Appendix 11A *Multi-product Break-Even Analysis*

Before concluding our discussion, we should consider one additional application of the ideas that we have developed—the use of CVP (cost-volume-profit) concepts in multi-product/multi-service settings. One concept that is critical in such a setting is that of sales mix which is discussed below.

The Definition of Sales Mix

KNOW

CC14A: Explain the concept of sales mix.

The term **sales mix** refers to the relative proportions in which a company's products/services are sold. Managers try to achieve the combination, or mix, that will yield the greatest amount of profits. Most companies have many products, and often these products are not equally profitable. In these companies, profits will depend to some extent on the company's sales mix. Profits will be greater if high-margin, rather than low-margin, items make up a relatively large proportion of total sales.

Once again the concept of contribution margin is the key. In a multiple product setting, managers who focus solely on increasing the total sales volume in an effort to improve the profitability of their companies can cause the profits to decline. On the one hand, if the increase in volume was obtained by shifting the sales mix from high-margin items to low-margin items, then total profits will decrease. On the other hand, if a shift in sales mix from low-margin items to high-margin items occurs, total profits can increase, even though total sales may decrease. It is one thing to achieve a particular sales volume; it is quite a different thing to sell the most profitable mix of products. Whether an organization's sales force will focus on achieving volume or profitability will partially depend on their incentive systems.

Sales Mix and Break-Even Analysis

APPLY

CC15A: Compute break-even sales in a multi-product environment.

If a company sells more than one product, break-even analysis is somewhat more complex than our previous coverage shown in Chapter 11. The reason is that different products will have different selling prices, different costs, and different contribution margins. To illustrate, consider Sound Unlimited, a small company that imports DVD-ROM drives from France for use in personal computers.

At present, the company distributes three models of DVD-ROM drives to retail computer stores: Le Louvre, Le Vin, and Le Rouge. Planned sales, expenses, income, and break-even sales for the month of September are shown in Exhibit 11A–1.

The planned sales mix for the month is 2:3:5, that is, the sales ratio is 20% for Le Louvre, 30% for Le Vin, and 50% for Le Rouge adding up to 100%.[1] Note that the contribution margin for each model is different: 30% for Le Louvre, 20% for Le Vin and

[1]Here we have calculated the sales mix ratio using sales revenues as the basis; it can also be computed using sales in units as the basis for calculation. It is important to note that the sales mix ratios of individual products calculated using sales revenues and sales in units will not be the same because sales revenue is a function of sales in units and sales price.

Exhibit 11A–1

Multi-product Break-Even Analysis (Planned)

SOUND UNLIMITED
MULTI-PRODUCT BREAK-EVEN SALES ANALYSIS
For the Month of September

	Le Louvre		Le Vin		Le Rouge		Total	
	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
Planned Sales and Income								
Sales	$20,000	100.0%	$30,000	100.0%	$50,000	100.0%	$100,000	100.0%
Less: Variable expenses	14,000	70.0	24,000	80.0	30,000	60.0	68,000	68.0
Contribution margin	$ 6,000	30.0%	$ 6,000	20.0%	$20,000	40.0%	$ 32,000	32.0%
Less: Fixed expenses							$ 24,000	
Net income							$ 8,000	
Sales Ratio and Overall Break-Even Sales								
Sales ratio	20.0%	:	30.0%	:	50.0%		100.0%	
Sales mix	2	:	3	:	5			
Contribution margin ratio	30.0%		20.0%		40.0%			
Weighted-average contribution margin ratio	32.0% (20% × 30% + 30% × 20% + 50% × 40%)							
Overall break-even sales	Fixed expenses, $24,000 / Weighted-average contribution margin ratio, 32% = $75,000							
Break-Even Sales by Product								
Break-even sales ratio	20.0%		30.0%		50.0%		100.0%	
Break-even sales by product	$15,000		$22,500		$37,500		$75,000	
Break-Even Income Statement								
Break-even sales	$15,000	100.0%	$22,500	100.0%	$37,500	100.0%	$75,000	100.0%
Less: Variable expenses	10,500	70.0	18,000	80.0	22,500	60.0	51,000	68.0
Contribution margin	$ 4,500	30.0%	$ 4,500	20.0%	$15,000	40.0%	$24,000	32.0%
Less: Fixed expenses							24,000	
Net income							$ 0	

Exhibit 11A–2

Multi-product Break-Even Analysis (Actual)

SOUND UNLIMITED
MULTI-PRODUCT BREAK-EVEN SALES ANALYSIS
For the Month of September

	Le Louvre		Le Vin		Le Rouge		Total	
	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
Planned Sales and Income								
Sales	$15,000	100.0%	$50,000	100.0%	$35,000	100.0%	$100,000	100.0%
Less: Variable expenses	10,500	70.0	40,000	80.0	21,000	60.0	71,500	71.5
Contribution margin	$ 4,500	30.0%	$ 10,000	20.0%	$14,000	40.0%	$ 28,500	28.5%
Less: Fixed expenses							$ 24,000	
Net income							$ 4,500	
Sales Ratio and Overall Break-Even Sales								
Sales ratio	15.0%	:	50.0%	:	35.0%		100.0%	
Sales mix	2	:	3	:	5			
Contribution margin ratio	30.0%		20.0%		40.0%			
Weighted-average contribution margin ratio	28.5% (15% × 30% + 50% × 20% + 35% × 40%)							
Overall break-even sales	Fixed expenses, $24,000 / Weighted-average contribution margin ratio, 28.5% = $84,211							
Break-Even Sales by Product								
Break-even sales ratio	15.0%		50.0%		35.0%		100.0%	
Break-even sales by product	$12,632		$42,105		$29,474		$84,211	
Break-Even Income Statement								
Break-even sales	$12,632	100.0%	$42,105	100.0%	$29,474	100.0%	$84,211	100.0%
Less: Variable expenses	8,842	70.0	33,684	80.0	17,684	60.0	60,210	71.5
Contribution margin	$ 3,789	30.0%	$ 8,421	20.0%	$11,789	40.0%	$24,001	28.5%
Less: Fixed expenses							24,000	
Net income							$ 1	

40% for Le Rouge. Using the sales mix (sales ratio) and the individual contribution ratios, we can compute the weighted-average contribution ratio, as follows:

$$\begin{aligned}\text{Weighted-average contribution margin ratio} &= (20\% \times 30\%) + (30\% \times 20\%) + (50\% \times 40\%)\\ &= 6\% + 6\% + 20\%\\ &= 32\%\end{aligned}$$

As is shown in Exhibit 11A–1, the break-even sales for the company is $75,000; this is computed by dividing the fixed expenses of $24,000 by the weighted-average contribution margin ratio of 32%. Using the planned sales mix, we can compute the break-even sales for the three DVD-ROM models as follows:

Le Louvre	20% of $75,000 = $15,000
Le Vin	30% of $75,000 = $22,500
Le Rouge	50% of $75,000 = $37,500

The sales of $75,000 represents the break-even level only as long as the sales mix does not change. *If the sales mix changes, the break-even sales will change.* This is illustrated in Exhibit 11A–2, which shows the actual sales for September.

As is shown in Exhibit 11A–2, the sales mix shifted away from the highest contribution margin product (Le Rouge) to the lowest contribution margin (Le Vin). Although total sales remained unchanged at $100,000, net income dropped from the planned $8,000 to $4,500 due to the shift in the sales mix—a decrease of $3,500 (over 43%). Moreover, the weighted-average contribution margin ratio dropped from the planned 32% to 28.5%, resulting in a higher break-even sales of $84,211 in contrast to the planned $75,000 (an increase of over 12%).

In performing the break-even analysis, you have to make certain key assumptions as discussed in the chapter. However, if the manager senses changes in the market conditions, as well as the internal environment, that might require a change in the sales mix or the contribution margin ratio, he or she must revise her assumptions, redo the analysis, and use the new results for purposes of planning and decision making.

Application Competency Summary for Appendix 11A

Application Competency	Deliverable	Source Documents and Key Information	Steps	Knowledge Competency
Compute break-even sales in a multi-product situation. CC15[A]	*Key Information* Sales required to incur no profit and no loss *Report/Document* No specific report	*Sales, Cost/Expense Accounts in the General Ledger* Actual sales, variable and fixed costs *Master Budget* Budgeted sales, variable and fixed costs (for budgeted reports)	1. Determine the sales mix, and use it to compute the weighted-average contribution margin per unit or contribution margin ratio. 2. Divide the fixed expenses by the weighted-average contribution margin per unit (ratio) to compute the break-even sales in units (dollars). 3. Determine break-even sales for individual products in the same ratio as the sales mix.	Contribution margin ratio Sales mix

Questions for Appendix 11A

11–11 What is meant by the term *sales mix*? What assumption is usually made concerning sales mix in CVP analysis?

11–12 Explain how a shift in the sales mix could result in both a higher break-even point and a lower net income.

Brief Exercises for Appendix 11A

BRIEF EXERCISE 11–13 Compute the Break-Even Point for a Multi-product Company (CC14A, 15A)

Lucido Products markets two computer games: Claimjumper and Makeover. A contribution margin income statement for a recent month for the two games appears as follows:

	Claimjumper	Makeover	Total
Sales	$65,000	$85,000	$150,000
Less: Variable expenses	45,000	60,000	105,000
Contribution margin	$20,000	$25,000	45,000
Less: Fixed expenses			36,000
Net income			$ 9,000

Required:

1. Compute the overall CM ratio for the company.
2. Compute the overall break-even point for the company in sales dollars.
3. Verify the overall break-even point for the company by constructing an income statement showing the appropriate levels of sales for the two products.

BRIEF EXERCISE 11–14 Break-Even Analysis (CC15A)

Jose Co. produces two products, X and Y. The following information is presented for the two products:

	X	Y
Selling price per unit	$9	$6
Variable cost per unit	7	3

Total fixed costs are $117,000.

Required:

What will the break-even point be for Jose in units of X and Y if the ratio of sales is expected to be 3:1?

(Adapted © CGA-Canada)

BRIEF EXERCISE 11–15 Contribution Margin Analysis (CC1, 15A)

Jeffries Ltd. has two divisions, Andrew and Baldwin. Jeffries' overall CM ratio is 30%, and combined sales in the two divisions total $500,000.

Required:

If variable expenses in Andrew are $300,000 and Andrew's contribution margin ratio is 25%, what are sales in Baldwin?

(Adapted © CGA-Canada)

BRIEF EXERCISE 11–16 Weighted-Average Contribution Margin Ratio (CC15A)

Abernathy Inc.'s sales mix ratio for its four products are 15%, 25%, 20%, and 40%. The respective contribution margins are 25%, 35%, 20%, and 30%.

Required:

What is the weighted-average contribution margin ratio of the sales mix?

(Adapted © CGA-Canada)

Exercise for Appendix 11A

EXERCISE 11–13 Multi-product Break-Even Analysis (CC15[A])

Olongapo Sports Corporation is the distributor in the Philippines of two premium golf balls—the Flight Dynamic and the Sure Shot. Monthly sales and the contribution margin ratios for the two products follow (the currency in the Philippines is the peso, denoted by P):

Sales	P300,000	P500,000	P800,000
CM ratio	70%	46%	?

Fixed expenses total P327,500 per month.

Required:

1. Prepare an income statement for the company as a whole. Carry computations to one decimal place.
2. Compute the break-even point for the company based on the current sales mix.
3. If total sales increase by P150,000 a month, by how much would you expect net income to increase? What are your assumptions?

Problems for Appendix 11A

CHECK FIGURE
(2) Break-even: ฿1,728,000

PROBLEM 11–11 Sales Mix; Multi-product Break-Even Analysis (CC1, 15[A])

Gold Star Rice, Ltd., of Thailand, exports Thai rice throughout Asia. The company grows three varieties of rice—Fragrant, White, and Loonzain. Budgeted sales by product and in total for the coming month are shown following (the currency in Thailand is the baht, denoted by ฿):

	Product							
	White		Fragrant		Loonzain		Total	
Percentage of total sales	20		52		28		100	
Sales.	฿300,000	100	฿780,000	100	฿420,000	100	฿1,500,000	100
Less: Variable expenses	216,000	72	156,000	20	168,000	40	540,000	36
Contribution margin	฿ 84,000	28	฿624,000	80	฿252,000	60	960,000	64
Less: Fixed expenses							898,560	
Net income							฿ 61,440	

$$\text{Break-even sales: } \frac{\text{Fixed expenses, ฿898,560}}{\text{CM ratio, 0.64}} = \text{฿1,404,000}$$

As shown by these data, net income is budgeted at ฿61,440 for the month and break-even sales at ฿1,404,000.

Assume that actual sales for the month total ฿1,500,000 as planned. Actual sales by product are: White, ฿600,000; Fragrant, ฿360,000; and Loonzain, ฿540,000.

Required:

1. Prepare a contribution margin income statement for the month on the basis of actual sales data. Present the income statement in the format shown above.
2. Compute the break-even sales for the month on the basis of your actual data.
3. Considering the fact that the company met its ฿1,500,000 sales budget for the month, the president is shocked at the results shown on your income statement in part (1). Prepare a brief memo for the president explaining why both the operating results and break-even sales are different from what was budgeted.

PROBLEM 11–12 Multi-product Break-Even and Target Profit Analysis (CC9, 15A)

CHECK FIGURE
(1) 48,000 units

Fashonista Inc. has created a new type of sandal that is expected to be popular with active people. It comes in two models—the Farideh and the Mercury. Cost and production data are as follows:

	Farideh	Mercury
Selling price	$29.99	$49.99
Cost to produce 50,000 units of each product:		
Direct materials	$350,000	$400,000
Direct labour	75,000	75,000
Variable overhead	500,000	550,000
Fixed overhead allocation	356,000	400,000
Selling and administrative costs:		
Shipping costs per unit	$ 1.99	$ 1.99
Advertising budget allocated	100,000	150,000

Required:

1. Calculate the break-even point in units for the Farideh model, assuming the allocations of fixed costs given above.
2. Total unit sales are budgeted at 100,000 units, the allocated fixed overhead amounts are as given, and the Farideh model is expected to account for 70% of unit sales and the Mercury model 30%. Calculate the break-even sales level in dollars for the products combined.
3. What is the break-even sales level in dollars for the combined products if the fixed overhead were allocated to the two models in proportion to their sales—that is, 70% of fixed overhead allocated to Farideh and 30% of fixed overhead allocated to Mercury? Briefly explain your response.

(Adapted © CGA-Canada)

PROBLEM 11–13 Sales Mix; Break-Even Analysis; Margin of Safety (CC12, 14A, 15A)

CHECK FIGURE
(1b) Break-even: $2,196,000
(2b) Margin of safety: 22%

Island Novelties, Inc. of Palau makes two products—Hawaiian Fantasy and Tahitian Joy. Present revenue, cost, and sales data on the two products follow:

	Hawaiian Fantasy	Tahitian Joy
Selling price per unit	$ 45	$ 300
Variable expenses per unit	27	60
Number of units sold annually	20,000	5,000

Fixed expenses total $1,427,400 per year. The Republic of Palau uses the U.S. dollar as its currency.

Required:

1. Assuming the sales mix given above, do the following:
   a. Prepare a contribution margin income statement as in Chapter 11, showing both dollar and percent columns for each product and for the company as a whole.
   b. Compute the break-even point in dollars for the company as a whole and the margin of safety in both dollars and as a percentage.
2. Another product, Samoan Delight, has just come on the market. Assume that the company could sell 10,000 units at $135 each. The variable expenses would be $108 each. The company's fixed expenses would not change.
   a. Prepare another contribution margin income statement, including sales of Samoan Delight (sales of the other two products would not change). Carry percentage computations to one decimal place.
   b. Compute the company's new break-even point in dollars and the new margin of safety in both dollars and percent.
3. The president of the company examines your figures and says, "There's something strange here. Our fixed costs haven't changed, and you show greater total contribution margin if we add the new product, but you also show our break-even point going up. With greater contribution margin, the break-even point should go down, not up. You've made a mistake somewhere." Explain to the president what has happened.

CHECK FIGURE
(1a) $42,695

PROBLEM 11–14 Multi-product Break-Even Analysis (CC15A)

Mitchell Co. Ltd. manufactures three lines of tires—models I, II, and III. The three different models sell for the same price, but they use different rubber compounds and have slightly different manufacturing processes.

Note: All data are in thousands, unless stated otherwise.

Budget, May 2008				
	Units	Sales	Variable Costs	Contribution
Model I	875	$ 43,750	$ 25,375	$ 18,375
Model II	250	52,500	31,500	21,000
Model III	350	61,250	22,050	39,200
Total	1,475	$157,500	$ 78,925	$ 78,575

Fixed costs for the combined sales are $21.3 million per month. During May, selling prices, variable costs per unit, and fixed costs were according to budget. However, the actual units sold were the following:

Model I	725
Model II	450
Model III	300
	1,475

Required:

1. Calculate the break-even volume for the month of May for:
   a. The budgeted mix of products
   b. The actual mix of products sold

(Adapted © CGA-Canada)

CHECK FIGURE
(2) 65,229 (rounded up)

PROBLEM 11–15 Multi-product Break-Even Analysis (CC15A)

OnTime Inc. produces two lines of clocks—standard and deluxe. Cost and revenue data are shown, as follows:

		Standard	Deluxe
Selling price (per clock):		$ 40	$ 60
Variable costs (per clock)			
Direct materials		10	18
Direct labour		12	16
Overhead		4	5
Selling		2	2
Contribution margin (per clock)		$ 12	$ 19
Sales mix (% of total sales in units)		60%	40%
Total contribution margin	$1,184,000	$576,000	$608,000
Fixed manufacturing costs (total for both lines of clocks)	450,000		
Administrative	305,000		
Net income	$ 384,000		
Total expected sales in units (the two lines of clocks combined)	80,000		
Capacity (the two lines of clocks combined)	100,000		

Required:

The following three cases are *independent* but are based on the preceding data.

1. The company is considering steps to increase sales, particularly of the deluxe model. It is considering increasing advertising by $200,000 and increasing the sales commission on the deluxe clock by $2 per clock. Management believes that these steps will increase total sales to 95,000 clocks and increase the proportion of deluxe models sold to 50%. Calculate the new net income if both changes were implemented and the resulting sales were as predicted.
2. The management of OnTime is considering purchasing new equipment that will reduce direct materials and direct labour costs by 20% for both products. The new equipment would increase fixed manufacturing costs by $175,000, reflecting the amortization on the new equipment. Calculate the total sales volume (in units) that must be achieved in order for the purchase of the new equipment to have a positive effect on net income. Assume that the sales mix would be unaffected.

(Adapted © CGA-Canada)