Manufacturing Planning and Control Systems

RZ

Chapter 2

2.4 The recipe for 6 serving of Little Nellie's Triple Chocolate Smoothie calls for 2 dashes of cinnamon, 1½ quarts of vanilla ice cream, 1 quart of chocolate ice cream, ½ quart of chocolate mile, and 1 bag of chocolate chips.

a. Nellie is planning an ice cream social for 12 people and wants to make Triple Chocolate Smoothies. How much chocolate ice cream does she need for 12 servings if her chocolate ice cream is totally gone?

b. How many quarts of vanilla ice cream must be bought if Nellie already has half a quart of vanilla on hand?

c. Nellie is planning her party for November 15. It's now November 11. The local dairy will deliver quarts of ice cream and milk if given a one-day notice. Fill in the following MRP record for chocolate mile if Nellie has ½ quart on hand and wants the rest delivered. Assume she can make the Smoothies on the day of the social.

	November				
	11	12	13	14	15
Gross requirements					
Scheduled receipts					
Projected available balance					
Planned order release					

ANSWER

a. **She needs 2 quarts of chocolate ice cream for 12 serving.**

b. **She must buy 2 ½ quarts vanilla ice cream.**

c. **See following MRP record:**

		November				
		11	12	13	14	15
Gross requirements						1
Scheduled receipts						
Projected available balance	1/2	1/2	1/2	1/2	1/2	0
Planned order release					1/2	

2.5 **Develop an MRP spreadsheet record for six periods using the following parameter for the item:**

Period	1	2	3	4	5	6
Gross requirements	20	20	20	30	30	30
Lead time	1 period					
Lot size	40 units					
Safety stock	0 units					
Inventory	2 units					
Scheduled receipt	40 units in period 1					

a. In what periods are there planned order releases?

b. What happens to the timing, number of planned order releases, and average inventory (for periods 1 through 6) if 10 units of safety stock are required?

c. What happens to the timing, number of planned order releases, and average inventory (for period 1 through 6) if a one-week safety lead time is used instead of the safety stock?

ANSWER

a.

Period		1	2	3	4	5	6
Gross requirements		20	20	20	30	30	30
Scheduled receipts		40					
Projected available balance	2	22	2	22	32	2	12
Planned order release			40	40		40	

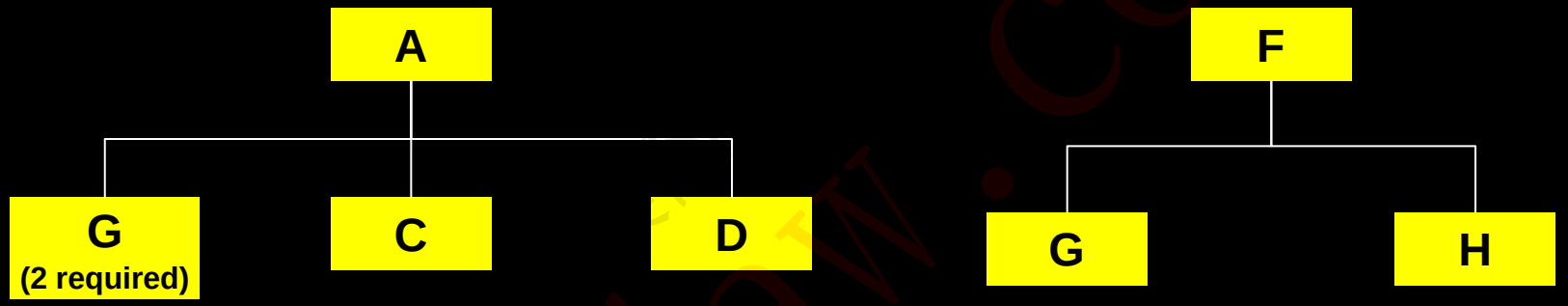
b.

Period		1	2	3	4	5	6
Gross requirements		20	20	20	30	30	30
Scheduled receipts		40					
Projected available balance	2	22	42	22	32	42	12
Planned order release		40		40	40		

c.

Period		1	2	3	4	5	6
Gross requirements		20	20	20	30	30	30
Scheduled receipts		40					
Projected available balance	2	22	42	62	32	42	12
Planned order release		40	40		40		

2.7 Given the product structure diagrams at Traci's Tomahawk shown below, complete the MRP records for Parts A, F, and G using the data provided for each.



		Week				
Part A		***1***	***2***	***3***	***4***	***5***
Gross requirements		5	15	10	15	15
Scheduled receipts		5				
Projected available balance	10					
Planned order release						

Lead time = 1; Q=L4L; SS=0.

Part F		Week 1	2	3	4	5
Gross requirements		10	20	5	15	5
Scheduled receipts			15			
Projected available balance	15					
Planned order release						

Lead time = 2; Q=L4L; SS=0.

Part G		Week 1	2	3	4	5
Gross requirements						
Scheduled receipts		20				
Projected available balance	30					
Planned order release						

Lead time = 1; Q=multiples of 20; SS=10.

ANSWER

Part A		Week 1	2	3	4	5
Gross requirements		5	15	10	15	15
Scheduled receipts		5				
Projected available balance	10	10	0	0	0	0
Planned order release		5	10	15	15	

Lead time = 1; Q=L4L; SS=0.

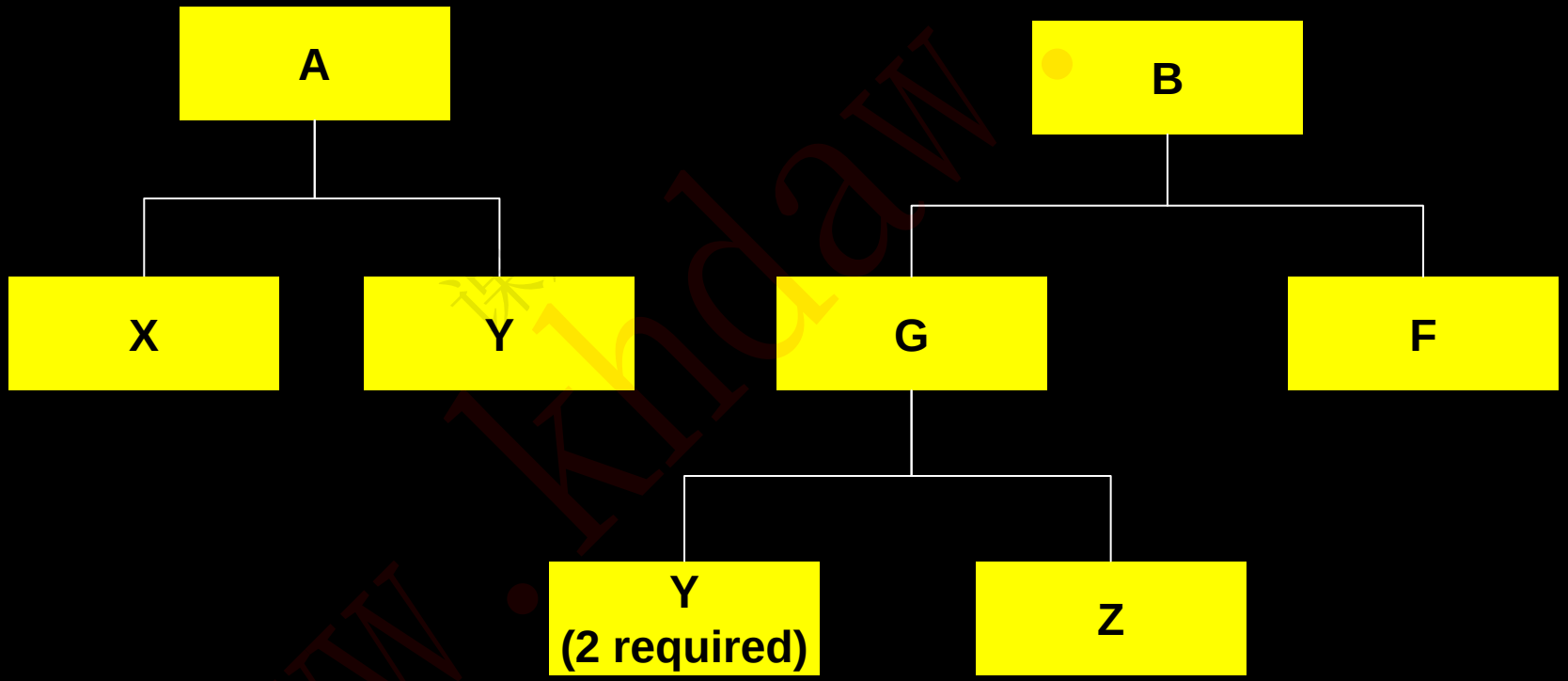
Part F		Week 1	2	3	4	5
Gross requirements		10	20	5	15	5
Scheduled receipts			15			
Projected available balance	15	5	0	0	0	0
Planned order release		5	15	5		

Lead time = 2; Q=L4L; SS=0.

Part G		Week 1	2	3	4	5
Gross requirements		15	35	35	30	
Scheduled receipts		20				
Projected available balance	30	35	20	25	15	
Planned order release		20	40	20		

Lead time = 1; Q=multiples of 20; SS=10.

2.8 The Big B Bike and Trike Shop produces two basic bikes called A and B. Each week, Paul, the owner, plans to assemble 10 A bikes and 5 B bikes. Given this information and the following product structure diagrams for A and B, fill out the MRP records(inventory status files)for component parts G and Y for the next seven weeks.



		Week						
		1	2	3	4	5	6	7
Gross requirements								
Scheduled receipts		7						
Projected available balance	0							
Planned order release								

Q= lot for lot; LT=1; SS=0

		Week						
		1	2	3	4	5	6	7
Gross requirements								
Scheduled receipts		10						
Projected available balance	28							
Planned order release								

Q= lot for lot; LT=2; SS=0

Suppose 10 units of safety stock are required for part Y. What changes would result in the records? Would the MRP system produce any exception message?

ANSWER

		Week 1	2	3	4	5	6	7
Gross requirements		5	5	5	5	5	5	5
Scheduled receipts		7						
Projected available balance	0	2	0	0	0	0	0	0
Planned order release		3	5	5	5	5	5	0

Q= lot for lot; LT=1; SS=0

		Week 1	2	3	4	5	6	7
Gross requirements		16	20	20	20	20	20	10
Scheduled receipts		10						
Projected available balance	28	22	2	0	0	0	0	0
Planned order release		18	20	20	20	10		

Q= lot for lot; LT=2; SS=0

Suppose 10 units of safety stock are required for part Y. What changes would result in the records? Would the MRP system produce any exception message?

		Week						
		1	2	3	4	5	6	7
Gross requirements		16	20	20	20	20	20	10
Scheduled receipts		10						
Projected available balance	28	22	2	10	10	10	10	10
Planned order release		28	20	20	20	10		

Q= lot for lot; LT=2; SS=0

The MRP system would produce the exception message that the projected available balance in week 2 is less than the safety stock quantity of 10.

2.11 Consider the information contained in the planned order row of the following MRP record at Hartley Sprockets, a supplier to Big B Bike and Trike Shop. The planned order releases in weeks 2 and 4 are firm planned orders and cannot be changed without managerial approval.

		Period				
		1	***2***	***3***	***4***	***5***
Gross requirements		10	30	20	25	20
Scheduled receipts		40				
Projected available balance	10	40	10	30	5	25
Planned order release (firm)			40		40	

Q = 40; LT = 1; SS =5.

a. Use an MRP spreadsheet to answer the following questions:
What transactions would cause an action message on the firm planned order in week 2?
What transactions would cause an action message on the firm planned order in week 4?

2.13 Complete the following MRP time phased record for the easy chair at Foremost Furniture.

		Week							
Item: Easy chair		***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Gross requirements		20	20	25	25	35	35	35	35
Scheduled receipts		50							
Projected available balance	10								
Planned order release									

Q = 50; LT = 2; SS = 5.

1. The following events occurred during week 1:
   Actual demand during week 1 was 25 units.
   A scheduled receipt of 45 was received during week 1.
   A cucle count of on-hand units showed only 7 units at the start of week 1.
   Marketing forecasted that 40 easy chaired would be required in week 9.
   Update the record below after rolling through time.

	Week							
Item: Easy chair	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***
Gross requirements	20	20	25	25	35	35	35	
Scheduled receipts								
Projected available balance								
Planned order release								

ANSWER

Item: Easy chair		Week 1	2	3	4	5	6	7	8
Gross requirements		20	20	25	25	35	35	35	35
Scheduled receipts		50							
Projected available balance	10	40	20	45	20	35	50	15	30
Planned order release		50		50	50		50		

Q = 50; LT = 2; SS = 5.

Item: Easy chair		Week 2	3	4	5	6	7	8	9
Gross requirements		20	25	25	25	35	35	35	40
Scheduled receipts			50						
Projected available balance	27	7	32	7	22	37	52	17	27
Planned order release			50	50	50		50		

Q = 50; LT = 2; SS = 5.

2.14 The MPC system at the Duckworth Manufacturing Company is run weekly to update the master production schedule(MPS) and MRP records. At the start of week 1, the MPS for end products A and B is:

Master production schedule

Week number	1	2	3	4	5	6
Product A	10	--	25	5	10	--
Product B	5	20	--	20	--	20

One unit of component C is required to manufacture one unit of either end product A or B. Purchasing lead time for component C is two weeks, and order quantity of 40 units is used, and no (zero) safety stock is maintained for this item. Inventory balance for component C is 5 units at the start of week 1, and there's an open order (scheduled receipt) for 40 units due to be delivered at the beginning of week 1.

a. Complete the MRP record for component C as it would appear at the beginning of week 1:

	Week					
	1	2	3	4	5	6
Gross requirements						
Scheduled receipts						
Projected available balance						
Planned order release						

b. **During week 1 , the following transaction occurred for component C:**

1. The open order for 40 units due to be received at the start of week 1 was received on Monday of week 1 with a quantity of 30 (10 units of component C were scrapped on this order).

2. An inventory cycle count during week 1 revealed that 5 units of component C were missing. Thus, an inventory adjustment of -5 was processed.

3. Ten units of component C were actually disbursed(instead of the 15 units planned for disbursement to produce end product A and B). (The MPS quantity of 5 in week 1 for product B was canceled due to a customer order cancellation.)

4. The MPS quantities for week 7 include 15 units for product A and 0 units for product B.

5. Due to a change in customer order requirements, marketing has requested that the MPS quantity of 25 units for product A scheduled in week 3 be moved to week 2.

6. An order for 40 units was released.

Appear at the beginning of week 2:

	Week					
	2	3	4	5	6	7
Gross requirements						
Scheduled receipts						
Projected available balance						
Planned order release						

What actions are required by the inventory planner at the start of week 2 as a result of transactions occurring during week 1?

ANSWER

		Week 1	2	3	4	5	6
Gross requirements		15	20	25	25	10	20
Scheduled receipts		40					
Projected available balance	5	30	10	25	0	30	10
Planned order release		40		40			

Q = 40; LT = 2; SS = 0.

		Week 2	3	4	5	6	7
Gross requirements		40	0	25	10	20	15
Scheduled receipts			40				
Projected available balance	20						
Planned order release							

The inventory planner can implement the following actions at the start of week 2 as a result of transactions occurring during week 1:

a. Negotiate with the customer if the 20 units which should have been delivered in week 2 could been postponed to week 3.

b. Release a emergency rush order with the quantity of 20 which is planned to be finished in week 2

c. Negotiate with the production department if a overtime could be committed to make 20 units of the order which is scheduled to be receipted at the beginning of week 3 could be delivered in week 2.

Chapter 3

3.5 The Yakima Lash Company produced four models. The forecasts of annual demand for each of the four are as follows:

	Model			
	I	*II*	*III*	*IV*
Forecast of annual demand	**500**	**1500**	**3500**	**4500**

a. Use a 250-day year and an eight-hour day to determine the mixed-model-level master schedule for a daily batch and hourly batch with minimum batch sizes.

b. What would be the schedule of production look like for an eight-hour day using mixed-model minimum batch size production?

ANSWER

a.

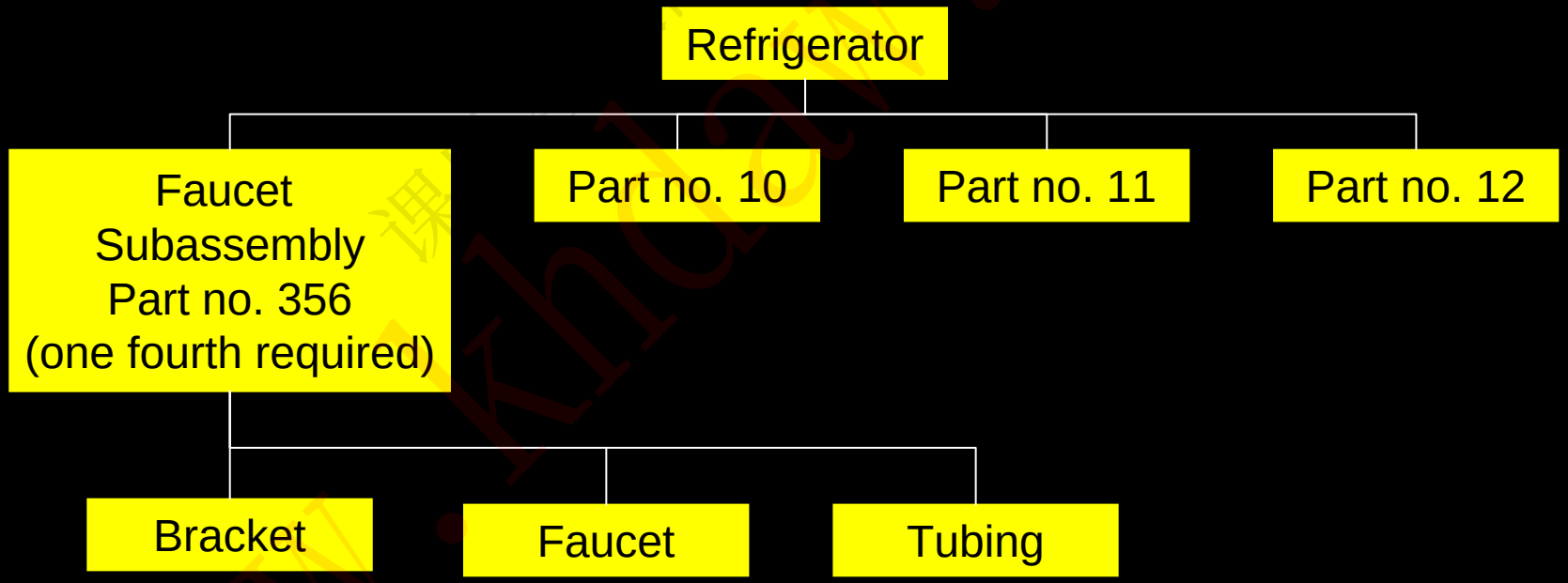
	Model			
	I	*II*	*III*	*IV*
Forecast of annual demand	**500**	**1500**	**3500**	**4500**

Possible mixed model master production Schedules:

Daily MPS	**2**	**6**	**14**	**18**
Hourly batch MPS	**0.25**	**0.75**	**1.75**	**2.25**
Minimum batch MPS	**1**	**3**	**7**	**9**

b. A feasible schedule of production would be: ***I（1）II（3）III（7）IV（9） I（1）II（3）III（7）IV（9）***

3.9 Develop the MRP record for the faucet subassembly (part no. 356) shown in the following bill of material. The refrigerator are assembled at the rate of 480/week, lead time is one week, there's no safety stock, lot size is 500, and 200 units are in inventory at the moment. (Note: The faucet subassembly is only used on every fourth refrigerator.)



ANSWER

		Week					
		1	2	3	4	5	6
Gross requirements		120	120	120	120	120	120
Scheduled receipts							
Projected available balance	200	80	460	340	220	100	480
Planned order release		500				500	

Q = 200; LT = 1; SS = 0.

3.10 Suppose that the faucet subassembly in Problem 3.9 had been "phantomed" (i.e., the faucet would be assembled onto the refrigerator directly from the bracket, faucet, and tubing parts).

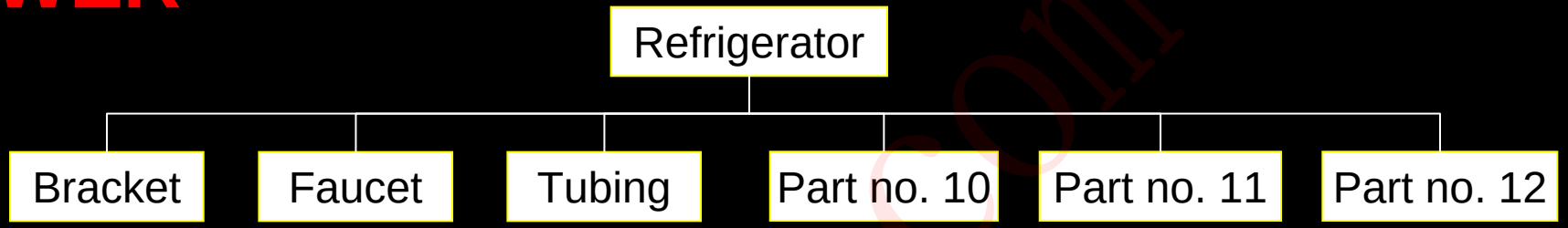
a. What would the bill of material look like now?

b. Construct the phantom MRP record and compare it to Problem 9's MRP record.

c. Construct the MRP record for the bracket (lot size = 200, no safety stock, 250 on hand, lead time = 2 weeks).

ANSWER

a



b

Period		1	2	3	4	5	6
Gross requirements		120	120	120	120	120	120
Scheduled receipts							
Projected available balance	200	80	0	0	0	0	0
Planned order release			40	120	120	120	120

c

Period		1	2	3	4	5	6
Gross requirements		120	120	120	120	120	120
Scheduled receipts							
Projected available balance	250	130	10	90	170	50	130
Planned order release		200	200		200		

Q = 200; LT = 2; SS = 0.

3.12 Graham Manufacturing has completed the following ABC analysis of the nine products it makes:

Product	*Daily sales forecast*
1	600
2	500
3	400
4	400
5	300
6	100
7	50
8	25
9	25
Total	2400

Graham has an assembly line that can produce 300 products per hour and works eight hours per day:

a. Assuming a batch (container size) of 100 for each product, prepare a daily level schedule for Graham.

b. Calculate the number of kanban cards required for each product, assuming a 0.5 day lead time and a 20 percent safety stock. What is the total number of kanban cards for all products?

c. If storage space is proportional to the number of kanban cards, by what percentage will storage be reduced if the lead time can be reduced to one hour?

d. What are the benefits, if any, of being able to cut all batch and container sizes to 50 units instead of 100?

ANSWER

a. **A feasible manufacturing level schedule for Graham would be represented: We can treat four days as a schedule cycle as follow: (a number represent the product number correspond to the product be manufactured with a batch of 100.)**

1st day: 1 1 1 1 1 1 2 2 2 2 2 3 3 3 3 4 4 4 4 5 5 5 6 7;
2nd day: 1 1 1 1 1 1 2 2 2 2 2 3 3 3 3 4 4 4 4 5 5 5 6 8;
3rd day: 1 1 1 1 1 1 2 2 2 2 2 3 3 3 3 4 4 4 4 5 5 5 6 7;
4th day: 1 1 1 1 1 1 2 2 2 2 2 3 3 3 3 4 4 4 4 5 5 5 6 9;

We can find that a batch of product 7 are produced in every two days, for the *Daily sales forecast of product 7 is 50 units, and a batch of 100 units could be satisfy the two days' sales demand; and* a batch of product 8 &9 are produced in every four days, for the *Daily sales forecast of product 8&9 is 25 nits, and a batch of 100 its could be satisfy the four days' sales demand. We assume that there is inventory for product 8 & product 9 at the beginning of the 1st day.*

b.

Calculating the Number of Kanban

$$y = \frac{DL(1+\alpha)}{a}$$

Where y=Number of kaban card sets

D=Demand per unit of time

L=Lead time

a=Container capacity

α=Policy variable (safety stock)

According to the formula we can calculate the number of kanban for every product as follow:

$y1 = 600 * 0.5 * (1 + 0.2) / 100 = 3.6 \approx 4$

$y2 = 500 * 0.5 * (1 + 0.2) / 100 = 3$

$y3 = 400 * 0.5 * (1 + 0.2) / 100 = 2.4 \approx 3$

$y4 = 400 * 0.5 * (1 + 0.2) / 100 = 2.4 \approx 3$

$y5 = 300 * 0.5 * (1 + 0.2) / 100 = 1.8 \approx 2$

$y6 = 100 * 0.5 * (1 + 0.2) / 100 = 0.6 \approx 1$

$y7 = 50 * 0.5 * (1 + 0.2) / 100 = 0.3 \approx 1$

$y8 = 25 * 0.5 * (1 + 0.2) / 100 = 0.15 \approx 1$

$y9 = 25 * 0.5 * (1 + 0.2) / 100 = 0.15 \approx 1$

The total number of kanban required for these product is 19.

c. According to the formula we can calculate the number of kanban for every product as follow:

$y1 = 600 * 0.125 * (1 + 0.2) / 100 = 0.9 \approx 1$

$y2 = 500 * 0.125 * (1 + 0.2) / 100 = 0.75 \approx 1$

$y3 = 400 * 0.125 * (1 + 0.2) / 100 = 0.6 \approx 1$

$y4 = 400 * 0.125 * (1 + 0.2) / 100 = 0.6 \approx 1$

$y5 = 300 * 0.125 * (1 + 0.2) / 100 = 0.45 \approx 1$

$y6 = 100 * 0.125 * (1 + 0.2) / 100 = 0.15 \approx 1$

$y7 = 50 * 0.125 * (1 + 0.2) / 100 = 0.075 \approx 1$

$y8 = 25 * 0.125 * (1 + 0.2) / 100 = 0.0375 \approx 1$

$y9 = 25 * 0.125 * (1 + 0.2) / 100 = 0.0375 \approx 1$

The total number of kanban required for these product is 10.

The percentage is (19 – 9) / 19 = 52.6%

d. 1. Small lots mean less average inventory and shorten manufacturing lead time.

2. Small lots with shorter setup times increase flexibility to respond to demand changes

3. Production of small lots is possible by drastically reducing set-up times

4. It is well documented that production of small lot-sizes in JIT manufacturing is closely associated with improved quality, reduced inventory, faster delivery, and is more responsive to market demands.

Ultimate goal is single unit lot sizes

Chapter 4

4.2 Bisutti Cams has gathered data on labor-hour and machine-hour requirements for producing its Racing Camshaft models RC1 and RC2:

	1994	1995	1996
Production RC1 (units)	1400	1500	1700
Production RC2 (units)	700	820	940
Labor-hours RC1	450	580	620
Labor-hours RC2	75	90	105
Machine-hours RC1	125	145	180
Machine-hours RC2	135	160	165

a. What planning factors should it use for 1997?

b. What capacity requirements for labor-hours and machine-hours would you project for 1997 if 50 percent of the labor-hours and machine-hours each were worked in departments 101 and 102? Use the quarterly summaries in the following master schedule to do the projections:

	Quarter				
1997 MPS	*1*	*2*	*3*	*4*	*Total*
Product RC1	400	700	300	400	1800
Product RC2	250	150	450	300	1150

ANSWER

	1994	1995	1996	TOTAL
Production RC1 (units)	1400	1500	1700	4600
Production RC2 (units)	700	820	940	
Labor-hours RC1	450	580	620	
Labor-hours per unit RC1	0.32	0.39	0.36	
Labor-hours RC2	75	90	105	
Labor-hours per unit RC2	0.11	0.11	0.11	
Machine-hours RC1	125	145	180	
Machine-hours per unit RC1	0.09	0.10	0.11	
Machine-hours RC2	135	160	165	
Machine-hours per unit RC2	0.19	0.20	0.18	

a. We could use the factor of 1996 as the planning factor for 1997

b. We could use the factor of 1996 as the planning factor for 1997

	Quarter				
1997 MPS	*1*	*2*	*3*	*4*	*Total*
Product RC1	400	700	300	400	1800
Product RC2	250	150	450	300	1150
Total labor-hours					
*RC1*0.36+RC2*0.11*	171.5	268.5	157.5	177	774.5
Total machine-hours					
*RC1*0.11+RC2*0.18*	89	104	114	98	405

Work center	*1*	*2*	*3*	*4*	*Total*
101 labor hours	86	134	79	89	387
101 machine hours	45	52	57	49	202
102 labor hours	86	134	79	89	387
102 machine hours	45	52	57	49	202
Total labor-hours required	171.5	268.5	157.5	177	774.5
Total machine-hours Required	89	104	114	98	405

A alternative solution:

a.

	1994	1995	1996	AVARAGE
Production RC1 (units)	1400	1500	1700	1533
Production RC2 (units)	700	820	940	820
Labor-hours RC1	450	580	620	550
Labor-hours per unit RC1	0.32	0.39	0.36	0.37
Labor-hours RC2	75	90	105	90
Labor-hours per unit RC2	0.11	0.11	0.11	0.11
Machine-hours RC1	125	145	180	150
Machine-hours per unit RC1	0.09	0.10	0.11	0.10
Machine-hours RC2	135	160	165	153
Machine-hours per unit RC2	0.19	0.20	0.18	0.19

We can use the mean value of the Labor-hours and the machine hours per unit in the past three years as the planning factor.

	Quarter				
1997 MPS	*1*	*2*	*3*	*4*	*Total*
Product RC1	400	700	300	400	1800
Product RC2	250	150	450	300	1150
Total labor-hours *RC1*0.37+RC2*0.11*	175.5	275.5	160.5	181	792.5
Total machine-hours *RC1*0.10+RC2*0.19*	87.5	98.5	115.5	97	398.5

Work center	*1*	*2*	*3*	*4*	*Total*
101 labor hours	87.75	137.5	80.25	90.5	396.25
101 machine hours	43.75	49.25	57.75	48.5	199.25
102 labor hours	87.75	137.5	80.25	90.5	396.25
102 machine hours	43.75	49.25	57.75	48.5	199.25
Total labor-hours required	175.5	275.5	160.5	181	792.5
Total machine-hours Required	87.5	98.5	115.5	97	398.5

4.3 Tom Swift, master scheduler at Curry Manufacturing Company, prepared the following master production schedule for one of the firm's major end products, the Kashmir Spice Pump.

	Week #					
	1	2	3	4	5	6
MPS	150	120	50	110	85	220

Tom is concerned about this schedule's impact on the Final Test Department. The Final Test Department manager has indicated that testing each Kashmir Spice Pump requires 0.30 hours of skilled labor capacity.

a. Prepare a rough-cut capacity analysis for the Final Test Depart using the bill of capacity technique.

b. What are the major advantages and disadvantages of the bill of capacity technique?

a.

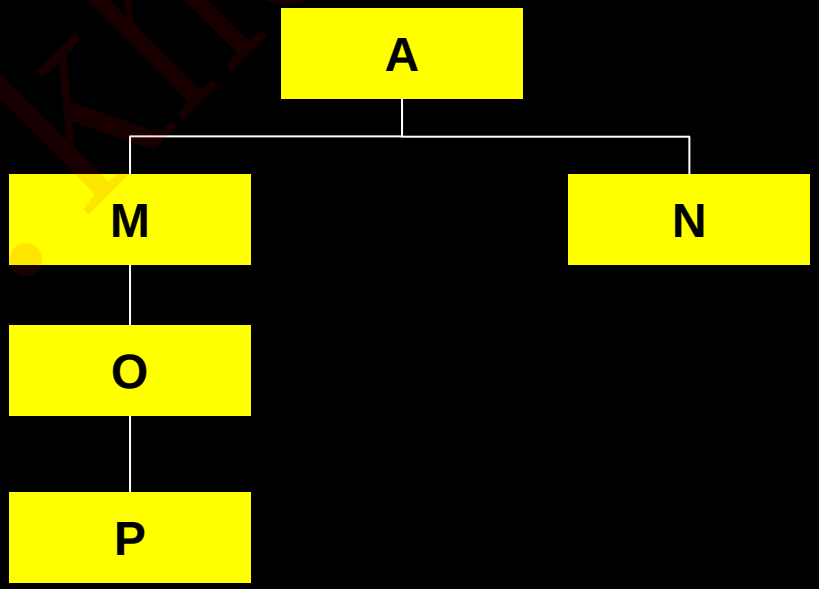
	Bill of capacity End product
	Kashmir Spice Pump
Work center	Total time/unit
Final Test	0.3

	Week					
	1	2	3	4	5	6
MPS	150	120	50	110	85	220
Final test	45	42	15	33	25.5	66

b.

4.5 Determine the capacity requirements in all work centers at Erben Fabricators using the MPS, resource profile, product structure, and lead time information given below for product Z and all of its components. (Assume all usages are one, and that a new setup must be made in each work center.)

	Week				
	1	2	3	4	5
MPS of product Z	10	20	15	10	15



Product Z resource profile

Part	Work center	Setup hours	Run hours/unit	Lead time
Z	201	8.0	1.5	1 week
M	201	5.0	1.0	1 week
N	202	3.0	2.0	1 week
O	202	2.0	1.0	1 week
P	203	1.0	0.5	1 week

ANSWER

Product Z resource profile(period5)				
Part	Work center	Setup hours	Run hours/unit	Total hours/unit
Z	201	8.0	1.5	8.0/15+1.5
M	201	5.0	1.0	5.0/15+1.0
N	202	3.0	2.0	3.0/15+2.0
O	202	2.0	1.0	2.0/15+1.0
P	203	1.0	0.5	1.0/15+0.5

Product Z resource profile(period4)

Part	Work center	Setup hours	Run hours/unit	Total hours/unit
Z	201	8.0	1.5	8.0/10+1.5
M	201	5.0	1.0	5.0/10+1.0
N	202	3.0	2.0	3.0/10+2.0
O	202	2.0	1.0	2.0/10+1.0
P	203	1.0	0.5	1.0/10+0.5

Product Z resource profile(period3)

Part	Work center	Setup hours	Run hours/unit	Total hours/unit
Z	201	8.0	1.5	8.0/15+1.5
M	201	5.0	1.0	5.0/15+1.0
N	202	3.0	2.0	3.0/15+2.0
O	202	2.0	1.0	2.0/15+1.0
P	203	1.0	0.5	1.0/15+0.5

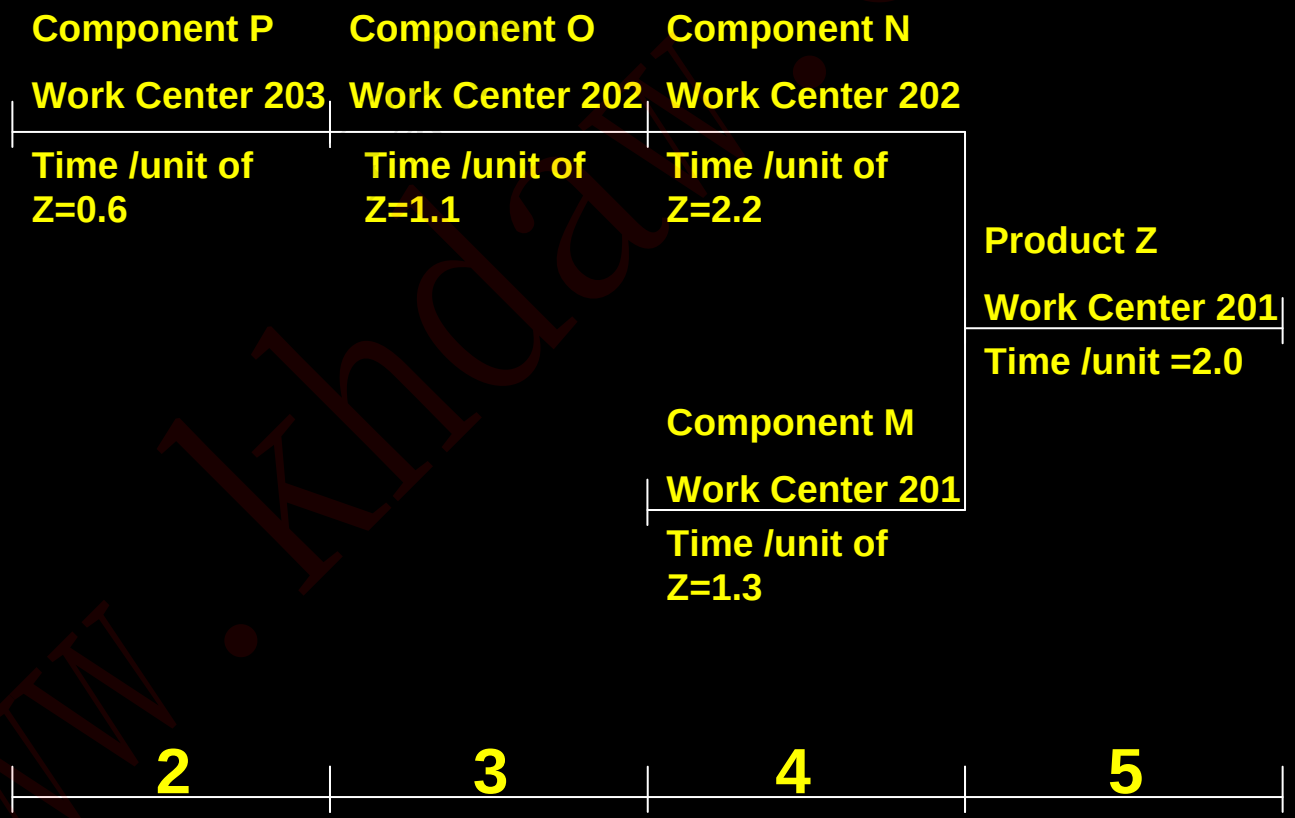
Product Z resource profile(period2)

Part	Work center	Setup hours	Run hours/unit	Total hours/unit
Z	201	8.0	1.5	8.0/20+1.5
M	201	5.0	1.0	5.0/20+1.0
N	202	3.0	2.0	3.0/20+2.0
O	202	2.0	1.0	2.0/20+1.0
P	203	1.0	0.5	1.0/20+0.5

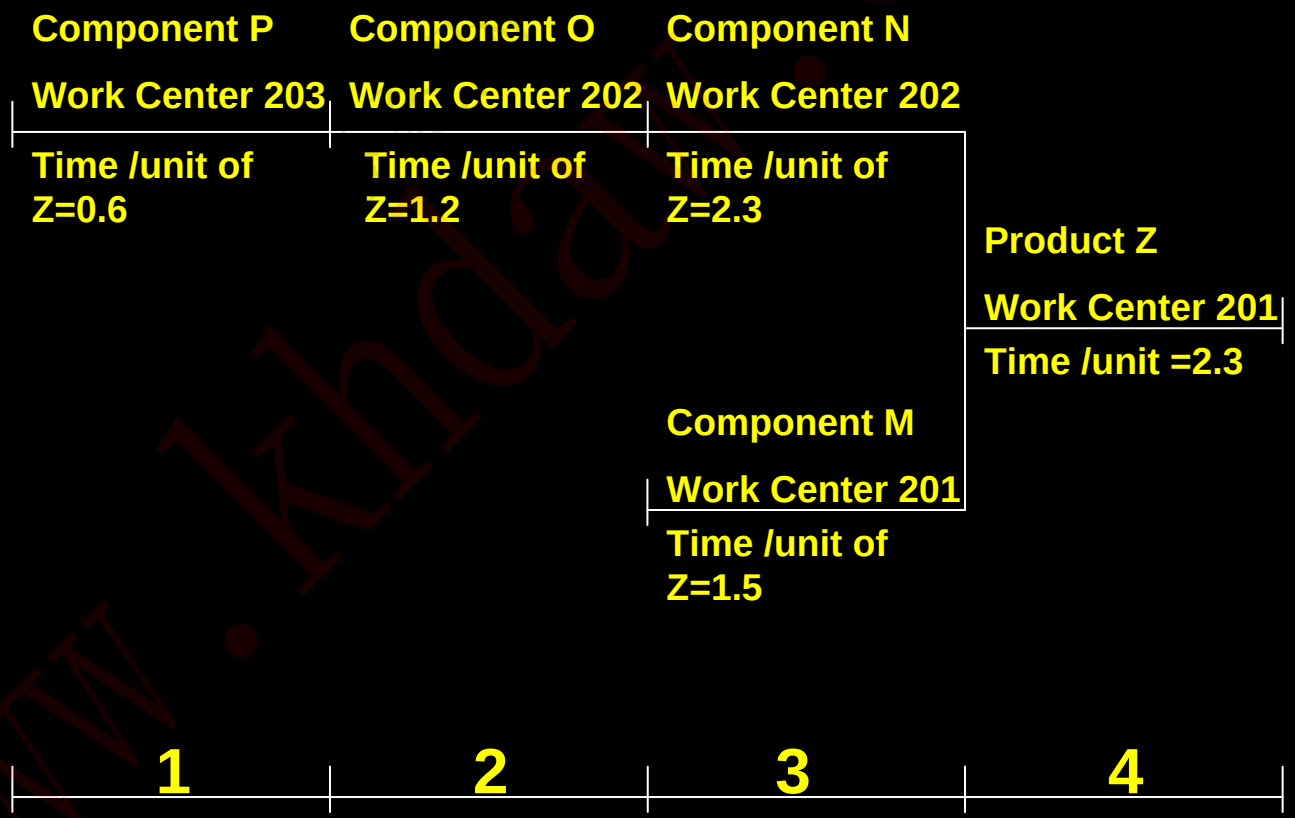
Product Z resource profile(period1)

Part	Work center	Setup hours	Run hours/unit	Total hours/unit
Z	201	8.0	1.5	8.0/15+1.5
M	201	5.0	1.0	5.0/15+1.0
N	202	3.0	2.0	3.0/15+2.0
O	202	2.0	1.0	2.0/15+1.0
P	203	1.0	0.5	1.0/15+0.5

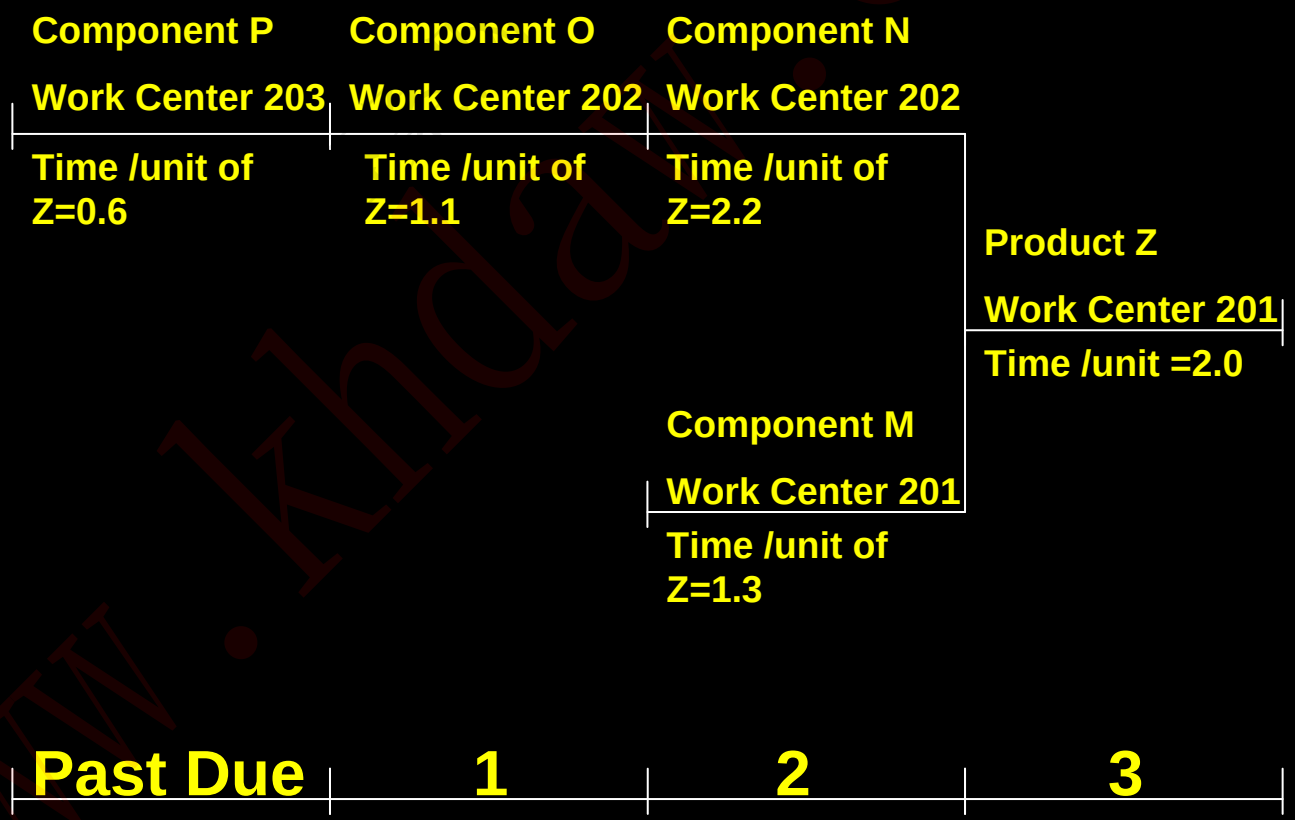
Product Z



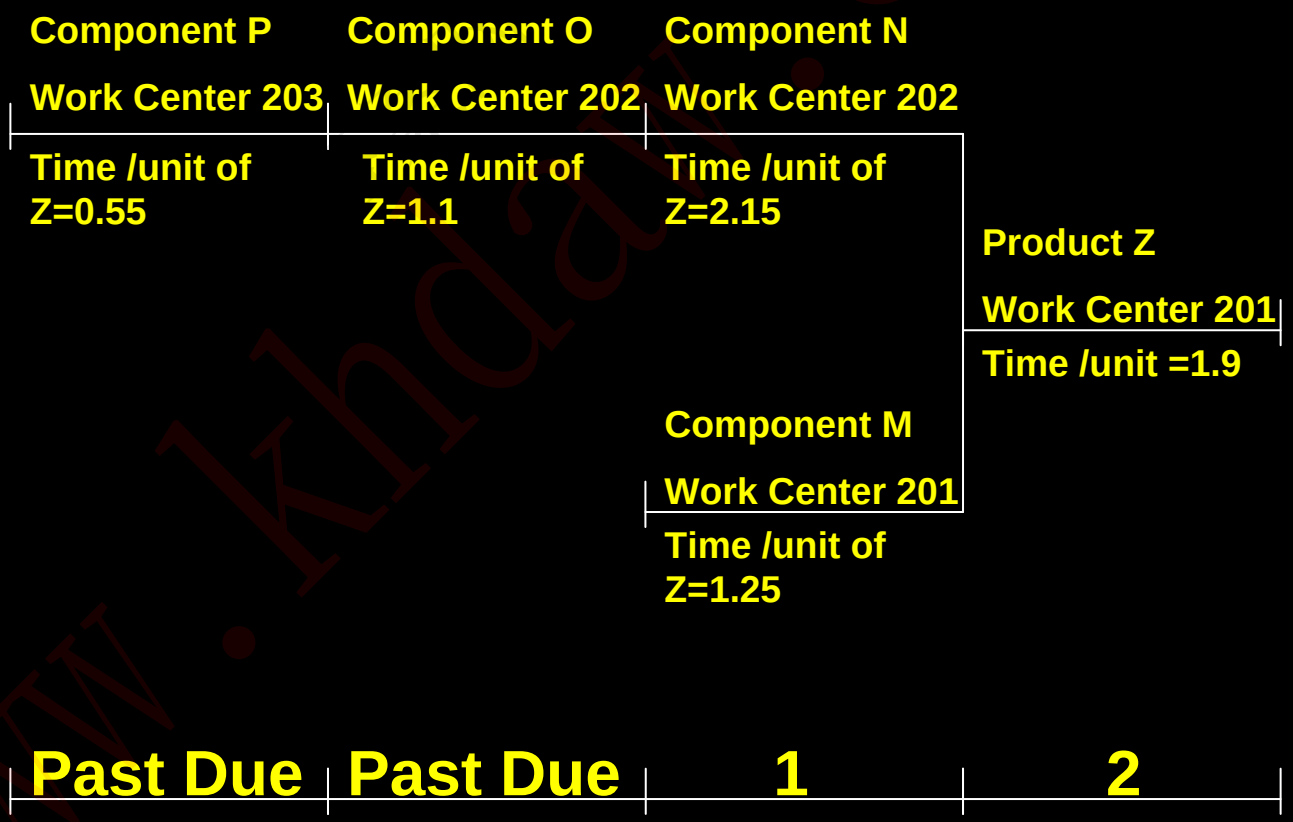
Product Z



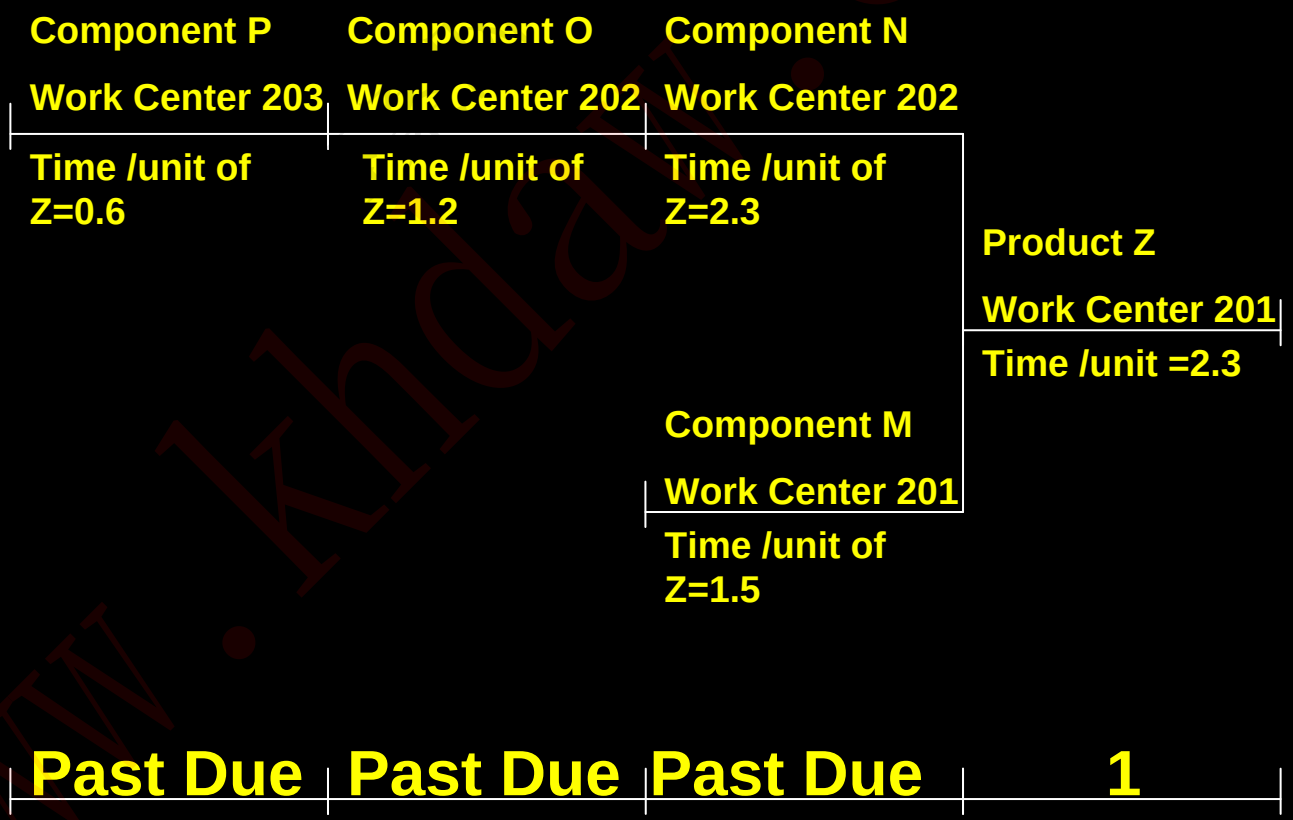
Product Z



Product Z



Product Z



Resource profiles by Work Center

Time required during preceding periods for one end product assembled in period 5:

	Time period			
	2	3	4	5
Work Center 201	0	0	1.3	2.0
Work Center 202	0	1.1	2.2	0
Work Center 203	0.6	0	0	0

Time-phased capacity requirements generated from MPS for 15 Zs in time period 5:

	Time period			
	2	3	4	5
Work Center 201	0	0	19.5	30
Work Center 202	0	16.5	33	0
Work Center 203	9	0	0	0

Resource profiles by Work Center

Time required during preceding periods for one end product assembled in period 4:

	Time period			
	1	2	3	4
Work Center 201	0	0	1.5	2.3
Work Center 202	0	1.2	2.3	0
Work Center 203	0.6	0	0	0

Time-phased capacity requirements generated from MPS for 10 Zs in time period 4:

	Time period			
	1	2	3	4
Work Center 201	0	0	12	23
Work Center 202	0	12	23	0
Work Center 203	6	0	0	0

Resource profiles by Work Center

Time required during preceding periods for one end product assembled in period 3:

	Time period			
	Past Due	1	2	3
Work Center 201	0	0	1.3	2.0
Work Center 202	0	1.1	2.2	0
Work Center 203	0.6	0	0	0

Time-phased capacity requirements generated from MPS for 15 Zs in time period 3:

	Time period			
	Past Due	1	2	3
Work Center 201	0	0	19.5	30
Work Center 202	0	16.5	33	0
Work Center 203	9	0	0	0

Resource profiles by Work Center

Time required during preceding periods for one end product assembled in period 2:

	Time period			
	Past Due	Past Due	1	2
Work Center 201	0	0	1.25	1.9
Work Center 202	0	1.1	2.15	0
Work Center 203	0.55	0	0	0

Time-phased capacity requirements generated from MPS for 20 Zs in time period 2:

	Time period			
	Past Due	Past Due	1	2
Work Center 201	0	0	25	38
Work Center 202	0	22	43	0
Work Center 203	11	0	0	0

Resource profiles by Work Center

Time required during preceding periods for one end product assembled in period 1:

	Time period			
	Past Due	Past Due	Past Due	1
Work Center 201	0	0	1.5	2.3
Work Center 202	0	1.2	2.3	0
Work Center 203	0.6	0	0	0

Time-phased capacity requirements generated from MPS for 10 Zs in time period 1:

	Time period			
	Past Due	Past Due	Past Due	1
Work Center 201	0	0	15	23
Work Center 202	0	12	23	0
Work Center 203	6	0	0	0

Time period								
	Past due	1	2	3	4	5	Total	Percentage
Work Center 201	15	48	57.5	42	42.5	30	235	46%
Work Center 202	57	59.5	45	39.5	33	0	234	46%
Work Center 203	26	6	9	0	0	0	39	8%
Total	98	113.5	111.5	81.5	75.5	30	508	100%

4.8 Bisutti Cams has a specialized programmed machining center that produces racing camshafts for Indianapolis 500 race cars. It takes about one day for the firm's programmed machining center to produce a racing camshaft to exact tolerances. Consequently, the firm used a two-week lead time to produce a "batch" of 10 camshafts. The current MRP record for the camshafts is as follows:

		Week					
		1	2	3	4	5	6
Gross requirements		2	8	5	8	6	5
Scheduled receipts			10				
Projected available balance	2	0	2	7	9	3	8
Planned order release		10	10		10		

a. There was a real concern whether the programmed machining center's capacity had been managed correctly, especially since the firm was having difficulty meeting customer delivery date promises. The programmed machining center designer had said the machine was capable of production two usable camshaft a day while operating. Bisutti's engineers had said it wasn't correct to count on the "theoretical" capacity but to use 75 percent as the expected output(1.5 camshaft per day). On the other hand, only over the past few months had the company been able to consistently produce one usable camshaft per day. Which capacity value do you think to be used? Why?

b. Given the preceding record, what are the capacity requirement over the next five weeks? (You can assume the open order has been in progress for almost a week and has produced five usable camshaft.) How do they compare to the three possible capacity measure? What advice can you give the firm's management?

ANSWER

a. I harbor the idea that the capacity value of 1 camshaft per day should be used. As indicated in the background material, the 2 camshaft per day is just a “theoretical” capacity . A theoretical capacity of any Work center can’t be fully utilized due to various interference. On the other hand, over the past few months had the company been able to consistently produce one usable camshaft per day .we must insure the output’s stability. The output can’t be improved so quickly.

b. This is the given record in the next 6 weeks

		Week					
		1	2	3	4	5	6
Gross requirements		2	8	5	8	6	5
Scheduled receipts			10				
Projected available balance	2	0	2	7	9	3	8
Planned order release		10	10		10		

b. **If we assume the company can produce one camshaft per day, the lead time for a batch is two weeks . We can come to the conclusion that the implementation which is given by the record can't be achieved for the reason that the capacity of week 1 has been used fully for the past due, there are no uneaten capacity for the planed order released in week 1. For the actual condition we can't release an order in week 1 which result in a backlog in week 3. The reality can be reflected in the following record;**

		Week				
		1	2	3	4	5
Gross requirements		2	8	5	8	6
Scheduled receipts			10	BL=3	BL=1	BL=7
Projected available balance	2	0	2	0	0	
Planned order release			10		10	

If we assume the production per week is 2 units, the lead time for a batch is one week, and the scheduled receipts would have been due in week 2 will move to week 1, and the reality will be changed respectively which is reflected in the following record.

		Week				
		1	2	3	4	5
Gross requirements		2	8	5	8	6
Scheduled receipts		10				
Projected available balance	2	10	2	7	9	3
Planned order release			10	10		

If we assume the production per week is 1.5 units, a week's production capacity is 7.5 units, the lead time for a batch is 20/3 days which is rounded to two weeks. The past due for the scheduled receipt in week 2 has occupy 2.5 units of week 1. There are remaining capacity in week 1, we can release an order at the beginning of week 1, which will be delivered in week 3. To the logic discussed above, the planed order release in week 2 and week 3 can be satisfied using the exiting capacity.

		Week				
		1	2	3	4	5
Gross requirements		2	8	5	8	6
Scheduled receipts			10			
Projected available balance	2	0	2	7	9	3
Planned order release		10	10			

We can give the company's management the advices as follow:
Take some measures to promote the production capacity forward to the target of 2 units per day, although that is a theoretical capacity measurement . We can see the fact that even if the capacity measurement is 1.5 units per day, the order in the following five weeks can be delivered on time, rather than making a part of them become backlogs.

4.12 Complete the following input/output control chart for Work Center 0262 at Penlesky's Pipe Works. The beginning backlog is 100 hours.

		1	2	3	4	5	6
Planned input*		50	50	50	50	50	50
Actual input*		0	100	0	50	55	95
Cum. deviation							
Planned output*		60	60	60	60	60	60
Actual output		45	70	40	50	45	50
Cum. deviation							
Actual backlog	100						

a. The plan for the six week period shown above was designed to change the backlog to how many hours?

b. What is you evaluation of Work Center 0262 performance?

ANSWER

		1	2	3	4	5	6
Planned input*		50	50	50	50	50	50
Actual input*		0	100	0	50	55	95
Cum. deviation		-50	0	-50	-50	-45	0
Planned output*		60	60	60	60	60	60
Actual output		45	70	40	50	45	50
Cum. deviation		-15	-5	-25	-35	-50	-60
Actual backlog	100	55	85	45	45	55	100

a. The plan for the six week period shown above was designed to change the backlog to 40 hours?

b. It's not so good that through 6 weeks, the work center can't achieve the planned goal to change the backlog from 100 to 40.

Chapter 5

5.2 The product manager at the Knox Machine Company is preparing a production schedule for one of the fabrication shop's machine's ---the P&W grinder. He has collected the following information on jobs currently waiting to be processed at this machine.(There are no other jobs and the machine is empty.)

Job	Machine processing (in days)*	Date job arrived at this machine	Job due date
A	4	6-23	8-15
B	1	6-24	9-10
C	5	7-01	8-01
D	2	6-19	8-17

*Note: This is the final operation for each of these jobs.

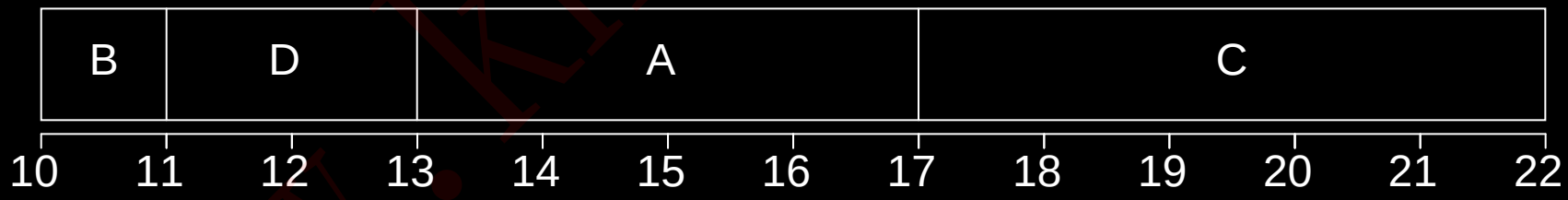
a. The production manager has heard about three dispatching rules: the Shortest Operation Next Rule, the First-Come/First-Served Rule, and the Earliest Due Date Rule. In what sequence would these jobs be processed at the P&W grinder if each rule was applied?

b. If it's now the morning of July 10 and the Shortest Operation Next Rule is used, when would each of the four jobs start and be completed on the P&W grinder?(Express your schedule in terms of the calendar dates involved, assuming that there are 7 working days each week.)

ANSWER

a. The schedule under the Shortest Operation Next rule:
B→D→A→C
The schedule under the First-Come/First-Served rule:
D→A→B→C
The schedule under the Earliest Due Date rule:
C→A→D→B

b.



5.11 The Bundy Company has orders in the shop for three products (A, K and P). Each order goes through the same three machine centers, but not necessarily in the same sequence. Each order must be finished at a machine center before another can be started. Orders cannot be split. The shop works a single eight-hour shift five days per week. Date on each order follow. Assume that the time to move between machines is negligible, each machine center is operated eight hours per day, all three machines are currently available for scheduling, and no further orders will arrive.

Order	Machine center routing	Processing Time (in days) at machine center			Order due date
		1	2	3	
A	3-1-2	1	3	2	14
K	2-3-1	3	1	3	12
P	3-2-1	2	3	4	10

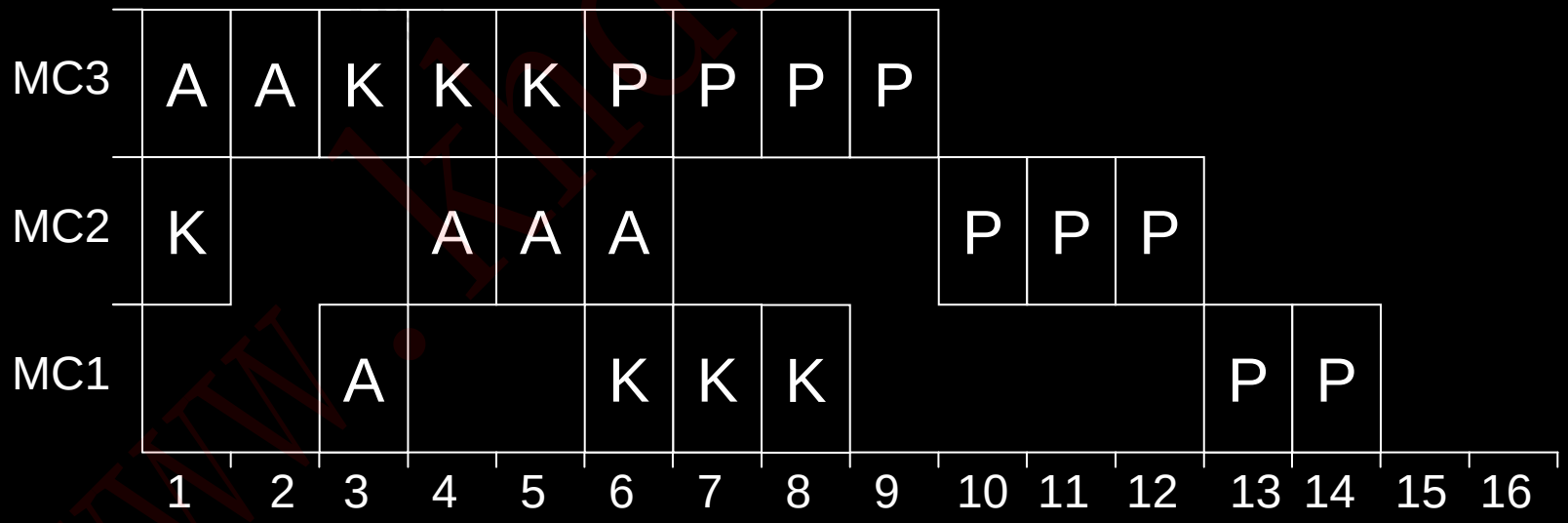
Note: Order due dates are fixed based on the shop calendar. It's now 8:00 A.M. Monday (day 1), Monday of next week is day 6, etc.

a. Using the vertical loading procedure and the shortest-operation-next priority sequencing rule, prepare a Gantt chart showing the production schedule for the three order above.

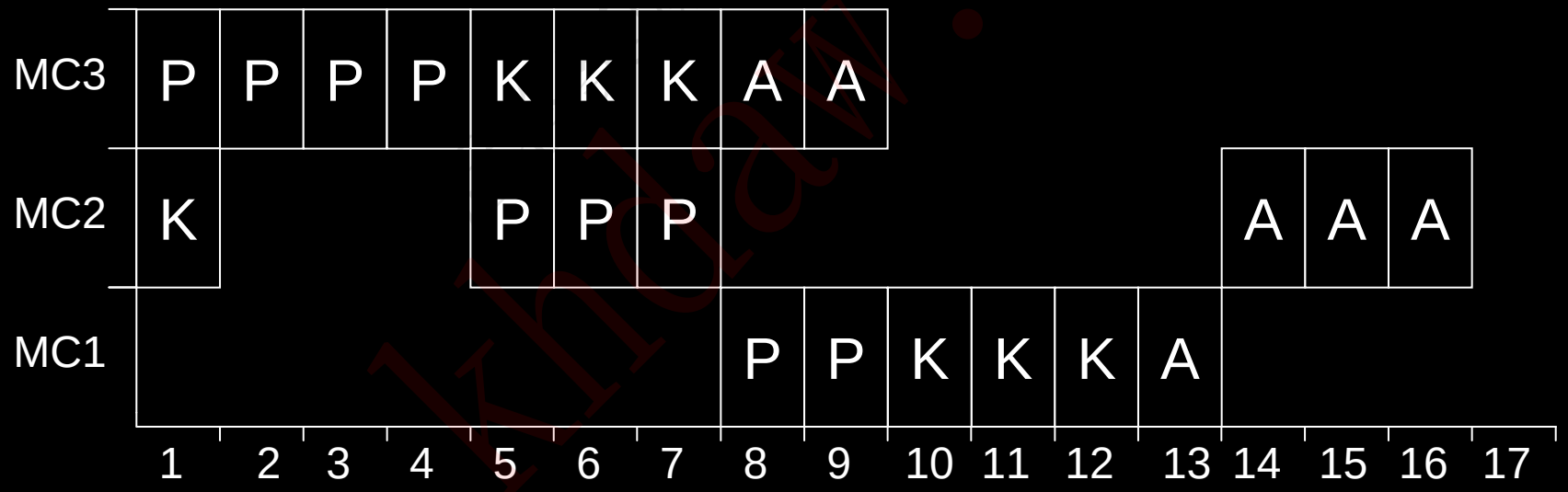
b. Using the horizontal loading procedure and the earliest-due-date priority sequencing rule, prepare a Gantt chart showing the production schedule for the three order above.

ANSWER

a. The vertical loading is scheduled to the Machine Center.
The shortest-operation-next rule to every Machine Center respectively:
Machine Center 1: A→P→K;
Machine Center 2: K→A→P or K→P→A;
Machine Center 3: A→K→P;



b. Horizontal loading under the earliest-due-date rule:
The sequence of the orders: P→K→A



5.13 On Monday morning of the week before the annual shutdown, the Limited Hours Company had orders in the shop for five products (cleverly called A-E), which had arrived in alphabetical order. Management decided not to take any more orders until after the shutdown, and the five orders on hand were assigned priorities in the order of arrival (i.e., A-E). Delivery promises hadn't yet been made on any of the orders. Each order went through the same three machine centers, but not necessarily in the same sequence. Each order had to be finished at a machine center before another could be started. They couldn't be split.

The company worked a demanding three-hour day, so it was concerned about whether there was enough total machine time (capacity) to finish the five orders in the five days remaining before the shutdown. Date on each order are as follows. Assume the time to move between work centers is negligible.

Order	Machine center routing	Hours at machine center		
		1	2	3
A	1-3-2	2	4	4
B	2-1-3	2	6	3
C	3-1-2	5	1	4
D	1-2-3	3	1	2
E	3-2-1	2	3	1

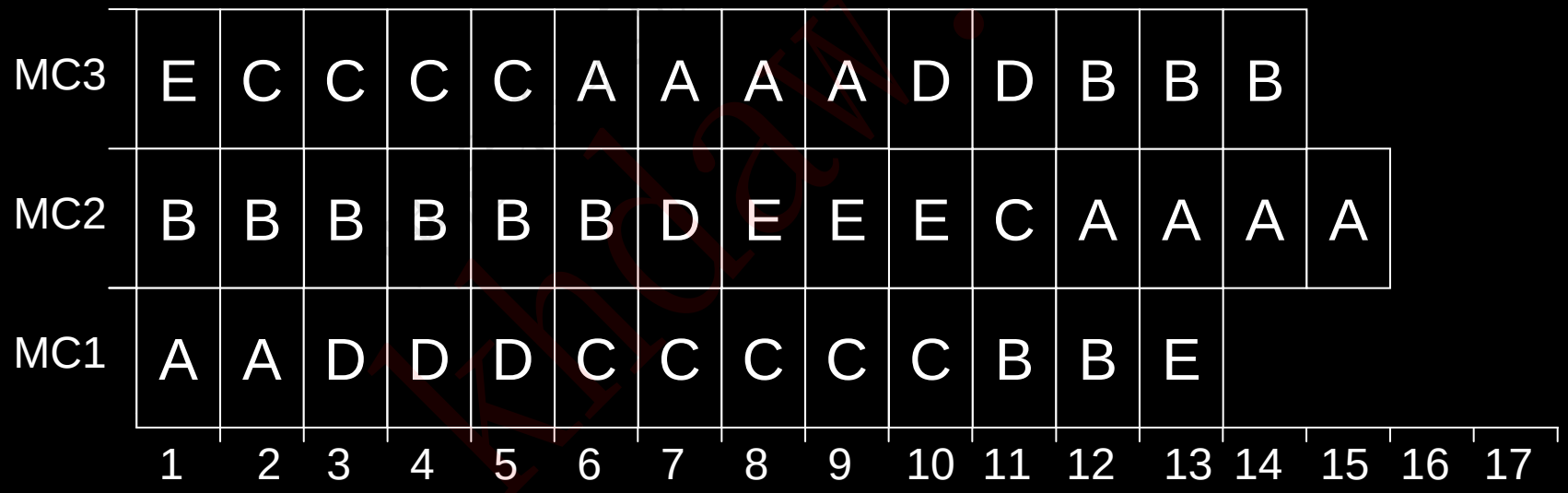
a. Is there enough machine time to finish the orders?

b. Using the horizontal loading technique to schedule each order through the machine center, on what days can the deliveries be promised?

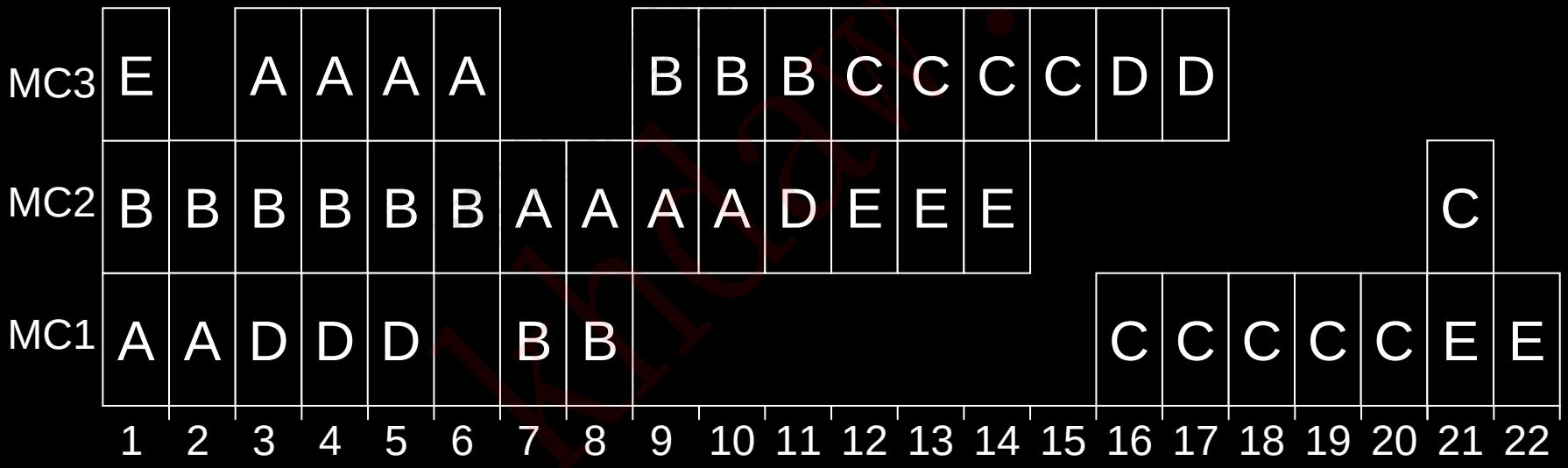
c. What changes occur if you use the vertical loading method?

ANSWER

a. **A feasible schedule, which is shown by the chart below, illustrate the fact that the remaining 15 hours are sufficient to achieve the five orders.**



b. Horizontal loading with the alphabetical order:



c. Vertical loading method:

5.15 Shown below is the MRP record for part number 483. The current shop day is 100 (with 5-day weeks); it's now Monday of week 1. Open orders (scheduled receipts) are due Mondays (shop days 100, 105, 110. etc.) of the week for which they're scheduled.

The shop floor has just reported that the batch of 40 on shop order number 32 has just finished at machine center A43 and is waiting to be moved to C06. It takes one day to move between machine centers (or to I02, the inventory location) and one day of queen time at the machine centers .(The inventory location doesn't require the queen time, but one day of "machine time" is shown for clearing the paper work.) Part number 483's routing and status are also given below.

		Week					
Part NO. 483		1	2	3	4	5	6
Gross requirements		14	4	10	20	3	10
Scheduled receipts			40*				
Projected available balance	20	6	42	32	12	9	39
Planned order release					40		

Q=40; LT=2; SS=5

*Shop Order Number 32

Part NO. 483

Routing (mach. Cent.):	A12	B17	A43	C06	102
Machine time (days)	4	1	3	1	1
Status shop ord. 32:	Done	Done	Done		

a. Use a spreadsheet to replicate the MRP record and calculate the critical ratio for part number 483. Should the planner take any action?

b. What would the priorities be if the inventory was 23 instead of 20? What action should be taken now?

c. What if inventory was 17 instead of 20?

ANSWER

		Week					
Part NO. 483		1	2	3	4	5	6
Gross requirements		14	4	10	20	3	10
Scheduled receipts			40*				
Projected available balance	20	6	42	32	12	9	39
Planned order release					40		

Q=40; LT=2; SS=5

*Shop Order Number 32

Part NO. 483

Routing (mach. Cent.):	A12	B17	A43	C06	I02
Machine time (days)	4	1	3	1	1
Status shop ord. 32:	Done	Done	Done		

a. Time remaining from now to the due date is 5 days (a week)
Work remaining is 5 days (one day move between work center A43 and C06, one day of queen time at the machine center C06, one day of machine time in work center C06,one day move between work center C06 and inventory location I02, one day of paper work in inventory location I02)
Critical ratio = Time remaining / Work remaining = 5 / 5 = 1
So the order is on time. The planner needn't take any action.

b. The respective change is reflected in the MRP record shown below if the inventory was 23 instead of 20

So the critical ratio = 10 / 5 = 2. The shop order will be finished ahead of schedule and the planner shouldn't take any action.

		Week					
Part NO. 483		1	2	3	4	5	6
Gross requirements		14	4	10	20	3	10
Scheduled receipts				40			
Projected available balance	23	9	5	35	15	12	42
Planned order release						40	

Q=40; LT=2; SS=5

c. The respective change is reflected in the MRP record shown below if the inventory was 17 instead of 20

So the critical ratio = 0 / 5 = 0. The order can't be finished on time, the planner should take some action to assure the order could be delivered on time, or it will become a backlog.

		Week					
Part NO. 483		1	2	3	4	5	6
Gross requirements		14	4	10	20	3	10
Scheduled receipts		40					
Projected available balance	17	43	39	29	9	6	36
Planned order release					40		
Q=40; LT=2; SS=5							

Chapter 6

6.4 The MPS planner at Murphy Motors use MPS time-phased records for planning end item production. The planner is currently working on a schedule for the P24, one of Murphy's top-selling motors. The planner uses a production lot size of 70 and a safety stock of 5 for the P24 motor.

Item: P24	Week 1	2	3	4	5	6	7	8
Forecast	30	30	30	40	40	40	45	45
Orders	13	8	4					
Available								
Available to promise								
MPS								

On hand = 20

a. Complete the MPS time-phased record for product P24.
b. Can Murphy accept the following orders? Update the MPS time-phased record for accepted orders.

Order	Amount	Desired week
1	40	4
2	30	6
3	30	2
4	25	3

ANSWER

a.

Item: P24		Week 1	2	3	4	5	6	7	8
Forecast		30	30	30	40	40	40	45	45
Orders		13	8	4					
Available	20	60	30	70	30	60	20	45	70
Available to promise		69		66				70	70
MPS		70		70		70		70	70

On hand = 20

b. Yes, they can accept these orders which is illustrated in the MPS record as follow:

Item: P24		Week 1	2	3	4	5	6	7	8
Forecast		30	30	30	40	40	40	45	45
Orders		13	38	29	40		30		
Available	20	60	22	62	22	52	12	37	62
Available to promise		39		1		40		70	70
MPS		70		70		70		70	70

On hand = 20

6.8 Georgia Clay and Gravel was updating the MPS record for one of its products, Smell Fresh Cat Litter.

a. Complete the following MPS time-phased record.

	Week							
Item: Smell fresh	1	2	3	4	5	6	7	8
Forecast	20	20	20	20	30	30	30	30
Orders	5	3	2					
Available	50	30	10	30	50	20	40	10
Available to promise								
MPS	50			50	50		50	

On hand = 20; MPS Lot Size = 50;

The following events occurred during week 1:

- -Actual demand during week 1 was 25 units.
- -Marketing forecasted that 40 units would be needed for week 9.
- -An order for 10 in week 2 was accepted.
- -An order for 20 in week 4 was accepted.
- -An order for 6 in week 3 was accepted.
- -The MPS in week 1 was produced as planned.

b. Update the record below after rolling through time,

Item: Smell fresh	Week 2	3	4	5	6	7	8	9
Forecast								
Orders								
Available								
Available to promise								
MPS								

On hand = 20+50-25=45 ; MPS Lot Size = 50;

ANSWER

a.

Item: Smell fresh	Week 1	2	3	4	5	6	7	8
Forecast	20	20	20	30	30	30	30	30
Orders	5	3	2					
Available	50	30	10	30	50	20	40	10
Available to promise	60			50	50		50	
MPS	50			50	50		50	

On hand = 20; MPS Lot Size = 50;

b.

Item: Smell fresh	Week 2	3	4	5	6	7	8	9
Forecast	20	20	30	30	30	30	30	40
Orders	13	8	20					
Available	25	5	25	45	15	35	5	15
Available to promise	24		30	50		50		50
MPS			50	50		50		50

On hand = 20+50-25=45 ; MPS Lot Size = 50;

6.10 Figure 6.21, the Ethan Allen example, is based on the following data:

Product	Beginning inventory	Weekly forecast	Lot size	Hours per lot size
A	20	5	50	20
B	50	40	250	80
C	-30	35	150	60
D	25	10	100	30

Priorities are calculated by dividing expected beginning inventory by forecast. In weeks after the first, expected beginning inventory takes account of production and expected sales.

a. Calculate weekly priorities and determine the master production schedule for weeks 1 through 8 for these data. Check your answer against Figure 6.21.

b. Assume the actual sales in week 1 were as follows:

Product	Sales
A	10
B	30
C	25
D	25

Given these actual sales data. Calculate the weekly priorities and determine the MPS for weeks 2 through 9, assuming the forecast remain unchanged. What impact do these changes have?

c. Given the actual sales data in part b, calculate the priorities for weeks 7,8 and 9. Determine the MPS for weeks 2 through 9, assuming the forecast remain unchanged and weeks 2 through are frozen; that is, the schedule in part a can be revised but only from week 7 on. What impact would the frozen schedule have on the inventory and customer service levels for products A and product D?

ANSWER

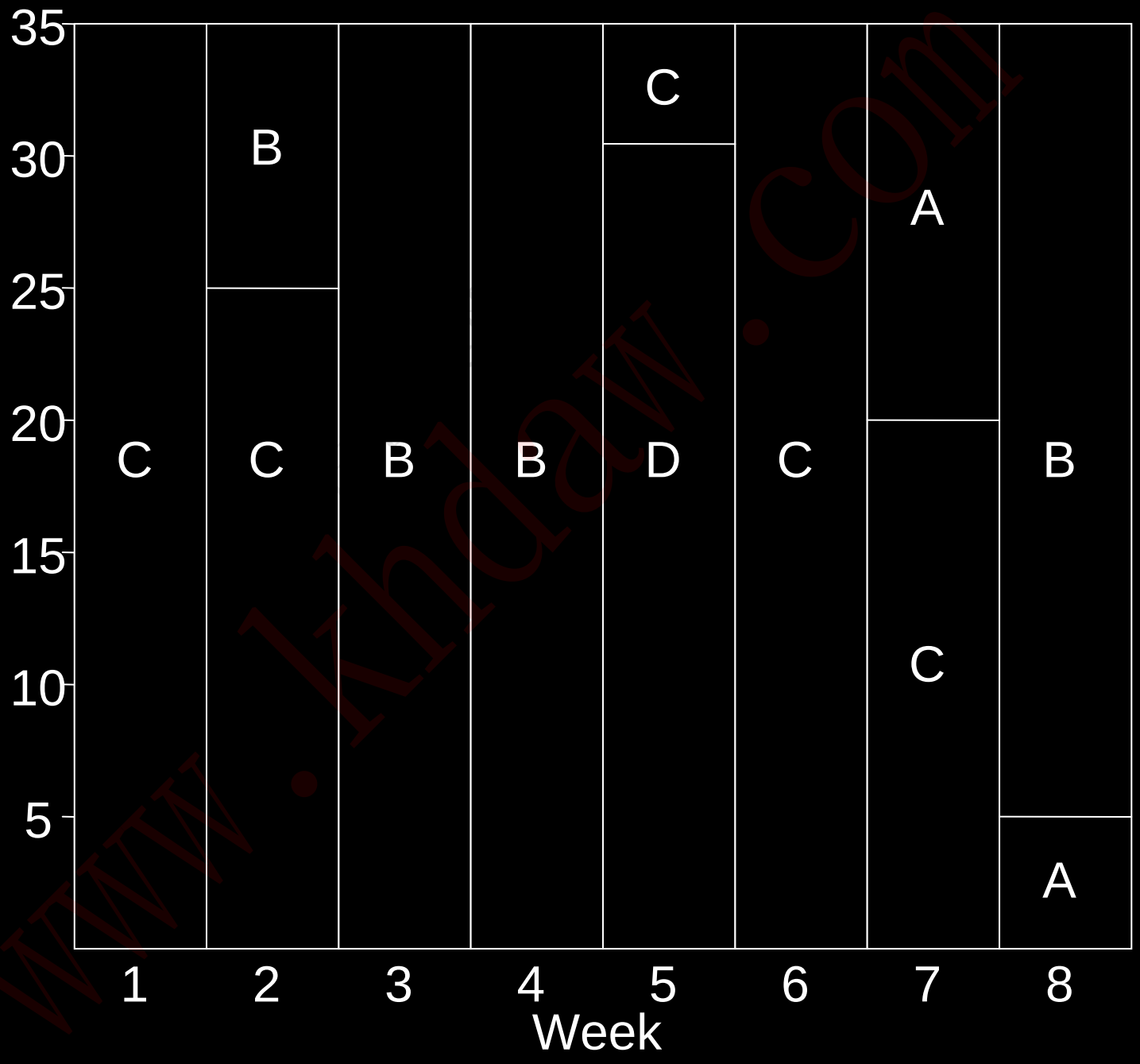
a.

Basic date:

Product	Beginning inventory	Weekly forecast	Lot size	Hours per lot size
A	20	5	50	20
B	50	40	250	80
C	-30	35	150	60
D	25	10	100	30

Priorities:

Products	P1	P2	P3	P4	P5	P6	P7	P8
A	4	3			0		-2	4.5
B	1.25	0.25			3.5		1.5	0.5
C	-0.86	0.64			-0.57		0.29	0.71
D	2.5	1.5			-1.5		6.5	5.5



b.

Basic date: (The state at the beginning of week 2)

Product	Beginning inventory	Weekly forecast	Lot size	Hours per lot size
A	10	5	50	20
B	20	40	250	80
C	32.5	35	150	60
D	0	10	100	30

Priorities:

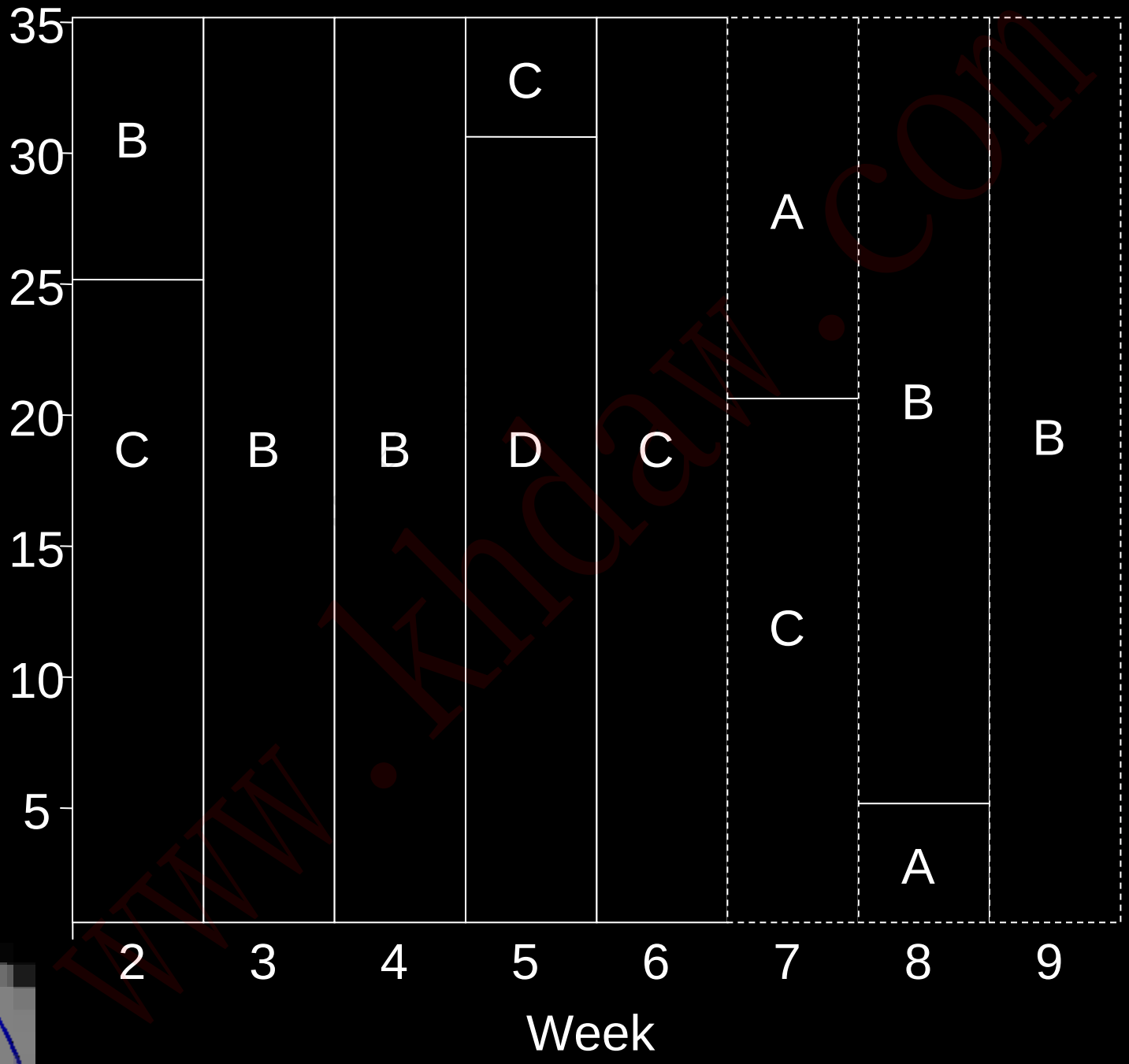
Products	P2	P3	P4	P5	P6	P7	P8	P9
A	2	1		-1	0.5		6	5
B	0.5	-0.5		1.41	2.75		0.75	-0.25
C	0.93	1.71		-0.29	-1.29		0.64	2.17
D	0	2.33		7	6		4	3

c.

Basic date: (The state at the beginning of week 2)

Product	Beginning inventory	Weekly forecast	Lot size	Hours per lot size
A	10	5	50	20
B	20	40	250	80
C	32.5	35	150	60
D	0	10	100	30

Product	Beginning inventory	Priority of week 7	Priority of week 8	Priority of week 9
A	-15	-3	3.5	5
B	70	1.75	0.75	2.09
C	20	0.57	1	0
D	50	5	4	3



Due to the frozen schedule the customer order of product A can't be satisfied on time, and the product D may built a relatively huge and unnecessary inventory.

Chapter 7

7.1 On December 20 (the end of the fourth quarter), Ivar Jorgenson, head production planner for Ski & Sea, Inc., is in charge of developing a production plan for the coming year. Ski & Sea assembles jet skis and snowmobiles from subassemblies and component parts provided by reliable vendors. Both products (end items) utilize the same small engines and many of the same parts. They require the same assembly time and employee labor skills. The available planning information is as follows:

Quarter	Jet Skis	Snowmobiles
1	10,000	9,000
2	15,000	7,000
3	16,000	19,000
4	3,000	10,000

Anticipated Quarter 1		
Beginning inventory:	**600 Skis**	**400 Snowmobiles**
Production and costs		
Regular time	**= $ 15.00 per unit**	
Over time	**= $ 22.50 per unit**	
Subcontract	**= $ 30.00 per unit**	
Part-time	**= $ 36.00 per unit**	
Inventory	**= $ 3.00 per unit per quarter based on average inventory during each quarter**	
Back order	**= $ 24.00 per unit per quarter (based on back orders at end of quarter)**	
Hiring	**= $ 300.00 per full-time employee (no cost if part-time)**	
Layoff	**= $ 1,500.00 per full-time employee (no cost if part-time)**	
Production rates		
Regular	**= 500 units per full-time employee per quarter (of either unit)**	

Over time (max.)	= 200 units per full-time employee per quarter (of either unit)
Part-time	= 400 units per full-time employee per quarter (of either unit)
Initial workforce size	= 44 full-time employee per quarter (of either unit)

Additional assumptions:

1. Part-time employees may not work overtime
2. Assume 100% utilization of employees on regular time (i.e., all employees on the payroll during a period produce at least 500 units). If overtime is used, up to another 200 units can be produced per employee.

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a. Develop an aggregate plan which utilizes a level, or constant, rate of output each quarter using full time regular employees only. Ending inventory and back orders for quarter 4 must be equal to zero. Summarize the plan, its cost, and its consequences.

b. Prepare a cumulative chart for your plan in Part a of this problem.

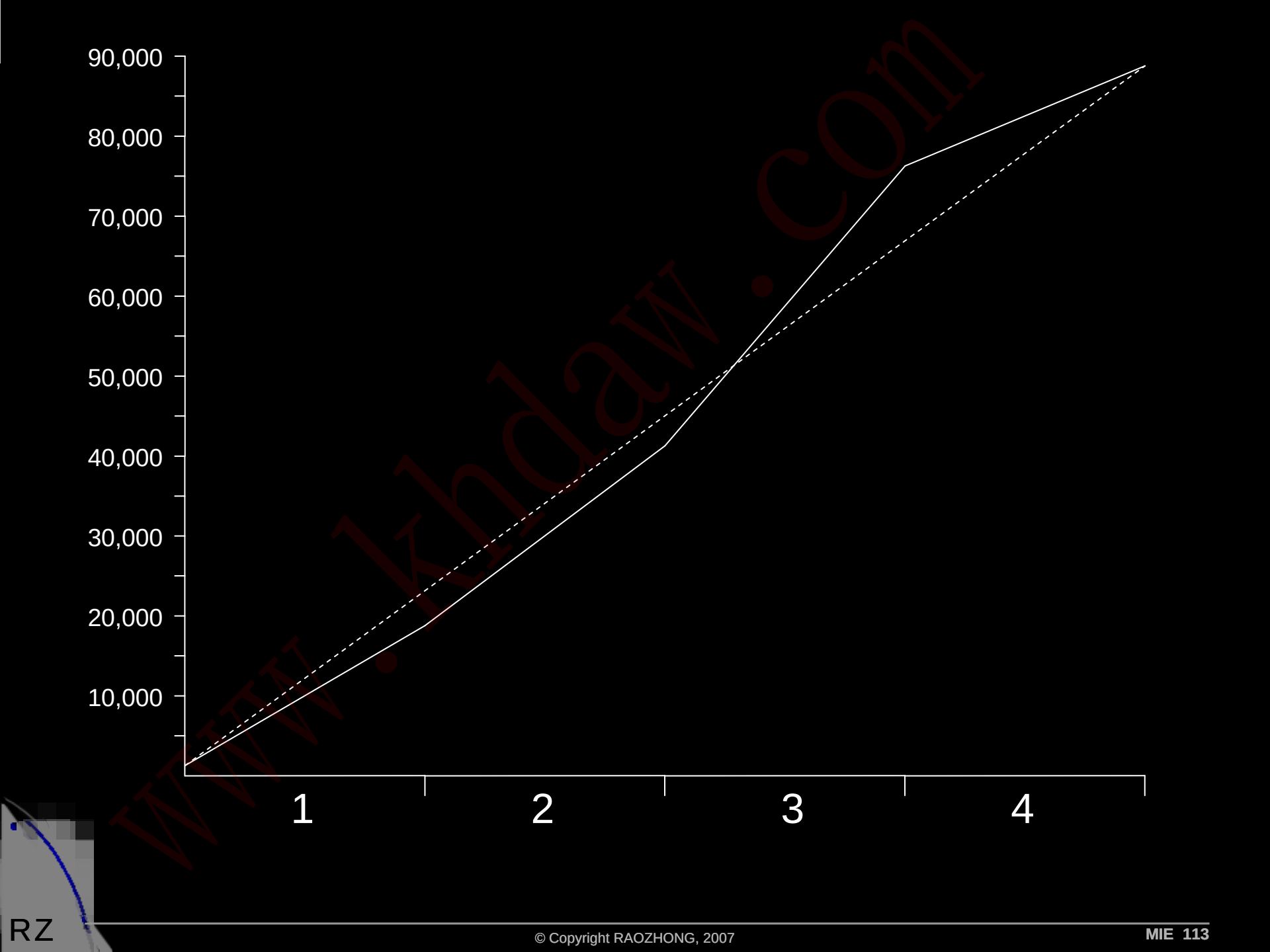
c. If each shipping container for completed jet skis and snowmobiles requires 20 cu. ft. of space, what is the maximum finished-goods warehouse space you will need next year if the plan in Part 2 of this problem is adopted.

d. If the cost of each completed end item is $600, what is the maximum amount of capital which will be tied up in finished-goods inventory during the year?

ANSWER

a. We can sum up the forecast quantities of every quarter, then we conclude that the gross requirement quantity in the next year is 89,000 units. With the inventory of 1,000 units, we get the net requirement of 88,000 units in total (i.e. 22,000 units per quarter). The result is divided by the 500 units that per full-time employee can produces per quarter, we come to the conclusion that we need 44 full-time employees per quarter, thus we needn't hire or fire workers at the beginning of the coming year with the level strategy.

Quarter	Forecast (Gross)	Inventory or Backlog	Quantity	Cost
1	19,000	Inventory	4,000	12,000
2	22,000	Inventory	4,000	12,000
3	35,000	Backlog	9,000	216,000
4	13,000	None	0	0



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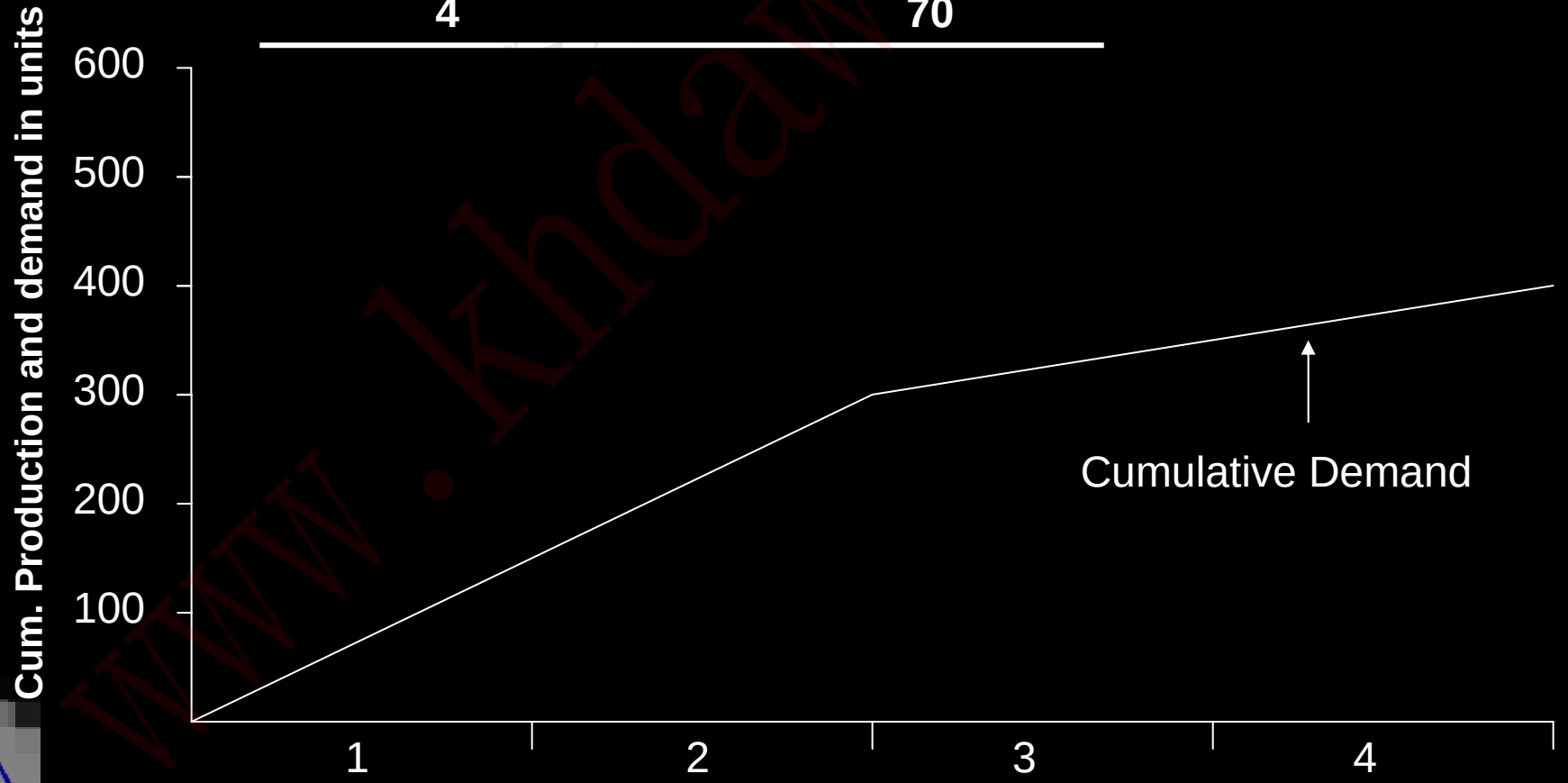
c. The maximum inventory in next year will be 4,000 units. So if one unit occupies 20 cu. ft. , a 80,000 cu. ft. will be necessary and sufficient.

d. If the cost of each completed end item is $600, the maximum amount of capital which will be tied up in finished-goods inventory will be $600 * 4,000 = $2,400,000 during the next year.

7.7 Below is the plotted cumulative demand for Joan's Joyous Nature Food (in products) for the next four months. Beginning inventory is 10 pounds.

Month	Demand
1	120
2	160
3	20
4	70



a. How much should Joan produce each month if she wishes to have a level production plan with no back orders or stockouts? Plot your cumulative production on the preceding graph.

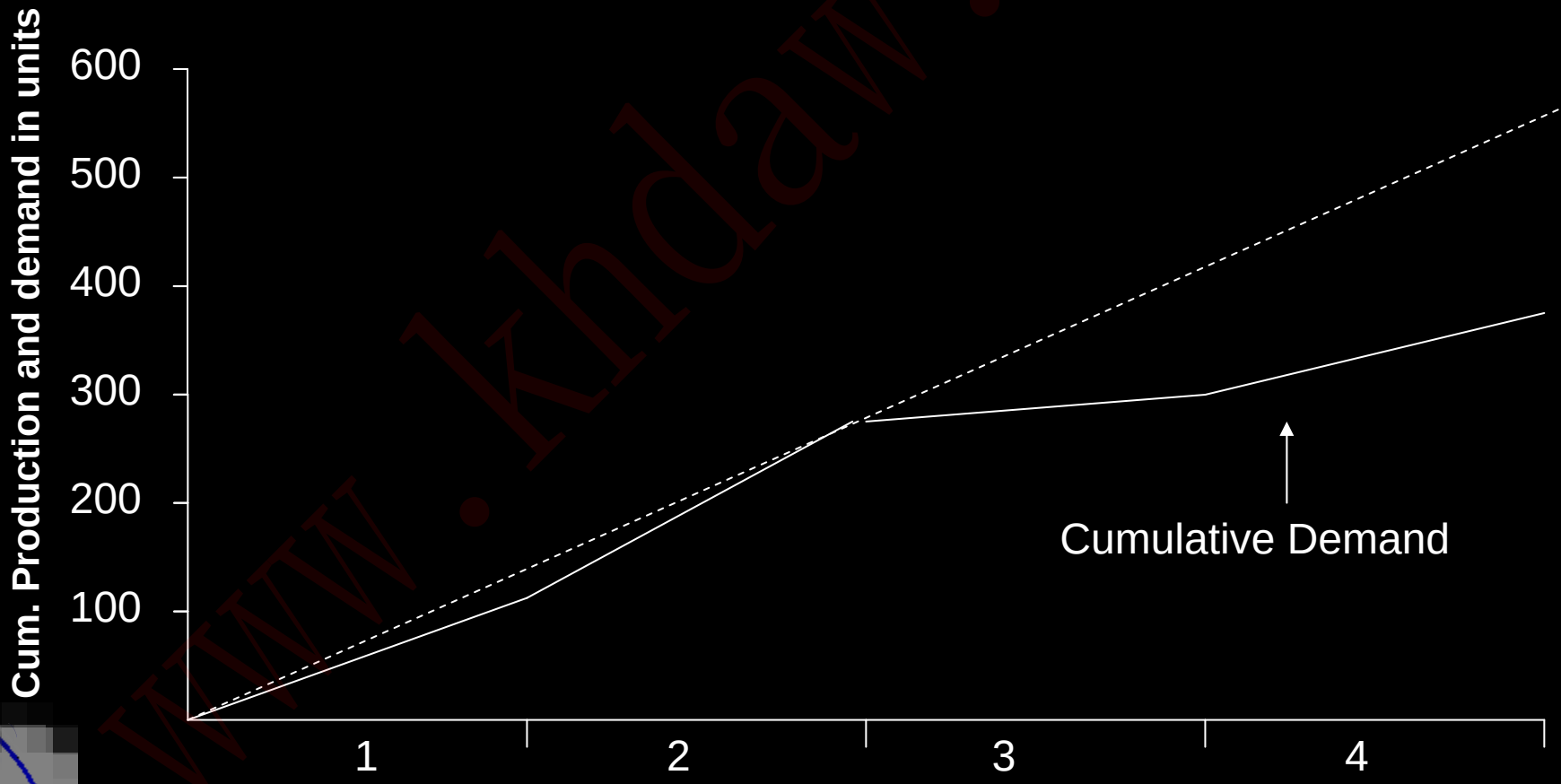
b. What is the ending inventory for month 4 under this plan?

c. Joan decides to have a level-production, level-employment production plan with no ending inventory at the end of the planning horizon. How much should she make each month? What are the monthly back orders?

d. Given inventory carrying costs of $5/pound/month (on the average inventory) and back orders of $8/pound/month (based on month-end back orders), calculate the cost of back orders and inventory for the plan in part c.

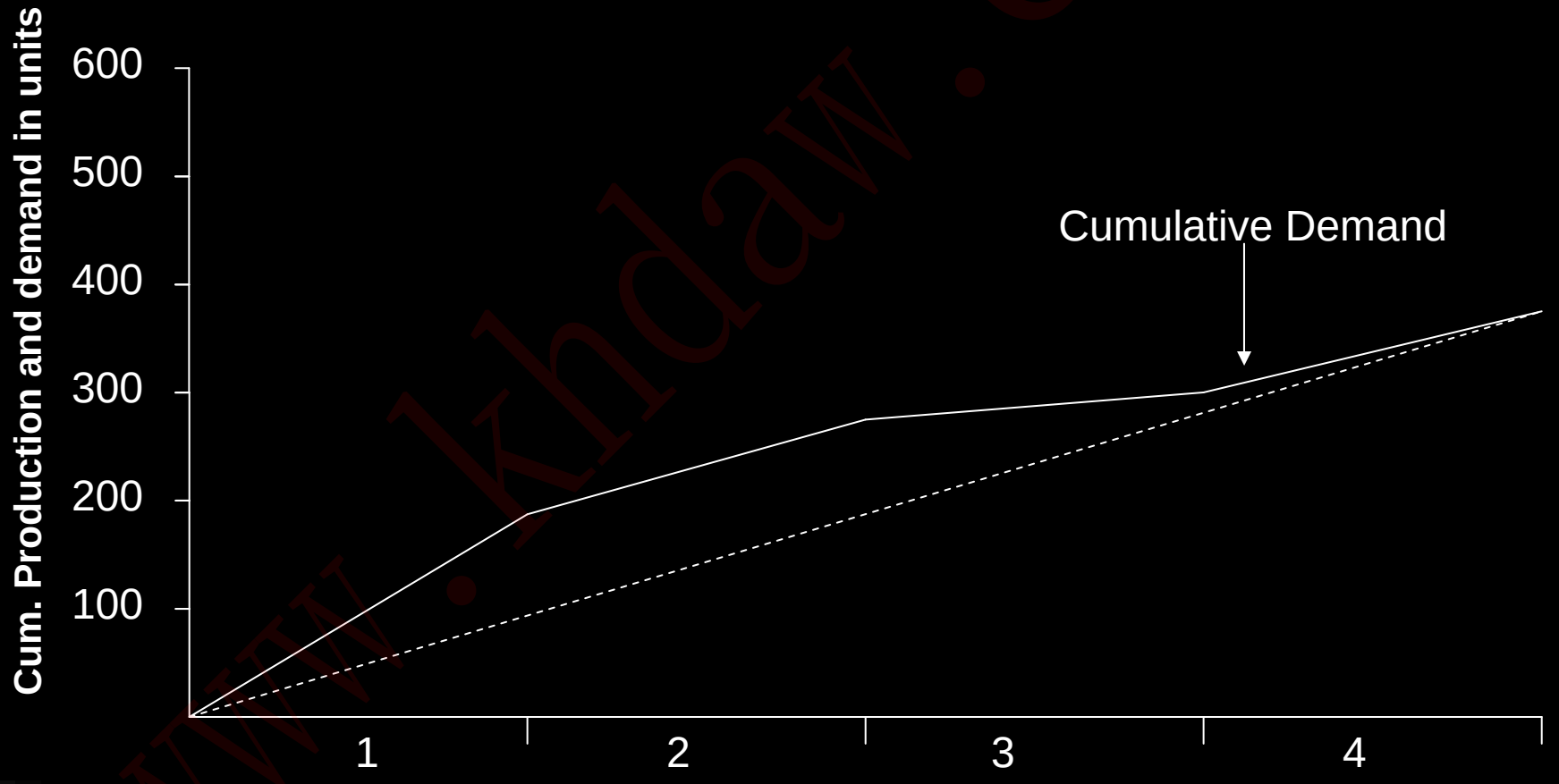
ANSWER

a. To make no backlog or stockout, the demand in the first two months sums to 280 pounds. With the 10 pounds inventory, There will be a 270 pounds net requirement in the first 2 months. To apply a level production strategy, there will be a average quantity of 270/2=135 pounds per month, so the cumulative chart with a level strategy is shown with the dashed line



b. The inventory at the end of the fourth month will be 135*4+10-370=180 pounds.

c. The demand in each month sums to 370 pounds. With the 10 pounds inventory, There will be a 360 pounds net requirement in the coming 4 months. To apply a level production strategy, there will be a average quantity of 90 pounds per month, so the cumulative chart with a level strategy is shown with the dashed line



d.

Month	Demand	Inventory or Backlog	Quantity	Cost
1	120	Backlog	20	160
2	160	Backlog	90	720
3	20	Backlog	20	160
4	70	None	None	0