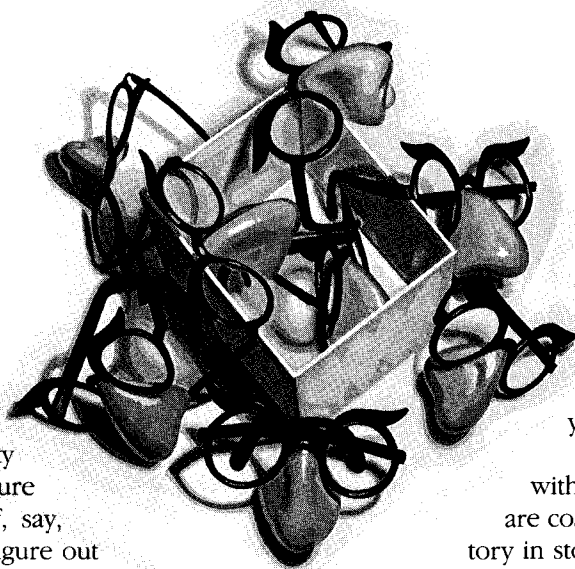


How Many Should You Order?



BY RICHARD CRANFORD

Imagine that you are the inventory manager for Uncle Bunko's Nifty Trick and Novelty Wholesalers. Your job is to make sure the company never runs out of, say, Groucho Marx noses. You must figure out how often and how many items to reorder at a time and also minimize the cost of maintaining the supply on hand.

You could order a week's worth every week to keep the supply topped off. But each time you order Groucho noses from the supplier, you incur expenses for everything from the order form to the labor involved in receiving the order. A company that manufactures what it sells must also consider order costs. Procuring a week's worth of an item from production means that once a week the machine that produces that item isn't producing anything while it's being set up. In a small proprietorship, the cost of placing an order can be a few dollars. In a large corporation, order costs can include computer time and the time of senior executives and can run into the hundreds or thousands of dollars. In either case, larger and less frequent orders are more efficient.

OK, you say, I'll order a year's worth every year. While this might be appropriate for plastic novelty items, it presents some obvious problems for businesses that deal in oranges or gardenias. And although funny noses fall into the nonperishable category, it's still risky to order a year's worth at a time. In six months, Groucho Marx noses may

be passé, and there you'd be with six months' worth of stock you can't unload.

Just as there are costs associated with ordering replacements, there are costs associated with keeping inventory in stock. While the former is easier to quantify, the latter is no less real. The cost of holding inventory is called carrying cost. Besides spoilage and obsolescence, carrying costs take into account the effects of inventory taxes, inventory insurance, storage costs, and the cost of capital. Determining carrying cost is tricky, and in the final analysis, the result is just an estimate. Many people hold, however, that the carrying cost of an item ranges between 20% and 30% of its cost.

Obviously, the amount to order is the amount that strikes the best balance between order costs and carrying costs. Another way to express this is to say that the appropriate reorder amount incurs the lowest total cost (the sum of order costs and carrying costs). This amount is the economic order quantity (EOQ).

One way to determine EOQ is to plot the order costs, carrying costs, and total costs for several order quantities on a graph. The point where the order costs and carrying costs cross, which is also the lowest total cost, is the optimal amount to reorder. The second way is to use the formula approach, in which you calculate the optimal reorder amount using your numbers for annual usage, order costs, and carrying costs. You'll soon see how to create a worksheet to determine EOQ with each approach.

The Economic Order Quantity model is a time-tested way to determine cost-efficient reorder amounts.

THE GRAPHICAL APPROACH

Before reading the next paragraphs, create the graphical approach worksheet shown in figure 1 from the instructions in the "How to Set Up the Worksheets" box.

The worksheet shown in figure 1 is used to create the graph shown in figure 2. Note that several of the worksheet's rows are not shown. This worksheet is designed so that you can enter the item name, per-item cost, yearly usage, order cost, and carrying-cost percentage of any inventory item, then calculate the worksheet, and display a graph showing the EOQ for that item. The following explains the reasoning behind the formulas.

We've entered a zero in cell A9. Each of the remaining formulas in column A takes the value above it and adds one-fiftieth of the annual usage of the item. When we create the graph, we'll be plotting the carrying costs, order costs, and total costs associated with 50 different reorder quantities. This is to insure that the curved line for order costs will be smooth. If we didn't want to see data labels on the graph, these formulas would stop at cell A59, where the formula returns the yearly usage value from cell C3. Instead, the formulas go beyond the yearly usage. Since these values are the X range for the graph, including the four extra values creates some space at the right side of the graph for the data labels. Notice that the values for carrying costs, order costs, and total costs do stop at row 59.

Each formula in column B starts by dividing the reorder quantity to its left by 2. This gives you average inventory, so called because the on-hand amount is assumed to alternate between the amount you order and zero. The formulas then multiply average inventory by the per-item costs to determine the dollar value of average inventory and then multiply that product by the carrying-cost percentage.

We haven't entered any formulas in the first four cells of the *Order Cost* and *Total Cost* columns because plotting these values for very low quantities would make the graph hard to read. The formulas in range C13..C59 divide the yearly usage by the reorder quantities from their respective rows, giving the number of orders per year, and then multiply those by the reorder cost from cell C4.

Finally, the formulas in range D13..D59 add the carrying costs and order costs in each row.

To create your graph, follow the instructions in one of the next two paragraphs. Note that the graph on your screen may not exactly match the graph in figure 2.

In 1-2-3 select /Graph Type XY. Select X and specify range A9..A63, select A and specify range B9..B59, select B and specify range C9..C59, and select C and specify range

	A	B	C	D	E	F	G
1	Name of Item	Groucho Marx Noses					
2	Cost per Item	\$0.50					
3	Yearly Usage	1600					
4	Order Cost	\$10					
5	Carrying Cost	20%					
6							
7	Reorder	Carrying	Order	Total			
8	Quantity	Cost	Cost	Cost			
9	0	\$0					
10	32	\$2					
11	64	\$3					
12	96	\$5					
13	128	\$6	\$125	\$131			
14	160	\$8	\$100	\$108			
15	192	\$10	\$83	\$93			
57	1536	\$77	\$10	\$87			
58	1568	\$78	\$10	\$89			
59	1600	\$80	\$10	\$90	Carrying Cost	Order Cost	Total Cost
60	1632						
61	1664						
62	1696						
63	1728						

FIGURE 1. This worksheet is used to create the graph shown in figure 2. Several rows are not shown. You enter data pertaining to an inventory item in range C1..C5. Column A computes several possible reorder quantities in increments of one-fiftieth of a year's usage. Columns B through D compute the carrying cost, order cost, and total cost associated with each reorder quantity. These values are plotted on an XY graph, using the values in column A as the X range and the values in columns B, C, and D as the A, B, and C ranges, respectively.

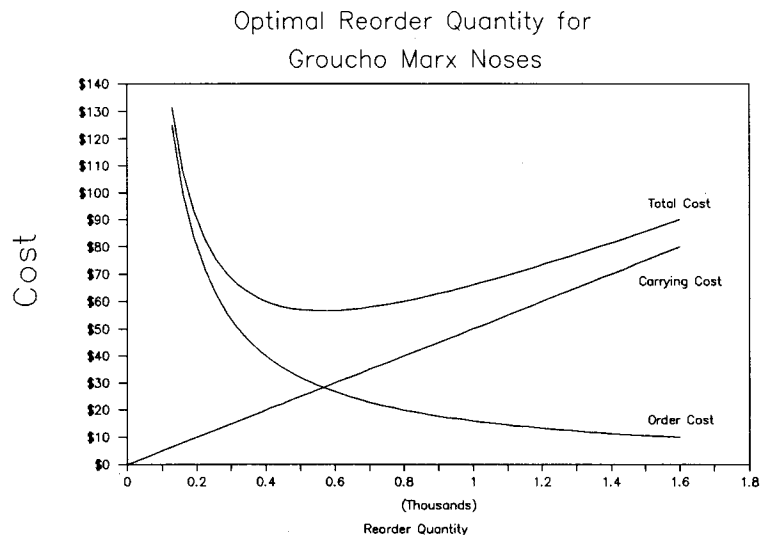


FIGURE 2. This graph shows the annual carrying costs, order costs, and total costs associated with different reorder quantities for an item, ranging from zero to 1,600. The point at which the order-cost and carrying-cost lines cross, which is also where the total-cost line is lowest, indicates the optimal reorder quantity for the item.

D9..D59. Then select Options Format Graph Lines Quit. Select Titles First, enter *Optimal Reorder Quantity for*; select Titles Second, enter \C1; select Titles Y-Axis, enter *Cost*; select Titles X-Axis, enter *Reorder Quantity*. Select Data-Labels A, specify range E9..E59, and select Below; select B, specify range F9..F59, and select Above; select C, specify range G9..G59, and select Above. Then select Quit Scale Y-Scale Format Currency, enter a zero, and select Quit Quit View. The graph in figure 2 should appear on your screen. If it doesn't, your computer may not have a display adapter with graphics capability, or 1-2-3 may not

have been installed to use your system's graphics capability. Press any key to clear the graph, then select Quit.

In *Symphony* select MENU Graph 1st-Settings Type XY. Select Range X and specify range A9..A63, select A and specify range B9..B59, select B and specify range C9..C59, select C and specify range D9..D59. Then select Quit. Select Format A Lines B Lines C Lines and select Quit. Select Data-Labels A, specify range E9..E59, and select Below; select B, specify range F9..F59, and select Above; select C, specify range G9..G59, and select Above. Then select Quit. Select Switch Titles First, enter *Optimal Reorder Quantity for*; select Second, enter \C1; select Y-Axis, enter *Cost*; select X-Axis and enter *Reorder Quantity*. Then select Quit Y-Scale Format Currency, enter a zero, and select Quit Quit Preview. The graph shown in figure 2 should appear on your screen. If it doesn't, your computer may not have a display adapter with graphics capability, or *Symphony* may not have been installed properly to use your system's graphics capability. Press any key to clear the graph, then select Quit.

Looking at figure 2, you can see that the lines for order costs and carrying costs cross just below 0.6 (meaning 600) on the horizontal axis. This tells you that the correct reorder quantity is whatever convenient amount falls between 500 and 600. If Groucho Marx noses come in lots of 25, for example, you should order 575 at a time.

The graphical approach helps you determine something besides the optimal reorder quantity. The shape of the *Total Cost* line indicates how sensitive an item is to variations in reorder quantity. Suppose your per-order cost was \$20 instead of \$10. Change the value in cell C4 to 20, press the CALC key, and redraw the graph by selecting /Graph View (in *Symphony*, MENU Graph Preview). The graph now indicates that the proper reorder quantity is 800. Note that the *Total Cost* curve is shallower and flatter in the area around its low point. With the higher ordering cost, you have more leeway in deciding how many to order.

You can use this worksheet, just as it is, to find the reorder quantity and sensitivity for any item you stock. Just enter the name, per-item cost, and yearly usage of the item in range C1..C3, enter your firm's per-order cost and the appropriate carrying-cost percentage in cells C4 and C5, and press the CALC key. The formulas in range A9..A63 will continue to return values from zero to just above the yearly usage. The values in range B9..D59 will adjust accordingly. When you redraw the graph, it will show the new results of the formulas, the X and Y axes

will be properly scaled, and the second line of the title will be the same as the label you enter in cell C1.

THE FORMULA APPROACH

Figure 3 shows a worksheet that calculates the optimal reorder quantity. It has the advantage of being able to show several inventory items at a time. Notice that the first item, Groucho noses, has a reorder quantity of 566. This bears up the first result we got with the graphical approach. The worksheet also shows the reorder point, the inventory level at which you should reorder, given the items' lead times, or the amount of time required to get them from your suppliers or from production. For example, it takes eight business days to order and receive the Groucho noses. You should therefore reorder when you have eight day's worth, or 49 pieces, in stock.

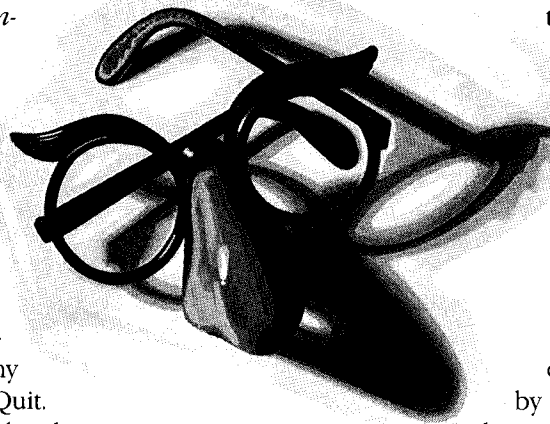
What happens if there are unexpected delays in receiving a shipment? As a wise inventory manager, you may designate some of the firm's stock as "safety" stock by subtracting the amount you want to keep in reserve from the on-hand amount you use for reordering purposes. You might designate 50 Groucho noses in your stockroom as safety stock. Thus, you would order more Groucho noses when you had 99 pieces, rather than 49, in stock. If your stock is depleted to "zero" and you use some additional stock, you're dipping into reserves.

The worksheet computes optimal reorder amounts by using the standard EOQ formula:

$$EOQ = \sqrt{\frac{2 \times S \times O}{C}}$$

In the formula, *S* stands for a year's supply, *O* stands for the cost of making an order, and *C* stands for the carrying cost for one unit for one year.

To use the worksheet, you enter the carrying-cost percentage and order cost in cells B1 and B2. Then enter the



	A	B	C	D	E	F	G
1	Carrying Cost %	20%					
2	Order Cost	\$10					
3							
4							
5							
6							
7		Cost per	Yearly	Carrying	Order	Lead	Reorder
		Item	Usage	Cost	Qty	Time	Point
8	Groucho Marx Noses	\$0.50	1600	\$0.10	566	8	49
9	Hand Buzzers	\$0.80	775	\$0.16	311	8	24
10	Squirting Flowers	\$0.50	1100	\$0.10	469	8	34
11	Hot Pepper Gum	\$0.10	300	\$0.02	548	8	9

FIGURE 3. Column E in this worksheet shows the optimal reorder quantities for several inventory items using the formula approach described in the text. It also computes, in column G, the inventory level at which the items should be reordered, given the lead times entered in column F.

item names, the per-item costs, and the yearly usage amounts in columns A through C. Formulas in column D compute the per-item carrying cost by multiplying the costs by the carrying-cost percentage in cell B1. Formulas in column E compute the reorder quantities, using the EOQ formula. Enter the lead times for the items in column F. Column G contains formulas that compute the reorder point by dividing yearly usage by 261 (the number of weekdays in a year) and multiplying that amount by the number of lead days. Replace the number 261 with the number of days per year in which your firm can place

and receive orders. For example, if your company conducts business on Saturdays, you'd use the number 313.

To create the formula approach worksheet in figure 3, follow the instructions in the "How to" box. Adapting the worksheet for your own firm is simple. Enter your own data in columns A, B, C, and F. Assign a currency format with two decimal places to all the cells in column B in which you enter values. Copy the formulas in columns D, E, and G as far down their columns as necessary. ■

Richard Cranford is assistant editor of features at LOTUS.

HOW TO SET UP THE WORKSHEETS

THE GRAPHICAL APPROACH WORKSHEET

1. Default settings

Recalculation: Manual

1-2-3: /Worksheet Global Recalculation Manual

Symph: MENU Settings Recalculation Method Manual Quit

Format: Currency, 0

1-2-3: /Worksheet Global Format Currency, enter 0

Symph: MENU Settings Format Currency, enter 0, select Quit

2. Cell formats

Format	Range
Currency, 2	C2
General	C3
Percent 0 (<i>Symph:</i> % 0)	C5
General	A9..A10

For example, to set the format for cell C2, select

1-2-3: /Range Format Currency, press Return to accept two decimal places, indicate cell C2

Symph: MENU Format Currency, press Return to accept two decimal places, indicate cell C2

3. Labels

Enter the labels shown in figure 1 in range A1..A5, cell C1, and range A7..D8. Right-align the labels in rows 7 and 8: Select /Range Label Right (*Symph:* MENU Range Label-Alignment Right), indicate range A7..D8. Enter the labels in range E59..G59 of figure 1. Note: These labels will overlap each other on your screen—columns in figure 1 are widened to show the labels.

4. Values

Enter values shown in range C2..C5 of figure 1. Remember to type % after the value in cell C5. Enter 0 in cell A9.

5. Range names

Name	Range
<i>cost</i>	C2
<i>usage</i>	C3
<i>ordercost</i>	C4
<i>carry</i>	C5

For example, to assign the range name *cost* to cell C2, press slash (*Symph:* MENU), select Range Name Create, enter *cost*, indicate cell C2.

6. Formulas

Cell Formula

A10 +A9+\$usage/50

Copy cell A10 to range A11..A63.

B9 +A9/2*\$cost*\$carry

Copy cell B9 to range B10..B59.

C13 + \$usage/A13*\$ordercost

D13 + B13 + C13

Copy range C13..D13 to range C14..C59.

THE FORMULA APPROACH WORKSHEET

1. Default settings

Recalculation: Manual

1-2-3: /Worksheet Global Recalculation Manual

Symph: MENU Settings Recalculation Method Manual Quit

Format: Fixed, 0

1-2-3: /Worksheet Global Format Fixed, enter 0

Symph: MENU Settings Format Fixed, enter 0, select Quit

2. Individual column widths

Column	Width
A	19

Position the cell pointer in column A, select

1-2-3: /Worksheet Column Set-Width, enter 19

Symph: MENU Width Set, enter 19

3. Cell formats

Format	Range
Percent 0 (<i>Symph:</i> % 0)	B1
Currency, 0	B2
Currency, 2	B8..B11
Currency, 2	D8

For example, to set the format for cell B1, select

1-2-3: /Range Format Percent, enter 0, indicate cell B1

Symph: MENU Format %, enter 0, indicate cell B1

4. Labels

Enter the labels shown in column A and in rows 6 and 7 of figure 3. Right-align the labels in rows 6 and 7: Select /Range Label Right (*Symph:* MENU Range Label-Alignment Right), indicate range B6..G7.

5. Values

Enter the values shown in figure 3 in ranges B1..B2, B8..C11, and F8..F11. Type % after the value in cell B1.

6. Range names

Name	Range
<i>carry</i>	B1
<i>ordercost</i>	B2

For example, to assign the range name *carry* to cell B1, press slash (*Symph:* MENU), select Range Name Create, enter *carry*, indicate cell B1.

7. Enter and copy formulas

Cell Formula

D8 + B8*\$carry

E8 @SQRT(2*C8*\$ordercost/D8)

Copy range D8..E8 to range D9..D11.

G8 + C8/261*F8

Copy cell G8 to range G9..G11.