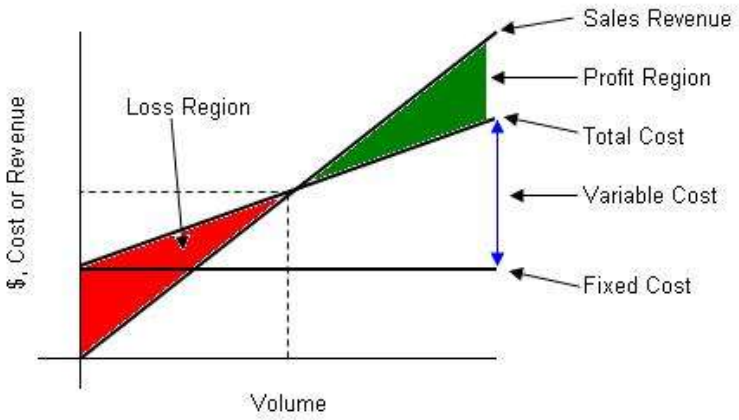
Break Even Analysis



Variable Cost increases in direct proportion to Volume
Fixed Costs do not change as Volume changes (in a relevant range).

If we are in business and we are selling something our price is going to be larger per unit than our costs are per unit and as a result our revenue stream (sales) is going to incline more rapidly than our total costs line.

Before our sales line reaches our total cost line we are in the LOSS TERITORY. In this region our total costs are greater than our total sales revenue.

If our sales are greater than our total costs we are in PROFIT TERITORY.

And at the point were sales and total costs intersect is called the **BREAK EVEN POINT**. There is no profit or loss at the break even point.

That point could be quoted in terms of the volume (number of units) which must be achieved to reach this point. Or it could be quoted in terms of the dollars of sales revenue needed in order to break even.

Recall that our Traditional Method of doing an income statement is:

Traditional Model

Sales	$ 10,000
COGS	$ 6,000 -
Gross Profit (GP)	$ 4,000
Operating Expenses	
-MKTG	$ 2,000 -
-G & A	$ 1,000 -
Total Operating Exp.	$ 3,000
Operating Income	**$ 1,000**

Note that the Traditional Model is GAAP and is used in industry and is useful for it's intended purpose.
The problem with the Traditional Model is that COGS is a combination of Fixed and Variable Costs. There are certain variable costs and certain fixed costs in COGS as well as in marketing and G&A. If we wanted to do a Cost Volume and Profit analysis we couldn't do it utilizing the Traditional format because there is a mixture of fixed and variable costs in each of the groupings. Instead we have to reform our income statement.

Lets say that we examine our costs categories and find the following mixture of fixed and variable costs:

Traditional Model

Sales	$ 10,000	Variable =	$4,000	
COGS	$ 6,000	Fixed =		$2,000
Gross Profit (GP)	$ 4,000			
Operating Expenses		Variable =	$1,200	
-MKTG	$ 2,000	Fixed =		$ 800
-G & A	$ 1,000	Variable =	$ 200	
Total Operating Exp.	$ 3,000	Fixed =		$ 800
Operating Income	**$ 1,000**		**$5,400**	**$3,600**

We can now group all the variable costs together and all the fixed costs together and we would be in much better shape…

Contribution Margin Format

		Per Unit
Sales	$ 10,000	$ 10.00
Variable Costs	$ (5,400)	$ (5.40)
Contribution Margin	**$ 4,600**	$ 4.60
Fixed Costs	$ (3,600)	
Operating Income	**$ 1,000**	

units sold = 1000

Now take our SALES and subtract the sum of the VARIABLE COSTS, this gives us the CONTRIBUTION MARGIN.

Subtracting FIXED COSTS from CONTRIBUTION MARGIN gives us OPERATING INCOME.

Now say we have sold 1000 units. Lets do a per unit calculation. We find our AVERAGE SALES PRICE is $10 per unit. $5.40 per unit is our AVERAGE VARIABLE COSTS and $4.60 is the contribution margin per unit.

Remember, we DO NOT calculate a per unit costs for our FIXED COSTS because fixed costs are not per unit related! Not related to the number of units. This isn't to say it would not be a useful number for something, just not for what we are doing.

Now we see in Contribution Margin Format our per unit numbers showing us that we are selling for $10 per unit but for every unit that we sell we have to incur a variable costs of $5.40. This lowers our contribution margin to $4.60 which means that every unit that we sell is actually only contributing $4.60 toward covering our fixed costs and going on to earning us a profit.

FORMULAS

Operating Income = Sales – Variable Costs – Fixed Costs
= (Quantity * Unit Sale Price) – (Quantity * Unit Variable Costs) – Fixed Costs
= Q * (USP – UVC) – FC
OI = Q * UMC – FC

Where: UCM = Unit Contribution Margin = USP – UVC
Sales = Quantity * Unit Sale Price
Variable Costs = Quantity * Unit Variable Costs
USP = Unit Sale Price
UVC = Unit Variable Costs

EXAM Know the Quantity and Break Even formulas.
Now add a "T" for "Target" and solve for Quantity

$$Q = \frac{FC + TOI}{UCM}$$

At the **Break Even Point** the **Target Operating Income** is **$0.00**:

Break Even Quantity

$$Q_{BE} = \frac{FC + 0}{UCM} = \frac{FC}{UCM}$$

Always show at least 1 decimal place

Find the break even quantity in our example:

$$Q_{BE} = \frac{FC + TOI}{UCM} = \frac{3600 + 0}{4.60} = 782.6$$

This says that we must sell 782.6 units to reach the **Break Even Point**.

We can also use this formula to find the break even quantity for a given Target Operating Income by plugging that number in. For example, if we want a TOI of $10,000:

$$Q_{BE} = \frac{FC + TOI}{UCM} = \frac{3600 + \$10{,}000}{4.60} = 2{,}956.5$$

Remember in this example we had sales of $10,000 on 1000 units sold for $10 per unit sales (i.e., $10 sale price).

Now consider the percentage of Contribution Margin to Unit Sale Price:

$$\frac{\text{Contribution Margin}}{\text{Per Unit Sales (Sale Price)}} = \frac{4.60}{10} = 0.46 = 46\%$$

This says 46% per unit sold went toward covering the contribution margin.

Now we will find the **Break Even Sales Point**: (where TOI = $0)

$$SALES_{BE} = \frac{FC}{\text{C/M as \% of Sales}}$$

In our example:

$$SALES_{BE} = \frac{FC + TOI}{\text{C/M as \% of Sales}} = \frac{3{,}600 + 0}{0.46} = \$\ 7{,}826$$

This says we must reach $7,826 in Sales to reach the break even point.

So there are 2 ways of coming up with Break Even Point:

1) Solving for Break Even Point in terms of Quantity (number units sold).

2) Solving for Break Even Point in terms of Sales ($ of sales).

To solve for BEP required to reach a certain operating income just solve with the desired target operating income (non-zero).

One at a Time Sensitivity Analysis

Here we are asking the question, what happens if there is some percent misestimation in items such as volume, variable costs, sales price, fixed costs. The purpose of One at a Time Sensitivity Analysis is NOT to evaluate the scenario possibilities, it is to evaluate the sensitivity of the variable to the bottom line.

There is something called a Scenario Analysis in which you assume a certain scenario and then do a projection based on what you think will happen in that scenario and how the company might position itself in that certain scenario.

The Four Horseman of Profitability:

Volume	**Fixed Costs**
Variable Costs	**Sales Price**

To do this we take the original base case and compare it to the modifications.

Say we need to increase our profitability's and the company wants to know how sensitive the bottom line is to a 10% change in volume. We do the analysis in one direction (positive) and hypothesis that the change is the absolute value and that it can go plus or minus. In our example we will explore a 10% increase in the various components.

One at a Time Sensitivity Analysis	Base Costs	+/- 10% Volume Change	+/- 10% Unit Sale Price Change	+/- 10% Unit Var. Costs Change	+/- 10% Fixed Costs Change
Sales	10,000	11,000	11,000	10,000	10,000
Variable Costs	(5,400)	(5,940)	(5,400)	(5,940)	(5,400)
Contribution Margin	4,600	5,060	5,600	4,060	4,600
Fixed Costs	3,600	3,600	3,600	3,600	3,960
Operating Income	**1,000**	**1,460**	**2,000**	**460**	**640**
Average from Base	0	+/- 460	+/- 1,000	+/- (540)	+/- (360)

10% Volume Change

What happens to Sales under a 10% volume increase? It goes up 10%! What happens to our variable costs? They also go up by 10%. Contribution Margin goes up 10%. Fixed costs DO NOT CHANGE. The result is that the 10% increase/decrease in sales generates a increase/decrease 460 change from the base.

10% Unit Sales Price Change

Start with the original data again and change only the one variable under consideration.
Sales go up. Variable costs STAY THE SAME because the volume didn't go up! We are only changing the price and that does not effect the number of units we produce. Fixed costs does not change. In this case we see the $1,000,000 change in sales do to the increase in per unit sales price works it's way down to the bottom line. The increase is pure margin. That is why pricing is so important. The opposite would have happened if there had been a decrease in unit sale price. Pricing decisions are very important because they impact the bottom line dollar for dollar.

10% Change in Unit Variable Costs

Sales do not change. Unit Variable Costs increase by 10% and contribution margin changes as a result. Fixed Costs remain the same. As a result of all this Operating Income is decreased by 540 to **460**.

10% Change in Fixed Costs

Sales and variable costs will not change. Fixed costs go up by 10%. This gives us $640 on the bottom line, a decrease of 360.

Multiple at a Time Sensitivity Analysis

Now we ask what happens if there is a beneficial change in ALL of the four profitability parameters at the same time? This is closer to a scenario analysis because all four variables are changing. We see here what effect a change in all for of the underpinnings of profitability can have: **Volume, Price, Variable Costs, Fixed Costs.**

Volume up 10%, Unit Sales Price up 10%, Unit Variable Costs down 10%, Fixed Costs down 10%. What is our operating income going to be?

Sensitivity Analysis: Beneficial Change In All 4 At Once

	Base Costs		Vol + 10% Change		USP + 10% Change		UVC - 10% Change		FC - 10% Change		Total
Sales	10,000	x	1.1	x	1.1					=	$ 12,100
Variable Costs	(5,400)	x	1.1			x	0.9			=	$ (5,346)
Contribution Margin	4,600										6754.0
Fixed Costs	3,600							x	0.9	=	$ 3,240
Operating Income	**1,000**										**3514.0**
Average from Base	0									+	2,514

The 1.1 multiplier for Volume Change appears twice; once to reflect it's own increase (first line) and again as part of the Unit Variable Costs increase (second line). This is because Unit Variable Costs are calculated based on Volume, so we must show the increase in Volume in our calculation.

EXAM

When you increase **VOLUME** you must also increase **VARAIBLE COSTS**.

All disciplines must get involved to make these kinds of changes; marketing for volume, manufacturing for variable costs, operating people for fixed costs, pricing, product design, product differentiation, tapping new markets. What this gives us is a quantitative assessment of what could be. Making it happen is a whole other aspect.

Process Costing

We will be learning the **Weighted Average Method** only.

Up until this time what we have been doing is known as **Job Order Costing**. This is a technique which is used when the projects are individually unique and they have to be costed individually. Example would be a custom shop, someone gives you a set of specifications, you build to the specs and cost it as you build it for the direct material, direct labor, and overhead. But we wouldn't use job order costing if we were manufacturing bottles of Snapple or anything else which involves high volumes of identical product. Instead we would use what is known as **Process Costing** because all the units go through the same process.

We will use the below book case as an example.

17-40 Transferred-in costs, weighted-average and FIFO methods. Frito-Lay, Inc., manufactures convenience foods, including potato chips and corn chips. Production of corn chips occurs in four departments: cleaning, mixing, cooking, and drying and packaging. Consider the Drying and Packaging Department, where direct materials (packaging) are added at the end of the process. Conversion costs are added evenly during the process. The accounting records of a Frito-Lay plant provide the following information for corn chips in its Drying and Packaging Department during a weekly period (week 37):

	Physical Units (Cases)	Transferred-In Costs	Direct Materials	Conversion Costs
Beginning work in process[a]	1,250	$29,000	$ 0	$ 9,060
Transferred in during week 37 from Cooking Department	5,000			
Completed during week 37	5,250			
Ending work in process, week 37[b]	1,000			
Total costs added during week 37		$96,000	$25,200	$38,400

[a]Degree of completion: transferred-in costs, 100%; direct materials, ?%; conversion costs, 80%.
[b]Degree of completion: transferred-in costs, 100%; direct materials, ?%; conversion costs, 40%.

1. Using the weighted-average method, summarize the total Drying and Packaging Department costs for week 37, and assign total costs to units completed (and transferred out) and to units in ending work in process.
2. Assume that the FIFO method is used for the Drying and Packaging Department. Under FIFO, the transferred-in costs for work-in-process beginning inventory in week 37 are $28,920 (instead of $29,000 under the weighted-average method), and the transferred-in costs during week 37 from the Cooking Department are $94,000 (instead of $96,000 under the weighted-average method). All other data are unchanged. Summarize the total Drying and Packaging Department costs for week 37, and assign total costs to units completed and transferred out and to units in ending work in process using the FIFO method.

Direct materials are added at the end of the process. It goes through the drying and packaging process. When it comes into this process there is no material added, that has been done in the

previous process, all it's doing is drying. Once it's dry near the end of the process they add material in the form of packaging. Key is that it is added at the end of the process.

What we are describing is really divided into two parts; the **Physical Flow** and the **Costs**.

Physical Flow	Units				Conversion
WIP - Beginning	1,250				
Started / Added During Process	5,000				Costs
Units to be Accounted For	6,250	X-Fers In	D/M		
Completed & Transferred Out	5,250	5,250	5,250		5,250
WIP - End	1,000	1,000	-	[1]	400
Units Accounted For	6,250	6,250	5,250		5,650

[1] See footnote b above. % completion for D/M is an unknown.

5000 units transferred in from prior process (called Started / Added above). Units to be Accounted For is the sum of WIP-beginning and transfers in. So at the beginning there are 6,250 units, these will be accounted for through the process. Now at the end of the process there are 5,250 completed and transferred out and 1,000 remaining as work in process. The sum of these are the units accounted for, 6,250.

Consider that we have two sets of units which are not on the same basis. One is Units **Whole & Complete (transferred out)** and the others are still in **WIP** and they are not complete. That means they are at different stages of completion. But regardless of the stage of completion of a unit, at the end of the period the process must stop and the number still in process must be determined. What we want to know is what is the **equivalent units in each category**. As far as the units which were completed and transferred out they were completely done, 100% complete in every category (transfer in, direct material, conversion) (by definition).

Now consider WIP-Ending; in order to be WIP at the end they must have been fully transferred in, so that's 100% complete. Regarding footnote 1 and b above. There are footnotes on the beginning and ending WIP. In our case we are not covering the FIFO method which examines beginning inventory, so disregard that footnote. Footnote b says that transferred in costs were 100% complete (we know), direct materials were ? % complete, and conversion costs were 40% complete. The question mark wants us to go to the information given in the problem and find out at what point do we put direct material into the process. When is it added, when do the laborers apply material? We know from the statement of the problem that the only material they add is packaging and it is not added until the end of the process. So if the units we are examining are only 40% complete than we know we have not yet added direct material. So with regard to direct material they were 0% complete. With regard to conversion costs we find in the problem statement they were 40% complete so they have 1000*.4 = 400.

Now we do the sums and find our equivalent units (listed as units accounted for). 6,250 transfer in, 5,250 direct material, 5,650 conversion costs.

Now we move on to the dollars, the COSTS. Basically the format is the same.

Costs	Total		X-Fers In		D/M		Conversion Costs
WIP - Beginning	38,060	=	29,000	+	-	+	9,060
Costs Added During Process	159,600	=	96,000	+	25,200	+	38,400
Costs Added During Period	197,660	=	125,000	+	25,200	+	47,460
Equivalent Unit Costs	$ 33.20	=	$ 20.00	+	$ 4.80	+	$ 8.40
Completed & Transferred Out	174,300	=	105,000	+	25,200	+	44,100
WIP - End	**23,360** [2]	=	20,000	+	-	+	3,360
Costs Accounted For	$ 197,660	=	125,000	+	25,200	+	47,460

[2] Solved for by difference.

Notes
Equivalent Unit Costs = Costs Added During Period / Units Accounted For
Conversion Costs include **Direct Labor and Overhead**.
Completed & X-ferred Out (Costs) = Completed & X-ferred Out (Phy) * Eqv. Unit Costs
WIP – End (Costs) = WIP - End (Phy) * Equivalent Unit Costs

Equivalent Unit Costs
Transfers In: $125000/6250 units = 20 (6250 is "Units Accounted For" line in Physical)
Direct Material: $25,200/5250 units = $4.80
Conversion Costs: $47,460/5650 = $840

At this point in our process the results are telling us is that the transfers in were transferred in at a cost of $20 per unit, we've incurred $4.80 in material and $840 in conversion costs.

EXAM

CONVERSION COST INCLUDE DIRECT LABOR AND OVERHEAD

Now we will assign the costs to those units which were completed and transferred out.

First are the units which were WIP – Ending, and that gives us our cost of accounting. The point is to get the last two lines. We will take the Completed and Transferred Out (Phy) multiplied by Equivalent Costs which gives us Completed & Transferred Out (Costs). Same for other lines. Then the "Total" column is the sum of the Transfers In, Direct Material, and Conversion Costs columns.

Both sheets together:

Physical Flow	Units						Conversion
WIP - Beginning	1,250						
Started / Added During Process	5,000						Costs
Units to be Accounted For	6,250		X-Fers In		D/M		
Completed & Transferred Out	5,250		5,250		5,250		5,250
WIP - End	1,000		1,000		-	[1]	400
Units Accounted For	6,250		6,250		5,250		5,650

[1] See footnote b above. % completion for D/M is an unknown.

Costs	Total		X-Fers In		D/M		Costs
WIP - Beginning	38,060	=	29,000	+	-	+	9,060
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Costs Added During Period	197,660	=	125,000	+	25,200	+	47,460
Equivalent Unit Costs	$ 33.20	=	$ 20.00	+	$ 4.80	+	$ 8.40
Completed & Transferred Out	174,300	=	105,000	+	25,200	+	44,100
WIP - End	**23,360**	[2]=	20,000	+	-	+	3,360
Costs Accounted For	$ 197,660	=	125,000	+	25,200	+	47,460

[2] Solved for by difference.

Finally, the sum of $197.660 is the total costs we had to account for.

In the Homework we will go beyond the pure computation of the numbers and give us a picture of how critically import tis is to understanding a lot about profitability. There are many very important things we can get out of a schedule like this. We will be amazed!

Homework

Ch 3 pb 19, 20
Both are break even analysis.

3-19
Given revenues, var & fixed costs as a starting point, that's there budget for the year. Asked to compute the budgeted operating income under each of the following deviations from that budget. Do like things in one exercise, for example, 1 & 2 are asking for 10% inc or dec in CM holding revenues constant. Figure out what the game plan is for that change, why are they asking us to do that change. What are the implications for an operating change that they might make. Also, just do 1 instead of 2 because the answer is plus or minus. Same for 3 & 4, 5 & 6. just doing 1, 3, 5, 7, 8.
In addition:
1) compute the present break even point (will have to compute it in sales dollars, no unit info).
2) determine what level of sales is required to achieve a profit of $5,000,000.
3) what would happen to the bottom line if there is a 10% beneficial change in every variable.

3-20
Similar.
Computer the BEP in units and revenue.
Compute the impact of a 10% beneficial change for every variable.

17-38
Very similar problem to what we did in class. Retain the class format, book's may be a little different.

He gives us the line items (row headings) and he gives us the information (numbers, statement of problem). We have to know where to plug the stuff in.