Consumables Inventory Management

A Small Case Study

Alexander Szewczak, PhD
Director, Pharmacology
Merck Research Laboratories Boston

Improving Pharma Productivity: Assets Matter

- For an individual, more assets is better. For a company, fewer assets (less invested capital) is better.
- Excess consumables inventory does not show up on the GAAP balance sheet, but it is an unproductive asset nonetheless.

- Well-run, lean companies use as little inventory as possible.
  - Avoid paying for unnecessary storage space
  - Avoid opportunity cost of tied-up capital

Reduce assets to increase return on equity

MRK Selected Financials

$ millions	2013*	2013	2012	2011
Revenue	$ 44,033	$ 44,033	$ 47,267	$ 48,047
Net Income	$ 4,404	$ 4,404	$ 6,168	$ 6,272
Assets	$ 100,363	$ 105,645	$ 106,132	$ 105,128
Liabilities	$ 55,880	$ 55,880	$ 53,112	$ 50,611
Equity	$ 44,483	$ 49,765	$ 53,020	$ 54,517

Source: Yahoo Finance

Dupont 3-component decomposition of ROE

	2013*	2013	2012	2011
Asset Utilization, Sales/Assets	0.439	0.417	0.445	0.457
Profitability, Income/Sales	0.100	0.100	0.130	0.131
Financial Leverage, Assets/Equity	2.256	2.123	2.002	1.928
Return on Equity	0.099	0.088	0.116	0.115

Return on Equity = Sales/Assets x Income/Sales x Assets/Equity

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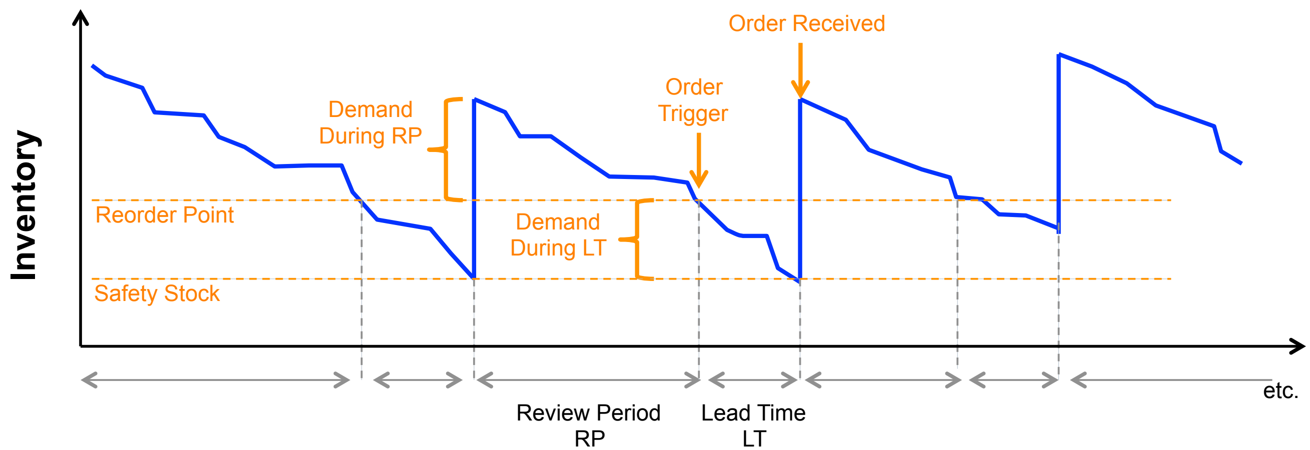
Decreasing assets by 5% increases return on equity by 12%

Modern Inventory Management

- Based on probabilistic models of the risk of stock outs vs. costs of ordering and holding inventory



Safety stock = Reserve stock held to guard against running our of supplies (stock out)
Review Period = Time between receiving an order and placing the next one
Lead Time = Time between placing order and receiving supplies
Demand During Lead Time (DDLT) = Amount of supplies consumed while waiting for order to arrive
Demand During Review Period (DDRP) = Amount consumed during review period
Order Point = Inventory level at which an order is triggered
Order Quantity (Q) = The amount of material ordered at one time
Order Cost = How much it costs to place an individual order
Inventory Holding Cost = How much it costs to hold inventory, % of value per year.

Economic Order Quantity Model

Single instantaneous purchase (Newsvendor Model)

D = Demand -- a random variable, assumed to be normally distributed

c = unit cost

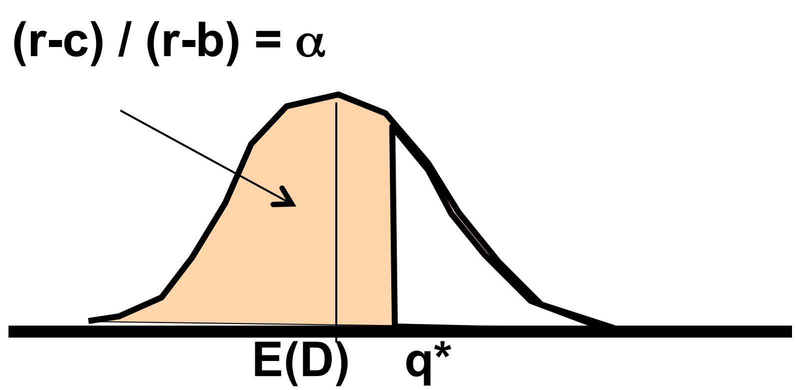
r = unit revenue

b = unit salvage value (r > c > b)

q* = Quantity to order

Find optimum balance between under order (r-c) vs. over order (c-b) – maximize profit

$$P(D \leq q^*) = (r-c) / r-b) = (r-c) / ((r-c) + (c-b)) = u / (u + o)$$



If D Normal(μ,σ)

$q^* = \mu + k^*\sigma$

α = 95% -> k = 1.64

α = 99% -> k = 2.32

α = 99.9% -> k = 3.09

Economic Order Quantity Model, continued

Optimal Ordering Quantity

Q = Order Quantity

D = Demand Rate (units/time)

C = Purchasing Cost ($/unit)

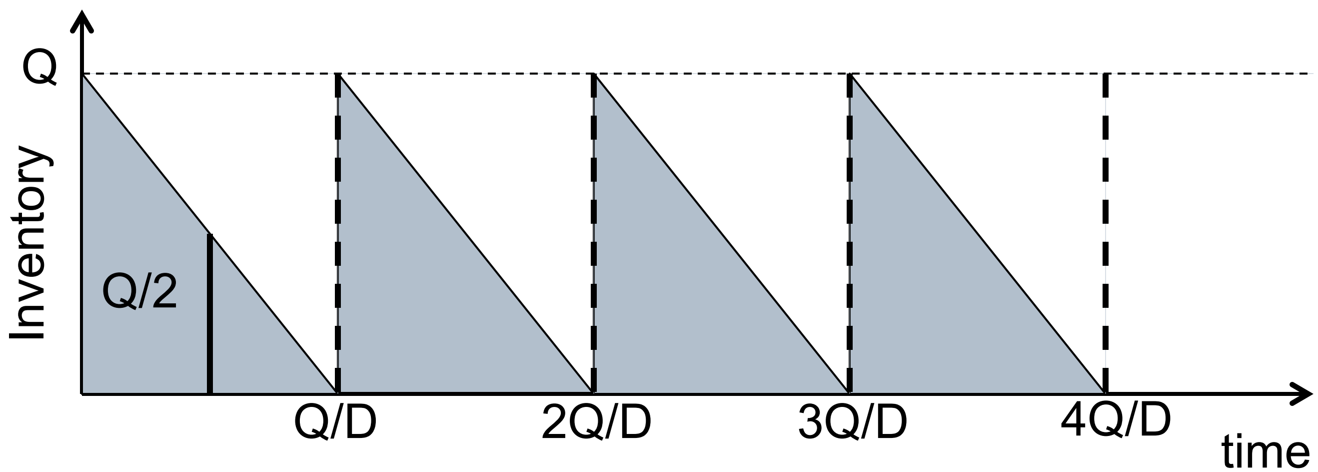
F = Fixed Order Cost ($)

H = Inventory Holding Cost Rate (% of inventory value per unit time)

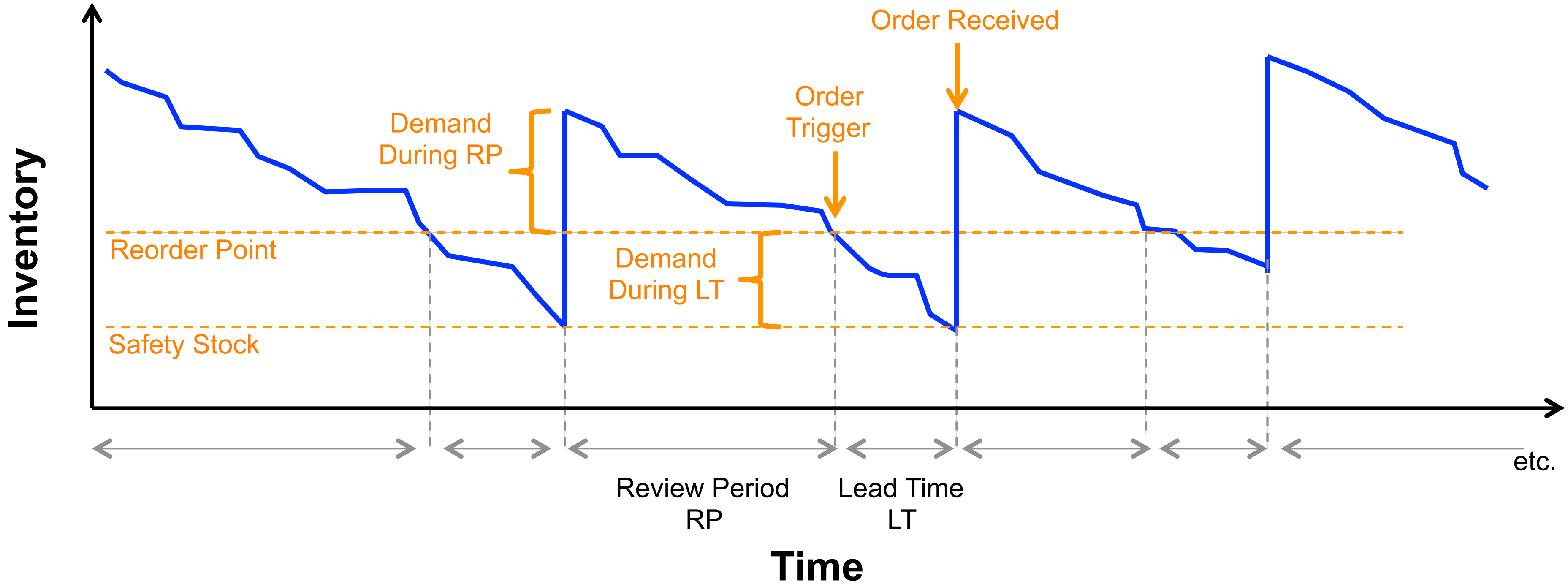
Q = sqrt((2D*F)/(C*H))

Inventory Holding Cost = C * H * (Q/2); Order Cost = F * (D/Q);

Total Cost = V(Q) = F * (D/Q) + C*H*(Q/2)



Periodic Review Model



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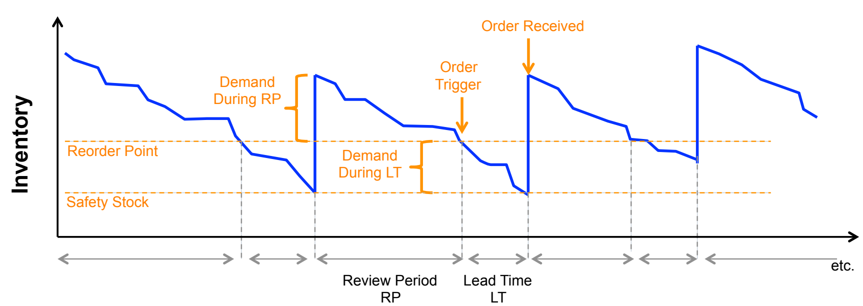
Periodic Review Model

Continuous review, "Order Q whenever inventory reaches R"

- Set Q as the EOQ solution
- Set R as the Newsvendor solution: P(DDLT ≤ R) = α
  where α is the desired service level (e.g. 95%) and DDLT = Demand During Lead Time

R = E(DDLT) + kσ(DDLT)

Q = sqrt((2DF)/(CH))

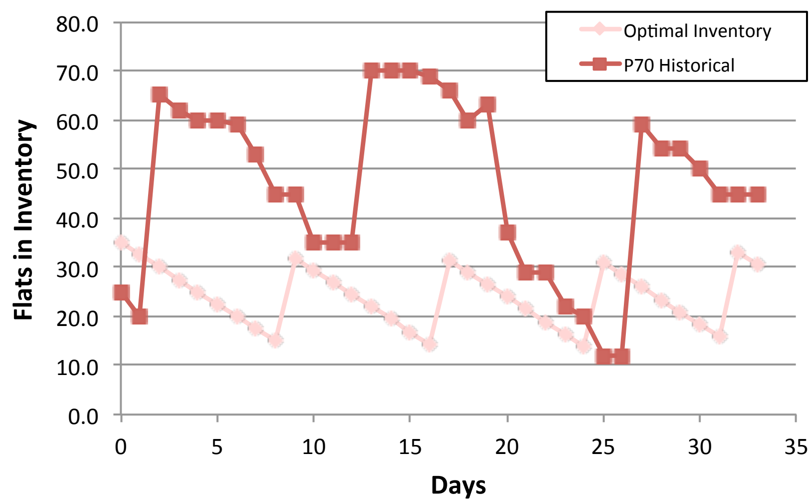


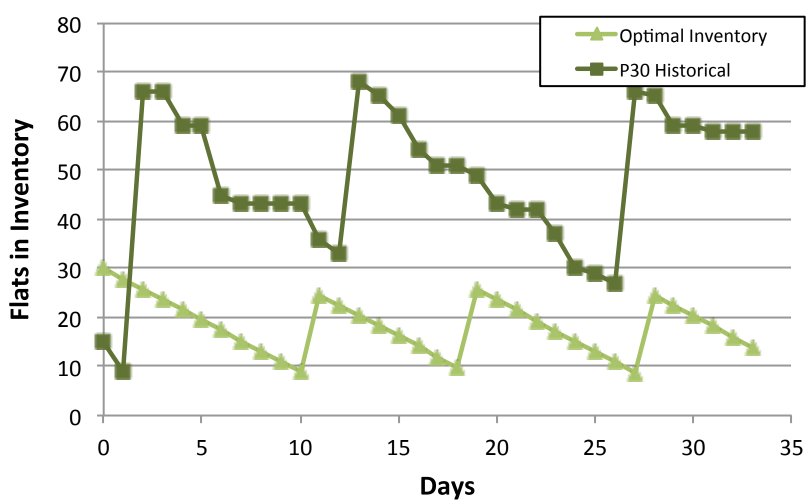
Real World Example

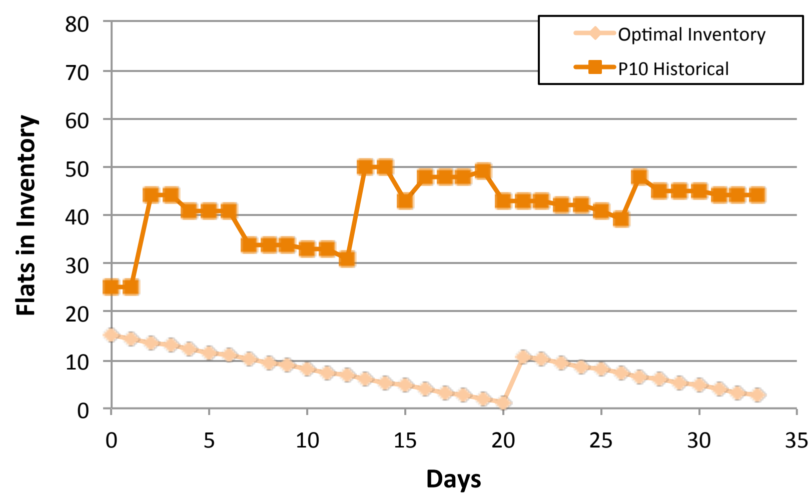
- In Vitro Pharmacology Automation Lab
- Eight liquid handler workstations for compound and reagent dispensing
  - Three tip sizes: 70, 30, 10 uL
  - Inventory stocked in the automation lab

Optimal vs. Historical Inventory

- Calculated optimal inventory based on expected demand and variability
- Optimal inventories are much lower!







Calculations

Economic Order Quantity (EOQ) Model	70 uL	30 uL	10 uL
Order Quantity, Q (units) =	19.6	17.9	10.2
Demand Rate DDLTRP/(LT+RP), D (units/time)	2.51	2.11	0.69
Purchasing Cost, C ($/unit)	$ 400	$ 400	$ 400
Fixed Order Cost, F ($)	$ 25	$ 25	$ 25
Annual Inventory Holding Cost Rate %/$/year)	30%	30%	30%

Continuous Review (R,Q) Model	70 uL	30 uL	10 uL
Order trigger level, R = E(DDLT) + k * sigma(DDLT)	28.8	20.7	5.1
Q from EOQ model above	19.6	17.9	10.2
Desired Service Level, alpha (%)	99.9%	99.0%	99.0%
k (95% = 1.64, 99% = 2.32, 99.9% = 3.09)	3.09	2.32	2.32

Results

	70 uL	30 uL	10 uL	Total
Historical Average Daily Inventory	48	36	24	108
Average Daily Reduction in Inventory	23	22	20	65
Value of Inventory Reduction @ $400/flat	$ 9,233	$ 8,982	$ 7,904	$ 26,119
Yearly Holding Cost @ 30%	$ 2,770	$ 2,695	$ 2,371	$ 7,836
Five Year Present Value of Inventory Savings				$ 58,248

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(For only one lab, one type of liquid handler)

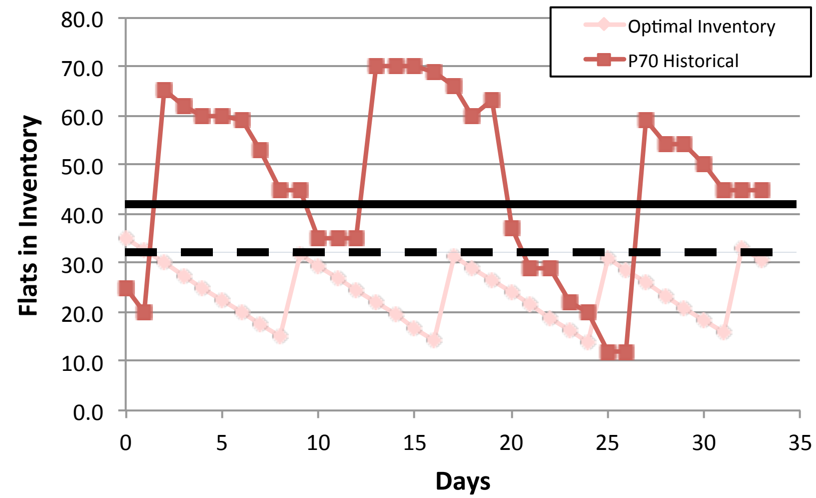
Before and After?

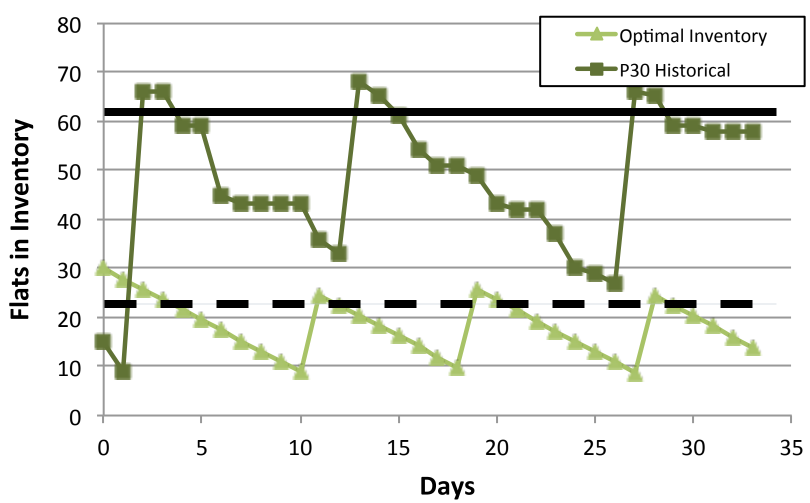
No!

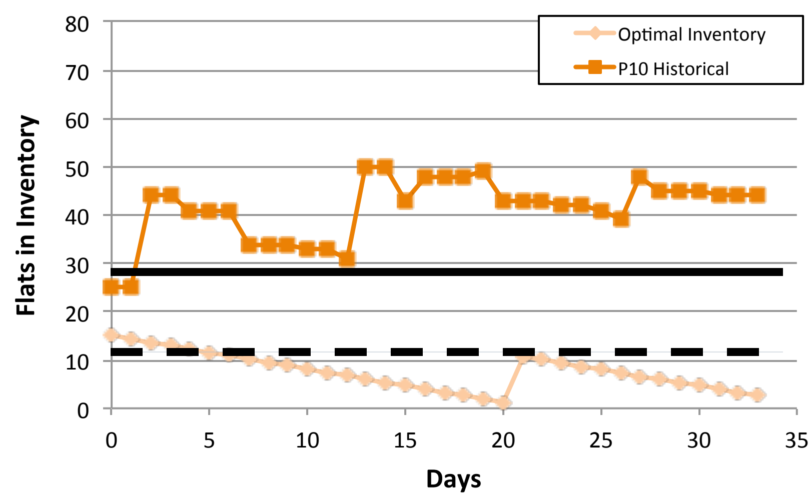
Kanban stocking system was set up, but staff continued to overstock inventory.

Historical, Optimal, and Actual Inventory

- Inventories have been lower, but not optimal (black lines indicate current full stock level)
- Round 2: Setting smaller shelf areas for stocking (dotted lines), encouraging more frequent replenishment
- Keep a building emergency reserve in stock room







Conclusions

- A few minutes of inventory tracking each day, and two hours of manual calculations can save many thousands of dollars, and free up valuable space.
- Ideally, a software ordering system with bar code scanner can do all the calculations automatically
  - Monitor inventory
  - Trigger consumable orders
  - Stock a more accurate mix of consumables
- Despite obvious benefits, staff are extremely reluctant to experience a stock out.
  - People don't like empty shelves & don't like to place orders
- The exercise does provide a reality check on current inventory levels and ordering frequency.

Acknowledgments

Andrew Hashkes

Peter Goldenblatt

Savannah Bilbao