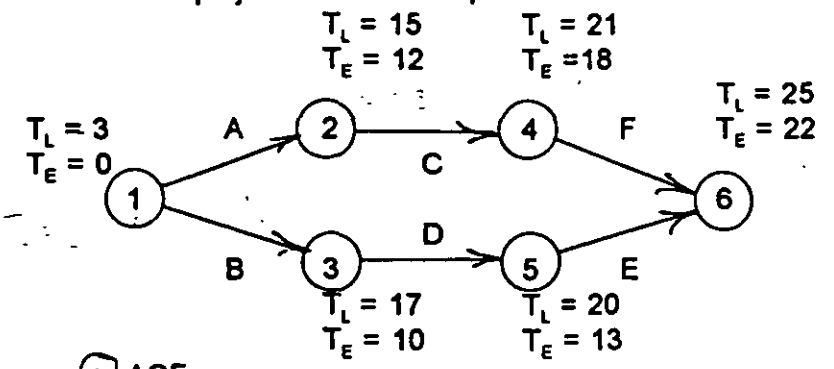
18. Suppose the STORM Project Management module is to be used for the project shown above in problem 16. What should be entered as the **Start node** and **End node** for Activity C?

	Start Node	End Node
a.	2	4
b.	A	E
c.	3	3
d.	C	C

19. Rough-cut capacity planning is used to:

a. test whether capacity is adequate for the aggregate plan.
b. test whether capacity is adequate for the master production schedule.
c. plan how much overtime will be scheduled each month.
d. plan the building of a new facility.

20. For the project shown below, what activities are on the critical path?



a. ACF
b. none
c. ABCDEF
d. BDE

21. A project has the activities listed below. Those in ***bold italic*** type are on the critical path. The expected time, crash time, and cost to expedite are indicated.

Activity	Expected Time	Crash Time	Cost to Expedite ($/day)
A	5	3	$20
B	***10***	***9***	***100***
C	***5***	***4***	***120***
D	15	12	75
E	***9***	***8***	***50***

If the project completion time must be reduced by one day, which activity should be shortened?

a. A
b. B
c. D
d. E

22. The purpose of a dummy activity in a PERT diagram is:

a. to use up slack time.
b. to indicate an activity that is not needed.
c. to indicate precedence.
d. to make scheduling easier.

23. The term **expediting** refers to:

a. Assigning specific jobs to each work center for the planning period.
b. Determining the sequence of processing for all jobs at each workplace.
c. Establishing start and finish times of all jobs at each work center.
(d.) Deviating from plans; taking special actions for special conditions.

24. Part of a company's **aggregate plan** is shown below.

Month	Demand Forecast	Planned Production	Beginning Inventory	Ending Inventory
Jan.	10,000	8,000	2,000	
Feb.	6,000	8,000		
Mar.	12,000	10,000		

If it costs **$1.50 per unit per month** to store inventory, what is the **total inventory carrying cost** for the months shown?

a. $9,000
(b.) 4,500
c. 3,000
d. 0

25. The following input-output report was produced. Based on this, what should **actual backlog be for week 4?**

Week	1	2	3	4
Planned Input	400	350	300	390
Actual Input	420	320	320	350
Cumulative Deviation	20	-10	10	-30

Week	1	2	3	4
Planned Output	400	340	290	380
Actual Output	410	350	270	350
Cumulative Deviation	10	0	-20	-50

Actual Backlog (Hours)	50	60	30	80	

a. 30
b. 60
(c.) 80
d. 90

MGMT 318 – STUDY GUIDE -- TEST #4

You should be able to:

Chapter 12

- Explain the difference between independent and dependent demand.
- List the uses of inventory.
- Explain the differences between Q/R and periodic inventory systems.
- Know how to calculate EOQ.
- Compute the total annual cost.
- Know how to calculate optimum order quantity with gradual replacement.
- Determine the reorder point .

You will be given the formulas for Q* and R*. However, you should know all other formulas including the total cost formula.

Homework: #10, 11

Chapter 13

- Determine order quantity under quantity discounts.
- Determine the reorder point with variable demand.
- Classify items using ABC analysis.

You will be given the EOQ and reorder point formulas and a normal distribution table. However, you should know all other formulas.

Homework: #6, 8

Chapter 14

- List the components of an MRP system.
- Explain the relationship between the aggregate plan and the master production schedule.
- Given a master schedule and product structure, calculate planned order releases for an item at any level.
- Combine requirements from several sources in determining gross requirements.
- Define the terms pegging, cycle counting, updating, and time fence.
- Calculate capacity requirements from planned order releases and standard times.
- Explain how MRP II differs from MRP.
- Describe what values must be input to the STORM MRP module.
- Interpret output from the STORM MRP module.

Homework: #18 (manually and using STORM)

Name _____

I.D. # _____

Jan.

1. A company makes toy automobiles. Each toy automobile requires **4 wheels** that are assembled directly onto the automobile. Based on the following information, how many units would be in the planned order release of **wheels for week 2**? Use lot-for-lot ordering with a **lead time of 1 week.**

Master Schedule - Toy Automobiles

Week	1	2	3	4	5	6
	50	60	75	50	60	75

Wheels - **(4 per automobile)**

Week	1	2	3	4	5	6
Gross Requirements						
Scheduled Receipts	300					
Available for next period (50)						
Net Requirements						
Planned Receipts						
Planned order releases						

a. 150
b. 200
c. 250
(d.) 300

2. An inventory item is a **dependent demand** item if:

a. Its demand depends on customer orders.
b. It is a finished product sold directly to consumers.
(c.) Its demand depends on the production schedule for another item.
d. Its level of inventory depends on amount of customer demand

3. Which of the following **IS NOT** a use of inventory?

a. Buffer against uncertainty
(b.) Allow for large variations in production
c. Decouple different processes
d. Allow for smooth production

4. Each **end product A** requires **one unit of assembly B**. Each **assembly B** requires **two units of part C**. The master schedule for end product A and the MRP for assembly B are shown below.

	Week		1	2	3	4	5
Product A:	Master Schedule		100	120	150	120	130
Assembly B (1 per A) :	Gross Requirements		100	120	150	120	130
	Scheduled Receipts		300				
	Available for next period	30	230	110	0	0	0
	Net Requirements				40	120	130
	Planned Receipts				40	120	130
	Planned order Releases		40	120	130		

Use this information to determine **planned order releases for part C in week 1** using the information provided below. **Lead time for Part C is 1 week. Use lot-for-lot ordering.**

Part C (2 per B):	Gross Requirements		80	240			
	Scheduled Receipts		300				
	Available for next period	30	220	10			
	Net Requirements						
	Planned Receipts						
	Planned order Releases						

(a) 0
b. 110
c. 250
d. 300

5. A material is ordered from a supplier. The **demand during the reorder lead time averages 60 units per day** with **standard deviation of 10 units per day.** If the company wants a **service rate of at least 98.5%**, what should be the **reorder point with safety stock** for this material if **lead time is 4 days?**

a. 240
b. 262
c. 275
(d.) 284

6. MRP II **differs** from MRP in that

a. only MRP is concerned with requirements for parts
b. MRP II includes requirements for other resources
c. MRP II is just a computerized version of MRP
d. MRP does not consider requirements for parts or raw materials

7. In a **periodic inventory system**, the inventory level is:

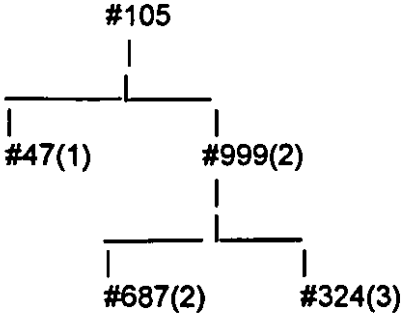
a. Checked only periodically.
b. Continuously monitored.
c. Held constant.
d. Always close to zero.

8. The **planned order releases for part X** are shown below. Also, information from the **routing sheet** and **labor standards** is given. How many standard hours will be required for **the lathe in week 2?**

			Week 1	2	3	4
Part Z:	Planned Order Releases		200	150	300	200
		Operation	Lead Time	Setup		Run
	Routing:	#1 Drill	1 week	.2 hr.		.1 hr./unit
		#2 Lathe	1 week	.5 hr.		.3 hr./unit
		#3 Grind	1 week	.1 hr.		.05 hr./unit

a. 10.1 hrs.
b. 45.5 hrs.
c. 60.5 hrs.
d. 90.5 hrs.

9. The following product structure tree diagram shows the subassemblies and component parts that are used in making product #105. Numbers in parentheses indicate the number of each part required. Based on this, input to the **STORM Bill of Materials File for Subassembly #999** should be:



	ITEM ID	ITEM TYPE	DESC 1	Q/ASSY 1	DESC 2	Q/ASSY2
a.	999	MAT	105	2		
b.	999	MAT	47	1	999	2
c.	999	MAT	999	2		
d.	999	MAT	687	2	324	3

10. Output from the **STORM MRP Module** is shown below.

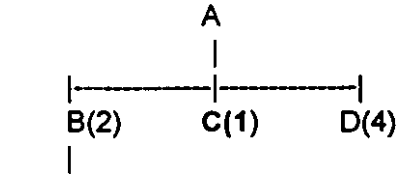
EXPLOSION REPORT

Planning Period	Gross Reqts	Sched'd Receipts	Projected On hand	--- Planned Orders --- Lot for Lot	Lot sized
C 3 Level 2 LT = 2 Lot size FQ					
Annual demand = 0		Scrap % = 0.00			
Order/Setup Cost = 0.00		Total order/setup cost = 0.00			Unit Value = 0.00
Total carrying cost = 0.00					
Safety stock = 0		Fixed Quantity = 1000			
	GR	SR	OH	LFL	PO
PAST DUE	0		1000		
WEEK 1	250	0	750	0	0
WEEK 2	275	0	475	50	1000
WEEK 3	195	0	280	385	0
WEEK 4	330	0	950	240	0
WEEK 5	385	0	565	0	0
WEEK 6	240	0	325	0	0

Based on this information, how many units will be **ordered in Week 2?**

a. 50
b. 475
c. 0
(d.) 1000

11. Given the master schedule for part A, the planned order releases for part B, and the product structure tree, what is the **Gross Requirements** for **part C in week 4?**



Master Schedule (A):

week :	1	2	3	4
quantity:	100	100	125	300

Planned Order Releases (B):

week :	1	2	3	4
quantity:	50	50	50	50

a. 100
b. 250
c. 300
(d.) 450

12. Which of the following is an **independent demand** inventory item?

a. a component part used in an assembled product.
b. a raw material used to make a component part.
(c.) a finished product sold to consumers.
d. a component part purchased from a supplier.

13. A retailer stocks a certain product that is sold at the rate of **10,000 units per year**. Each replenishment **order from the outside supplier costs $50**. The price is **$40 per unit and inventory carrying cost per year is 10% of unit price**, how many units should be **ordered each time to minimize total annual cost?**

    a. 100
    b. 250
    c. 500
    d. 1000

14. **Referring to the preceding problem**, suppose the supplier requires that orders be placed for **2,000 units at a time**. What would be the **total annual variable cost of ordering and carrying inventory?**

    a. $ 2,000
    b. $ 2,500
    c. $ 4,250
    d. $ 8,000

15. Which of the following is a **component of an MRP system?**

    a. The aggregate plan.
    b. Economic order quantity.
    c. Forward scheduling.
    d. Bill of materials file.

16. Suppose a company finds that scheduled receipt of a certain component part will be delayed. If the company wants to find **which customer orders will be affected by this delay**, its MRP system should have:

    a. cycle counting
    b. updating
    c. pegging
    d. backward scheduling

17. A company that uses MRP **counts its inventory at regular intervals** to verify that its inventory status file has the correct amount for each item. This is called:

    a. pegging.
    b. cycle counting.
    c. a Q/R inventory system.
    d. safety stock.

18. In MRP a **time fence** is:

    a. a time within which no changes can be made in the master schedule.
    b. the time period represented by each block of the MRP table.
    c. the time between when an order is placed and it is received.
    d. the length of time for which planning is done.

19. Which of the following is used in MRP to **generate all gross requirements of level 1 items?**

a. The aggregate plan.
b. The capacity requirements plan.
c. Rough-cut capacity planning.
d. The master production schedule.

20. A certain item is subject to **quantity discounts** as shown below:

Quantity Purchased	Price Per Unit
1 - 49	$ 2.50
50 - 999	$ 2.00
1000 or more	$ 1.80

If 1,000 units are used per year and it **costs $450 to place an order** due to high shipping costs, how many should be ordered at a time to minimize variable costs if **carrying cost per unit per year is 50% of unit value?**

a. 1000
b. 500
c. 100
d. 50

21. A particular item is used at the rate of **10 units per day** and the reorder **lead time is 8 days.** What should the **reorder point** be with **no safety stock?**

a. 8
b. 10
c. 18
d. 80

22. A company has 100 inventory items with **total annual dollar usage of $3,000,000.** Which of the following is most likely a **C inventory item based on ABC analysis?**

	Part #	Annual $ Usage
a.	1078	$500,000
b.	2365	$250,000
c.	1287	$52,000
d.	7864	$1,000

23. The term **updating** in MRP refers to:

a. performing MRP calculations to reflect the impact of changes.
b. obtaining the latest copy of MRP computer software.
c. moving from MRP to MRP II.
d. tying a particular customer order to each planned order release.

24. A company manufactures repair parts. These parts are **used at the rate of 5000 units per year.** It costs **$100 every time more are produced.** The cost of holding these parts in **inventory is 20% of unit price, which is $25 per unit.** The parts can be **produced at the rate of 6250 per year.** How many units should be produced at a time to minimize total annual cost?

a. 500
b. 1000
c. 1500
d. 2000

25. A particular part **must be ordered in multiples of 1000 units.** In the **STORM MRP module,** the **Item Master File** would have which of the following?

	ITEM ID	CLASS	LOT SIZE	MULTIPLE
a.	3		FQ	1
b.	3		1000	FQ
c.	3		FQ	1000
d.	3		LFL	1000

FORMULAS

$$Q^* = \sqrt{\frac{2DS}{IC}} \qquad Q^* = \sqrt{\frac{2DS}{IC}\left(\frac{P}{P-D}\right)} \qquad R^* = L\,d_L$$

$$R^* = \bar{d}\,L + z\,\sigma_\mu \qquad \sigma_\mu = \sqrt{L}\,\sigma_l$$

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2517	.2549
0.7	.2580	.2611	.2642	.2673	.2703	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4515	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4864	.4868	.4871	.4875	.4878	.4881	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	.4904	.4906	.4909	.4911	.4913	.4916
2.4	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	.4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.4960	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	.4981
2.9	.4981	.4982	.4982	.4983	.4984	.4984	.4985	.4985	.4986	.4986
3.0	.4987	.4987	.4987	.4988	.4988	.4989	.4989	.4989	.4990	.4990

MGMT 318 – Study Guide, Test #5

Chapter 15

- list and define the seven wastes.
- define "value-added manufacturing."
- explain the fundamental concepts of JIT
- explain the difference between a pull system and a push system
- describe how a kanban system works
- define the terms "visible control," "andon," poka-yoke," and "quality circle."
- explain the purpose and structure of a "fishbone" diagram.
- explain the meaning of the Taguchi Loss Function.
- give some reasons why U-shaped manufacturing cells are desirable.
- explain why uniform load scheduling is important.
- list ways that JIT purchasing differs from traditional purchasing.

Chapter 16

- list and define the categories of quality costs.
- list the elements of company-wide quality control (TQM).
- discuss how Pareto analysis is used in problem solving.
- explain briefly some differences between the Deming Prize and the Baldrige Award.
- define the terms "competitive benchmarking," "employee involvement," and "leadership through quality."
- explain how various charts were used by the company shown in the class video

Homework: #2

Chapter 17

- list the sources of variation in a process and define each.
- discuss what is meant by process capability.
- know how to calculate control limits for X-bar, R, c, and p charts.
- know how to interpret the results from a control chart.
- explain the difference between specification limits and control limits
- explain how employees at the company in the video shown in class feel about control charts

Homework: #3, 5, 7

Chapter 18

- List the three areas of the conversion process that can be modified as part of the change process.
- List and explain the five procedures for overcoming resistance to change.
- List and explain some trends in production/operations management.

Name _____

I. D. # _____

Jan.

1. Which of the following is **NOT** one of the **"seven wastes"**?

   a. Waste of processing
   b. Waste of overproduction
   c. Waste of motion
   (d.) Waste of setups

2. What is meant by the term **"value-added manufacturing"**?

   (a.) Every step of the process adds value for the customer
   b. Only manufacturing adds value, not services
   c. Any manufacturing operation always adds value
   d. An accounting method that calculates the value of manufacturing

3. Which of the following **IS a fundamental concept of JIT**?

   (a.) Perfect quality
   b. Focus on bottlenecks
   c. Carry buffer inventory
   d. Top-down planning

4. In a **push system** the movement of material is based on:

   (a.) a production plan.
   b. the production rate of the bottleneck
   c. the conveyor system that moves material
   d. the need for more material at the next operation

5. In a **kanban system**, when can a **container of parts be moved** ?

   a. Whenever a forklift truck is available.
   b. When the production schedule dictates.
   c. Only when the supervisor says it is okay.
   (d.) Only when a kanban card is attached.

6. A company wants to use statistical process control in manufacturing radios. A batch of **100 radios is tested** at the end of the radio assembly line to see **what percentage will "plug and play"** (work on the first try). Which type of process control chart would be most appropriate?

   a. X-bar
   b. R
   (c.) p
   d. c

7. The term **"poka-yoke"** refers to:

   a. lights that indicate problems in production
   b. foolproofing to prevent errors
   c. a group of employees who deal with quality issues
   d. the use of visual devices such signs or tags in production

8. Which of the following **IS** a reason why **uniform load scheduling** is important?

   a. To have sufficient inventory available.
   b. So production is tied to customer demand.
   c. To avoid having too many setups.
   d. Because there are not enough kanban cards.

9. Which category of **quality costs** would include **costs of inspecting parts** for defects?

   a. internal failure
   b. external failure
   c. prevention
   d. appraisal

10. Which of the following **IS** a reason why **U-shaped manufacturing cells** are desirable?

    a. robots can only work in a U-shaped area
    b. because a U is like a cup and can hold material without spilling
    c. better communication is possible among workers
    d. it is easier to store large inventories

11. Which of the following is **NOT a component of TQM**?

    a. meeting customer needs
    b. statistical process control
    c. employee training
    d. only quality control department responsible for quality

12. The **"fishbone" diagram** is used to

    a. Identify the most common problem
    b. Identify the cause of a problem
    c. Determine the capability of a process
    d. Calculate the Taguchi Loss Function

13. Which of the following is **most likely** to be an assignable cause of variation?

    a. changes in line voltage from a utility
    b. outside temperature changes
    c. moisture content of materials
    d. tool wear

14. Which of the following is **TRUE** about the difference between **traditional approaches to purchasing and the JIT approach?**

a. The JIT approach emphasizes cost in selecting suppliers.
b. The traditional approach was based on a partnership with suppliers.
c. The JIT approach uses inspection of every shipment to ensure quality from suppliers.
d. the traditional approach usually involved many suppliers for each part.

15. The purpose of **Pareto analysis** is to:

a. Identify the most common problem
b. Identify the cause of a problem
c. Determine the capability of a process
d. Calculate the Taguchi Loss Function

16. **Process capability** refers to:

a. the ability of a process to produce good output with high probability
b. the difference between the upper and lower specification limits
c. the difference between the upper and lower control limits
d. the relation between control limits and specification limits

17. According to the **Taguchi Loss Function,**

a. Companies lose money if quality is too high.
b. Cost to society increases exponentially as we move away from the target value.
c. Cost to society is incurred only when a dimension is outside the specification limits.
d. Only the consumer loses if quality is low.

18. Which of the following is **NOT** a difference between the **Deming Prize and the Baldrige Award?**

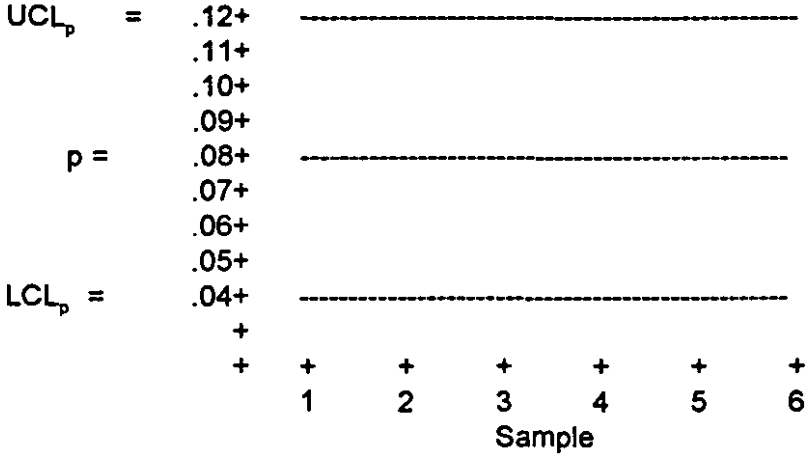
a. The Deming Prize is awarded in Japan and the Baldrige Award is given in the U.S.
b. Most companies that apply for the Deming Prize win the award but few win the Baldrige Award.
c. The Deming Prize is only for manufacturers while the Baldrige Award includes services.
d. The Baldrige Award focuses on outcomes while the Deming Prize emphasizes activities.

19. A difference between **control limits and specification limits** is that:

a. Control limits are determined by the design engineers.
b. Specification limits are always narrower than control limits.
c. Control limits are based on process variation due to random causes.
d. There is no difference; they are the same.

20. The **p chart** shown below was developed while a process was in control and uses control limits that are three standard deviations from the mean. **Five samples** have been taken subsequently with the following results:

Sample	p
1	.07
2	.08
3	.09
4	.10
5	.11



Based on this information, should the process be checked for possible assignable causes of variation?

a. No, because all points are within the control limits
b. Yes, because some points are outside the control limits
c. No, because not enough points are above the mean
(d.) Yes, because non-random behavior is indicated

21. A process is in control and 25 samples of **size n = 100** are taken. The following is calculated:

$$\bar{p} = .2$$

Based on this, what should be the **lower control limit for a p chart?**

a. 0
(b.) .08
c. .32
d. .44

22. The term **"competitive benchmarking"** refers to:

a. Using the worst competitor as a starting point for comparison of companies.
b. Comparing our company's procedures and performance against those of an outstanding company.
c. Marking each competing product with a letter for "blind" comparison testing.
d. Using the same measurement scale to evaluate different products.

23. A company plans to use statistical process control. **Samples of size 9** are taken from the process and it is found that

$$\bar{\bar{X}} = 15, \quad \bar{R} = 2$$

Based on this, calculate the **Lower control limit** for an X-bar chart.

a. 14.04
b. 15.68
c. 15.96
d. 14.32

24. For the preceding problem, what is the **Lower control limit for an R chart?**

a. 0
b. .36
c. 3.64
d. 4.00

25. Which of the following is **NOT** a procedure for **overcoming resistance to change?**

a. Peer group influences
b. Suggestions from employees
c. Terminology
d. Use of threats

FORMULAS

$$UCL_{\bar{X}} = \bar{\bar{X}} + A_2\bar{R} \qquad LCL_{\bar{X}} = \bar{\bar{X}} - A_2\bar{R} \qquad UCL_R = D_4\bar{R} \qquad LCL_R = D_3\bar{R}$$

$$S_p = \sqrt{\frac{\bar{p}(1 - \bar{p})}{n}} \qquad UCL_p = \bar{p} + 3S_p \qquad LCL_p = \bar{p} - 3S_p$$

$$S_c = \sqrt{\bar{c}} \qquad UCL_c = \bar{c} + 3S_c \qquad LCL_c = \bar{c} - 3S_c$$

TABLE 17.1 Factors A_2, D_3, and D_4 for $\bar{X}$ and R charts (for three-standard-deviation control limits)

		R Chart	
Number of Units in Sampling *n*	A_2 for $\bar{X}$ Chart	D_3 for LCL	D_4 for UCL
2	1.88	0	3.27
3	1.02	0	2.57
4	0.73	0	2.28
5	0.58	0	2.11
6	0.48	0	2.00
7	0.42	0.08	1.92
8	0.37	0.14	1.86
9	0.34	0.18	1.82
10	0.31	0.22	1.78
11	0.29	0.26	1.74
12	0.27	0.28	1.72
13	0.25	0.31	1.69
14	0.24	0.33	1.67
15	0.22	0.35	1.65
16	0.21	0.36	1.64
17	0.20	0.38	1.62
18	0.19	0.39	1.61
19	0.19	0.40	1.60
20	0.18	0.41	1.59