Exercise !

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Superchip

- Firm makes a variety of microprocessors and uses sales dollars as its aggregate production measure. Next year's forecasts are as such;

	Production days	Predicted demand (in $1 000)
1-Jan.	22	3400
2-Feb.	16	3800
3-Mar.	21	2200
4-Apr.	19	1000
5-May.	23	4900
6-June	20	6250
7-July	24	3750
8-Aug.	12	3100
9-Sep.	19	1750
10-Oct.	22	1450
11-Nov.	20	1200
12-Dec.	16	1650

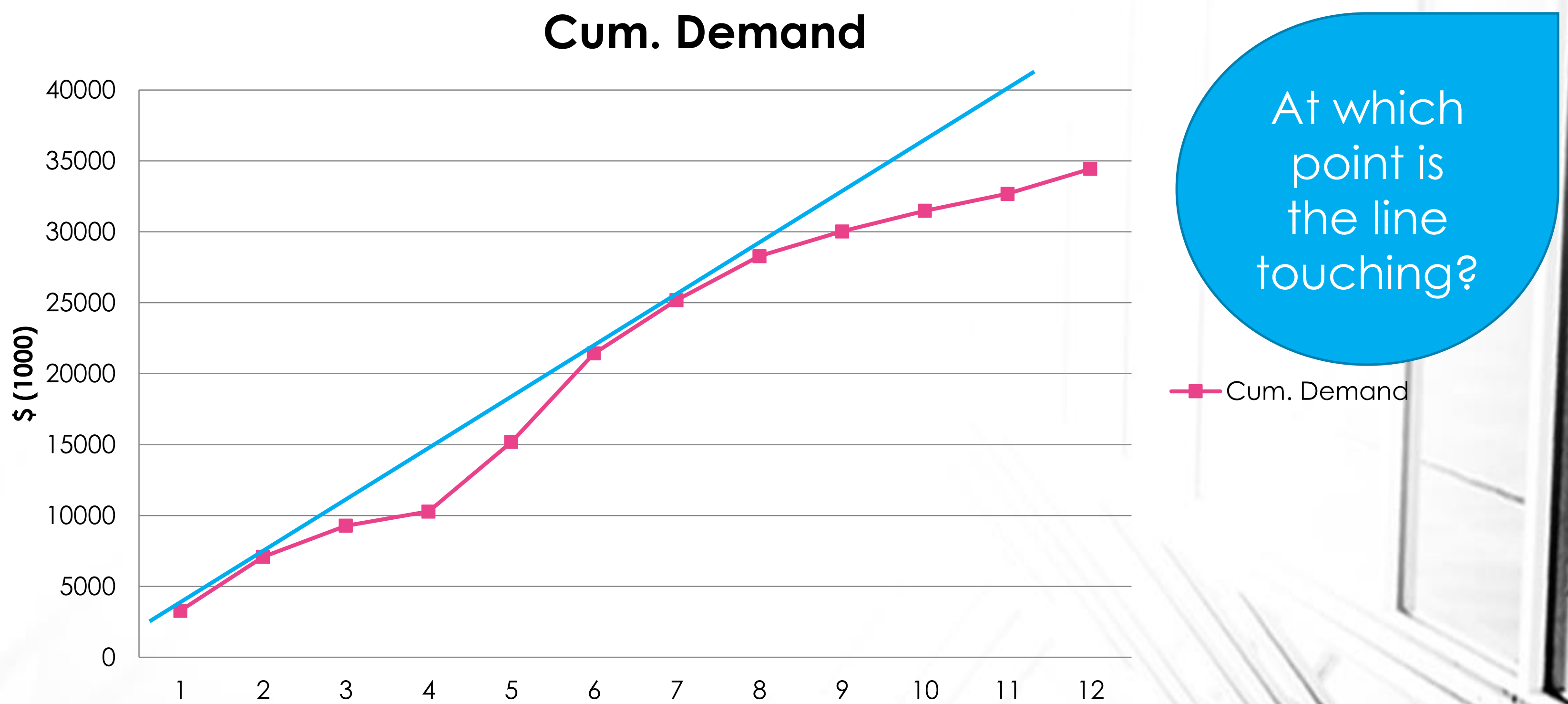
Superchip

- Inventory holding costs are based on a 25% annual interest charge. It is anticipated that there will be 675 workers on the payroll at the end of the current year and inventories will amount to $120 000. The firm would like to have at least $100 000 of inventory at the end of December next year. It is estimated that each worker accounts for an average of $60 000 of production per year (Assume that one year consists of 250 days). The cost of hiring a new worker is $200 and the cost of laying off a worker is $400.

Superchip

- Determine the minimum constant workforce that will meet the predicted demand for the coming year !

K = $60 000 / 250 = $240 per day
Each worker produces $240 value each day on average.



Superchip

- Minimum workforce plan

	Production days	Cumulative net demand ($1000)	Value produced per worker ($1000)	Cumulative value produced per worker ($1000)	Ratio
1-Jan.	22	3280	5.28	5.28	622
2-Feb.	16	7080	3.84	9.12	**777**
3-Mar.	21	9280	5.04	14.16	656
4-Apr.	19	10280	4.56	18.72	550
5-May.	23	15180	5.52	24.24	627
6-June	20	21430	4.80	29.04	738
7-July	24	25180	5.76	34.80	724
8-Aug.	12	28280	2.88	37.68	751
9-Sep.	19	30030	4.56	42.24	711
10-Oct.	22	31480	5.28	47.52	663
11-Nov.	20	32680	4.80	52.32	625
12-Dec.	16	34430	3.84	56.16	614

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- Evaluate the cost of minimum workforce plan.

- C_H = \$200
- C_F= \$400
- Initial # workers = 675 Beg. inv = \$120000
- Workers added = 102 Ending inv = \$100000

Superchip

- Evaluate the cost of minimum workforce plan.

	Production days	Monthly produced value ($1000)	Cum. monthly produced value ($1000)	Cumulative net demand ($1000)	Ending inventory ($1000)
1-Jan.	22	4102.56	4102.56	3280	822.56
2-Feb.	16	2983.68	7086.24	7080	6.24
3-Mar.	21	3916.08	11002.32	9280	1722.32
4-Apr.	19	3543.12	14545.44	10280	4265.44
5-May.	23	4289.04	18834.48	15180	3654.48
6-June	20	3729.60	22564.08	21430	1134.08
7-July	24	4475.52	27039.60	25180	1859.60
8-Aug.	12	2237.76	29277.36	28280	997.36
9-Sep.	19	3543.12	32820.48	30030	2790.48
10-Oct.	22	4102.56	36923.04	31480	5443.04
11-Nov.	20	3729.60	40652.64	32680	7972.64
12-Dec.	16	2983.68	43636.32	34430	9206.32
			TOTAL:		**$39,874.56**

Superchip

- Evaluate the cost of minimum workforce plan.

- Total value of ending inventory

= 39,874,560 + 100,000

= $39,974,560

- 25% annual rate for inventory holding cost.
  - 0,25/12 = 0.020833/$/month

- Inventory holding cost =

$39,974,560 * 0.020833 = $832,790

- Hiring cost, 777-675 = 102 workers to be hired

102*200 = $20,400

- Hence total hiring + inventory costs for the constant work force plan are;

- 20,400+832,790 = **$853,190**

Superchip

- Determine the cost of zero inventory plan

	Production days	Value produced per worker ($1000)	Predicted net demand ($1000)	Min. worker needed
1-Jan.	22	5.28	3280	622
2-Feb.	16	3.84	3800	990
3-Mar.	21	5.04	2200	437
4-Apr.	19	4.56	1000	220
5-May.	23	5.52	4900	888
6-June	20	4.80	6250	1303
7-July	24	5.76	3750	652
8-Aug.	12	2.88	3100	1077
9-Sep.	19	4.56	1750	384
10-Oct.	22	5.28	1450	275
11-Nov.	20	4.80	1200	251
12-Dec.	16	3.84	1750	456

Superchip

- Determine the cost of zero inventory plan

	Min. worker needed	Hired	Fired	Value produced per worker ($1000)	Value produced ($1000)	Cum. Value produced ($1000)	Cum. Net demand ($1000)	Ending inventory ($1000)
1-Jan.	622	0	53	5.28	3284.16	3284.16	3280	4.16
2-Feb.	990	368	0	3.84	3801.60	7085.76	7080	5.76
3-Mar.	437	0	553	5.04	2202.48	9288.24	9280	8.24
4-Apr.	220	0	217	4.56	1000.32	10291.44	10280	11.44
5-May.	888	668	0	5.52	4901.76	15193.20	15180	13.20
6-June	1303	415	0	4.80	6254.40	21447.60	21430	17.60
7-July	652	0	651	5.76	3755.52	25203.12	25180	23.12
8-Aug.	1077	425	0	2.88	3101.76	28304.88	28280	24.88
9-Sep.	384	0	693	4.56	1751.04	30055.92	30030	25.92
10-Oct.	275	0	109	5.28	1452.00	31507.92	31480	27.92
11-Nov.	251	0	24	4.80	1204.80	32712.72	32680	32.72
12-Dec.	456	205	0	3.84	1751.04	34463.76	34430	33.76
TOTAL		2081	2300					$228.72

Superchip

- Determine the cost of zero inventory plan

- Hiring cost = 2081*200 = $416,200
- Firing cost = 2300*400 =$920,000
- Inventory cost = 328,720*0.020833 = $6848.2

- Total cost = **$1,343,048.20**

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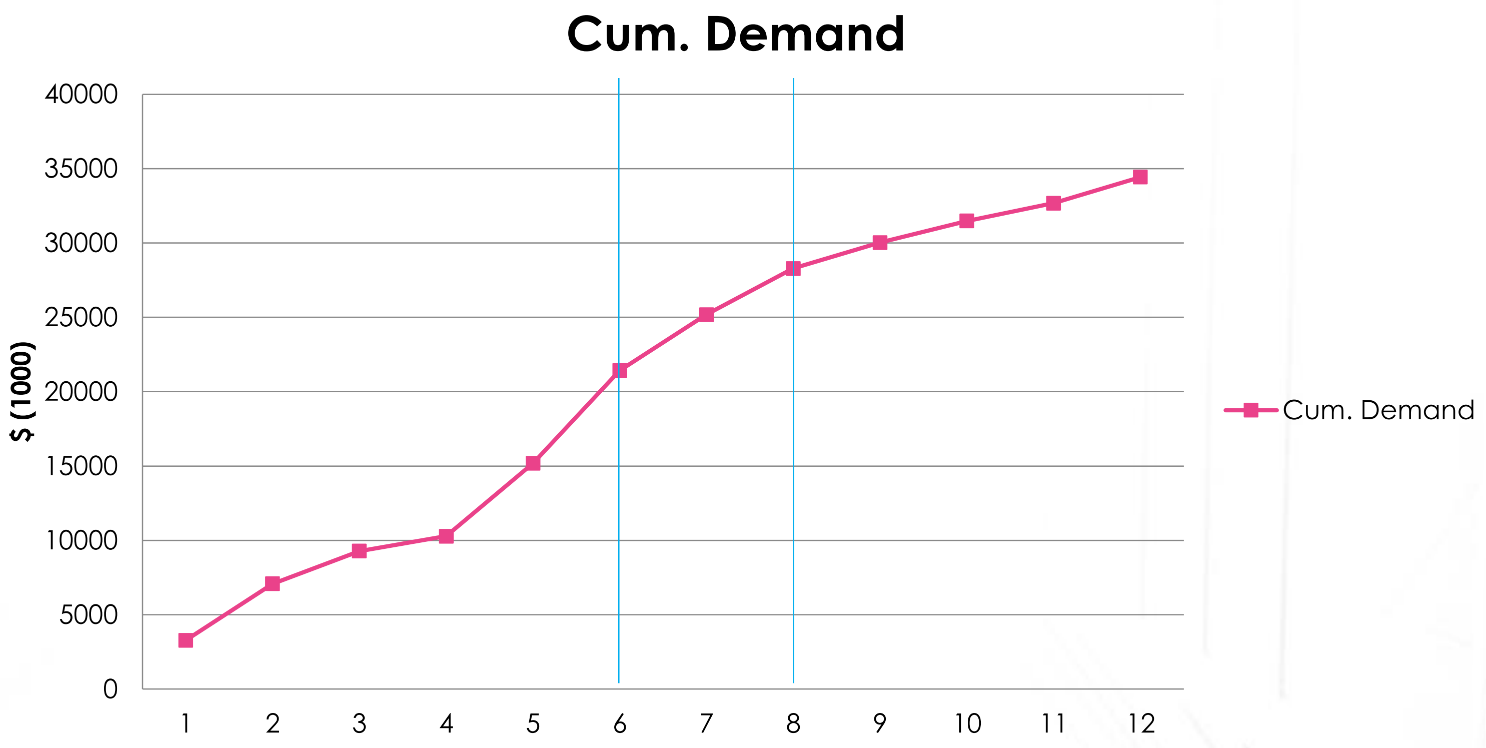
- Graphically determine a production plan with changes **the production level** 2 times and calculate the cost !



A machine shop

A local machine shop buys hex nuts and molly screws from the same supplier. The hex nuts cost 15 cents each and molly screws cost 38 cents each. A setup cost of $100 is assumed for all orders. This includes the cost of tracking and receiving the orders. Holding costs are based on a 25% annual interest rate. The shop uses an average of 20 000 hex nuts and 14 000 molly screws annually.

a) Determine the optimal size of the orders of hex nuts and molly screws, and the optimal time between placement of orders of these two items.

b) If both items are ordered and received simultaneously, the setup cost of $100 applies to the combined order. Compare the average annual cost of holding and setup for following cases;

1. if these items are ordered seperately;
2. If they are both ordered when the hex nuts would normally be ordered
3. If they are both ordered when the molly screws would normally be ordered.

A machine shop

- Determine the optimal size of the orders of hex nuts and molly screws, and the optimal time between placement of orders of these two items.

K = $100

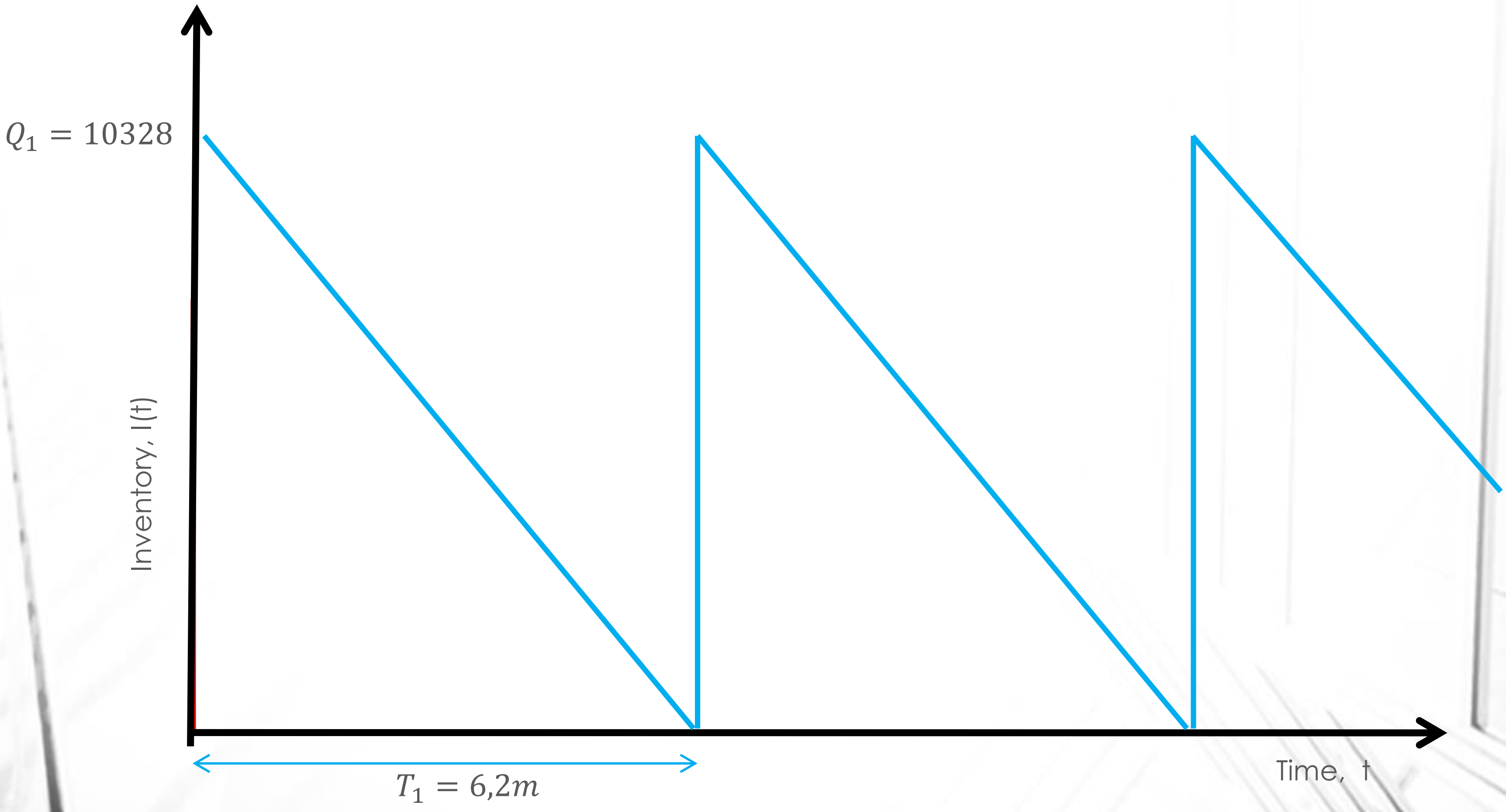
i = 25%

	Hex Nuts	Molly Screws
Unit cost	C_{hn}=$0,15	C_{ms}=$0,38
Yearly demand	λ_{hn}= 20 000	λ_{ms} = 14 000

A machine shop

For hex nuts:

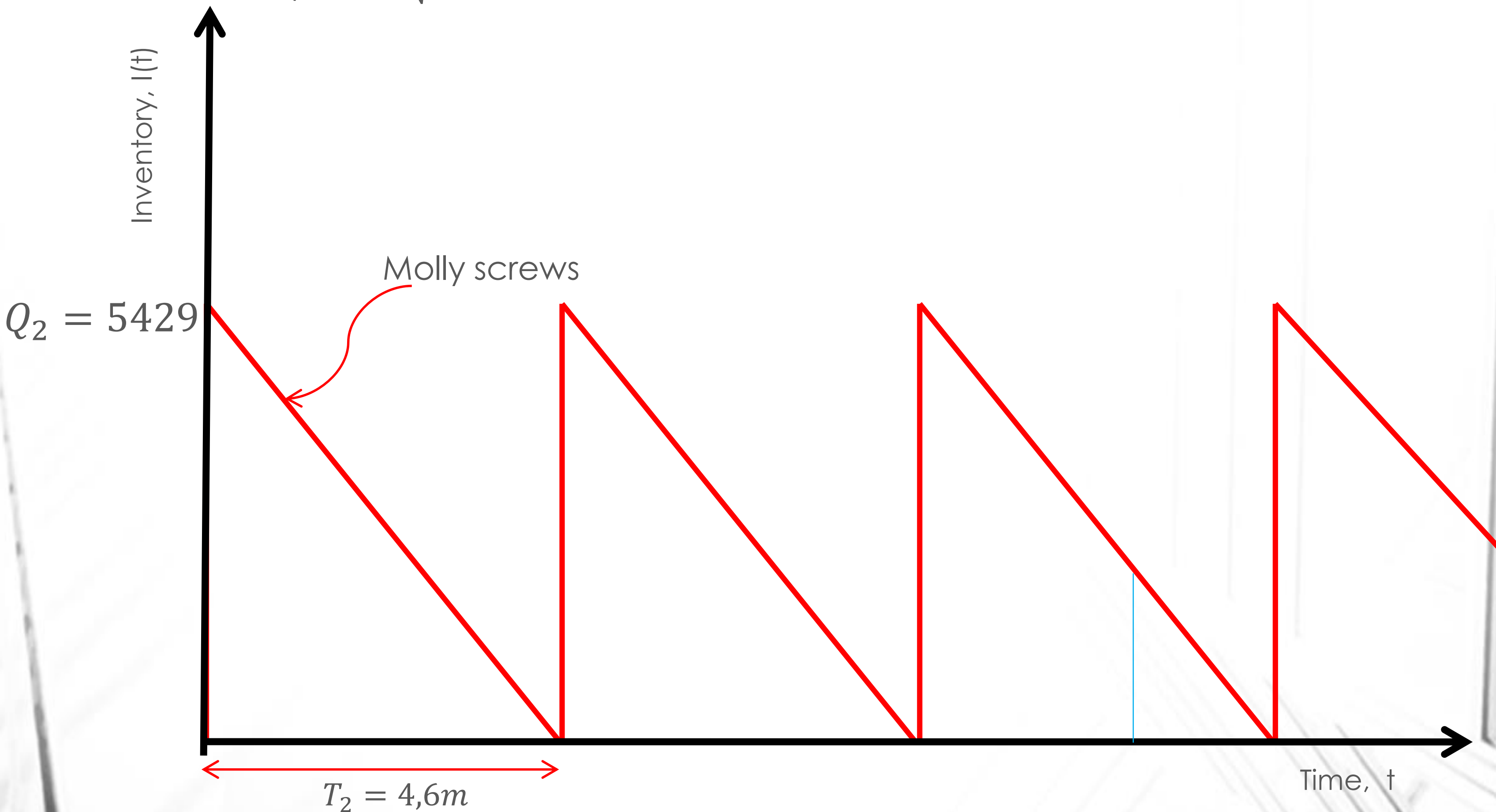
$$Q_1 = \sqrt{\frac{2K\lambda}{h}} = \sqrt{\frac{2*100*20000}{0,25*0,15}} = 10328 \quad T_1 = {}^{Q_1}/_{\lambda} = 0,5164\, yrs = 6,2\, months$$



A machine shop

For Molly screws

$$Q_2 = \sqrt{\frac{2K\lambda}{h}} = \sqrt{\frac{2*100*14000}{0{,}25*0{,}38}} = 5429 \quad T_2 = {}^{Q_2}/_{\lambda} = 0{,}3879\ yrs = 4{,}6\ months$$



A machine shop

If both items are ordered and received simultaneously, the setup cost of $100 applies to the combined order. Compare the average **annual cost of holding and setup** for following cases;

1. if these items are ordered seperately

$$\mathrm{G(Q)} = \frac{K\lambda}{Q} + \frac{hQ}{2} \qquad \& \qquad Q = \sqrt{\frac{2K\lambda}{h}}$$

$$\mathrm{G(Q)} = \sqrt{2K\lambda h} = \sqrt{2K\lambda ic}$$

$$\mathrm{G(Q)} = Cost\ of\ hex\ nuts + cost\ of\ molly\ screws$$

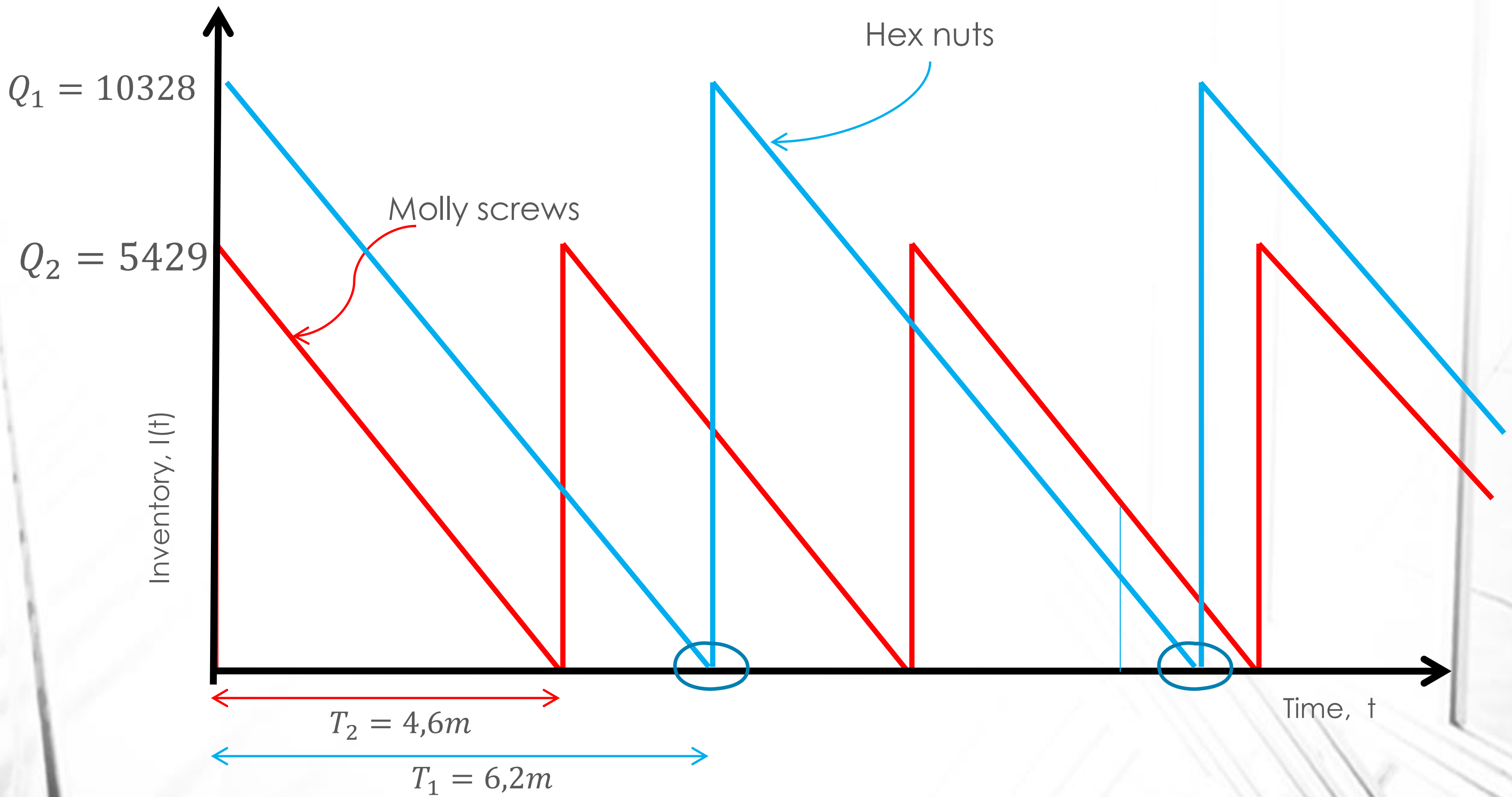
$$= \sqrt{2 * 100 * 20\,000 * 0{,}25 * 0{,}15} + \sqrt{2 * 100 * 14\,000 * 0{,}25 * 0{,}38}$$

$$= \$387{,}3 + \$515{,}75 = \$903{,}05$$

A machine shop

If both items are ordered and received simultaneously, the setup cost of $100 applies to the combined order. Compare the average annual cost of holding and setup for following cases;

2- If they are both ordered when the hex nuts would normally be ordered



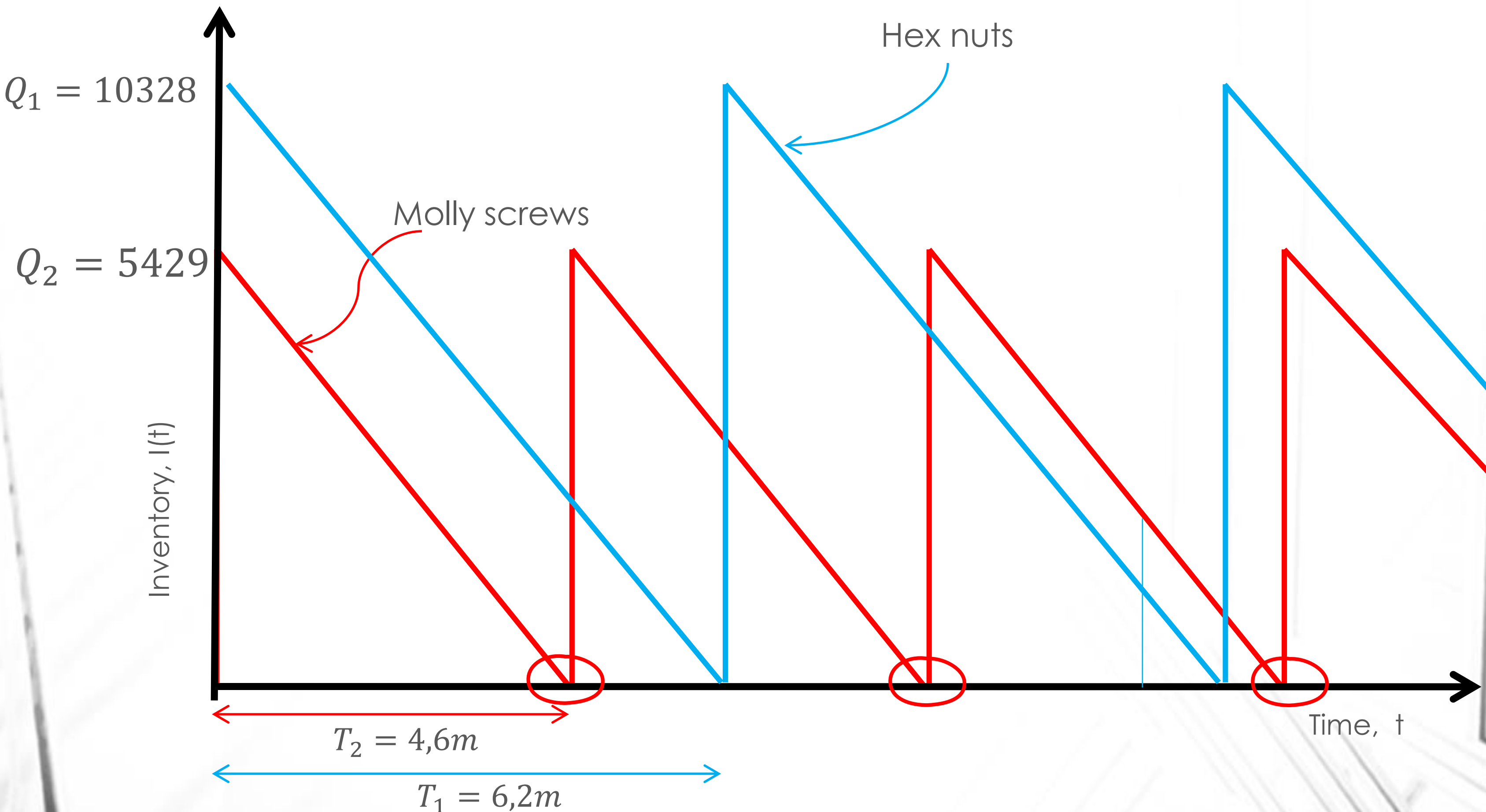
A machine shop

- If both products are ordered when the hex nuts are ordered (every 6,2 months), then hex nut cost is the same.
- Molly screw cost is only the holding cost.
- $Q_{Molly\ screw} = 14\ 000 * 0{,}5164 = 7230$
- $Holding\ cost_{Molly\ screw} = {}^{7230}/_{2} * 0{,}25 * 0{,}38 = \$343{,}43$
- Total cost of this policy = $387,3 + $343,43 =$730,73
- a savings of $172.34 annually from ordering separately

A machine shop

If both items are ordered and received simultaneously, the setup cost of $100 applies to the combined order. Compare the average annual cost of holding and setup for following cases;

2- If they are <u>both ordered when the molly screws would normally be ordered</u>.



A machine shop

- If both products are ordered when the molly screws are normally ordered (every 4,6 months), then the lot size for the hex nuts is: Molly screw cost is only the holding cost.
- $Q_{Hex\ nuts} = 20\ 000 * 0{,}3878 = 7756$
- $Holding\ cost_{Hex\ nuts} = {}^{7756}/_{2} * 0{,}25 * 0{,}15 = \$145{,}43$
- Total cost of this policy = $515,75 + $145,43 =$661,18
- a savings of $241.87 over ordering separately

Wod Chemical Company

- The Wod Chemical Company produces a chemical compund that is used as a lawn fertiziler. The compound can be produced at a rate of 10 000 pounds per day. Annual demand for the compound is 0.6 million pounds per year. The fixed cost of setting up for a production run of the chemical is $1500, and the variable cost of production is $3.50 per pound. The company uses an interest rate of 22 percent to account for the cost of capital and the costs of storage and handling of the chemical account to 12 percent of the value. Assume that there are 250 working days in a year.
  1. What is the optimal size of the production run for this particular compound?
  2. What proportion of each production cycle consists of uptime and what proportion consists of downtime?
  3. What is the average annual cost of holding and setup attributed to this item? If the compound sells for $3.9 per pound, what is the annual profit the company is realizing from this item?

Wod Chemical Company

$P = 10{,}000$ lbs/day

$\lambda = .6 \times 10^6$ lbs/year $= .6 \times 10^6/250 = 2400$ lbs/day

$K = \$1500$

$c = \$3.50$

$i = .22 + .12 = .34$ annual

Wod Chemical Company

(1) What is the optimal size of the production run for this particular compound?

h′ = i*c*(1 - λ/P) = (.34)(3.50)(1 - 2400/10,000) = 0.9044

$$EPQ = Q^* = \sqrt{\frac{2K\lambda}{h(1-\frac{\lambda}{P})}}$$

$$Q = \sqrt{\frac{2 * K * \lambda}{h'}} = \sqrt{\frac{2 * 1500 * 2400 * 250}{0.9044}} = 44612$$

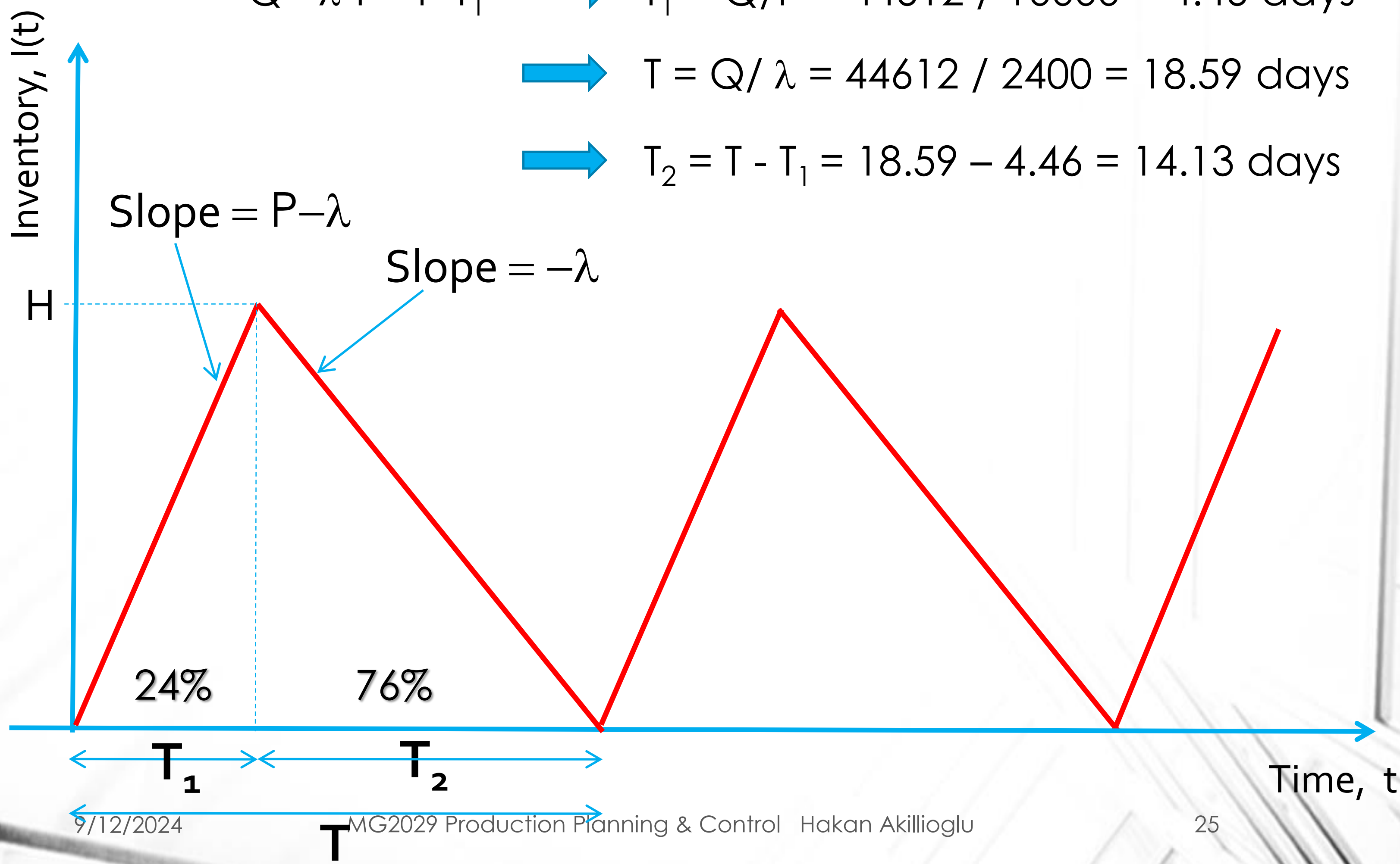
Wod Chemical Company

(2) What proportion of each production cycle consists of uptime and what proportion consists of downtime?

$Q = \lambda T = P T_1$ ➡ $T_1 = Q/P = 44612 / 10000 = 4.46$ days

➡ $T = Q/\lambda = 44612 / 2400 = 18.59$ days

➡ $T_2 = T - T_1 = 18.59 – 4.46 = 14.13$ days



Wod Chemical Company

(3) What is the average annual cost of holding and setup attributed to this item? If the compound sells for $3.9 per pound, what is the annual profit the company is realizing from this item?

$$Z(Q) = \frac{K}{T} + h\frac{H}{2} = \frac{K\lambda}{Q} + \frac{hQ}{2}\left(1 - \lambda/P\right) = \sqrt{2K\lambda h'}$$

$$= \sqrt{2 * 1500 * 600000 * 0.9044} = \$40{,}347.5$$

the annual profit exclusive of holding and set-up cost is

(3.90 - 3.50)(600,000) = $240,000.00

Hence the profit

$240,000.00 - 40,347.49 = $199,652.51 annually.