PART

# VII

# *Tools to Plan, Monitor, & Manage Financial Status*

CHAPTER 17

# Variance Analysis and Sensitivity Analysis

## VARIANCE ANALYSIS OVERVIEW

A variance is, basically, the difference between standard and actual prices and quantities. Variance analysis analyzes these differences. This discussion assumes a flexible budget prepared in accordance with the steps described in Chapters 15 and 16.

Flexible budgeting variance analysis was conceived by industry and subsequently discovered by health care. It provides a method to get more information about the composition of departmental expenses.

## THREE TYPES OF FLEXIBLE BUDGET VARIANCE

The method subdivides total variance into three types:

### Volume Variance

The volume variance is the portion of the overall variance caused by a difference between the expected workload and the actual workload and is calculated as the difference between the total budgeted cost based on a predetermined, expected workload level and the amount that would have been budgeted had the actual workload been known in advance.[1]

### Quantity (or Use) Variance

The quantity variance is also known as the use variance or the efficiency variance. It is the portion of the overall variance that is caused by a difference between the budgeted and actual quantity of input needed per unit of



## Progress Notes

After completing this chapter, you should be able to

1. Understand the three types of flexible budget variance.
2. Perform budget variance.
3. Compute a contribution margin.
4. Perform sensitivity analysis.

output, and is calculated as the difference between the actual quantity of inputs used per unit of output multiplied by the actual output level and the budgeted unit price.

### Price (or Spending) Variance

The price variance is also known as the spending or rate variance. This variance is the portion of the overall variance caused by a difference between the actual and expected price of an input and is calculated as the difference between the actual and budgeted unit price, or hourly rate, multiplied by the actual quantity of goods, or labor, consumed per unit of output, and by the actual output level.

## TWO-VARIANCE ANALYSIS AND THREE-VARIANCE ANALYSIS COMPARED

Variance analysis can be performed as a two- or a three-variance analysis. (There is also a five-variance analysis that is beyond the scope of this discussion.) The two-variance analysis involves the volume variance as compared with budgeted costs (defined as standard hours for actual production). The three-variance analysis involves the three types of variances defined above. **Figure 17-1** illustrates these elements.

### Composition Compared

The makeup of the two-variance analysis is compared with the three-variance analysis in **Figure 17-2**. As is shown, two elements (A and B) remain the same in both methods. The third element (C) is a single amount in the two-variance method but splits into two amounts (C-1 and C-2) in the three-variance method.

### Computation Compared

Actual computation is illustrated in **Figure 17-3** for two-variance analysis and **Figure 17-4** for three-variance analysis. The A, B, C, C-1, and C-2 designations are carried forward from Fig-

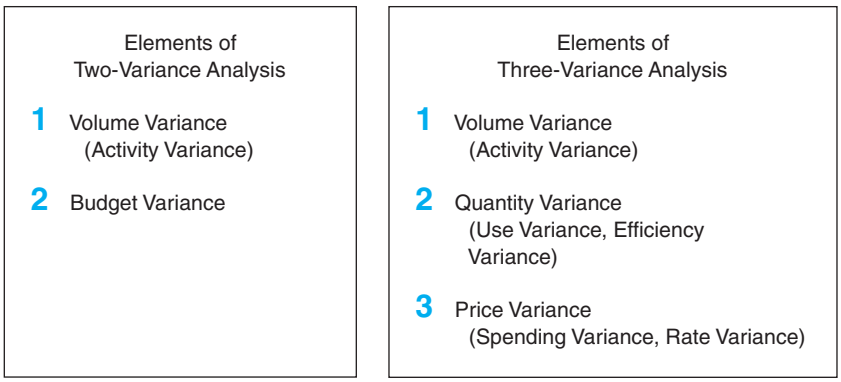



**Figure 17–1** Elements of Variance Analysis.

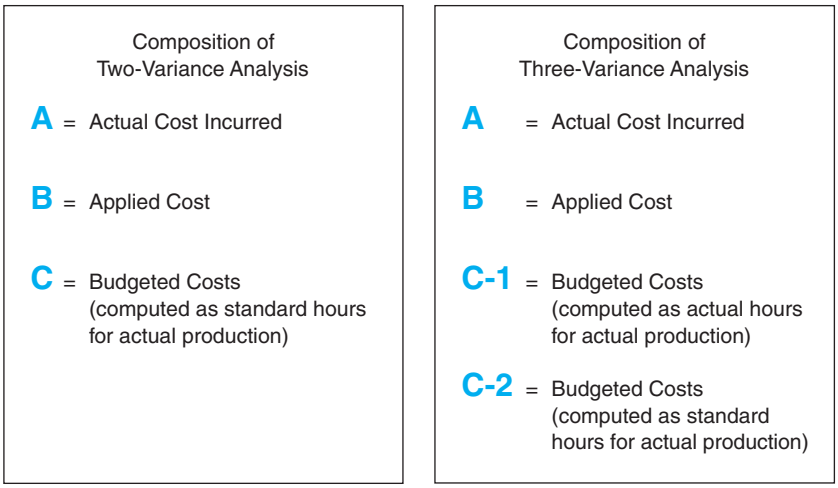
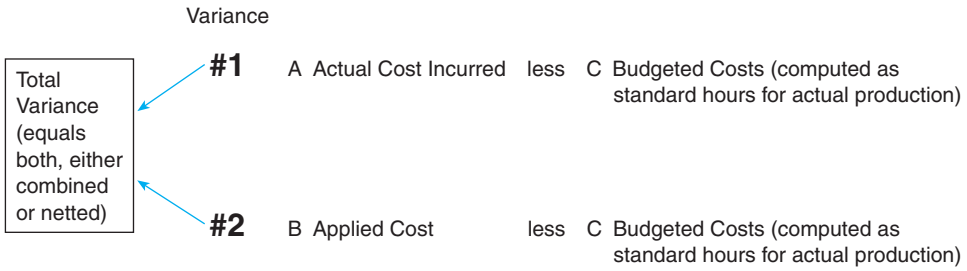



**Figure 17–2** Composition of Two- and Three-Variance Analysis.



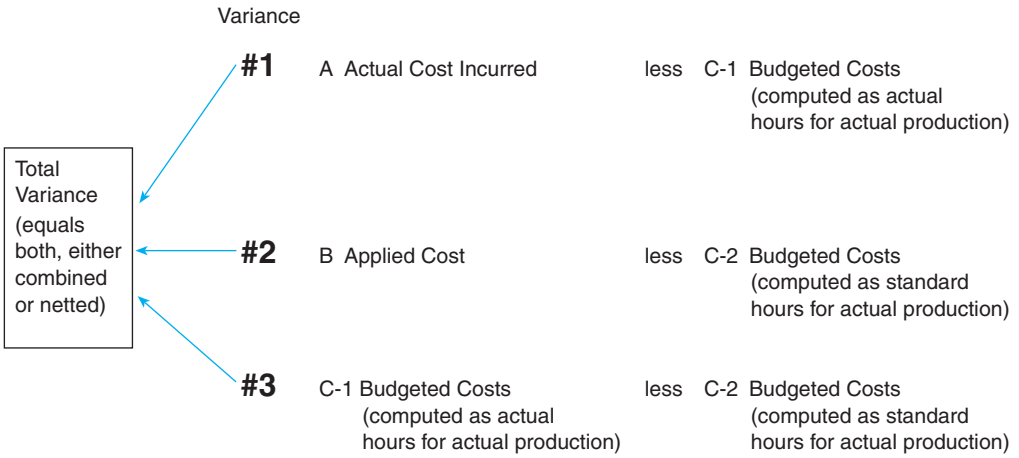

*Note:* To obtain proof total, perform the following calculation:
A, Actual Cost Incurred, less B, Applied Cost = Total Variance

**Figure 17–3** A Calculation of Two-Variance Analysis.

ure 17-2. In Figure 17-3, the two-variance calculation is illustrated, and a proof total computation is supplied at the bottom of the illustration. In Figure 17-4, the three-variance calculation is likewise illustrated, and a proof total computation is also supplied at the bottom of the illustration. This set of three illustrations deserves study. If the manager understands the concept presented here, then he or she understands the theory of variance analysis.

## Different Names for the Three Variable Cost Elements

Another oddity in variance analysis that contributes to confusion is this. All three variable cost elements—that is, direct materials, direct labor, and variable overhead—can have a price variance and a quantity variance computed. But the variance is not known by the same




*Note:* To obtain proof total, perform the following calculation:
A, Actual Cost Incurred, less B, Applied Cost = Total Variance

**Figure 17–4** Calculation of Three-Variance Analysis.

name in all instances. **Exhibit 17-1** sets out the different names. Even though the names differ, the calculation for all three is the same. Note, too, that variance analysis is primarily a matter of input–output analysis. The inputs represent actual quantities of direct materials, direct labor, and variable overhead used. The outputs represent the services or products delivered (e.g., produced) for the applicable time period, expressed in terms of standard quantity (in the case of materials) or of standard hours (in the case of labor). In other words, the standard quantity or standard hours equates to what should have been used (the standard) rather than what was actually used. This is an important point to remember.

## THREE EXAMPLES OF VARIANCE ANALYSIS

This section provides three useful examples of variance analysis. The St. Joseph Hospital example is a flexible budget with all the variances expressed in relative value units, or RVUs.

**Exhibit 17–1** Different Names for Materials, Labor, and Overhead Variances

| | |
|---|---|
| Price or Spending Variance = Materials Price Variance | [for direct materials] |
| Price or Spending Variance = Labor Rate Variance | [for direct labor] |
| Price or Spending Variance = Overhead Spending Variance | [for variable overhead] |

(RVUs serve as uniform units of measure regarding services.) The two following examples—one a static budget variance analysis and the other a flexible budget example—carry forward from examples originating in Chapter 15.

## Example 1: St. Joseph Hospital Nursing Center Variance Analysis

An example of variance analysis in a hospital system is given in **Exhibit 17-2**. It deals with price or spending variance and quantity or use variance. The price variance is expressed in RVUs. The quantity variance is broken out into four subtypes—patient, caregiver, environmental, and efficiency variances, all of which are expressed in RVUs. Finally, it is assumed that the budgeted activity level is equal to the standard activity level for purposes of this example.

**Exhibit 17–2** St. Joseph Hospital Nursing Center Variance Analysis

Summary Variance Report for Nursing Activity Center

| Actual Costs | Flexible Budget (based on actual quantity) | Budgeted Costs |
|---|---|---|
| 641,331 RVUs × $4.15 per RVU = $2,661,523 | 641,331 RVUs × $4.50 per RVU = $2,885,989 | 600,000 RVUs × $4.50 per RVU = $2,700,000 |
| Price Variance | | Quantity Variance |
| = $224,466* (favorable) | | = $185,989† (unfavorable) |

Assume the following information for the nursing activity center of St. Joseph Hospital for the month of September:

Input Data
Nursing Activity Center
Cost Driver = Number of Relative Value Units (RVUs)

| Actual | Budget |
|---|---|
| Activity Level = 641,331 RVUs | Activity Level = 600,000 RVUs |
| Overhead Costs = $2,661,523 | Overhead Costs = $2,700,000 |
| Actual Cost per RVU = $4.15 | Budgeted Cost per RVU = $4.50 |

*2,885,989 < 2,661,523 > = 224,466.
†2,885,989 < 2,700,000 > 185,989.
*Source:* Adapted from S. Upda, Activity-Based Costing for Hospitals, *Health Care Management Review*, Vol. 21, No. 3, p. 93, © 1996, Aspen Publishers, Inc.

The flexible budget calculation ($2,885,989) is based on actual quantity. When the $2,885,989 is compared with the actual cost of $2,661,523 for this activity center, a favorable price variance of $224,466 is realized. When the $2,885,989 is compared with the budgeted cost of $2,700,000 for this activity center, an unfavorable quantity variance of ($185,989) is realized.

### Example 2: Static Budget Variance Analysis for an Open Imaging Center

An example of static budget variance analysis for an open imaging center is given in **Table 17-1**. As shown, the static budget's number of procedures performed totaled 1,000, while the actual number totaled 1,100. The revenue per procedure is $400 for both budget and actual. The net revenue variance is favorable in the amount of $40,000 ($440,000 less $400,000).

The salaries and employee benefits expense line item exceeded budget by an unfavorable balance of $20,000. Likewise, the supplies expense line item exceeded budget by an unfavorable balance of $15,000. The remaining expenses did not vary; thus the total expense variance is an unfavorable $35,000. The operating income variance equals a favorable $5,000 (the net difference between $40,000 favorable and $35,000 unfavorable).

### Example 3: Flexible Budget Variance Analysis for an Infusion Center within a Physician Practice

An example of flexible budget variance using different terminology is given for an infusion center within a physician practice in **Table 17-2**. Assumptions for revenue, variable expense,

**Table 17–1** Static Budget Variance Analysis for an Open Imaging Center

| | *Actual Amounts Incurred* | *Static Budget Totals* | *Static Budget Variance* |
|---|---|---|---|
| *# Procedures Performed* | *1,100* | *1,000* | — |
| Net Revenue ($400/procedure) | $440,000 | $400,000 | $40,000 F |
| Expenses: | | | |
| Salaries & Employee Benefits | $170,000 | $150,000 | $20,000 U |
| Supplies | 40,000 | 25,000 | 15,000 U |
| Insurance-General | 5,000 | 5,000 | -0- |
| Insurance-Malpractice | 10,000 | 10,000 | -0- |
| Depreciation-Building | 50,000 | 50,000 | -0- |
| Depreciation-Equipment | 100,000 | 100,000 | -0- |
| Total Expenses | $375,000 | $340,000 | $35,000 U |
| Operating Income | $65,000 | $60,000 | $5,000 F |

Key: "F" = "Favorable" variance, while "U" = "Unfavorable" variance.
Note: Dollar amounts shown for illustration only.

**Table 17–2** Flexible Budget Variance Analysis for Infusion Center within a Physician Practice

| | (A) | (B) | (C) | (D) | (E) |
|---|---|---|---|---|---|
| | *Actual Amounts at Actual Prices* | *Flexible Budget Variance* | *Flexible Budget for Actual Volume* | *Sales Volume Variance* | *Static Planning (Master) Budget* |
| *# Procedures* | | | | | |
| 1 Performed | 96 | — | 96 | 16 F | 80 |
| 2 Net Revenue | $216,000 | — | $216,000 | $36,000 F | $180,000 |
| 3 Variable Expense | $151,200 | $6,000 U | $144,000 | $25,200 U | 120,000 |
| 4 Fixed Expense | 44,000 | 4,000 U | 40,000 | — | 40,000 |
| 5 Total Expense | $195,200 | $10,000 U | $184,000 | $25,200 U | $160,000 |
| 6 Operating Income | $20,800 | $10,000 U | $32,000 | $10,800 F | $20,000 |

Flexible Budget Variance = $11,200 U

Sales Volume Variance = $12,000 F

Static Budget Variance = $800 F

Assumptions:
Revenue per procedure = $2,250 per static budget and per actual amounts (no increase).
Variable expense (drugs) = $1,500 per static budget; increase to $1,575 actual amounts.
Fixed expense = $40,000 total per static budget; increase in total to $44,000.

Key: "F" = "Favorable" variance, while "U" = "Unfavorable" variance.
Note: Dollar amounts shown for illustration only.

and fixed expense are set out below the table itself. An explanation of the computations in Table 17-2 follows.

### As to Line 1 Number of Procedures:

Line 1 presents the number of planned procedures (80) and the number of actual procedures (96). Thus the procedures sales volume difference is 16 (96 less 80), and is favorable.

### As to Line 2 Net Revenue:

1. Eighty planned budget procedures at $2,250 revenue apiece totals line 1 column E $180,000, while 96 actual procedures at $2,250 apiece totals line 1 column C $216,000.
2. The sales volume difference in column D totals $36,000 ($216,000 less $180,000).
3. To prove this figure, multiply the excess 16 procedures at the top of column D times $2,250 apiece equals the $36,000.

### As to Line 3 Variable Expense:

1. The budgeted variable expense for drugs was $1,500 per procedure. Thus, 80 planned budget procedures times $1,500 drug expense apiece totals line 2 column E

$120,000. The 96 actual procedures times the planned budget expense of $1,500 apiece totals line 2 column C $144,000. The 96 actual procedures times the actual increased variable drug expense of $1,575 apiece totals line 2 column A $151,200.
2. The total variable expense difference is $31,200 (line 2 column A $151,200 less line 2 column E $120,000).
3. Of this difference, the sales volume difference is line 2 column D $25,200. It is represented by the 16 extra procedures (96 minus 80 equals the 16 extra) times the $1,575 actual variable expense ($1,575 times 16 equals $25,200).
4. The remaining difference is line 2 column B $6,000. It is represented by the rise in expense attributed to the 80 planned budget procedures, or line 2 column B 80 procedures times $75 apiece (the difference between $1,500 and $1,575) equals $6,000. Note that line 2 column B accounts for only the rise in expense for the planned procedures (80), while line 2 column D accounts for the entire variable expense for the increase in sales volume of the extra 16 procedures.
5. Proof total is as follows: the column B $6,000 and the column D $25,200 equals the entire variable expense difference of $31,200 ($151,200 less $120,000 equals $31,200).

### As to Line 4 Fixed Expense:

1. The entire $4,000 increase in line 4 fixed expense is attributed to the flexible budget variance, as it does not relate to sales volume.
2. The $4,000 excess expense is an unfavorable variance.

### As to Line 5 Total Expense

Total expenses on line 5 represents, of course, the total of variable and fixed expenses.

### As to Line 6 Operating Income:

1. The entire operating income variance amounts to a favorable $800 (line 6 column E static budget of $20,000 minus line 6 column A actual of $20,800 equals $800). The $800 represents the Static Budget Variance.
2. The Flexible Budget Variance equals an unfavorable $11,200 (line 6 column C $32,000 flexible budget for actual volume minus line 6 column A actual $20,800 equals the unfavorable variance of $11,200).
3. The Sales Volume Variance equals a favorable $12,000 (line 6 column C $32,000 less line 6 column E $20,000 equals the favorable variance of $12,000).
4. Proof total is as follows: favorable $12,000 variance less unfavorable variance $11,200 equals the overall static budget variance of $800.

## SUMMARY

In closing, when should variances be investigated? Variances will fluctuate within some type of normal range. The trick is to separate normal randomness from those factors requiring

correction. The manager would be well advised to calculate the cost–benefit of performing a variance analysis before commencing the analysis.

## SENSITIVITY ANALYSIS OVERVIEW

Sensitivity analysis is a "what if" proposition. It answers questions about what may happen if major assumptions change or if certain predicted events do not occur. The "what if" feature allows the manager to plan for a variety of possibilities in different scenarios.

Forecasts almost always should be subjected to sensitivity analysis. As previously defined, a forecast is a view of the organization's future events. Because the future cannot be predicted with absolute precision, forecasts will always contain a degree of uncertainty. Thus "what-if" analyses become important to the manager's decision making. For example, "*What* will the radiology department's operating income be *if* the department's revenue is ten percent greater than expected?" Or, conversely, "*What* will the radiology department's operating income be *if* the department's revenue is ten percent less than expected?"

A common example of sensitivity analysis is computing three levels of forecast revenue; the basic, or most likely level, which is the planned goal, plus a high (best case) level, and a low (worst case) level. A chart illustrating this three-level concept for revenue appears as **Figure 17-5**.

## SENSITIVITY ANALYSIS TOOLS

Manager's tools involving sensitivity analysis and described in this section include the contribution margin and the contribution income statement; target operating income using the contribution margin method; and finding the break-even point using the contribution margin method.

### Contribution Margin and the Contribution Income Statement

The contribution income statement specifically identifies the contribution margin within the income statement format. You will recall that the contribution margin is the difference between revenue and variable costs. The remaining difference is available for fixed costs and operating income.

For example, assume 100 units are sold at $50 each for a total of $5,000 revenue. Further, assume variable costs amount to $30 per unit. One hundred units have been sold, so variable costs amount to $3,000

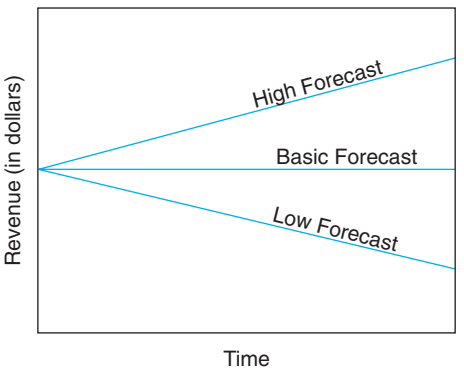



**Figure 17–5** Three-Level Revenue Forecast (Sensitivity Analysis).

(100 times $30/unit = $3,000). The contribution margin equals $2,000 ($5,000 revenue less $3,000 variable costs). (For a further discussion of the contribution margin, refer to Chapter 7.) Now further assume that fixed costs in this example amount to $1,200. Therefore, the operating income will amount to $800 ($2,000 contribution margin less $1,200 equals $800). The format of a contribution margin income statement will appear as follows:

| | |
|---|---|
| Revenue | $5,000 |
| Variable costs | 3,000 |
| Contribution margin | $2,000 |
| Fixed costs | 1,200 |
| Operating income | $800 |

## Target Operating Income Using the Contribution Margin Method

A target operating income computation allows the manager to determine how many units must be sold in order to yield a particular operating income. We will describe the contribution margin method of computing target operating income. This method is particularly useful to the manager because it is easily understood and can be applied in many circumstances. The formula for the contribution margin method of determining target operating income is as follows:

$$N = \frac{\text{Fixed Costs} + \text{Target Operating Income}}{\text{Contribution Margin per Unit}}$$

The necessary inputs for this formula include the following:

- Desired (target) operating income amount
- Unit price for sales
- Variable cost per unit
- Total fixed cost

For example, if

- Desired (target) operating income amount = $1,600
- Unit price for sales = $100
- Variable cost per unit = $60
- Total fixed cost = $2,000

The contribution margin per unit therefore amounts to $40 ($100 sales price per unit less $60 variable cost per unit), and the formula will appear as follows:

$$N = \frac{\$2,000 + \$1,600}{\$40}$$

$40N = $3,600
N = $3,600 divided by $40 = 90 units

Therefore: 90 units times $100 unit price for sales = $9,000 required revenue.

We can then create a contribution income statement to prove the formula results, as follows:

| | |
|---|---|
| Revenue $100/unit × 90 units = | $9,000 |
| Variable costs $60/unit × 90 units = | 5,400 |
| Contribution margin | $3,600 |
| Fixed costs | 2,000 |
| Desired (target) operating income = | $1,600 |

In summary, note that this formula is one type of cost-volume-profit or CVP equation. (For a further discussion of the CVP concept, refer to Chapter 7.)

### Worksheet Example

Julie Smith is the Metropolis Health System's Director of Community Relations. She has been informed that the Health System will participate in the first area "Wellness Gala," to be held at the city convention center. The gala is an annual fund-raising event in which a variety of nonprofit organizations each have an opportunity to earn dollars for their cause. Individuals attending the gala will be prepared to, and are expected to, purchase items from the various booths. Julie's boss wants their proceeds to go to the Health System's auxiliary.

It is now Julie's responsibility to make the financial arrangements and to coordinate the Health System's participation in the event. Last year the booth expense was $1,000, and Julie uses this figure as her assumption of fixed cost for the coming year's event. She finds a local vendor who assembles unique gift baskets. Her wholesale cost per basket will be $30 apiece, if she can place the order within ten days. (Otherwise, the cost rises after the ten days expires.)

Julie believes the gift baskets will sell at the gala for a sales price of $50 apiece. She prepares a worksheet to determine what dollar amount of sales would be required to earn three ranges of operating income: $5,000, $6,250, and $7,500. **Exhibit 17-3** illustrates Julie's worksheet. Line number 1 contains her first set of assumptions: $1,000 fixed cost for the booth rental and $30 variable cost for each basket.

The convention center representative now e-mails Julie with news: due to a recent renovation of the convention center, booth rental fees have increased. It will cost Julie $1,500 for the booth. She then adds line 2 to her worksheet with a second set of assumptions: $1,500 fixed cost for the booth rental and the same $30 variable cost for each basket. She is now prepared to discuss her findings with her boss.

### Break-Even Point Using the Contribution Margin Method

You will recall that the break-even point is the point at which operating revenues and costs equal each other and operating income is zero. The graph method for illustrating the

**Exhibit 17–3** Target Operating Income Worksheet

| | Fixed Cost | Variable Cost per Unit | (A) | (B) | (C) |
|---|---|---|---|---|---|
| | | | At $50 Sales Price per Unit, $$ Sales Required to Earn Operating Income of: | | |
| (1) | $1,000 | $30 | $5,000 | $6,250 | $7,500 |
| (2) | $1,500 | $30 | $6,250 | $7,500 | $8,750 |

break-even point has been previously discussed in Chapter 7. In this sensitivity analysis section we will describe another method to determine the break-even point. It is called the "contribution margin method." The advantage of this method is its transparency. The manager can easily explain his or her results, because the computations can be easily seen and understood.

It is understood that operating income is zero at the break-even point. It follows, then, that the number of units at break-even point can be computed. The formula is as follows:

$$\text{Break-Even Number of Units} = \frac{\text{Fixed Costs}}{\text{Contribution Margin per Unit}}$$

To compute the contribution margin per unit, subtract the variable costs per unit from the sales price per unit. In the Target Operating Income formula inputs as previously described, the sales price per unit was $100 and the variable costs per unit were $60. Thus the contribution margin per unit is $40 ($100 less $60 equals $40).

Using the same inputs, our break-even formula will now appear as follows:

$$\text{Break-Even Number of Units} = \frac{\$2{,}000}{\$40}$$

Thus the break-even number of units will equal $2,000 divided by $40 = 50 units.

We can create a contribution income statement to prove this formula's results, as follows:

| | |
|---|---|
| Revenue $100/unit × 50 units = | $5,000 |
| Variable costs $60/unit × 50 units = | 3,000 |
| Contribution margin | $2,000 |
| Fixed costs | 2,000 |
| Operating income at break even = | $-0- |

## SUMMARY

Sensitivity analysis, in its various forms, is a useful and flexible tool for planning purposes.

## INFORMATION CHECKPOINT

| | |
|---|---|
| What Is Needed? | Example of variance analysis performed on a budget. |
| Where Is It Found? | Possibly with the supervisor responsible for the budget. More likely, it will be found in the office of the strategic planner or financial analyst charged with actually performing the analysis. |
| How Is It Used? | To find where and how variances have occurred during the budget period, in order to manage better in the future. |

## KEY TERMS

Contribution Margin
Contribution Income Statement
Target Operating Income
Three-Variance Method
Two-Variance Method
Variance Analysis

## DISCUSSION QUESTIONS

1. Do you believe variance analysis (or a better variance analysis) would be a good idea at your workplace? If so, why? If not, why not?
2. Are any of the reports you receive in the course of your work ever in a format that includes a contribution margin? If so, what were the circumstances?
3. Have you ever had to compute target operating income? If so, what were the circumstances?