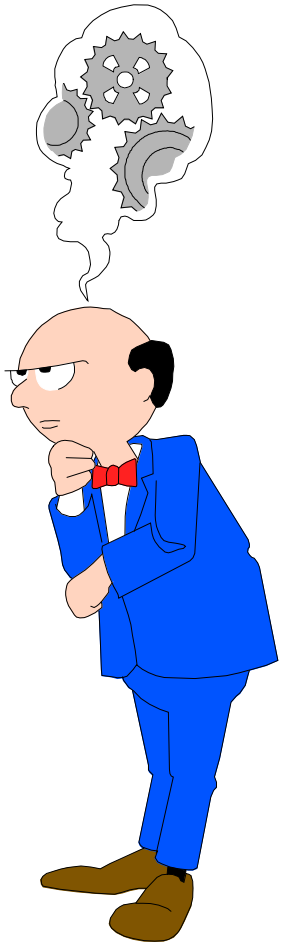
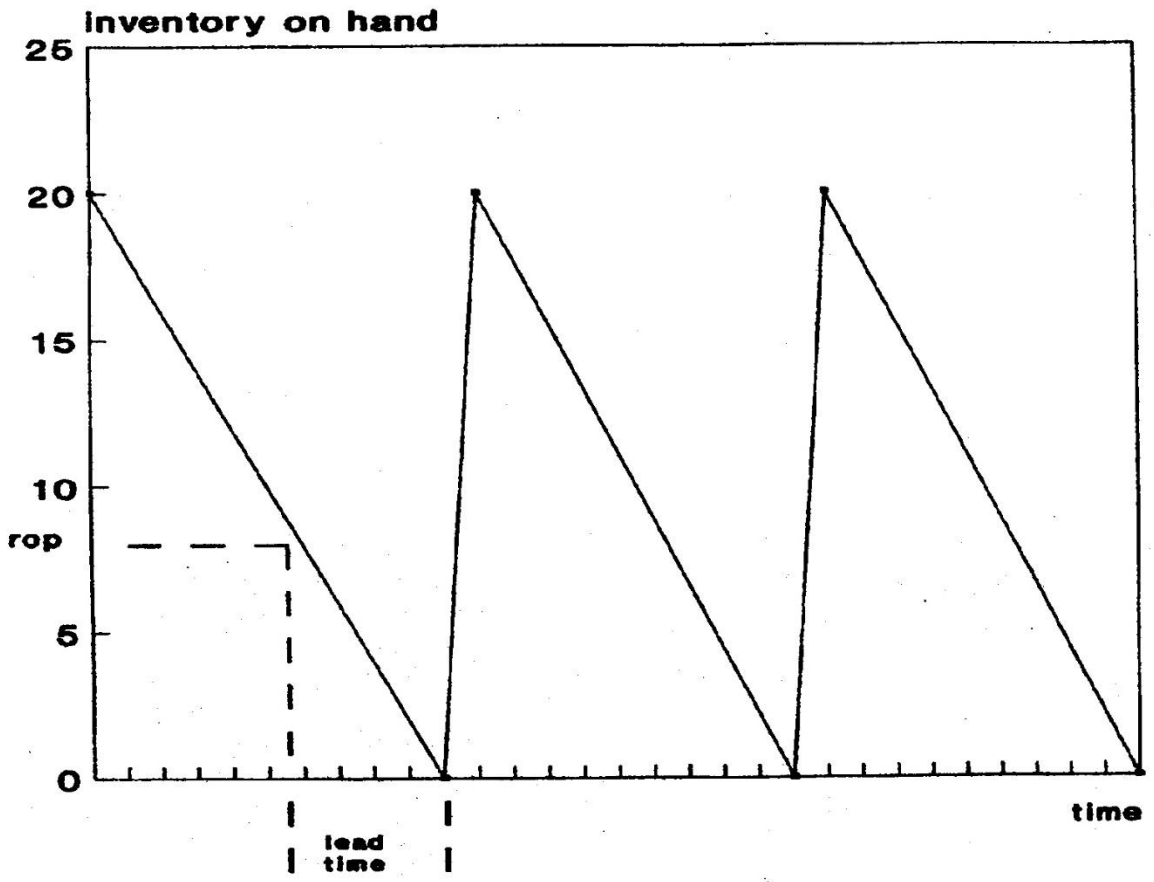
Inventory Control Models

- EOQ/Re-Order Point
  - Also Called Max-Min Model
- Assumptions
  - Demand is Known
  - Demand is Constant
  - Orders are Received on Time
  - Orders are Received in Full
  - Product Cost Does Not Vary
  - No System Constraints

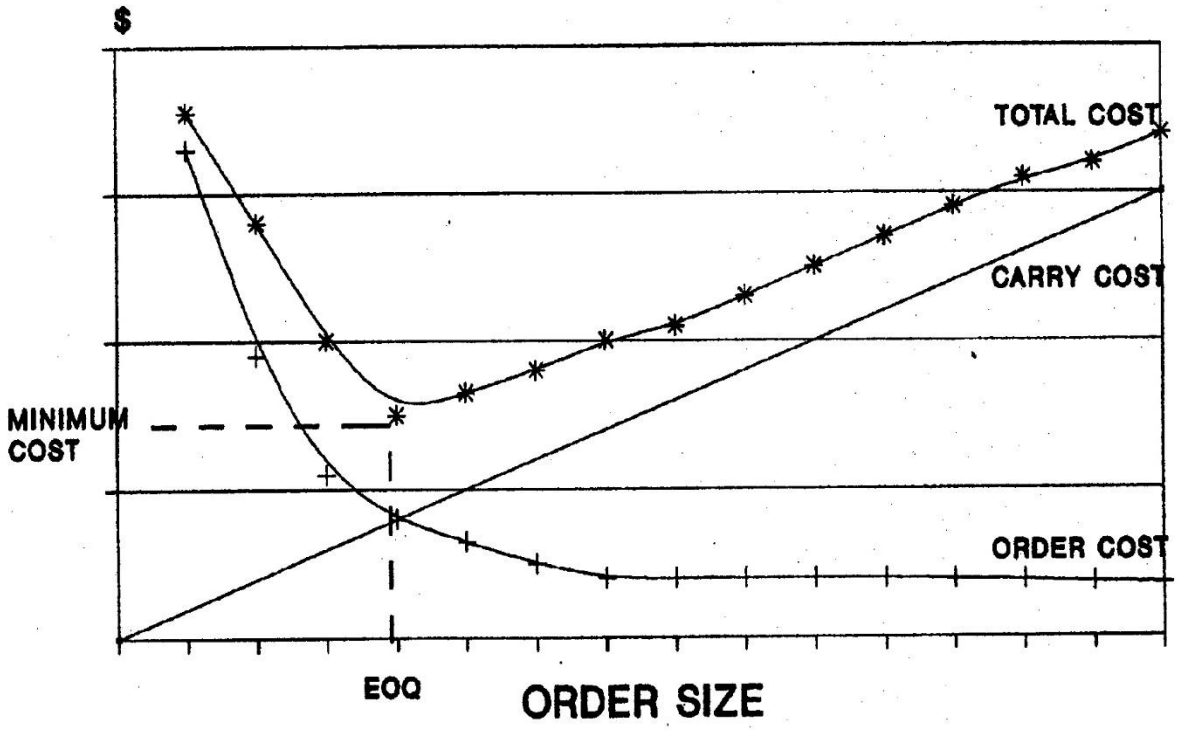


MAX-MIN MODEL
ALSO CALLED EOQ\REORDER



RESEMBLES SAWTOOTH

INVENTORY COST MODEL



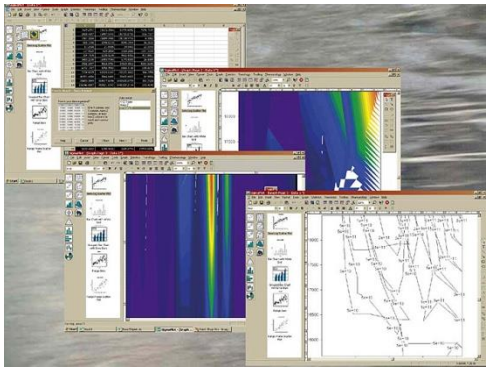
Inventory Problem

- **Annual Usage = 24,000 units**
- **We Order 6 Times Per Year**
- **Price =$10 Each**
- **Annual Usage÷ # of Orders Per Year**

  24,000÷6=4,000 units per order
- **Maximum Level=4,000**
- **Minimum Level =0**
- **Average Level=4,000÷2**

  =2,000
- **Average $ Investment=2,000*10**

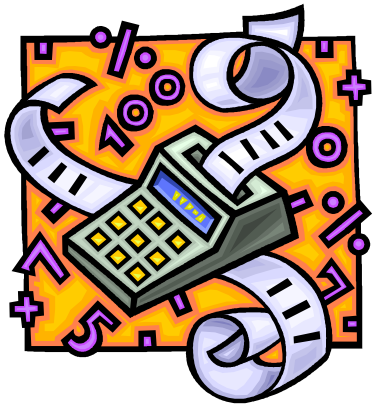
  =$20,000



$$EOQ = \sqrt{(2*OC*AU) \div (P*CC(decimal))}$$

- order cost=15
- annual usage=15,000 units
- price= $5
- carry cost = 25 %
  - we will express as .25

- EOQ= $\sqrt{(2*15*15{,}000) \div (5*.25)}$
- =600
- Note: Variables included in EOQ
- Order Cost
- Annual Usage
- Price
- Carry Cost
- Lead Time is **NOT** included in EOQ Calculations
-



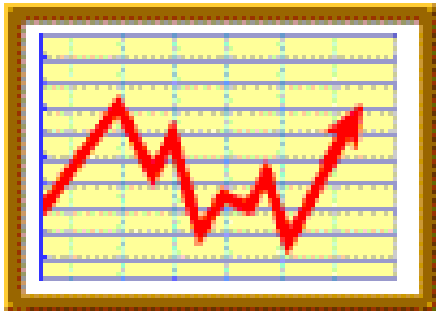
Inventory Cost At EOQ

- Total Annual Order Cost =(AU÷EOQ)*OC
- =(15,000÷600)*15
- =25*15
- =$375
- Total Annual Carry Cost
- =((EOQ*P) ÷2)*CC(as a decimal)
- =((600*5) ÷2)*.25
- =375
- Total Cost =Order Cost+Carry Cost
- =375+375
- =$750

What Happens To Cost If We Order Some Quantity Other Than EOQ?

- Cost Goes UP
- Example
- What If We Ordered 1,500?

- Order cost= (15,000÷1,500)*15
  - »= 10 orders*15= $150
- Carry cost = ((1,500*5)÷2)*.25
  - »= 937.5
  - »Total Cost= $1,087.50
- 1,087.5-750= 337.5

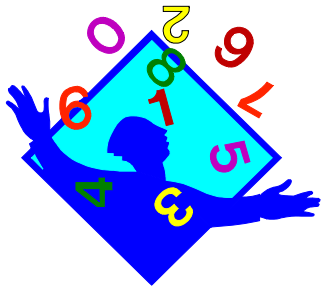


Quantity Discount

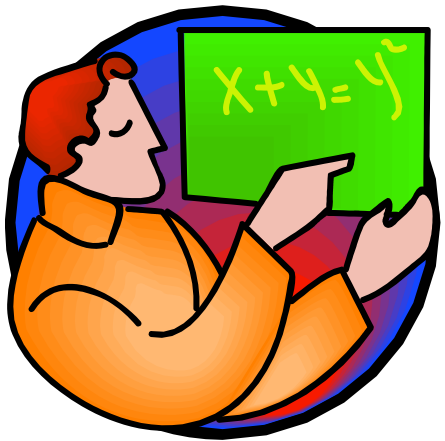
- order cost 15
- carry cost .30
- annual usage 36,000 units
- price 10 or 9.80 if 6,000 are ordered
- EOQ = 600

EOQ/Discount Problem

- EOQ
- material 36,000*10 360,000
- order cost (36,000÷600)*15 900
- carry cost ((600*10)÷2)*.30 900
- total 361,800

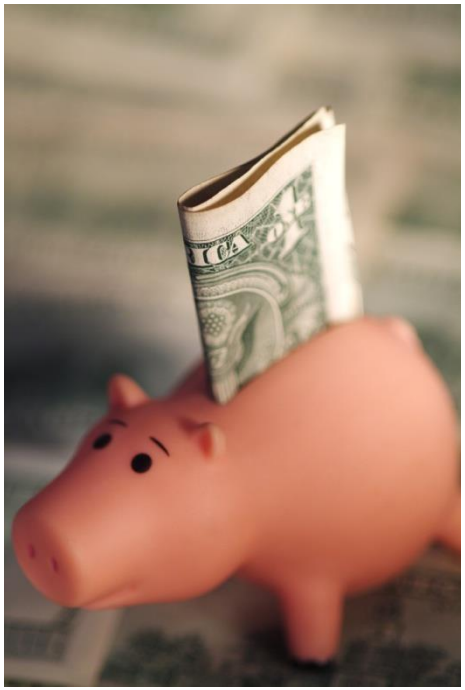


- Discount
- material 36,000*9.8 352,800
- order cost (36,000÷6,000)*15 90
- carry cost ((6,000*9.8)÷2)*.3 8,820
- total 361,710



- Savings
- EOQ 361,800
- minus discount - 361,710

» = 90



Discount

$

Avg
Inventory

EOQ

Avg
Inventory

Time

Return on Investment=

Savings÷Investment

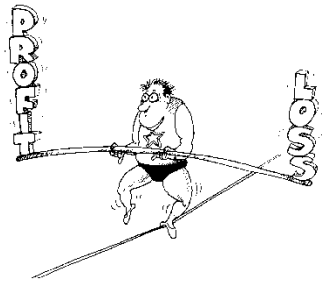
Savings = $90

Discount Average Investment

=6,000*9.8÷2 = 29,400

EOQ Average Investment

=600*10÷2 = 3,000



Extra investment required = 29,400

\- 3,000

= 26,400

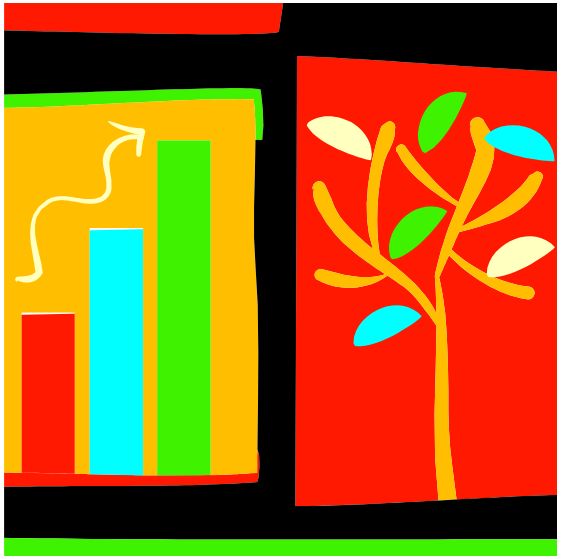
Return on Investment=

Savings/Investment 90÷26,400

= .0033 or .33%

Less than a 1% ROI

- What if the vendor offered the same discount for only buying 3,000 units ?



- Discount
- material 36,000*9.8 352,800
- order cost (36,000÷3,000)*15 180
- carry cost ((3,000*9.8)÷2)*.3 4,410
- total 357,390

- Savings
- EOQ 361,800
- minus discount - 357,390

» = 4,410

Discount Average Investment

=3,000*9.8÷2 = 14,700

EOQ Average Investment

=600*10÷2 = 3,000

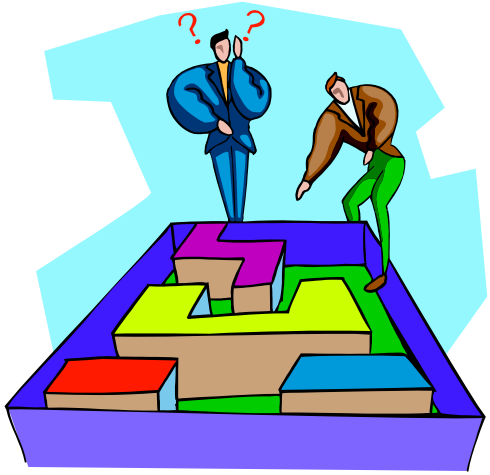
Extra investment required = 11,700

Return on Investment=

Savings/Investment 4,410÷11,700

= .38 or 38%

Additional Problems (not homework)



- Order cost 10
- Carry cost 20%
- Annual usage 10,000
- Price $ 4
- EOQ = 500
- How much would we save by ordering EOQ
- rather than current approach of ordering a
- 3 month supply?
- Savings = 640

Additional Problems (not homework)

- order cost 15
- carry cost .25
- annual usage 1,500
- price $8 or 7.50 if 500 are ordered
- EOQ 150
- Should we take the discount?
- savings 536.25
- extra investment 1,275
- return extra investment = .42 or 42 %

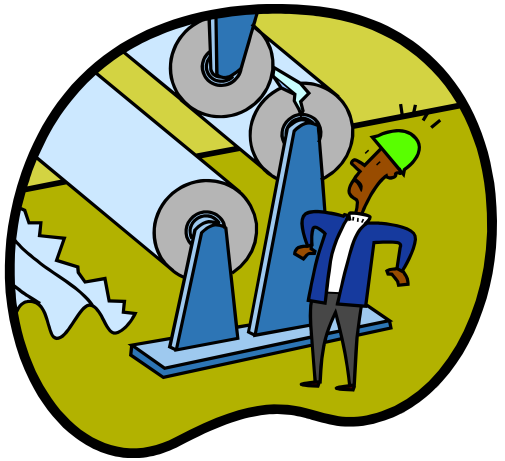
HOMEWORK PROBLEMS
OPERATIONS MANAGEMENT

- 13
- Order cost $25
- Carry cost .25
- Annual usage = 5,000 units
- Price = $ 10 or $9.75 is 500 ordered
- ROI = 1.37 (137%)

- 14
- Order cost $33
- Carry cost .30
- Annual usage = 250 units
- Price $100 or $95 if 100 ordered
- Use the computer program to determine whether or not the discount offer should be taken
- NOTE: When the program asks you for the
- AVERAGE LEAD TIME IN WEEKS?
- Close the program.
- ROI = .12 (12%)

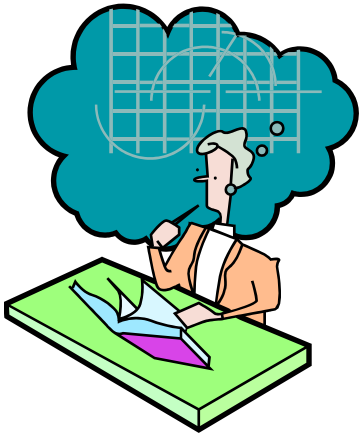
Re-Order Point Problem

- Order cost 12
- Carry cost 20% or .20
- Annual usage 3,000
- Price $4
- Lead Time 3 weeks
- Stockout cost $20 per Stockout
- Weeks of Operation 50
- Orders per year 10



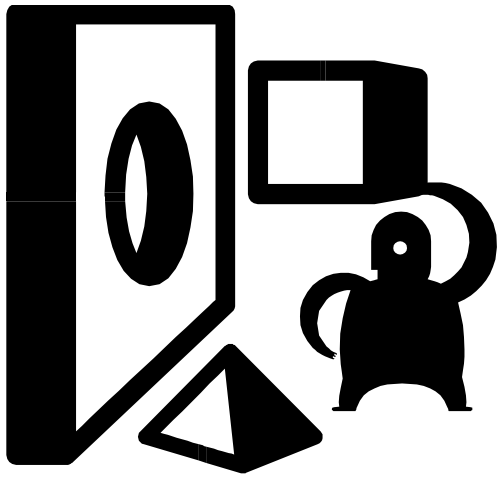
Frequency Distribution Demand

Demand during – avg lead time	frequency (f)	f´ (relative f)
100	4	2
120	10	5
140	18	9
160	32	16
180	70	35
200	28	14
220	20	10
240	12	6
260	6	3
totals	200	100

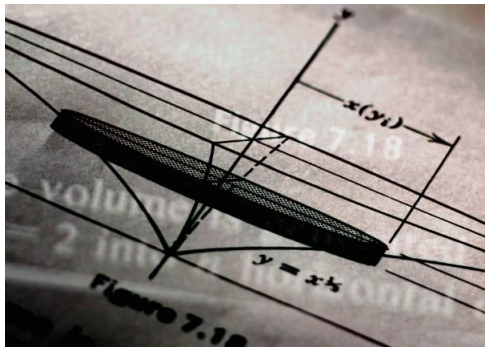


Step 1 Find Avg. Lead Time Usage

- =(annual usage/weeks)*avg lead time
- =(3000/50)*3
- =60*3
- =180



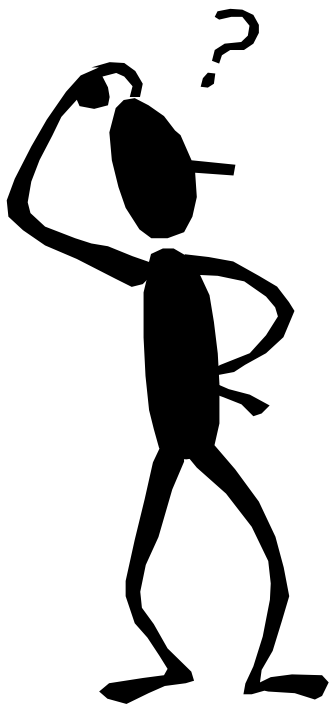
Safety Stock	Order Point	f'	Probability of Stockout	Stockout Cost	Carry Cost	Total Cost
0	180	.35	.33			
20	200	.14	.19			
40	220	.10	.09			
60	240	.06	.03			
80	260	.03	0			



Stockout Cost

- (# of orders*probability of stockout)*stockout cost
- Reorder Point

180	(10*.33)*20 = 66
200	(10*.19)*20 = 38
220	(10*.09)*20 = 18
240	(10*.03)*20 = 6
260	(10*0)*20 = 0

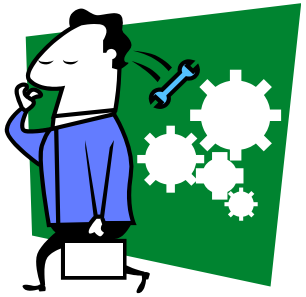


Carry Cost

- =(safety stock level*price)*carry cost (decimal)
- Reorder Point

180	(0*4)*.20 = 0
200	(20*4)*.20 = 16
220	(40*4)*.20 = 32
240	(60*4)*.20 = 48
260	(80*4)*.20 = 64

Safety Stock	Order Point	Probability of Stockout	Stockout Cost	Carry Cost	Total Cost
0	180	.33	66	0	66
20	200	.19	38	16	54
40	**220**	**.09**	**18**	**32**	**50**
60	240	.03	6	48	54
80	260	0	0	64	64



Simulation

- Simulation is used to model complex systems, such as a manufacturing systems, inventory control systems, airplane flights and even war.
- Sometimes mathematical formulas are not useful.
- Simulation can be very helpful in complex environments.

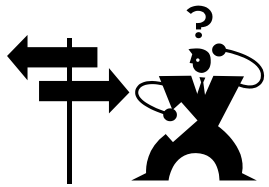
Simulation

- Order cost 10
- Carry Cost $1 per unit per week on the ending balance
- Stockout cost $3 per unit per week
- Balance on hand 12 units
- Order point 7
- Order Quantity 8
- No Open Orders

Lead Time Analysis

Lead Time	f	f'	Cumulative f'	Random #'s
1	2	8	8	01-08
2	6	24	32	09-32
3	11	44	76	33-76
4	5	20	96	77-96
5	1	4	100	97-00
	25	100		

Demand

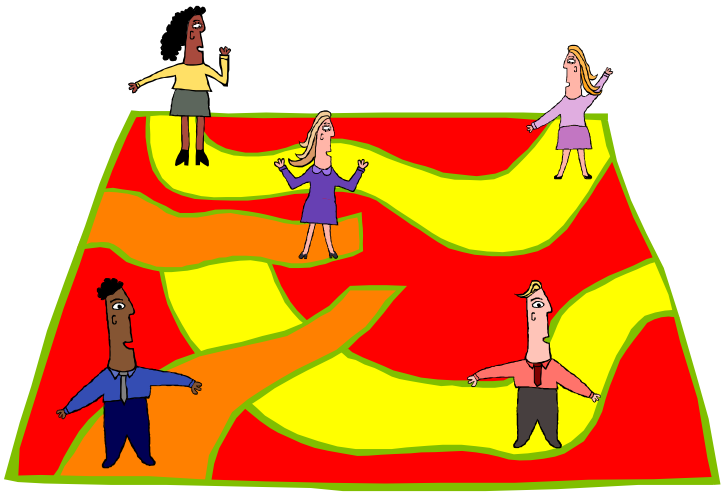


Demand Per Week	f	f'	Cumulative f'	Random #'s
0	1	02	02	01-02
1	6	12	14	03-14
2	9	18	32	15-32
3	19	38	70	33-70
4	8	16	86	71-86
5	5	10	96	87-96
6	2	4	100	97-00
	50	100		

Reorder Question

- On Hand+On Order<=Reorder Point?
- Yes Order
- No Do Not Order

- 1 Week
- 2 Lead Time Random #
- 3 Demand Random #
- 4 Quantity Ordered
- 5 Quantity Demanded
- 6 Quantity Received
- 7 Quantity On Hand
- 8 Quantity On Hand + Quantity On Order
- 9 Order Cost
- 10 Carry Cost
- 11 Stockout Cost
- 12 Total Cost
- 13 Cumulative Cost



1	2	3	4	5	6	7	8	9	10	11	12	13
Wk	LTRnd	DRnd	Ord	Dem	Rec	Qty	OH+OO	Ord$	Carry$	S/O$	Tot$	Cum$
1		7		1		11	11		11		11	11
2		36		3		8	8		8		8	19
3		29		2		6	6		6		6	25
4	76	79	8	4		2	10	10	2		12	37
5		17		2		0	8				0	37
6		11		1		-1	7			3	3	40
7	27	60	8	3	8	4	12	10	4		14	54
8		42		3		1	9		1		1	55
9		02		0	8	9	9		9		9	64
10		75		4		5	5		5		5	69

week	L.T Rnd	Dem Rnd	Ord	Dem	Rec	on Hand	OH+OO	Ord $	Carry $	S/O $	Tot $	Cum $
1		7		1		11	11		11		11	11
2		36		3		8	8		8		8	19
3		29		2		6	6		6		6	25
4	76	79	8	4		2	10	10	2		12	37
5		17		2		0	8		0		0	37
6		11		1		-1	7			3	3	40
7	27	60	8	3	8	4	12	10	4		14	54
8		42		3		1	9		1		1	55
9		2		0	8	9	9		9		9	64
10		75		4		5	5		5		5	69

- Simulation Problem
- Lead Time Weeks Random # Demand per Week Random #
-
- 1 01-03 0 01-06
- 2 04-12 1 07-21
-
- 3 13-49 2 22-63
-
- 4 50-82 3 64-86
- 5 83-00 4 87-98
  - 5 99-00
  -

Order Point 5 Order Quantity 6

- Order Cost 10 Carry Cost $2 per unit per week
- Stock-out Cost $5 per unit per week
- Balance 7 units
- Lead Time Random #’s are 04, 52, 22, 81, 33, 19
-

Wk	LT Rnd #	Dem Rnd #	Qty Dem	Qty Ord.	Qty Rec.	Qty On Hand	Qty On Hand + On Ord	Ord $	Carry $	SOC $	TOT $	Cum Tot $
1		35	2			5	5		10		10	10
2	4	96	4	6		1	7	10	2		12	22
3		39	2			-1	5			5	5	27
4	52	32	2	6	6	3	9	10	6		16	43
5		46	2			1	7		2		2	45
6		72										
7		50										
8		48										
9		91										
10		67										

WEEK	L.T. RND #	DEM RND #	DEMAND	ORD'D	REC'D	BAL	BAL +OO	ORDER COST	CARRY COST	STOCKOUT COST	TTL COST	CUML TOT COST
1		35	2			5	5		10		10	10
2	4	96	4	6		1	7	10	2		12	22
3		39	2			-1	5			5	5	27
4	52	32	2	6	6	3	9	10	6		16	43
5		46	2			1	7		2		2	45
6		72	3			-2	4			10	10	55
7	22	50	2	6		-4	8	10		20	30	85
8		48	2		6	0	6				0	85
9		91	4			-4	2			20	20	105
10	81	67	3	6	6	-1	5	10		5	15	120

- OPERATIONS MANAGEMENT Homework # 15-17

- HOMEWORK PROBLEM - 50-WEEK SIMULATION
- Order Cost = $28 Average Lead Time in Weeks 1.
- Annual Usage = 5,000 units Stockout Cost = 25
- Price = $22.50 Weeks of Operation 50
- Carry Cost = 40%
- No Discount

Demand during Average Lead Time	Frequency
70	6
80	12
90	20
100	26
110	17
120	8
130	4

OPERATIONS MANAGEMENT Homework # 15-17 cont.

- Remember to enter a negative # for demand when you are finished.
- Stockout Cost on a Per Unit Basis 25
- Beginning Quantity on Hand = 150
- Lead Time Distribution f
- 1 22
- 2 8
- 3 3
- Demand Distribution use same one above since
- Average Lead Time = 1 week
- Run a 50-week simulation
- Also, try at least 2 other combinations of Order Point and
- Order Quantity to see if you can reduce the total cost.