

# ***Managerial and Leadership Think-Work Functions***

***and  
Associated Concepts and Practices***

## **Decision Making**

**Part 2:**

**Analytic Techniques and Tools**

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Fourth Edition

***R. D. Cecil and Company***  
Human Resources Development

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## Analytic Techniques and Tools That Aid Decision Making

As shown in **Figure 1** on page I-2 of the Introduction, analyzing is very much a part of the decision-making process. Here we discuss some of the most widely used revenue/cost/volume techniques, financial criteria and techniques, operations research techniques, and decision-making tools for aiding the analysis/evaluation and comparison of alternatives.

### Techniques for Analyzing the Relationships Among Price, Revenue, Cost, Volume, and Profit

First we discuss marginal analysis, contribution analysis, and break-even analysis. These analyses can be performed during the analytic phase or the decision-making phase. In either case, the results are often used as inputs for making production/sales volume and pricing decisions.

Before discussing these techniques, let us review the definitions of several terms used below:

- a. Variable cost is the sum total of all variable costs. “Variable costs” are those operating costs that tend to increase or decrease as operations (production and sales) increase or decrease. Production costs—particularly labor and materials costs—tend to be the most variable; however, some marketing and G&A costs can also be variable.
- b. Fixed (or overhead) cost is the sum total of all fixed costs. “Fixed costs” are those operating costs that do not tend to increase or decrease as operations increase or decrease. General/administrative costs (e.g., administrative and clerical costs) tend to be the most fixed; however, some production and marketing costs can also be fixed.
- c. Total cost is composed of variable cost plus fixed/overhead cost.

### Marginal Analysis

Based on microeconomic theory (economic theory applied to business), this technique can be—but is rarely—used by managers to determine the level of unit price and (resulting) quantity of sales/output that will maximize profit. Profit is maximized (at least mathematically) at the “price-output level” where the incremental or marginal cost of producing one more unit equals the incremental or marginal revenue generated by selling that additional unit (and where total revenue exceeds total cost by the greatest amount).

Performing a marginal analysis involves the following basic steps:

1. Prepare a computation table that indicates the following projections/estimates for each level of unit price and resulting quantity of sales/output: the total sales revenue generated; the total (production) cost incurred; the average (production) cost per unit; the total profit earned; the marginal revenue generated; and the marginal cost incurred. [For an adaptation of a classic example,<sup>36</sup> see the table for Case A in **Table 5** on the next page.]
  - a. Forecast a “demand curve” for the product (or service)—i.e., estimate the number of units that are likely to be sold at each price on some range of possible prices. In Case A, the company has estimated that it will sell 0 units at a price of \$1000, 1 unit at a price of \$900, 2 units at a price of \$800—and so forth. Record the prices in column 1 and the resulting quantity of sales/output at each price in column 2. [The demand curve in Case A (indicated by the line “d-d” in the left-hand graph in **Figure 19**) is “relatively elastic.” A completely elastic demand curve would be a horizontal line indicating that any percentage change in price tends to result in a large percentage change in demand. A completely inelastic demand curve would be a vertical line indicating that any percentage change in price tends to result in virtually no change in demand.]

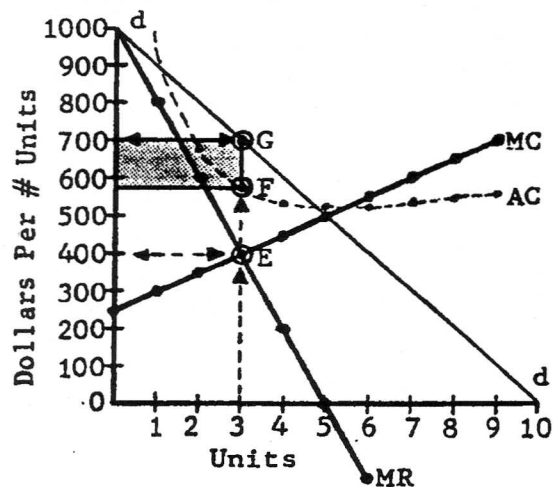
**Table 5: Calculations for Determining the "Price-Output Level"**  
**Where Profit is Maximized (as in Case A)**

1 Price Per Unit (P) (\$s)	2 Quantity of Sales/Output (q) (Units)	3 Total Revenue (TR) [1 x 2]	4 Total Cost (TC)	5 Average Cost (AC) [4 / 2]	6 Total Profit (TP) [3 / 4]	7 Marginal Revenue (MR) [*]	8 Marginal Cost (MC) [#]
1000			750	750.00	-750	1000	250
						<b>900</b>	<b>275</b>
900	1	900	1,025	1,025.00	-125	800	300
						<b>700</b>	<b>325</b>
800	2	1,600	1,350	675.00	250	600	350
						<b>500</b>	<b>375</b>
700	3	2,100	1,725	575.00	375	400 =	400
						<b>300</b>	<b>425</b>
600	4	2,400	2,150	537.50	250	200	450
						<b>100</b>	<b>475</b>
500	5	2,500	2,625	525.00	-125		500
						<b>-100</b>	<b>525</b>
400	6	2,400	3,150	525	-750	-200	550
						<b>-300</b>	<b>575</b>
300	7	2,100	3,725	532.14	-1,625	-400	600
						<b>-500</b>	<b>625</b>
200	8	1,600	4,350	543.75	-2,750	-600	650
						<b>-700</b>	<b>675</b>
100	9	900	5,025	558.33	-4,125	-800	700
						<b>-900</b>	<b>725</b>

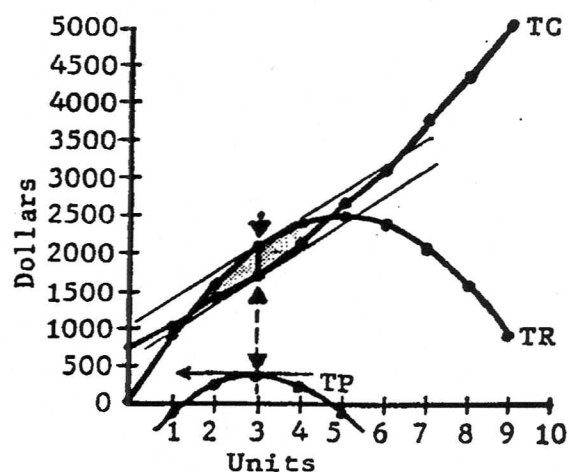
[\*] See paragraph c. \* [#] See paragraph d.

**Figure 19: Graphs Depicting the Data and "Maximum Profit Price-Output Level"**  
**(as in Case A)**

**Graph based on  
Marginal Figures**



**Graph based on  
Total Figures**



- b. For each level of price and resulting quantity of sales/output, . . .
    1. Calculate the total revenue (TR) generated—i.e., multiply the unit price (in column 1) by the (resulting) quantity of sales/output (in Column 2). In Case A, multiplying an \$800 price times the resulting 2 units of sales/output equals \$1,600. This figure is entered (on the same line) in column 3.
    2. Using cost data, calculate the total cost (TC) to produce that quantity of output. Enter the figure (on the same line) in column 4.
    3. Calculate the average (production) cost per unit (AC)—i.e., divide the total cost figure (in column 4) by the quantity of sales/output (in column 2). In Case A, dividing the \$1,350 total cost by 2 units of sales/output equals \$675.00. This figure is entered (on the same line) in column 5.
  - c. Using the figures in column 3, calculate the marginal (incremental) revenue (MR) generated by selling each additional unit (or, as in Case B on the next page, each incremental 100 units). (The basic definition of marginal revenue is “the incremental revenue generated by selling one more unit.”) In column 7 of Table 5, the bold figures are calculated by subtracting the total revenue figure at a given level of price-output from the total revenue figure at the next higher level of price-output. In Case A, for example, subtracting \$2,100 (at a \$700 price and 3-unit output) from \$2,400 (at a \$600 price and 4-unit output) results in \$300. After all the bold figures have been calculated and entered in column 7, the light figures are found by interpolation. In Case A, 600 lies directly between 700 and 500, and 400 lies directly between 500 and 300—and so forth.
  - d. Using the figures in column 4, calculate the marginal (incremental) cost (MC) to produce each additional unit (or, as in Case B, some incremental number of units). (Marginal cost is essentially the incremental variable cost incurred by producing one more unit.) In column 8 of Table 5, the bold figures are calculated by subtracting the total cost at a given level of price-output from the total cost at the next higher level of (price)-output. In Case A, for example, subtracting \$1,725 (at a \$700 price and 3-unit output) from \$2,150 (at a \$600 price and 4-unit output) results in \$425. After all the bold figures have been calculated and entered in column 8, the light figures are found by interpolation.
  - e. Identify the “maximum profit price-quantity level”—the “P-q level—at which marginal cost equals marginal revenue (and total revenue exceeds total cost by the greatest amount). In Case A, for example, maximum profit is generated at a unit price of \$700 and a 3-unit quantity of output—the “P-q level” where marginal revenue of \$400 equals marginal cost of \$400 (and where total profit, at \$375, is the highest).
2. After completing the computation table, some individuals may wish to view the figures in a graphic format. The following steps are taken to construct the types of graphs shown in **Figures 19 and 20**:
    - a. Left-hand graph — This graph primarily deals with the marginal revenue and marginal cost figures in columns 7 and 8 respectively.
      1. Construct a graph having a horizontal axis labeled “quantity of sales/output,” and a vertical axis labeled “dollars” (of marginal revenue, marginal cost, price, and average cost). [In Case A, the scale on the vertical axis (“0” to \$1,000) accommodates almost all of the unit price, average cost per unit, marginal revenue, and marginal cost figures. In Case B, however, we have constructed two graphs. The scale of the upper graph accommodates the large figures for marginal revenue and marginal cost, but cannot clearly show the much smaller figures for unit price and average cost per unit. The scale in the lower graph helps show the P and AC figures much more clearly.]

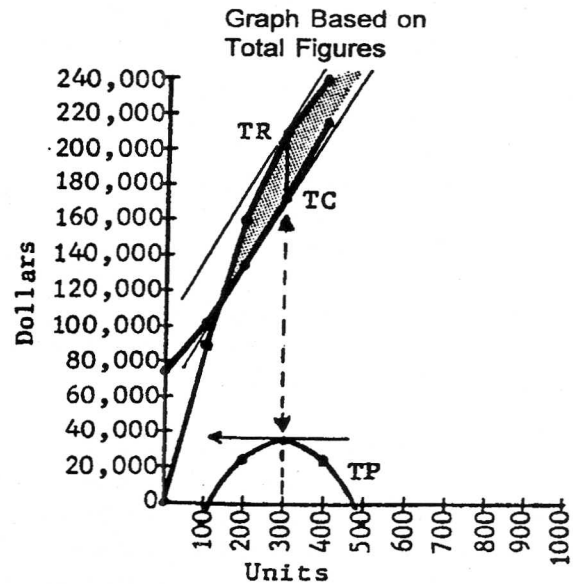
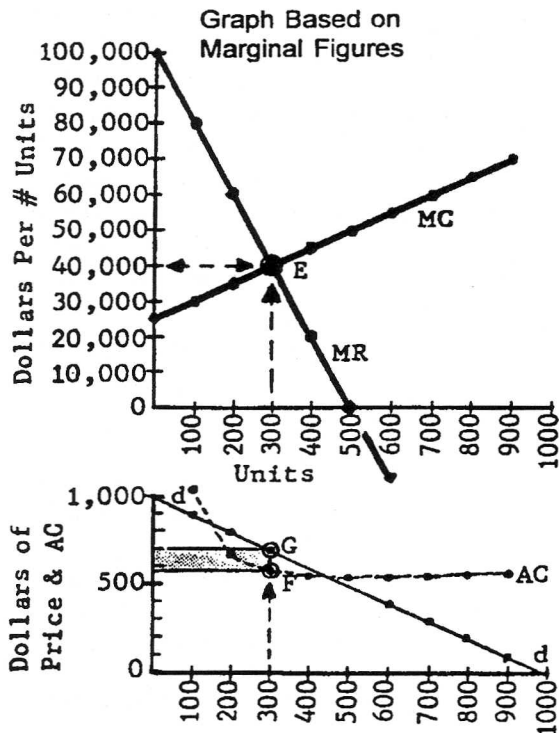
Note: We have included Case B because (a) its figures are closer to the larger figures that businesses normally generate; and (b) it shows how to graph unit price and average cost figures when these figures are much lower than the figures for marginal revenue and marginal cost—as they generally are in mass production/sales operations (as opposed to job shop operations).

**Table 6: Calculations for Determining the "Price-Output Level" Where Profit Is Maximized (as in Case B)**

1 Price Per Unit (P) (Ss)	2 Quantity of Sales/Output (q) (Units)	3 Total Revenue (TR) [1 x 2]	4 Total Cost (TC)	5 Average Cost (AC) [4 / 2]	6 Total Profit (TP) [3 / 4]	7 Marginal Revenue (MR) [*]	8 Marginal Cost (MC) [#]
1000			75,000		-75,000	100,000	25,000
900	100	90,000	102,500	1,025.00	-12,500	<b>90,000</b>	<b>27,500</b>
800	200	160,000	135,000	675.00	25,000	80,000	30,000
700	300	210,000	172,500	575.00	37,500	<b>70,000</b>	<b>32,500</b>
600	400	240,000	215,000	537.50	25,000	60,000	35,000
500	500	250,000	262,500	525.00	-12,500	<b>50,000</b>	<b>37,500</b>
400	600	240,000	315,000	525.00	-75,000	40,000 =	40,000
300	700	210,000	372,500	532.14	-162,500	<b>30,000</b>	<b>42,500</b>
200	800	160,000	435,000	543.75	-275,000	<b>20,000</b>	<b>45,000</b>
100	900	90,000	502,500	558.33	-412,500	<b>10,000</b>	<b>47,500</b>
						<b>-10,000</b>	<b>50,000</b>
						<b>-20,000</b>	<b>52,500</b>
						<b>-30,000</b>	<b>55,000</b>
						<b>-40,000</b>	<b>57,500</b>
						<b>-50,000</b>	<b>60,000</b>
						<b>-60,000</b>	<b>62,500</b>
						<b>-70,000</b>	<b>65,000</b>
						<b>-80,000</b>	<b>67,500</b>
						<b>-90,000</b>	<b>70,000</b>
							<b>72,500</b>

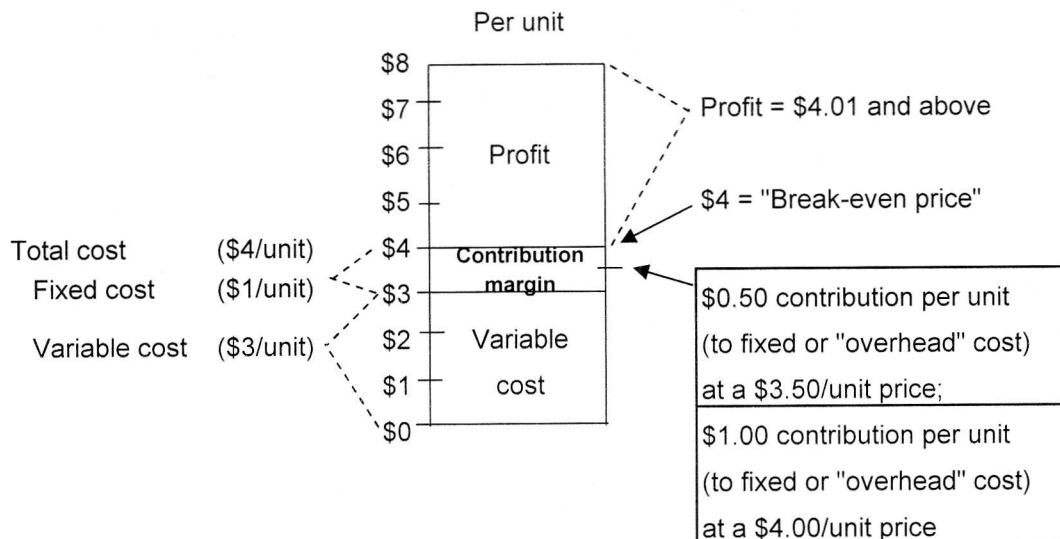
On previous page -- [\*] see paragraph c; [#] see paragraph d.

**Figure 20: Graphs Depicting the Data and "Maximum Profit Price-Output Level" in Case B**



2. Based on the figures in columns 1 and 2 of the computation table, plot the forecasted demand curve for the product/service. First, for each particular “q” (quantity of sales/output) in its turn, trace upwards on a vertical line drawn from that “q” and place a dot on it at the point where a horizontal line drawn from the corresponding unit price figure intersects it. Then, connect all the dots (or “fair a curve” through the dots) in order to draw the demand curve. In Cases A and B, the demand curve (line “d-d”) turns out to be a straight line. [In Case B, however, the demand curve (and average cost curve) have been plotted on the lower graph.]
  3. Based on the figures in columns 2 and 7, plot the marginal revenue curve in the same manner as above—but substitute marginal revenue for unit price.
  4. Based on the figures in columns 2 and 8, plot the marginal cost curve in the same manner—but substitute marginal cost for unit price.
  5. Identify the “price-output level” at which profit is maximized. First, identify point E—the point at which the marginal revenue and marginal cost curves intersect. Then, identify the corresponding price-output level. In Case B, for example, point E lies on the vertical line drawn upwards from a 300-Unit quantity of sales/output. The same line is extended up to the demand curve (line “d-d”) and intersects it at point G. At G, the corresponding unit price is \$700.
  6. Based on the figures in columns 2 and 5, plot the average cost curve in the same manner as above—but substitute “average cost” for “unit price.”
  7. Identify point F—the point at which the vertical line through point E intersects the average cost curve. In Case B, for example, point F corresponds to an average cost per unit of \$575.
  8. Total profit (at the profit-maximizing price-output level) is represented by the shaded rectangle. In Case B, for example, the total profit of \$37,500 is calculated by subtracting the average cost per unit of \$575 (at point F) from the unit price of \$700 (at point G), and then multiplying the resulting \$125 (average) profit per unit by 300 Units.
- b. Right-hand graph — This graph shows the total revenue, total cost, and total profit curves, which are based on the figures in columns 3, 4, and 6 respectively.
1. In the same manner as described above, plot the total revenue curve, the total cost curve, and the total profit curve.
  2. In either of two ways, graphically determine the maximum total profit and the quantity of sales/output at which profit is maximized:
    - a. Using the total revenue and total cost curves —
      1. Identify each quantity (each “q” on the horizontal axis) that lies directly below the shaded area where the TR curve is higher than the TC curve.
      2. Where TR exceeds TC, do the following for each curve in its turn: At a point on the curve directly above each “q” identified, draw a tangent to the curve (a straight line touching the curve at that point) that indicates the slope of the curve at that point. (“Slope” is defined as the “rise” divided by the “run”—or the increase in the height of a line or curve divided by the distance over which the increase in height occurs.)
      3. Find the “q” at which the slopes of the two curves are equal and parallel. As shown in the right-hand graph for Case B, they are equal and parallel at a “q” of 300 units. At this “q,” the total profit of \$37,500 is the vertical distance between TR and TC—or \$210,000 minus \$172,500.
    - b. Using the total profit curve — Draw a flat/horizontal (“0” slope) tangent that

**Figure 21: An Illustration of Contribution Margin  
(Determined by Contribution Analysis)**



touches the total profit curve at its highest point above “0” on the vertical axis. The “q” directly below this point is the maximum-profit quantity of sales/output—or 300 units in Case B. The total profit of \$37,500 can be read off the vertical axis at the level of the tangent.

- b. A demand curve can be difficult to forecast.
- c. Marginal analysis does not account for the probabilities of other possible levels of demand (sales) at any particular price.

### Contribution Analysis

The term “contribution” means contribution to fixed/overhead cost. Contribution analysis involves using price, variable cost, and fixed cost figures to (a) determine contribution margin; (b) calculate contribution; and (c) prepare a contribution margin income statement.

Determination of contribution margin — As shown in **Figure 21**, contribution margin can be regarded as a range of less-than-profitable but contribution-generating unit prices—i.e., prices that (a) are higher than variable cost per unit, but are lower than total cost per unit; and (b) could be charged in order to cover variable cost per unit and also contribute revenue toward covering fixed cost per unit. [A profitable unit price more than covers total (variable + fixed) cost per unit; a less-than-profitable unit price does not.]

Marginal analysis has two main advantages:

- a. Once a profit-maximizing price-output level has been identified, it can at least be used as a reference point when pricing and production decisions are being made.
- b. Its use helps get managers to think in terms of incremental revenues and costs.

However, managers rarely use this tool, because they perceive these disadvantages:

- a. The quantity of sales/output is influenced not only by price, but also by these and other factors that are major concerns of businesspeople: market share; product quality; product differentiation; promotion; inventory level; and cash flow.



Figure 21 illustrates this example: The variable cost per unit is \$3; the fixed cost per unit is \$1; and the total cost per unit is \$4. The shaded area between \$3.01 and \$4 represents the total potential contribution margin, which is \$.99 per unit at a unit price of \$4. Any price in the range between \$3.01 and \$4 will contribute revenue toward the coverage of fixed cost. For example: A unit price of \$3.50 yields a \$.50 contribution per unit. Similarly, a unit price of \$3.90 yields a \$.90 contribution per unit. [Also note the following: At a unit price of \$4, the firm “breaks even” (just covers variable and fixed costs per unit). At a unit price of \$4.01, the firm just begins to make a profit (of \$.01 Per unit). At a unit price of \$6, the firm makes a profit of \$2 per unit.]

Calculation of contribution — The following calculation is usually performed in order to determine how much a particular less-than-profitable unit price will contribute toward covering fixed cost per unit:

- Price (revenue) per unit
- (-) Variable cost per unit
- (=) Contribution per unit (to fixed/overhead cost)

Contribution per unit is most often calculated when a firm has excess (unused) capacity and can sell additional units—but at some price below a normal, profitable price. Although the firm will not make a profit on such sales, whatever it charges over the variable cost of the units sold will contribute to profit by helping to cover fixed cost.

A contribution margin income statement is basically constructed as follows:

- Total sales revenue
- (-) Variable production costs
- (-) Variable selling and administrative costs
- (=) contribution margin
- (-) Fixed production, selling, and administrative costs (including income tax)
- (=) Net income

This type of income statement can be used to determine the following:

- a. the bid price on a contract (to produce some item or render some service);
- b. the optimal way to utilize production capacity; and

- c. how to generate the same profit as last year, even though sales volume is expected to be lower during the current year.

Note: Methods for doing the above are described in detail in various texts on financial analysis.<sup>37</sup>

A contribution margin income statement has several disadvantages:

- a. It fails to treat fixed overhead as a product cost. (Thus, it is not acceptable for financial reporting and tax purposes.)
- b. Distinguishing between fixed and variable costs can be difficult.

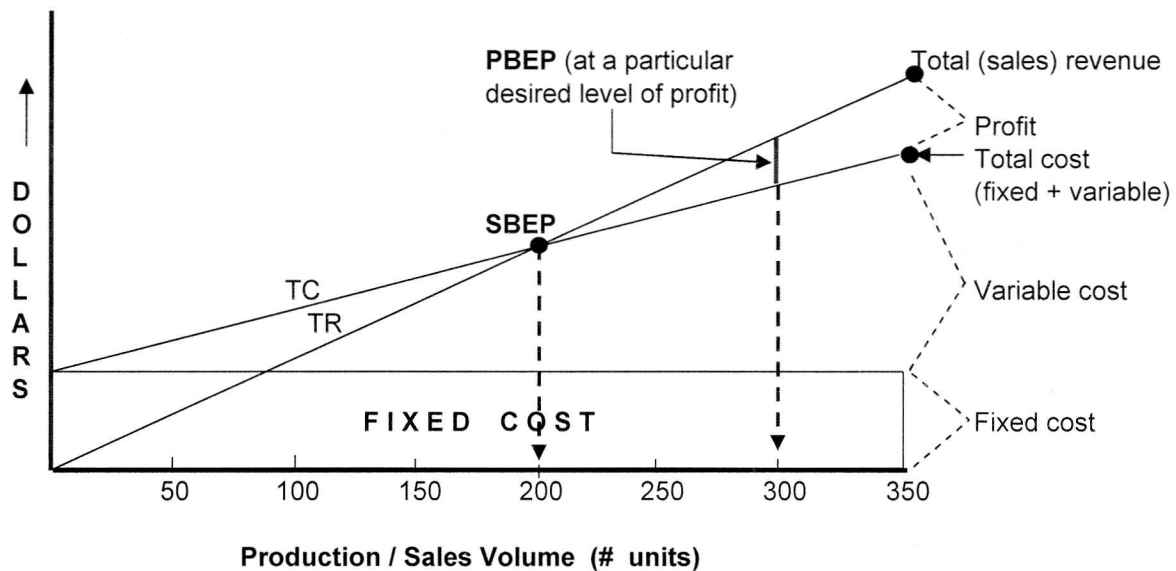
### Break-Even Analysis

This valuable financial technique is also called “cost-volume-profit analysis” (or CVP). It is widely used to determine the following (based on factors such as variable cost, fixed cost, sales volume, production volume, price, and product mix):

- a. the sales break-even point—i.e., the sales volume necessary to “break even” (at least cover total cost);
- b. whether or not, given projected/estimated total unit sales, the sales break-even point is likely to be reached;
- c. the profit break-even point—i.e., the sales volume necessary to earn some desired level of profit/income;
- d. whether or not, given projected/estimated total unit sales, some desired level of profit is likely to be generated;
- e. how the sales break-even point or the profit break-even point would be affected by changes in factors such as selling price, variable cost, fixed cost, production volume, or product mix; and
- f. the optimal proportion of fixed cost to variable cost.

It is useful to make such determinations when (a) starting a new project or business; (b) introducing a new product or service; (c) expanding a project or business; and (d) evaluating production and administrative activities.

Figure 22: Example of a Break-Even Chart



A. The sales break-even point (SBEP) — This is the sales volume necessary to cover all variable and fixed costs and at least “break even.” It can be determined graphically or by calculation.

1. The graphic approach, illustrated in **Figure 22**, involves these basic steps:

- a. Construct a graph having a horizontal axis labeled “production/sales volume,” and a vertical axis labeled “dollars” (of revenue and various costs).
- b. For each (incremental) level of production/sales (from 0 units to X units), plot the following in dollar terms: (a) the fixed cost (which is usually constant); (b) the total cost (which consists of fixed cost plus variable cost); and (c) the total revenue generated (from sales of that production volume).
- c. Find the SBEP. This is the point on the graph at which the total revenue line intersects the total cost line. It is also the corresponding sales (break-even) volume (on the horizontal axis) that lies directly below the point on the graph. (Note in Figure 22 that profit is

earned where total sales revenue exceeds total cost.)

2. The SBEP is calculated as follows:

SBEP =

$$\frac{\text{Total fixed/overhead cost/unit (allocated to product)}}{\text{Contribution per unit (or price per unit minus variable cost per unit)}}$$

B. The profit break-even point (PBEP) — This is the sales volume necessary to cover all fixed and variable costs and also generate some desired level of profit. (In Figure 22, a PBEP is shown for one particular desired amount of profit.) The PBEP is calculated as follows:

PBEP =

$$\frac{[(\text{Total fixed cost per unit}) + (\text{\$ amount of desired profit per unit})]}{\text{Contribution per unit (or price per unit minus variable cost per unit)}}$$

An increase in selling price generally reduces the number of units that must be sold in order to break even. An increase in either fixed cost or variable cost generally increases the number of units that must be sold in order to break even.

In general, break-even analysis is most justifiable and easiest to perform when . . .

- a. these factors are constant: selling price; production efficiency; (total) fixed cost; and variable cost per unit;
- b. the only factor affecting (total) variable cost is production volume;
- c. Fixed cost and variable cost can be determined accurately;
- d. there is only one product, or there is a constant product mix (which requires additional calculations, because more than one product is involved); and
- e. inventories do not change significantly from period to period.

### **Financial Criteria (and Computational Techniques) for Evaluating and/or Comparing Programs/Projects**

These financial tools are used in conjunction with decision-making steps 2, 3, and 4 on page DM-1. Financial criteria such as the following are used to evaluate and/or compare the financial advantages and disadvantages of alternative programs/projects: profitability; average/accounting rate of return; payback period; net present (discounted) value; profitability index; benefit/cost ratio; and internal rate of return. Financial techniques are essentially the computational methods used to calculate figures that correspond to the financial criteria. (These figures are usually calculated based on figures in the program/project budgets that were previously constructed during the budgeting process.)

### **Program/Project Budgets**

Expenditures for plant and equipment, marketing programs, and other types of investments are expected to yield financial benefits such as increased profit and/or improved cash flow. In order to evaluate and/or compare the bene-

fits of programs/projects in terms of various financial criteria, it is first necessary to construct program/project budgets. These budgets should contain capital expenditure, P&L/earnings, and cash flow figures that can be used to (1) calculate figures for various financial criteria, and then (2) evaluate and/or compare the financial results of programs/projects in terms of those criteria.

During a planning process, a program/project budget is usually prepared for each alternative program/project. Next, based on the projected budgetary figures for each alternative, figures for selected financial criteria are calculated. Then, the projected financial results of the alternative programs/projects are evaluated and compared in terms of those criteria—in order to (1) screen and/or eliminate various alternatives before final decisions are made, and then (2) make final decisions.

In an interim or ad hoc situation involving a decision to “undertake” or “not undertake” a single program/project, a program/project budget is first constructed. Next, figures for selected financial criteria are calculated based on the program’s/project’s projected budgetary figures. Then, the figures for selected criteria are usually compared against prescribed “cut-off levels” for those criteria. In general, the greater the extent to which the program’s/project’s criteria-related figures surpass the cut-off levels, the greater the chance that a decision will be made to implement the program/project.

Note: Although the implications for assets and liabilities are also evaluated and/or compared, pro forma balance sheets are not constructed for individual programs/projects—unless they constitute newly acquired/initiated and financially autonomous business ventures.

Construction of a program/project budget — The preparation of a program/project budget revolves around Items 1 through 5 on page B-15. Different budget formats are used for different types of programs/projects. **Exhibit Z** on the next page shows the budget format for a capital project. Note that it consists of two major sections: an investment cost section, and an investment benefits section. Also note that the second section is further divided into two sub-sections: an income/earnings section, and a cash flow section. Budget formats for other types of programs/projects often consist of only the income/earnings section. Below we discuss these sections and sub-sections and the types of programs/projects in which they are either included or not included.

**Exhibit Z: Capital Program/Project Budget -- for Project X**

	2000	2001	2002	2003	2004	2005	2006
<b>Investment Cost</b>							
1 Cost of machinery/equipment	268,000						
2 + <u>Cost to install machinery/equipment</u>	12,000						
3 = Total (depreciable) M/E cost	280,000						
4 + Cost of plant/office facilities							
5 + Cost of land							
6 (-) Proceeds from sale of replaced assets							
7 (-) Trade-in allowance on replaced assets							
8 (-) Debt Incurred to finance purchases <sup>a</sup>							
9 + <u>Recapture of deprec'n on replaced assets</u>							
10 = <b>Net cash outflow on investment</b>	280,000						
<b>Investment Benefits</b>							
<u>(Annual) Income/Earnings</u>							
11 New/additional sales revenue generated	20,000	25,000	30,000	35,000	40,000	45,000	50,000
12 + Cost reductions/savings realized	65,000	80,000	95,000	110,000	125,000	140,000	155,000
13 (-) New/additional operating costs incurred	(5,000)	(5,000)	(5,000)	(5,000)	(5,000)	(5,000)	(5,000)
14 (-) Depreciation expense	(40,000)	(40,000)	(40,000)	(40,000)	(40,000)	(40,000)	(40,000)
15 (-) <u>Interest expense</u> <sup>a</sup>							
16 = Income/earnings before tax	40,000	60,000	80,000	100,000	120,000	140,000	160,000
17 (-) <u>Income tax</u> <sup>b</sup>	(20,000)	(30,000)	(40,000)	(50,000)	(60,000)	(70,000)	(80,000)
18 = Net (after-tax) income/earnings	20,000	30,000	40,000	50,000	60,000	70,000	80,000
<u>(Annual) Cash Flow</u>							
19 Net (after-tax) earnings (line 18)	20,000	30,000	40,000	50,000	60,000	70,000	80,000
20 + Depreciation expense	40,000	40,000	40,000	40,000	40,000	40,000	40,000
21 + Net proceeds from disposal of assets							20,000
22 (-) Debt repayment <sup>c</sup>							
23 (-) <u>Net increase in working capital</u> <sup>d</sup>							
24 = <b>Net beneficial cash flow</b>	60,000	70,000	80,000	90,000	100,000	110,000	140,000

<sup>a</sup> Many practitioners do not enter figures on this line, because they do not use financing cost figures to calculate figures for certain financial criteria.

<sup>b</sup> Here we have assumed a combined federal/state tax rate of 50% (for the sake of simplicity).

<sup>c</sup> Debt repayments are often entered on this line in order to calculate net cash flow for cash budgeting purposes, but they are not taken into account when calculating "net beneficial cash flow."

<sup>d</sup> There are often figures on this line, because a sales increase usually requires an increase in working capital.

- A. The investment cost section: A program/project budget contains this section when the acquisition of capital assets is involved. (Capital assets are physical or tangible assets such as machinery/equipment, buildings, and land.) A program/project that involves the acquisition of capital assets is called a “capital program/project.” (Many R&D, production, marketing, finance, and human resources programs/projects do not involve expenditures for capital assets. Those that do not are not considered capital programs/projects, and, therefore, usually have a format that consists of only the income/earnings section.)

Lines 1 through 5 — These lines contain figures for cash expenditures (cash payments or outflows) associated with the purchase, construction, and installation of capital assets. The figures are added (as indicated by a plus sign), because line 10 will reflect the net cash outflow associated with the acquisition of capital assets. In our example in Exhibit Z, machines are being purchased and installed in vacant plant space—so no purchases of buildings or land are involved. They are being installed and made operational at the very beginning of 2000, so that they will generate financial benefits during the entire year. (In Exhibit Z, the different types of capital assets are shown on separate lines in order to facilitate the calculation of depreciation. As discussed below, different types of assets have different depreciation schedules.)

Lines 6 and 7 — These contain figures for cash inflows (or savings) generated by the sale of (or trade-in allowances on) any assets being replaced. These figures are subtracted (as indicated by a minus sign), because they reduce the net cash outflow figure on line 10. In our example in Exhibit Z, no existing machines are being replaced.

Line 8 (Debt incurred) — This line can contain the figure for the amount of debt incurred in order to pay for new capital assets. (It is placed at this point because the amount of cash that might have to be borrowed to purchase assets is reduced by the figures in lines 6 and 7.) Borrowed funds constitute a cash inflow, and, therefore, are subtracted in this section (as indicated by a minus sign). As mentioned in Note “b” in Exhibit Z, many practitioners do not enter this figure, because they do not use it to calculate the figures for certain financial criteria. In our example in Exhibit Z, the

machines are being purchased out of available internal funds, so that no additional debt will be incurred.

Line 9 (Recaptured depreciation) — The recapture of depreciation on any replaced asset(s) is treated as a cash outflow, and, therefore, is added in this section (as indicated by a plus sign).

Line 10 (Net cash outflow on investment) — This figure constitutes the (net) total of the cash outflows (costs/expenditures) and cash inflows (receipts/credits) entered on the lines above. Line 10 almost always indicates a net cash outflow.

- B. The investment benefits section: Even though many capital programs/projects are completed in one or two years, most of them provide earnings and cash flow benefits over some number of years. Many have a “beneficial lifetime” of at least five to ten years. Others, such as large plant and equipment projects, generally have a beneficial lifetime of twenty to forty years. Therefore, in order to determine a capital project’s total financial benefits over time, a pro forma P&L and a pro forma cash flow statement are prepared for each year of its beneficial life. Today, a computer spreadsheet is used to help generate the annual figures in these program/project budget sections.

1. The income/earnings section: This pro forma P&L section is included in all program/project budgets. Its format is similar to a corporate P&L statement—except that the items/lines deal with new/additional revenues, cost savings, and costs/expenses that are attributable only to the particular program/project (are experienced in addition to the benefits and costs attributable to existing or ongoing operations). The budgets for those R&D, production, marketing, finance, and other programs/projects that involve new/additional benefits and costs—but do not involve the acquisition of capital assets—normally consist of this section alone.

Line 11 (Sales revenue) — The figure for each year is calculated by multiplying the intended price per unit (for the product/service) by the forecasted/estimated new/additional unit sales for that particular year—if any. New/additional sales revenue figures are usually shown in marketing programs/projects

budgets, and are often shown in R&D and production programs/projects budgets. The annual figures are added, because increased annual revenues increase the income figures on line 18.

Line 12 (Cost savings) — The figure for each year is the total of that particular year's estimated/projected savings in personnel, materials, supplies, services, and other operating costs—if any. (Another format might be used to list different cost items separately.) Cost savings figures are usually shown in production and productivity programs/projects budgets, and are often shown in marketing and finance programs/projects budgets. The annual figures are added, because cost savings increase the income/earnings figures on line 18.

Line 13 (New/additional operating costs) — The figure for each year is the total of that particular year's estimated new/additional personnel, materials, supplies, maintenance, services, and other operating costs—if any. (Again, another format might list different cost items separately.) Many if not most programs/projects incur at least some new or additional operating costs. The annual figures are subtracted, because costs reduce the income figures on line 18.

Line 14 (Depreciation) — The figure for each year is that year's depreciation expense—if any. Capital programs/projects involve this expense, but others usually do not. Since 1987, machines and equipment items are depreciated over 7 years, while buildings (plants and offices) are depreciated over 31 years. The annual depreciation expense on a particular asset is calculated by dividing the cost of that asset by its depreciable life. In our example in Exhibit Z, the (annual) \$40,000 figure is calculated by dividing \$280,000 (the total for all the newly acquired machines) by 7 years. (The straight-line method of depreciation is normally used.) Depreciation is subtracted just as other expenses/costs are subtracted in order to calculate income. (Unlike other expenses, however, it does not involve an actual cash outflow.)

Line 15 (Interest) — The figure for each year is that year's interest expense (interest owed on borrowed funds)—if any. Capital programs/projects often involve this expense, because organizations often borrow funds to pay for new capital assets. In our example in Exhibit Z, the company did not borrow funds, so it is not paying interest on a loan. As mentioned in Note "b" to Table 7, many practitioners do not enter annual figures on this line, because they do not use them to calculate the figures for certain financial criteria.

Line 16 (Before-tax income/earnings) — Each year's figure is calculated as follows: New/additional revenue (+) new cost savings (-) new/additional operating costs (-) depreciation and interest expenses (=) before-tax income/earnings.

Line 17 (Income tax) — Each year's tax figure is calculated based on the before-tax income figure and federal and state tax rates. (Refer to recent federal and state instructions for tax rates and correct calculation procedures.) As noted in Exhibit Z, we have used a combined federal/state tax rate of 50% for the sake of simplicity.

Line 18 (Net income/earnings) — Each year's figure is calculated as on any P&L (and as shown in Exhibit Z). It reflects the net (after-tax) income/earnings that are generated in addition to the profit/income/earnings generated by existing or on-going operations. The annual figures on line 18 are used to calculate the average/accounting/simple rate of return on an investment.

2. The Cash flow section: This section is used to determine the net beneficial cash flow generated during each year of a capital program's/project's life. As mentioned earlier in the section on budgeting, profits/earnings are not necessarily the same as cash flows—especially in the cases of capital programs/projects. Therefore, the cash flow section makes an adjustment for depreciation and takes account of cash flows that were not included in the income/earnings section. This whole section is usually excluded from the budgets of other programs/projects, because the cash flows associ-

ated with them (i.e., additional revenues, cost savings, and additional costs/expenses) have already been taken into account in the income/earnings section.

Line 19 — The yearly figures on line 18 are entered on this line, because they represent beneficial cash flows that have been calculated on an “income/earnings basis.”

Line 20 (Depreciation) — Each year’s depreciation expense is brought down from the income/earnings section. It is then added back in (as indicated by a plus sign), because, unlike other expenses, depreciation does not actually involve a cash outflow. In effect, this section treats depreciation as a “positive supplement” to cash flow.

Line 21 (Proceeds from asset disposal) — Here, a cash inflow figure is entered under the year in which assets are sold for their (estimated) market or salvage value.

Line 22 (Debt repayments) — The (total) loan principal repayments made during each year are entered on this line. Although these are cash outflows, many practitioners do not enter the figures, because they do not use them to calculate the figures for certain financial criteria. In our example in Exhibit Z, the company incurred no debt, and, therefore, is not making principal repayments.

Line 23 (Net increase in working capital) — The figure for each year is projected and then entered on this line. Yearly increases in sales and operations generally result in yearly net increases in working capital (current assets minus current liabilities). (For example, increases in inventory and accounts receivable increase working capital, while an increase in accounts payable decreases it.) A net increase in working capital constitutes a net cash outflow, because funds must be expended in order to finance the net increase (in assets). Therefore, it is subtracted in this section (as indicated by a minus sign). Although any year’s net increase in working capital can be 10% to 20% of an increase in sales revenue, we have simply shown no figures on

this line in Exhibit Z.

Line 24 (Net beneficial cash flow) — Each year’s figure is the net total of that year’s cash inflows and cash outflows (on lines 19, 20, 21, and 23). (Yearly debt repayment figures on line 22 are often used to calculate yearly net cash flow figures for cash budgeting purposes, but are not used to calculate net beneficial cash flow figures.) Each year’s net beneficial cash flow figure usually indicates a (positive) net cash inflow. Yearly net beneficial cash flow figures are used to calculate figures for all but one of the financial criteria discussed below.

Although program/project Budgets are necessary tools for arriving at the figures used to evaluate and compare the financial results of programs/projects, those who prepare and use them should keep in mind two inherent problems/limitations:

- a. Many organizations’ cost accounting systems are not sophisticated enough to distinguish accurately between the costs attributable to proposed programs/projects and the costs attributable to existing operations.
- b. Program/project budgets generally contain figures considered to be the “most probable” or “most realistic.” Consequently, they do not necessarily account for other possible levels of revenues, cost savings, costs, and cash flows that also have some probability of occurring. [Therefore, in order to determine the financial implications of other possibilities, decision makers will often use a computer spreadsheet to construct additional budgets containing other possible (combinations of) figures. For example, in addition to a “most probable or realistic budget,” they may also construct a “best case budget” and a “worst case budget.”]

Below we discuss the major financial criteria (and associated computational techniques) that are used to evaluate and/or compare the financial desirability of capital programs/projects. Each criterion is essentially an indicator of how efficiently the invested dollars will work to yield financial benefits.

**Table 7: Average Rate of Return Calculation for Project X**  
**(Based on the "Average Book Method" and Figures in Exhibit Z)**

Year	A New/Additional Net Income (from Line 18)	B Net Investment at Begin'g of Year (from Line 10)	C Annual Depreciation (from Line 14)	D Net Investment at Year End (B - C)	E Average Net Investment [(B + D) / 2]
2000	20,000	280,000	40,000	240,000	260,000
2001	30,000	240,000	40,000	200,000	220,000
2002	40,000	200,000	40,000	160,000	180,000
2003	50,000	160,000	40,000	120,000	140,000
2004	60,000	120,000	40,000	80,000	100,000
2005	70,000	80,000	40,000	40,000	60,000
2006	80,000	40,000	40,000	0	20,000
	<b>350,000</b>				<b>980,000</b>
	divided by 7 years = \$50,000 per Yr.				divided by 7 years = \$140,000 Per Yr.
<b>ARR (Average Book) = <math>\frac{\text{Average Net Income}}{\text{Average Net Investment}} = \frac{\\$50,000}{\\$140,000} = 36\%</math></b>					

#### Average Rate of Return on Investment (ARR)

Also called the "accounting or simple rate of return," this old criterion is the only widely-used criterion to be calculated with income/earnings figures rather than cash flow figures. Two methods for calculating the ARR of a capital investment are discussed below.

A. The original book method: Here, average net income/earnings is divided by the original net cost (book value) of the investment. (As shown in column A of Table 7 above, average net income/earnings is calculated by totalling the years' net income/earnings figures and then dividing that sum by the appropriate number of years.) In our example in Exhibit Z, the average of the yearly figures on line 18 (or \$50,000) is divided by the figure on line 10 (\$280,000). Thus, using this method, the ARR of Project X is:

ARR (original book) =

$$\frac{\text{Average net income}}{\text{Original net investment}} = \frac{\$50,000}{\$280,000} = 18\%$$

B. The average book method: This second method, which we have illustrated in **Table 7**, is preferred and more widely used. Here, the average net income/earnings figure is divided by an (overall) average net investment figure (instead of the original net investment figure). Each year's average net investment is calculated as shown at the top of column E in Table 7, which uses the Project X figures in Exhibit Z. (Table 7 indicates which figures come from which lines in Exhibit Z: the yearly net income figures in column A come from line 18; the first net investment figure in column B comes from line 10; and the depreciation figures in column C come from line 14.) The overall average net investment figure is calculated by adding the figures in column E and dividing the result by the appropriate number of years. Thus, using this method, the ARR for Project X is 36% (as shown at the bottom of Table 7).

Note that, when the average net investment figure is used instead of the original net investment figure, a project's ARR is doubled—e.g., 36% vs. 18%. Thus, when capital projects are being compared, their ARRs should be calculated using only one of the two methods—preferably the second.



**Table 8: Payback Period Calculation for Project X**  
(Based on Figures in Table 7)

Year	A Net Investment Awaiting Payback at Beg'g of Year (from Line 10)	B Net Beneficial Cash Flow (from Line 24)	C Net Investment Awaiting Pay- back at Yr. End (A - B)	D Contribution to Payback Period (in Years)
2000	280,000	60,000	220,000	1.00
2001	220,000	70,000	150,000	1.00
2002	150,000	80,000	70,000	1.00
2003	70,000	90,000		0.78
<b>Payback Period =</b>				<b>3.78 Years</b>

A capital project is usually accepted if its ARR is (a) greater than some pre-selected cutoff or hurdle rate of return, and/or (b) greater than alternative projects' ARR's.

Using the ARR has several advantages: (a) it is easy to calculate; (b) it takes profitability into account; (c) it can be related to financial statements; and (d) the yearly earnings can be added in order to estimate the total earnings generated over the program's/project's lifetime.

Using the ARR also has several disadvantages: (a) it utilizes income/earnings figures rather than cash flow figures; (b) it ignores the time value of money; (c) it tends to either overstate or understate the rate of return (compared to other criteria); and (d) it utilizes the most probable/realistic estimated income figures (which are more or less treated as certainties).

### Payback Period

This more widely-used criterion for evaluating and/or comparing capital programs/projects is the number of years it will take for a project to generate enough cash to pay for itself. Put another way, it is the number of years that will be required to recover the original cash expenditure through the generation of net beneficial cash flows. In effect, this criterion is one indicator of a program's/project's level of financial risk. It is most often used by companies that are experiencing cash problems and wish to determine how quickly their scarce resources will be recovered and will

begin working to help improve their cash flows.

**Table 8** illustrates the accepted method for calculating payback period, which involves utilizing net beneficial cash flow figures rather than net income/earnings figures. (Debt repayment figures are not used to calculate the yearly net beneficial cash flow.) Using figures in Exhibit Z, the payback period for Project X is 3.78 years. (The first figure in column A comes from line 10 of Table 7, and the figures in column B come from line 24.) Note that, given the \$90,000 net beneficial cash flow generated during the fourth year, it takes .78 of that year to recoup the remaining \$70,000 (i.e., \$70,000 divided by \$90,000 is .78).

If the same net beneficial cash flow—say, \$75,000—is being projected for each year of a capital project's life, the payback period can be calculated using the following equation:

$$\begin{aligned}
 \text{Payback period} &= \\
 &\frac{\text{Net initial investment}}{\text{Annual net beneficial cash flow}} = \frac{\$280,000}{\$75,000} \\
 &= 3.73 \text{ years}
 \end{aligned}$$

The shorter a project's payback period, the sooner the investment's recovery, the better the implications for liquidity, and the lower the financial risk.

**Exhibit AA: Worksheets for Calculating a Project's Net Present (Discounted) Value (NPV)**
**Worksheet 1 -- Calculation of After-Tax Cash Flows**

Year	Continuous Level Streams of Cash						Year	End-of-Year Lump Sum Cash Receipts/Payments				
	A	B	C	D	E	F		G	H	I	J	K
	Taxable (pre-tax) income	Deprec.	Interest	Income (cash basis) (A+B-C)	Tax	After-tax cash flow (D - E)		Outflows		Inflows  (+)	Tax  (-)	After-tax net flows (G+H+I+J)
								Interest (-)	Other (-)			
								-5,000,000				-5,000,000
1	7,526,000	2,000,000	500,000	9,026,000	3,763,000	5,263,000	1	-500,000	-1,000,000			-1,500,000
2	7,607,320	2,000,000	400,000	9,207,320	3,803,660	5,403,660	2	-400,000	-1,000,000			-1,400,000
3	8,554,832	2,000,000	300,000	10,254,832	4,277,416	5,977,416	3	-300,000	-1,000,000			-1,300,000
4	9,445,171	2,000,000	200,000	11,245,171	4,722,586	6,522,585	4	-200,000	-1,000,000			-1,200,000
5	10,303,333	2,000,000	100,000	12,203,333	5,151,666	7,051,667	5	-100,000	-1,000,000			-1,100,000
6	13,402,566			13,402,566	6,701,283	6,701,283	6					
7	14,364,246			14,364,246	7,182,123	7,182,123	7					
8	15,757,743			15,757,743	7,878,872	7,878,871	8					
9	16,900,285			16,900,285	8,450,142	8,450,143	9					
10	18,006,805			18,006,805	9,003,402	9,003,403	10					

**Worksheet 2 -- Calculation of Discounted Values**

Year	L Interest rate (%)	M Flow (Col. F)	N Accum. Factor	O Value at end (M x N)	P End-year lump (Col. K)	Q Total end-year (O + P)	R Discount factor	S Discounted value	T Accum. total
	Continuous Level Streams								
1	7	5,263,000	1.035	5,447,205	-5,000,000	-5,000,000	1.000	-5,000,000	-5,000,000
2	7	5,403,660	1.035	5,592,788	-1,500,000	3,947,205	0.935	3,690,637	-1,309,363
3	7	5,977,416	1.035	6,186,626	-1,400,000	4,192,788	0.873	3,660,304	2,350,941
4	7	6,522,585	1.035	6,750,875	-1,300,000	4,886,626	0.816	3,987,487	6,338,428
5	7	7,051,667	1.035	7,298,475	-1,200,000	5,550,875	0.763	4,235,318	10,573,746
6	7	7,051,667	1.035	7,298,475	-1,100,000	6,198,475	0.713	4,419,513	14,993,259
7	7	6,701,283	1.035	6,935,828		6,935,828	0.666	4,619,261	19,612,520
8	7	7,182,123	1.035	7,433,497		7,433,497	0.623	4,631,069	24,243,589
9	7	7,878,871	1.035	8,154,631		8,154,631	0.582	4,745,995	28,989,584
10	7	8,450,143	1.035	8,745,898		8,745,898	0.544	4,757,769	33,747,353
10	7	9,003,403	1.035	9,318,522		9,318,522	0.508	4,733,809	38,481,162

In general, a capital project is more likely to be accepted if its payback period is shorter than (a) some pre-selected cutoff or hurdle payback period, and/or (b) the payback periods of alternative programs/projects.

Payback period has several advantages: (a) it is easy to understand and calculate; (b) it is a good indicator of financial risk; and (c) it is useful for initially screening alternatives.

Payback period also has several disadvantages: (a) it does not account for cash flows generated following the payback period; (b) it does not account for the time value of money; (c) it will inappropriately indicate that very beneficial high-cost projects having longer payback periods are less desirable than much less significant low-cost projects having shorter payback periods; and (d) it uses the most probable/realistic figures (which are more or less treated as certainties). [Therefore, it is advisable to use this criterion in conjunction with others—such as net present value and internal rate of return.]

### Net Present (Discounted) Value (NPV)

Basically, a capital project's net present value is the difference between the net cash inflows it will generate and its initial net cost—with all yearly cash flows discounted to their present values in order to account for the time value of money. A firm discounts cash flows based on its (after-tax weighted average) cost of Capital.

Because NPV provides precise values and reliable signals with respect to projects, many practitioners prefer to use it as the only criterion for making investment decisions. NPV is used to (a) evaluate a single capital project in an interim or ad hoc situation; (b) evaluate and compare alternative capital projects during a planning process; and even (c) place a value on a business.

Several methods can be used to determine NPV. The easiest is to use one of the computer programs that can be bought for this purpose. Another is to use the formula that can be found in various financial texts. We briefly discuss the formula on page DM-54. The method we fully discuss here is more difficult to use, but is more accurate than other methods in certain respects. The steps involved are described below. They are also illustrated in the two worksheets provided in **Exhibit AA**. We describe the steps in detail so that the reader (a) will fully understand NPV prin-

ciples and calculations; (b) will be able to calculate NPV “by hand” if necessary; and (c) will be able to develop his or her own computer program or spreadsheet template for calculating NPV.

The sample worksheets deal with a ten-million-dollar capital (machinery/equipment) project. The machinery/equipment would be installed in plant space that has been vacant for some time, so no investments in buildings and land would be involved. To finance the project, the company would use five million dollars from retained earnings and would borrow the other five million. A budget—such as the one in **Exhibit Z**—has been prepared for the first ten years of the project's beneficial life, and the figures have been entered on the worksheets.

### Worksheet 1 — Calculation of after-tax cash flows

The “continuous level streams” columns (A through F) deal with cash inflows (e.g. sales revenues) and cash outflows (e.g., expenditures for labor, materials, supplies, and services) that occur over the course of a year and eventually add up to the figures entered in columns A through F. Even though these cash flows may occur from month to month or from quarter to quarter rather than from day to day, they can still be treated as uniform, continuous flows. (Less accurate NPV methods treat these cash flows as year-end lump sums, and thereby understate their end-of-year values.)

The “lump sum” columns deal with cash inflows/receipts (such as cash receipts from borrowing funds and from selling facilities or equipment) and cash outflows/payments (such as principal and interest payments on a loan) that occur in lump sums at the end of a year.

1. Year Column: Under this first column, number each row from year 0 down to year “n.” Year 0 is the year during which project facilities are being installed and the project is not yet producing benefits or earnings. Year 1 is the first year during which benefits or earnings are being generated. Year “n” is the last year for which cash flows are to be discounted—and is usually the last year of the project's beneficial or useful life. The length of beneficial/useful life varies from project to project. It may be five years, ten years, or as many as fifty years. The life of the project in our example is twenty years. We discontinued the analysis after ten years because of the limited space on page DM-46.

A generalization: Over time, discounted cash flows can tend to become decreasingly significant—especially when (a) cash inflows and outflows are in the relatively low figures; (b) cash inflows and outflows are being discounted for about twenty years or more; and (c) the interest rate (cost of capital) being used as a basis for determining discounting factors is relatively high (e.g., 11% or higher).

2. Column A — Taxable income: For each year, record the project's taxable or pre-tax income/earnings. The yearly figures would come from line 16 of a project budget such as the one in Exhibit Z on page DM-40. (Before-tax income equals new/additional sales/operating revenue plus cost savings minus new/additional operating expenses minus depreciation and interest expenses.)
3. Column B — Depreciation: For each year, enter the year's depreciation expense (the amount of depreciation written off against the original capital investment). Yearly depreciation figures would come from line 14 of a budget such as the one in Exhibit Z. Depreciation can be calculated using either the straight-line method or one of several accelerated methods. In our example, it has been calculated on a straight-line basis—i.e., \$10 million depreciated over five years equals a \$2-million-dollar per year depreciation expense. [We have used five years for the sake of simplicity. Actually, machines and equipment items are now depreciated over seven years.] Each year's depreciation expense is identified in a separate column because it does not constitute an actual cash outflow (and, therefore, will be added back in column D).
4. Column C — Interest expense: This column is filled in only if a project has been financed either wholly or partly with an outside loan. If interest would be paid in a lump sum at the end of each year, enter each year's interest expense in this column—so that it will be subtracted out in column D and will not be treated as a continuous level stream. However, if interest would be paid on some regular basis over the course of each year (such as monthly or quarterly), do not enter figures in this column. In our example, interest (at 10% of the unpaid balance of the loan) would be paid in a lump sum at the end of each year. Thus, each year's interest expense is shown in column C.
5. Column D — Income before taxes (continuous cash stream basis): For each year, calculate this figure by

adding the year's figures in columns A and B and then subtracting the interest figure (if any) in column C. This adds back depreciation (because it is not actually a cash outflow) and subtracts out any year-end lump sum interest payments. The resulting figure constitutes the year's "continuous stream income/earnings cash flow before taxes."

6. Column E — Tax: For each year, calculate the tax that would be paid (a cash outflow) by multiplying the figure in column A by the organization's (combined) federal/state tax rate. In our example, we have simply assumed a combined tax rate of 50%. Tax payments are considered a continuous level stream, because they are paid to the IRS on a quarterly basis.
7. Column F — After-tax (net) cash flow (continuous stream): For each year, calculate this figure by subtracting the tax figure in column E from the before-tax cash flow figure in column D. The resulting figure is essentially the "net (after-tax) continuous beneficial cash flow."
8. Column G — Lump sum outflows, interest payments: Figures are entered in this column only if (a) borrowed funds would be used to finance a project, and (b) interest payments on the loan would be made in year-end lump sums. For each year, enter the year-end lump sum interest payment figure (if any) with a minus sign preceding it. In our example, interest (on the declining balance of the \$5 million loan) would be paid in end-of-year lump sums over a five-year period. Note in Worksheet 1 that the figures in columns C and G are the same—except for the minus signs in column G.
9. Column H — Lump sum outflows, other: For each year, enter the (net) total of all "other" end-of-year lump sum cash outflows (preceded by a minus sign). This net figure can include (a) follow-up capital investments in subsequent years of a project's life; (b) borrowed funds; and (c) principal repayments on a loan. (It should be pointed out that the format in Exhibit AA is particularly useful when accounting for additional capital investments in subsequent years.) Note the following in our example: Year 0 shows a (net) lump sum cash outflow of -\$5 million. [\$10 million would be paid for machinery/equipment (an outflow), but \$5 million would be borrowed (an inflow). Thus, the result in year 0 would be a net outflow of -\$5 million.] At the ends of years 1 through 5, the

company would repay the \$5 million loan in five annual, end-of-year lump sum installments of \$1 million.

10. Column I — Lump sum inflows: For each year, enter the total of all end-of-year lump sum cash inflows (if any). In the cases of most capital projects, only one figure is entered in this column—the cash inflow generated when capital assets are sold for their (estimated) market or salvage value at the end of the last year of their lives. Since the company in our example would use its new machinery/equipment for about twenty years, we would have shown a cash inflow at the end of year 20 if page space had permitted a full-term analysis.
11. Column J — Tax (on lump sum inflows in column I): For each year having a figure in column I, calculate the tax on that figure and enter the amount of tax in column J (preceded by a minus sign). For example: If capital assets would be sold at the end of year 20, that year's tax figure would be the capital gains tax on any proceeds in excess of the depreciated or "book value" of the assets.
12. Column K — Net lump sum cash flows (after taxes): For each year, add that year's positive and negative figures in columns G, H, I, and J. As in our example, the yearly sums (net totals) are usually negative figures—and are therefore preceded by minus signs.

### Worksheet 2 — Calculation of the discounted values of yearly cash flows

While yearly net lump sum cash flows after taxes (in column K) can be directly discounted to their present value, yearly after-tax continuous cash flows (in column F) should first be "accumulated" or "accrued" to their end-of-year values. Accumulation accounts for two facts: (a) that these cash flows occur over the course of a year, and (b) that a dollar earned at the beginning of a year is worth more than a dollar earned later in the year. Columns M, N, and O are used to accrue continuous level streams to their respective year-end values.

13. Year Column — Here again, number each row/line from year 0 down to the last year for which cash flows are to be discounted.
  14. Column L — Interest rate (%): This figure is the basis for determining the appropriate accumulation factors (in column N) and the appropriate discounting factors (in column R). Many firms have used the interest rate being paid on long-term debt. Others have used a weighted average of the rates being paid on both short- and long-term debt. Neither of these methods is currently considered as accurate as using the firm's "(total) weighted average cost of capital (after taxes)," which is the after-tax cost of all external sources of capital—i.e., both debt and equity.
- Determining the after-tax weighted average cost of capital: See **Exhibit AB** on the next page.
- A. Column 1: List all existing debt instruments (i.e., short-term loans, long-term loans, corporate bonds, and debentures) and all existing classes of stock (i.e., common and preferred).
  - B. Column 2: Enter the dollar amount of each debt instrument, and the book value of issued/outstanding stock in each class of stock. In Exhibit AB, the second long-term loan is the five million dollar loan for the machinery/equipment project.
  - C. Column 3: For each debt instrument, enter the applicable interest rate. For equities, enter the figure that represents the total % return desired by investors. (Some practitioners simply use the figure derived by dividing total dividends being paid by the book value of a class of stock. However, various financial experts recommend adding the rate of capital appreciation that investors expect in order to keep ahead of inflation. We have shown these two rates separately in Exhibit AB.)
  - D. Column 4: For each source of capital, multiply the figure in column 2 by the figure in column 3. The result is either (a) the amount of interest being paid to a lender, or (b) the dividends being paid to, and/or the capital appreciation being realized by, investors.
  - E. Total the figures in column 2; and then total the figures in column 4.
  - F. Divide the column 4 total by the c2 total. The result is the "weighted average cost of capital before taxes."

**Exhibit AB: Sample Worksheet for Calculating the "After-Tax Weighted Average Cost of Capital"**

1 Sources of capital	2 Amount	3 Rate	4 Cost
<b>Debt</b>			
Short-term loan	500,000	x 8%	= 40,000
Long-term loans (1)	10,000,000	x 14%	= 1,400,000
(2)	5,000,000	x 10%	= 500,000
Corporate bonds (none)			
Debentures (none)			
<b>Equity</b>			
Common stock	20,000,000	x 10%	= 2,000,000
		x x%	=
Preferred stock (none)			
<b>TOTALS:</b>	<b>35,500,000</b>		<b>3,940,000</b>

$3,940,000 / 35,500,000 = 11.10\%$  (rounded) before-tax weighted avg. cost of capital;

then,  $11.10\% \times .50$  (Tax) = 5.55% after-tax weighted avg. cost of capital

- G. To calculate the "after-tax weighted average cost of capital," multiply the before-tax figure by the firm's combined federal/state tax rate, and then subtract the amount of tax from the before-tax figure. If the weighted average cost of capital before taxes were 14% (as in Exhibit AB), and if the combined tax rate were 50%, the after-tax weighted average cost of capital would be 7%.

In the view of many financial experts, this figure more accurately reflects the "real" cost of capital. It accounts for the fact that interest expense is deducted from revenue for tax purposes, thereby reducing a firm's tax bill and saving money. It also accounts for the fact that dividends are paid out of after-tax earnings, which include tax savings from "leveraging" (using debt to finance operations and gain a greater return for stockholders).

For each year, enter the after-tax weighted average cost of capital figure in column L of Worksheet 2. The same figure is generally used for all the years—even though an organization's debt/equity struc-

ture or interest rates and dividend payments might change slightly over time.

15. Column M — Flow (continuous level streams): For each year, simply transfer that particular year's figure from column F of Worksheet 1.
16. Column N — Accumulation factor (continuous level streams): This figure is used to accumulate or accrue continuous level streams to the end of a year. Since the interest rate (cost of capital) figures in column L are all the same, the accumulation factor is the same for all years. Note in Exhibit AA that an accumulation factor is greater than 1. When it is multiplied times the continuous flow throughout the year (in column M), it increases the value of cash flows occurring earlier in the year (because they are worth more than cash flows occurring later in the year). Accumulation factors for various interest rates can be found in compound interest tables. However, for the reader's convenience, we have provided **Table 9** (pages DM-52 and 53), which lists accumulation factors for interest rates from 1% to 20%. [The formula for an accumulation factor is:  $1 + (i/2)$ —where "i" is the interest rate.]

17. Column O — Value at end of year (of continuous level stream): For each year, multiply the figure in column M by the accumulation factor in column N. The result is the value of the continuous stream at the end of the year.
18. Column P — End-of-year lump sum cash flow: For each year, simply transfer that particular year's figure from column K of Worksheet 1.
19. Column Q — Total end-of-year net cash flow: For each year, add that year's figures in columns O and P. The sum is the total year-end value of all cash flows during the year. (Since the figures in column O are accumulated to year-end, they can be added to those in column P—as one can add apples to apples.)
20. Column R — Discount factor: For each year, enter that particular year's discount factor. Discount factors are used to translate cash flows in future years to their present value. Note in Exhibit AA that the values of discount factors decrease over time. This accounts for the time value of money—i.e., the fact that dollars earned in the future are not worth as much as dollars earned today. Also note that the factor for year 0 is always 1.0. Discount factors for various interest rates can be found in compound interest tables. However, for the reader's convenience, we have provided **Table 9**, which lists discount factors for fifty years at interest rates from 1% to 20%. [The formula for the discount factor for year "x" is:  $1/(1 + i)^x$ —where "i" is the interest rate and "x" is the year.]
21. Column S — Present (discounted) values of yearly cash flows: For each year, multiply the figure in column Q by the year's discount factor in column R. The result is the present (discounted) value of that year's total year-end cash flow—i.e., what that year's cash flow is worth today (at the specified interest rate in column L).
22. Column T — Cumulative total of present values of yearly cash flows: The figures in this column are derived simply by adding the present value of each year's discounted cash flow to the cumulative total as of the previous year. For example, **Exhibit U** shows the following: The cumulative total present value of cash flows at year 0 is -\$5,000,000. By adding the positive \$3,690,637 discounted cash flow in year 1, the cumulative total becomes -\$1,309,363. By adding the positive discounted cash flow of \$3,660,304 in year 2,

the cumulative present value becomes a +\$2,350,941. And so forth. In other words, the project in our example will have generated a positive present value during year 2. It should be noted that the total cumulative present value of this project is not the \$38,481,162 shown for the end of year 10. If we had carried the analysis out to twenty years, the project's NPV would have been significantly greater.

To apply this method more quickly, first design a computer spreadsheet that (a) contains Worksheets 1 and 2, and (b) automatically calculates figures in cells where formulas can be used—including the accumulation and discount factor cells (where the formulas utilize the interest rate in column L). Then, to compute the NPV, simply enter basic data in the appropriate cells and let the computer perform the calculations.

To find the ("simple") payback period of a project such as that analyzed in Exhibit AA, one would not use the figures in columns S or T. Instead, one would do the following: (1) Calculate the net beneficial cash flow for each year by subtracting the tax figure in column E from the taxable income figure in column A, and then adding back the depreciation figure in column B. [Notes: These calculations correspond to the calculations in Exhibit Z. Any interest expense could have been subtracted from revenue in the process of calculating pre-tax income. Practitioners normally do not account for loan repayments when calculating payback period.] With respect to our example in Exhibit AA, the figure for year 1 would be \$5,763,000; the figure for year 2 would be \$5,803,660; the figure for year 3 would be \$6,277,416; and so forth. (2) Use the format illustrated in Table 8 to calculate the payback period—which would be 1.73 years in the case of the example in Exhibit AA.

Some practitioners calculate the present value (discounted) payback period. (1) Calculate each year's net beneficial cash flow (in the manner described in the paragraph above). (2) Using the discount factors in column R, discount each year's net beneficial cash flow to its present value. Based on the figures in Exhibit AA, the present value of the first year's cash flow would be \$5,388,405; the present value of the second year's cash flow would be \$5,066,595; and so forth. [Notes: Yearly net beneficial cash flows are usually treated as end-of-year lump sums. Practitioners normally do not include loan repayment figures in these cash flow calculations.] (3) Use the format illustrated in Table 8 to calculate the discounted payback period—which would be 1.91 years in the case of the example in Exhibit AA. The discounted payback period is longer than the "simple" payback period.

**Table 9: Accumulation and Discount Factors (for Interest Rates of 1% to 20%)**

Interest Rates:	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
Accumulation Factors (for 1 yr):	1.005	1.01	1.015	1.02	1.025	1.03	1.035	1.039	1.044	1.049
Discount Factors:										
Year 1	0.990	0.980	0.971	0.962	0.952	0.943	0.935	0.926	0.917	0.909
2	0.980	0.961	0.943	0.925	0.907	0.890	0.873	0.857	0.842	0.826
3	0.971	0.942	0.915	0.889	0.864	0.840	0.816	0.794	0.772	0.751
4	0.961	0.924	0.888	0.855	0.823	0.792	0.763	0.735	0.708	0.683
5	0.951	0.906	0.863	0.822	0.784	0.747	0.713	0.681	0.650	0.621
6	0.942	0.888	0.837	0.790	0.746	0.705	0.666	0.630	0.596	0.564
7	0.933	0.871	0.813	0.760	0.711	0.665	0.623	0.583	0.547	0.513
8	0.923	0.853	0.789	0.731	0.677	0.627	0.582	0.540	0.502	0.467
9	0.914	0.837	0.766	0.703	0.645	0.592	0.544	0.500	0.460	0.424
10	0.905	0.820	0.744	0.676	0.614	0.558	0.508	0.463	0.422	0.386
11	0.896	0.804	0.722	0.650	0.585	0.527	0.475	0.429	0.388	0.350
12	0.887	0.788	0.701	0.625	0.557	0.497	0.444	0.397	0.356	0.319
13	0.879	0.773	0.681	0.601	0.530	0.469	0.415	0.368	0.326	0.290
14	0.870	0.758	0.661	0.577	0.505	0.442	0.388	0.340	0.299	0.263
15	0.861	0.743	0.642	0.555	0.481	0.417	0.362	0.315	0.275	0.239
16	0.853	0.728	0.623	0.534	0.458	0.394	0.339	0.292	0.252	0.218
17	0.844	0.714	0.605	0.513	0.436	0.371	0.317	0.270	0.231	0.198
18	0.836	0.700	0.587	0.494	0.416	0.350	0.296	0.250	0.212	0.180
19	0.828	0.686	0.570	0.475	0.396	0.331	0.277	0.232	0.194	0.164
20	0.820	0.673	0.554	0.456	0.377	0.312	0.258	0.215	0.178	0.149
21	0.811	0.660	0.538	0.439	0.359	0.294	0.242	0.199	0.164	0.135
22	0.803	0.647	0.522	0.422	0.342	0.278	0.226	0.184	0.150	0.123
23	0.795	0.634	0.507	0.406	0.326	0.262	0.211	0.170	0.138	0.112
24	0.788	0.622	0.492	0.390	0.310	0.247	0.197	0.158	0.126	0.102
25	0.780	0.610	0.478	0.375	0.295	0.233	0.184	0.146	0.116	0.092
26	0.772	0.598	0.464	0.361	0.281	0.220	0.172	0.135	0.106	0.084
27	0.764	0.586	0.450	0.325	0.268	0.207	0.161	0.125	0.098	0.076
28	0.757	0.574	0.437	0.333	0.255	0.196	0.150	0.116	0.090	0.069
29	0.749	0.563	0.424	0.321	0.243	0.185	0.141	0.107	0.082	0.063
30	0.742	0.552	0.412	0.308	0.231	0.174	0.131	0.099	0.075	0.057
31	0.735	0.541	0.400	0.296	0.220	0.164	0.123	0.092	0.069	0.052
32	0.727	0.531	0.388	0.285	0.210	0.155	0.115	0.085	0.063	0.047
33	0.720	0.520	0.377	0.274	0.200	0.146	0.107	0.079	0.058	0.043
34	0.713	0.510	0.366	0.264	0.190	0.138	0.100	0.073	0.053	0.039
35	0.706	0.500	0.355	0.253	0.181	0.130	0.094	0.068	0.049	0.036
36	0.699	0.490	0.345	0.244	0.173	0.123	0.088	0.063	0.045	0.032
37	0.692	0.481	0.335	0.234	0.164	0.116	0.082	0.058	0.041	0.029
38	0.685	0.471	0.325	0.225	0.157	0.109	0.076	0.054	0.038	0.027
39	0.678	0.462	0.316	0.217	0.149	0.103	0.071	0.050	0.035	0.024
40	0.672	0.453	0.307	0.208	0.142	0.097	0.067	0.046	0.032	0.022
41	0.665	0.444	0.298	0.200	0.135	0.092	0.062	0.043	0.029	0.020
42	0.658	0.435	0.289	0.193	0.129	0.087	0.058	0.039	0.027	0.018
43	0.652	0.427	0.281	0.185	0.123	0.082	0.055	0.037	0.025	0.017
44	0.645	0.418	0.272	0.178	0.117	0.077	0.051	0.034	0.023	0.015
45	0.639	0.410	0.264	0.171	0.111	0.073	0.048	0.031	0.021	0.014
46	0.633	0.402	0.257	0.165	0.106	0.069	0.044	0.029	0.019	0.012
47	0.626	0.394	0.249	0.158	0.101	0.065	0.042	0.027	0.017	0.011
48	0.620	0.387	0.242	0.152	0.096	0.061	0.039	0.025	0.016	0.010
49	0.614	0.379	0.235	0.146	0.092	0.058	0.036	0.023	0.015	0.009
50	0.608	0.372	0.228	0.141	0.087	0.054	0.034	0.021	0.013	0.009



Interest Rates:		11%	12%	13%	14%	15%	16%	17%	18%	19%	20%
Accumulation Factors (for 1 yr):		1.054	1.059	1.064	1.068	1.073	1.078	1.083	1.088	1.092	1.097
Discount Factors:											
Year 1		0.901	0.893	0.885	0.877	0.870	0.862	0.855	0.847	0.840	0.833
2		0.812	0.797	0.783	0.769	0.756	0.743	0.731	0.718	0.706	0.694
3		0.731	0.712	0.693	0.675	0.658	0.641	0.624	0.609	0.593	0.579
4		0.659	0.636	0.613	0.592	0.572	0.552	0.534	0.516	0.499	0.482
5		0.593	0.567	0.543	0.519	0.497	0.476	0.456	0.437	0.419	0.402
6		0.535	0.507	0.480	0.456	0.432	0.410	0.390	0.370	0.352	0.335
7		0.482	0.452	0.425	0.400	0.376	0.354	0.333	0.314	0.296	0.279
8		0.434	0.404	0.376	0.351	0.327	0.305	0.285	0.266	0.249	0.233
9		0.391	0.361	0.333	0.308	0.284	0.263	0.243	0.225	0.209	0.194
10		0.352	0.322	0.295	0.270	0.247	0.227	0.208	0.191	0.176	0.162
11		0.317	0.287	0.261	0.237	0.215	0.195	0.178	0.162	0.148	0.135
12		0.286	0.257	0.231	0.208	0.187	0.168	0.152	0.137	0.124	0.112
13		0.258	0.229	0.204	0.182	0.163	0.145	0.130	0.116	0.104	0.093
14		0.232	0.205	0.181	0.160	0.141	0.125	0.111	0.099	0.088	0.078
15		0.209	0.183	0.160	0.140	0.123	0.108	0.095	0.084	0.074	0.065
16		0.188	0.163	0.141	0.123	0.107	0.093	0.081	0.071	0.062	0.054
17		0.170	0.146	0.125	0.108	0.093	0.080	0.069	0.060	0.052	0.045
18		0.153	0.130	0.111	0.095	0.081	0.069	0.059	0.051	0.044	0.038
19		0.138	0.116	0.098	0.083	0.070	0.060	0.051	0.043	0.037	0.031
20		0.124	0.104	0.087	0.073	0.061	0.051	0.043	0.037	0.031	0.026
21		0.112	0.093	0.077	0.064	0.053	0.044	0.037	0.031	0.026	0.022
22		0.101	0.083	0.068	0.056	0.046	0.038	0.032	0.026	0.022	0.018
23		0.091	0.074	0.060	0.049	0.040	0.033	0.027	0.022	0.018	0.015
24		0.082	0.066	0.053	0.043	0.035	0.028	0.023	0.019	0.015	0.013
25		0.074	0.059	0.047	0.038	0.030	0.024	0.020	0.016	0.013	0.010
26		0.066	0.053	0.042	0.033	0.026	0.021	0.017	0.014	0.011	0.009
27		0.060	0.047	0.037	0.029	0.023	0.018	0.014	0.011	0.009	0.007
28		0.054	0.042	0.033	0.026	0.020	0.016	0.012	0.010	0.008	0.006
29		0.048	0.037	0.029	0.022	0.017	0.014	0.011	0.008	0.006	0.005
30		0.044	0.033	0.026	0.020	0.015	0.012	0.009	0.007	0.005	0.004
31		0.039	0.030	0.023	0.017	0.013	0.010	0.008	0.006	0.005	0.004
32		0.035	0.027	0.020	0.015	0.011	0.009	0.007	0.005	0.004	0.003
33		0.032	0.024	0.018	0.013	0.010	0.007	0.006	0.004	0.003	0.002
34		0.029	0.021	0.016	0.012	0.009	0.006	0.005	0.004	0.003	0.002
35		0.026	0.019	0.014	0.010	0.008	0.006	0.004	0.003	0.002	0.002
36		0.023	0.017	0.012	0.009	0.007	0.005	0.004	0.003	0.002	0.001
37		0.021	0.015	0.011	0.008	0.006	0.004	0.003	0.002	0.002	0.001
38		0.019	0.013	0.010	0.007	0.005	0.004	0.003	0.002	0.001	0.001
39		0.017	0.012	0.009	0.006	0.004	0.003	0.002	0.002	0.001	0.001
40		0.015	0.011	0.008	0.005	0.004	0.003	0.002	0.001	0.001	0.001
41		0.014	0.010	0.007	0.005	0.003	0.002	0.002	0.001	0.001	0.001
42		0.012	0.009	0.006	0.004	0.003	0.002	0.001	0.001	0.001	
43		0.011	0.008	0.005	0.004	0.002	0.002	0.001	0.001	0.001	
44		0.010	0.007	0.005	0.003	0.002	0.001	0.001	0.001		
45		0.009	0.006	0.004	0.003	0.002	0.001	0.001	0.001		
46		0.008	0.005	0.004	0.002	0.002	0.001	0.001			
47		0.007	0.005	0.003	0.002	0.001	0.001	0.001			
48		0.007	0.004	0.003	0.002	0.001	0.001	0.001			
49		0.006	0.004	0.003	0.002	0.001	0.001				
50		0.005	0.003	0.002	0.001	0.001	0.001				

**Exhibit AC: NPV Calculations Using the NPV Equation**

(and Figures in Columns A, E, and B in Exhibit AA)

Year	Net beneficial cash flow				=	NBCF	/	(1 + i) <sup>x</sup>	=	PV of year's cash flow
	(A)	-	E	+ B)						
1	( 7,526,000	-	3,763,000	+ 2,000,000)	=	5,763,000	/	1.07 or (1.07) <sup>1</sup>	=	5,385,981
2	( 7,607,320	-	3,803,660	+ 2,000,000)	=	5,803,660	/	1.14 or (1.07) <sup>2</sup>	=	5,090,930
3	( 8,554,832	-	4,277,416	+ 2,000,000)	=	6,277,416	/	1.23 or (1.07) <sup>3</sup>	=	5,103,590
4	( 9,445,171	-	4,722,586	+ 2,000,000)	=	6,722,585	/	1.32 or (1.07) <sup>4</sup>	=	5,092,867
5	(10,303,333	-	5,151,666	+ 2,000,000)	=	7,151,667	/	1.41 or (1.07) <sup>5</sup>	=	5,072,104
6	(13,402,566	-	6,701,283	+ 0 )	=	6,701,283	/	1.51 or (1.07) <sup>6</sup>	=	4,437,936
7	(14,364,246	-	7,182,123	+ 0 )	=	7,182,123	/	1.62 or (1.07) <sup>7</sup>	=	4,433,409
8	(15,757,743	-	7,878,871	+ 0 )	=	7,878,871	/	1.73 or (1.07) <sup>8</sup>	=	4,554,261
9	(16,900,285	-	8,450,143	+ 0 )	=	8,450,143	/	1.85 or (1.07) <sup>9</sup>	=	4,567,645
10	(18,006,805	-	9,003,403	+ 0 )	=	9,003,403	/	1.98 or (1.07) <sup>10</sup>	=	4,547,173
<b>Total PV</b>									=	<b>48,285,896</b>

$$\text{NPV} = (\text{PV} - \text{CI}) = (\$48,285,896 - \$10,000,000) = \$38,285,896$$

NPV can also be calculated using the equation found in many financial references:

$$\text{NPV} = \text{PV} - \text{CI}$$

“PV” is the total present value of all years’ net beneficial cash flows (from year 1 through year n, the last year of the projects’ life. The equation for PV is:

$$\text{PV} = \frac{\text{NBCF}_1}{(1+i)} + \frac{\text{NBCF}_2}{(1+i)^2} + \dots + \frac{\text{NBCF}_n}{(1+i)^n}$$

“NBCF” is the net beneficial cash flow for the year indicated (by a subscript).

“i” is the “interest rate” (the firm’s after-tax weighted average cost of capital). Note that in the years after year 1, the quantity (1+i) is taken to the power indicated (e.g., in year 2 it is squared, in year 3 it is cubed, and in year “n” it is taken to the “nth” power).

“CI” is the (total) capital investment—i.e., the total net cash outflow resulting from the acquisition of capital assets. This figure should include not only (a) the initial investment made in year 0 (or perhaps at the beginning of year 1), but also (b) any additional/supplemental capital investments made in subsequent years of the project’s life. (Note: Rather than simply adding any subsequent investments to the initial investment, calculate a more accurate CI by first discounting subsequent investments to their respective present values

and then adding those values to the initial investment.) With reference to the example in Exhibits U and W, the CI would be \$10,000,000.

**Exhibit AC** illustrates this NPV calculation using the figures in columns A, E, and B of Exhibit AA. Note, however, that the total (cumulative) NPV figure at the bottom of column T in Exhibit AA is somewhat higher than the NPV calculated in Exhibit AC. This is mostly due to the fact that the method illustrated in Exhibit AA accumulates continuous level streams to their respective year-end values—instead of treating them as year-end lump sums and thereby understating their year-end values (as does the method illustrated in Exhibit AC). It is also due to the fact that the method illustrated in Exhibit AA takes account of the timing of all cash flows—including principal repayments on borrowed funds and subsequent capital expenditures. [Note: Dividing a year’s NBCF by the quantity (1 + i)<sup>x</sup> will produce virtually the same figure as multiplying that year’s NBCF by the discount factor for “i” in year X. Any slight difference between the two figures is due to dividing and multiplying by decimals that have been rounded off to the nearest hundredth or thousandth.]

In general, a project is accepted if its NPV is (a) positive (greater than 0); and/or (b) greater than the NPVs of alternative projects.

Using net present value has two main advantages: (a) it accounts for the time value of money; and (b) it can be used in conjunction with other project evaluation and comparison criteria.

However, NPV also has several problems/limitations common to all criteria: (a) its accuracy depends upon the accuracy of estimated/projected revenue, expense, and capital expenditure figures in a project's budget; and (b) it utilizes the "most probable/realistic" figures, which are more or less treated as certainties.

### **Profitability Index (PI) or Present Value Index (PVI)**

This "project ranking index" is often used when budgetary constraints exist and it is desirable to compare alternative projects based on an index of their profitability. Although it uses the same variables as the NPV formula shown above (where  $NPV = PV - CI$ ), it uses them differently. In the following equation, CI is divided into PV (instead of being subtracted from it):

$$PI = \frac{PV \text{ [the total present value of net beneficial cash flows in years 1 through n]}}{CI \text{ [the total (discounted value of) net capital investment cash outflows]}}$$

Using the figures in Exhibit AC, the PI or PVI for the project (in Exhibit AA) would be 4.83 (or \$48,285,896 divided by \$10,000,000). This figure indicates that every dollar invested will return \$4.83. [To calculate the PI or PVI using the figures in Exhibit AC, add the \$10,000,000 capital investment to the \$38,481,162 figure at the bottom of column T (because it was subtracted from yearly cash flows in column H and thereby decreased the cumulative figures in column T), and then divide the resulting \$48,481,162 by \$10,000,000 (the CI) to get 4.85.]

In general, a project is accepted if its PI or PVI is (a) equal to or greater than 1; and/or (b) greater than the PIs or PVIs of alternative projects.

Using the PI or PVI has several advantages: (a) it accounts for the time value of money; and (b) it can be used by those who prefer to compare projects based on index numbers rather than NPVs.

However, it also has several problems/limitations: First, it has the same problems/limitations that are common to NPV and other criteria. Second, the project having the highest index number is not always the project having the highest NPV. (In general, given capital rationing, the project having the highest PI/PVI should be selected over alternative projects having higher NPVs.)

### **Benefit/Cost Ratio (or Cost/Benefit Ratio)**

The equation for this project-ranking criterion is basically the same as for PI and PVI. Here, however, the resulting figure is expressed as a ratio instead of an index number. It is the ratio of (a) the total present value of yearly net beneficial cash flows to (b) the total (discounted value of) net capital investment cash outflows during a project's life. Using the figures in Exhibit AC, the equation would look and be solved like this:

$$\text{Benefit/Cost Ratio} = \frac{PV}{CI} \text{ (or } PV:CI) = \frac{\$48,285,896}{\$10,000,000} = 4.83, \text{ or the ratio, } 4.83:1 \text{ ("4.83 to 1")}$$

If the project had involved follow-up capital investments having a total (discounted) value of \$2,000,000, then the benefit to cost ratio would be 4.02:1.

Although current practice is to calculate a capital project's B/C ratio using discounted cash flows (as above), a few individuals still use an antiquated and less accurate method. Without discounting any figures, they simply add yearly net income/earnings (without depreciation added back), and then divide that sum by the total net capital investment.

To calculate a capital project's cost/benefit ratio, which some practitioners prefer to use, simply do the reverse: First, divide the total (discounted value of) net capital investments by the total present value of yearly net beneficial cash flows. Then express the result as a ratio. For example: \$10,000,000 divided by \$48,285,896 equals .21—which, expressed as a C/B ratio, is .21:1 ("0.21 to 1").

To calculate the B/C ratio of a non-capital program/project (which does not involve the acquisition of capital assets), it is common practice to divide total projected benefits (new/additional revenue + cost savings) by the total projected new/additional costs involved. This is often done to compare alternative annual (one-year) non-capital programs/projects. Because the B/C ratios of non-capital programs/projects are calculated differently, they should not be compared with the B/C ratios of capital projects.

Using a capital project benefit/cost ratio (or cost/benefit ratio) has several advantages: (a) it takes account of the time value of money; and (b) it can be used by those who prefer to compare ratios rather than NPVs.

However, it also has the the same basic problems/limitations as NPV.

## Internal Rate of Return (IRR)

This widely-used criterion for evaluating, comparing, and ranking Capital Projects also involves discounted cash flows. IRR can be defined as the simple return on the amount that remains “internally invested” in a project. It can also be defined as the interest rate at which PV is equal to CI. In other words, it is the rate at which NPV (or PV - CI) equals 0. With NPV set to 0, then . . .

$$\text{NPV} = \text{PV} - \text{CI} = 0 \quad \text{where . . .}$$

$$\text{PV} = \frac{\text{NBCF}_1}{(1 + \text{IRR})} + \frac{\text{NBCF}_2}{(1 + \text{IRR})^2} + \dots + \frac{\text{NBCF}_n}{(1 + \text{IRR})^n}$$

Determining a project’s IRR (solving the equation for IRR) involves trial and error calculations. Two approaches are outlined below.

A. When using (a) a computer program for determining NPV, or (b) a computer spreadsheet that contains the worksheets in Exhibit AA (and uses formulas to calculate accumulation and discount factors at any given interest rate), take these basic steps:

1. Calculate the project’s NPV using the after-tax weighted average cost of capital as the interest rate.
2. If the NPV is positive (higher than “0”), recompute the NPV using a higher rate. As long as a re-computation produces a positive NPV, increase the rate and recompute—until NPV equals “0” (or very close to it).

If the NPV is negative (lower than “0”), recompute the NPV using a lower rate. As long as a re-computation produces a negative NPV, decrease the rate and recompute—until NPV equals “0” (or very close to it).

3. IRR usually lies between two whole rates (such as 16% and 17%), one of which just produces a positive NPV and the other of which just produces a negative NPV. Thus, it is usually necessary to interpolate between the two rates to find an exact IRR of, say, 16.6%.

B. When using the format in Exhibit AC (which does not accumulate continuous level streams to their year-end

values), take the basic steps outlined below.

Given a CI of \$10,000,000 in Exhibit AC, PV would have to be \$10,000,000 in order to have an NPV of “0.” Thus, it would be necessary to determine the IRR at which PV would equal \$10,000,000.

1. Calculate the total PV (of all yearly net beneficial cash flows) using the after-tax weighted average cost of capital as the interest rate.
2. If the total PV is greater than CI, recalculate PV using a higher rate. As long as a recalculation produces a PV greater than CI, increase the rate and recalculate—until PV equals CI (or very close to it).

If the total PV is less than CI, recalculate PV using a lower rate. As long as a recalculation produces a PV less than CI, decrease the rate and recalculate—until PV equals CI (or very close to it).

3. In order to determine the exact IRR, interpolate between the two rates that straddle the rate where PV equals CI. [The IRR of the project in Exhibit AC lies closest to 61%—which can be found by interpolating between (a) a rate of 60%, where the PV would be \$10,163,361 (or \$163,361 above the \$10,000,000 CI), and (b) a rate of 61%, where PV would be \$9,995,599 (or only \$4,401 below the \$10,000,000 CI).]

In general, a project is accepted if its IRR is (a) equal to or greater than a required/hurdle rate of return (which is usually a firm’s cost of capital, perhaps adjusted upward to account for risk); and/or (b) greater than the IRRs of alternative projects.

Using IRR has several advantages: (a) it accounts for the time value of money; (b) it is an easily understood measure of rate of return; (c) it serves as a means for ranking projects when capital is being rationed; and (d) it can be used by those who prefer to measure value in terms of rate of return rather than dollars of NPV.

However, it also has problems/limitations: (a) calculation by hand is time-consuming; (b) it can produce misleading results when yearly cash flows are uneven and/or vary from positive to negative; and (c) it is not the best indicator of alternative projects’ relative size, significance, and organizational worth.

## **Financial Tools (Statements and Ratios) for Evaluating and/or Comparing the Financial Implications of Organizational Plans**

While financial criteria are used to evaluate and compare alternative programs/projects, financial statements and ratios are used to evaluate and/or compare the financial implications of (alternative) organizational plans. (They are also used at the end of a period to evaluate the financial results of operations.)

The basic financial statements used during a planning process are the pro forma P&L (or operating) statement, the cash budget, and the pro forma balance sheet. (See the examples in **Exhibits W, X, and Y** on pages B-42, B-48, and B-52 respectively.)

As discussed in the section on budgeting, organizations normally construct pro forma financial statements in order to project and then evaluate the overall financial results of their planned operations. In fact, during planning processes, organizations that formulate several alternative sets of goals and associated plans will usually construct separate pro formas for each alternative set. Then, in order to choose among alternative sets of goals/plans during the decision-making phase, they will (a) use the (separate) pro forma P&Ls to evaluate and compare the sales, costs, and profit figures associated with the alternatives; (b) use the (separate) cash budgets to evaluate and compare cash flows associated with the alternatives; and (c) use the (separate) pro forma balance sheets to evaluate and compare the asset and liability implications of the alternatives.

(Alternative sets of) these pro forma financial statements are evaluated and compared after the following annual or long-range planning process steps have been taken: (1) (alternative sets of) goals have been formulated; (2) alternative plans (programs/projects) have been formulated and translated into action plans; (3) program/project budgets have been prepared; (4) alternative programs/projects have been initially screened, evaluated/compared, and selected based on the financial criteria discussed in the section above; (5) recommended goals, plans (programs/projects), and budgets have been forwarded to higher levels of management for review and final decision making; and (6) (alternative sets of) pro forma financials have been prepared based on (alternative sets of) goals/plans.

Since we have already discussed these financial tools at length on pages B-43 to B-45, pages B-47 to B-53, and

pages B-53 to B-56, we will only discuss financial ratios at this point.

Financial ratios are basically measures or indicators of significant relationships between specified P&L and/or balance sheet figures.

Different ratios deal with different financial matters—e.g., income and profitability; short-term liquidity; the financial implications of operational activities; leverage; and long-term financial strength and solvency.

Financial ratios are written as formulas that relate one particular figure to another. Some measure the relationship between two P&L figures, some measure the relationship between two balance sheet figures, and some measure the relationship between a P&L figure and a balance sheet figure.

Financial ratios are calculated by dividing one of the figures (the numerator) by the other (the denominator). While the resulting figures for some ratios are actually expressed as ratios, the resulting figures for many ratios are expressed as percentages. The resulting figures for a few ratios are expressed as, for example, index numbers or number of days.

Although the resulting figures for some ratios mean something all by themselves, the resulting figures for most ratios are meaningful only when they are compared against the following: (a) an organization's goals; (b) an organization's historical data; (c) intelligence data on competitors; and/or (d) industry norms and averages (which are reported in business almanacs, Commerce Department publications, and industry journals). It should be kept in mind that industry norms and averages vary from industry to industry.

Below we briefly describe some of the most widely-used financial ratios. Since our descriptions are basic and do not deal with all the finer points involved, we recommend that the reader refer to texts on financial analysis for more in-depth discussions.<sup>38</sup>

### **Percentages for Evaluating (Pro Forma) P&L Figures**

In addition to the figures for each expense and profit item in a (pro forma) P&L, many if not most organizations also show each figure as a percentage of net sales. These per-

centage figures are usually compared with historical data and industry norms and averages in order to measure a firm's ability to manage production, sales, and G&A costs and to generate profits on sales. For example: If a firm's cost of goods sold as a percentage of net sales is 75%, and the industry average is 68%, the firm may not be managing the costs of materials, labor, and factory overhead as effectively as it might.

Three of these percentages are equivalent to the first three ratios described below.

### Profitability and Income Ratios

#### A. Gross Margin Ratio, Gross Margin on Net Sales, or Gross Profit on Net Sales

$$\text{equals } \frac{\text{Gross profit}}{\text{Net sales}}$$

A measure of the spread between cost of goods sold and net sales revenue, this indicates the extent to which the firm's average selling price (which includes a mark-up over costs) covers all expenses and results in a profit. This ratio, which is normally expressed as a percentage, can vary widely from company to company within an industry. [Gross profit = net sales - cost of goods sold.]

#### B. Operating Ratio or Net Operating Profit Ratio

$$\text{equals } \frac{\text{Operating income (or EBIT)}}{\text{Net sales}}$$

This ratio, which is normally expressed as a percentage, indicates the profitability of sales resulting from the normal conduct of business. A figure in the 15-25% range is considered normal for most manufacturing firms. [Operating income (or EBIT) is earnings before (deductions for) interest and taxes (and perhaps certain "extraordinary expenses").]

#### C. Net Profit Rate, Net Profit to Net Sales, Return on Sales, or Profit Margin Ratio

$$\text{equals } \frac{\text{Net profit (or income/earnings after taxes)}}{\text{Net sales}}$$

This indicates the percentage of each sales dollar that ends up as profit (on the bottom line). A high profit margin is more desirable than a low profit margin. In some industries, this figure can be as low as 1%—and even lower; but in other industries, it can be as high as 10-15%—and even higher.

The next four ratios are calculated using both P&L and balance sheet figures. They are essentially measures/indicators of a firm's ability to earn a return on invested dollars.

#### D. (Rate of) Return on Assets (ROA) or Asset Earning Power

$$\text{equals } \frac{\text{Net income}}{\text{Total assets}}$$

Expressed as a percentage, this ratio measures how efficiently a firm utilizes the dollars invested in its assets to generate earnings. [A number of practitioners use average net assets as the denominator. This is calculated by adding the total assets at the beginning of a year to the total assets at the end of the year, and then dividing that sum by 2. Also, some practitioners use operating profit (or income/earnings before taxes) as the numerator.] ROA should be used in conjunction with ROI, because ROA ignores capital structure, whereas ROI is based on it.

#### E. (Rate of) Return on Capital Employed (ROCE)

$$\text{equals } \frac{\text{Net income}}{\text{Average long-term debt} + \text{Average equity}}$$

Expressed as a percentage, this ratio indicates how efficiently a firm utilizes its capital structure (total invested dollars) to generate earnings. [The denominator is calculated by adding the figures for beginning-of-year equity plus long-term debt to end-of-year equity plus long-term debt, and then dividing that sum by 2. Equity = capital stock (both common and preferred) + capital surplus (the amount over par value paid for stock) + retained earnings.]

#### F. (Rate of) Return on Investment (ROI)

$$\text{equals } \frac{\text{Net income}}{\text{Average equity}}$$

Expressed as a percentage, this ratio measures how efficiently the dollars invested by common and preferred shareholders generate a return (in terms of earnings). [Average equity is calculated by adding total equity at the beginning of the year to total equity at the end of the year, and then dividing that sum by 2. Total equity is calculated as above.]

G. (Rate of) **Return on Common Equity**

$$\text{equals } \frac{\text{Net profit} - \text{Preferred stock dividends}}{\text{Net worth} - \text{Par value of preferred stock}}$$

Expressed as a percentage, this ratio measures how efficiently the dollars invested by common stock shareholders generate a return. [Net worth is the same as total equity.]

H. **Earnings Per Share (EPS)**

equals

$$\frac{\text{Net income/earnings} - \text{Preferred stock dividends}}{\text{Average number of outstanding common shares}}$$

Expressed in dollars, this indicates the earnings per share of common stock. [The denominator is calculated by adding beginning-of-year and end-of-year outstanding shares of common stock, and then dividing that sum by 2.]

- I. **Other Income and Profitability Ratios** include: net profit to tangible net worth; net operating profit rate of return; management rate of return; and price-earnings ratio.

**Liquidity Ratios**

Liquidity is a firm's ability to convert current assets into cash in order to meet its current or short-term financial obligations. Accounting for the fact that some non-cash assets can be converted into cash more readily than others, various liquidity ratios indicate how readily various combinations of current assets can be converted into cash. Thus, these ratios are of interest to short-term creditors (suppliers and bankers) and financial managers.

A. **Working Capital Ratio**

$$\text{equals } \frac{\text{Current assets}}{\text{Total assets}}$$

This ratio indicates the proportion of total assets that are not fixed assets (not equipment, buildings, or land). Although it is used as an indicator of liquidity, it is not as stringent as the next three ratios. (Be careful not to confuse the name of this ratio with "working capital," which is the difference between current assets and current liabilities.)

B. **Current Ratio**

$$\text{equals } \frac{\text{Current assets}}{\text{Current liabilities}}$$

This is the most often used liquidity ratio. The higher the current ratio, the higher the liquidity. In general, a firm is considered "liquid" if it has a current ratio of about 2:1. [Current assets considered to be liquid are cash in bank, marketable securities, accounts receivable, and inventory. Current liabilities include items such as accounts payable, taxes payable, and (current) notes/loans/bonds payable.]

C. **Quick Ratio or "Acid Test"**

equals

$$\frac{\text{Cash} + \text{Marketable securities} + \text{Accounts receivable}}{\text{Current liabilities}}$$

This more stringent ratio indicates a firm's ability to cover its current obligations without having to sell off inventory, which can take some time to sell (convert to cash).

D. **Absolute Liquidity Ratio**

$$\text{equals } \frac{\text{Cash} + \text{Marketable securities}}{\text{Current liabilities}}$$

Since this ratio excludes receivables, which cannot be converted to cash as readily as marketable securities, it is an even more stringent indicator of short-term liquidity.

## Activity Ratios

The following ratios are used to measure the effectiveness and efficiency of various operational activities in financial terms. Most of them are also indicators of liquidity, because they indicate how quickly cash inflows tend to be generated.

### A. Receivables Turnover Ratio or Accounts Receivable Turnover

$$\text{equals } \frac{\text{Total credit sales}}{\text{Average accounts receivable}}$$

This indicates the number of times per year that accounts receivable turn over (are collected as cash inflows). In general, it is more desirable to have a relatively high turnover, because funding receivables can be costly. [The denominator is calculated by adding beginning-of-year and end-of-year receivables, and then dividing that sum by 2.]

### B. Average Collection Period

$$\text{equals } \frac{(\text{Accounts \& notes receivable})}{\text{Annual net credit sales}} \times 365$$

This indicates the average number of days it takes for receivables to become collections. A high number of days (e.g. more than 120) usually indicates a need to review/revise credit and collection policies/activities. (Notice that the receivables figure in the numerator can include notes held on customers' credit balances.) [This indicator is the inverse of the previous ratio. For example: If receivables turn over 6 times per year, then the average collection period is about 60 days (360/6).]

Other activity ratios involving credit sales include: the collection index; the past due index; and the bad debt loss index.

### C. Net Sales to Inventory

$$\text{equals } \frac{\text{Net sales}}{\text{Inventory}}$$

Usually expressed as a ratio, this is an indicator of how effectively inventory is controlled with respect to sales activity. Especially when sales volume is relatively steady, a low figure tends to indicate that inventory is too large.

### D. Inventory Turnover Ratio

$$\text{equals } \frac{\text{Cost of goods sold}}{\text{Average inventory}}$$

This indicates the number of times per year that inventory "turns over." In general, inventory should be "moved" or turned over as quickly (or as many times) as possible in order to minimize inventory carrying costs. Thus, in general, a low figure indicates a slow-moving Inventory, slow cash generation, and the need for more effective inventory control. [Average inventory is calculated by adding the beginning-of-year and end-of-year inventories, and then dividing that sum by 2.]

### E. Days of Inventory or Days' Sales in Inventory

$$\text{equals } \frac{\text{Average inventory}}{\text{Avg. daily cost of goods sold}}$$

$$\text{or } \frac{\text{Inventory}}{\text{Cost of goods sold}} \times 365$$

Expressed in number of days, this is another measure of the effectiveness of inventory control and the resulting implications for cash generation. The first formula indicates average days during a year. [Average inventory and average daily COGS are calculated by adding the beginning-of-year and end-of-year figures, and then dividing the two separate sums by 2.] The second formula indicates days of inventory as of a particular date (given the figures on that date). Unlike the relationship between receivables turnover and average collection period, the second formula is not the inverse of the inventory turnover ratio.

The following activity ratios revolve around working capital and various asset items. Again, working capital = current assets - current liabilities.



**F. Working Capital Turnover**

equals

$$\frac{\text{Net sales}}{\text{Net working capital}} \quad \text{or} \quad \frac{\text{Net Sales}}{\text{Average working capital}}$$

Expressed as a ratio, this indicates the efficiency with which the dollars invested in working capital help generate sales—and the degree to which efficiency is impaired by slow-turning assets. In general, a high ratio is preferable to a low one. [A number of practitioners use average working capital instead of net working capital. Average working capital is calculated by adding the beginning-of-year to end-of-year figures, and then dividing that sum by 2.]

**G. Inventory to Net Working Capital**

equals  $\frac{\text{Inventory}}{\text{Net working capital}}$

Often expressed as a percentage instead of a ratio, this measures how much working capital is tied up in inventory—and also indicates the degree of overstocking. In general, a low percentage is preferable to a high one.

**H. Current Asset Turnover**

equals

$$\frac{(\text{COGS} + \text{selling \& G\&A expenses} + \text{taxes} - \text{depreciation})}{\text{Net working capital}}$$

This indicates the number of times that net working capital (current assets - current liabilities, or net current assets) is/(are) used to pay expenses. In general, a high ratio is preferable to a low one. (COGS is cost of goods sold. Depreciation is subtracted because it does not constitute an actual cash outflow.)

**I. Fixed Asset Turnover**

equals  $\frac{\text{Net sales}}{\text{Average net fixed assets}}$

The number of times that fixed assets turn over, this indicates the efficiency with which a firm utilizes its

fixed assets (equipment, buildings, land) to generate sales. In general, a high figure is preferable.

**J. Total Asset Turnover**

equals  $\frac{\text{Net sales}}{\text{Average total assets}}$

The number of times that total assets turn over, this indicates the efficiency with which a firm utilizes all its assets (both current and fixed) to generate sales. Again, a high figure is preferable to a low figure. A low figure tends to indicate excessive investment.

**K. Other Ratios Involving Working Capital Items** include: current liabilities to inventory; net working capital to total assets; working capital per dollar's sales; net profits on net working capital; and funded debt (long-term liabilities) to net working capital.

**Solvency Ratios**

Most of the following ratios indicate a firm's financial viability and strength over a longer term. They are of particular interest to banks, other creditors, financial managers, and many stockholders—all of whom tend to be concerned about how a firm is capitalized.

**A. Current Assets to Total Debt**

equals  $\frac{\text{Current assets}}{\text{Current debt} + \text{Long-term debt}}$

The higher this ratio, the more that creditors are protected by working capital.

**B. Stockholders' Equity Ratio**

equals  $\frac{\text{Stockholders' equity}}{\text{Total assets}}$

A high ratio indicates longer-term financial viability as a function of the equity base. It also indicates the relative ease with which fixed interest charges and maturing debt obligations can be met. A low ratio indicates possible future difficulties.

**C. Fixed Assets to Net Worth**

$$\text{equals } \frac{\text{Fixed assets}}{(\text{Tangible}) \text{ net worth}}$$

The lower this ratio, the the greater a firm's flexibility with respect to financing current operations. [Net worth equals equity (capital stock + surplus + retained earnings). Here, (net) fixed assets do not include intangible assets.]

**D. Total Debt to Net Worth**

$$\text{equals } \frac{\text{Current debt} + \text{Long-term debt}}{(\text{Tangible}) \text{ net worth}}$$

This ratio indicates the degree to which a firm depends on creditors to fund its operations. In general, creditors prefer a ratio of about 1:1. When total liabilities exceed net worth (and the ratio is higher), creditors are shouldering more financial risk than stockholders.

**E. Times Interest Earned or Interest Coverage Ratio**

$$\text{equals } \frac{\text{Earnings before interest and taxes (or EBIT)}}{\text{Interest expense payable on debt}}$$

This indicates how many times (how sufficiently) earnings will pay fixed interest charges on long-term debt. In general, a higher figure is preferable to a lower figure.

Other coverage ratios include: debt cash flow coverage ratio; preferred stock cash flow coverage ratio; common stock cash flow coverage ratio; preferred dividend coverage ratio; total coverage ratio; and total fixed charge coverage ratio.

**F. Other Longer-Term Indicators** include: Return on Residual Equity; Dividend Payout Ratio; and Dividend Yield Ratio.**Leverage Ratios**

A firm is "leveraged" when, in addition to equity, it utilizes debt—especially long-term debt—to finance its operations. Debt is usually less costly than equity, because

interest on debt is tax-deductible, whereas dividends are not. Debt is used as a "lever" to acquire more income-generating assets and thereby increase earnings for stockholders.

Leverage ratios indicate the proportionate contributions of owners and (vs.) creditors to the funding of operations.

**A. Debt Ratio**

equals

$$\frac{\text{Total debt (or Current debt} + \text{Long-term debt)}}{\text{Total assets}}$$

Expressed as either a ratio or a percentage, this indicates the proportion of total funds provided by creditors. For most manufacturers, the percentage is usually under 35-40%.

**B. Equity Ratio**

$$\text{equals } \frac{\text{Common shareholders' equity}}{\text{Total capital employed}}$$

Expressed as either a ratio or a percentage, this indicates the proportion of capitalization (total funding) provided by shareholders of common stock. (Common equity includes retained earnings.)

**C. Debt/Equity Ratio**

$$\text{equals } \frac{\text{Total Debt}}{\text{Equity}} \quad \text{or}$$

$$\frac{\text{Total debt (or Long-term debt} + \text{Preferred stock)}}{\text{Equity (owned by common stockholders)}}$$

This indicates the relative positions of (degrees of financial risk assumed/borne by) creditors versus owners. Some practitioners calculate this ratio using the first formula, which indicates the relative positions of creditors versus common and preferred shareholders. Some practitioners calculate it using the second formula, which indicates the relative positions of creditors and preferred stockholders versus common stockholders. High ratios indicate more risk and less protection for creditors. [Some practitioners also calculate this ratio by dividing total liabilities by total assets.]

## D. Long-Term Debt to Equity Ratio

$$\text{equals } \frac{\text{Long-term debt}}{\text{Total equity}}$$

This ratio indicates the proportions of debt and equity that comprise the “permanent” or “long-term” funding of a business. [Total equity = common stock + preferred stock + surplus + retained earnings.]

## Operations Research (“OR”) Decision-Making Techniques/Tools

Earlier, in the section on the analysis phase, we discussed the following operations research techniques: linear and nonlinear programming; queuing theory; information theory; servo theory; symbolic logic; and simulation models. (See pages A-25 to A-28.) These techniques are applied during the analysis phase to (1) analyze systems of variables, (2) identify cause and effect relationships among the variables, and (3) express the relationships as mathematical equations.

Once having been developed during the analysis phase, several tools—linear and nonlinear equations and simulation models—are also used during the decision-making phase to test, play “what if” with, evaluate, and/or compare alternative programs/projects and consolidated organizational plans. For example: By altering certain (independent) variables in linear and nonlinear equations to reflect differences in production and distribution programs/projects, decision makers can determine how (dependent) variables such as production volume, production costs, and distribution efficiency would be affected. Similarly, by altering (independent) variables in production, marketing, and financial simulation models to reflect differences in production, marketing, and financial programs/projects, decision makers can determine how (dependent) variables such as production volume, production costs, sales, and profits would be affected.

Since we have already discussed the techniques mentioned above, we turn our attention at this point to several additional OR techniques and tools that are usually developed during the decision-making phase to evaluate, test, play “what if” with, compare, and choose alternatives. These techniques are game theory and probability theory—both of which involve diagrammatic tools.

## Game Theory

This decision-making technique is used not only in games such as checkers and chess, but also in competitive business situations, where decisions are made under conditions of conflict, uncertainty, and risk. It is primarily applied during decision-making steps 1.1 and 1.2 on page 105 of the book (*N-GMD*) to help analyze/evaluate (alternative) market-oriented strategies/tactics. Applying game theory is often called “gaming.”<sup>39</sup>

Several assumptions underlie game theory: (a) the player will try to maximize gains and/or minimize losses; (b) the player will make rational decisions; and (c) the player’s opponent will do the same.

Two terms are used in connection with game theory: *Minimax* is the minimum of a set of maxima—i.e., the smallest of the maximum possible losses or undesirable outcomes resulting from the implementation of a strategy. *Maximin* is the maximum of a set of minima—i.e., the largest of the minimum possible gains or desirable outcomes resulting from the implementation of a strategy.

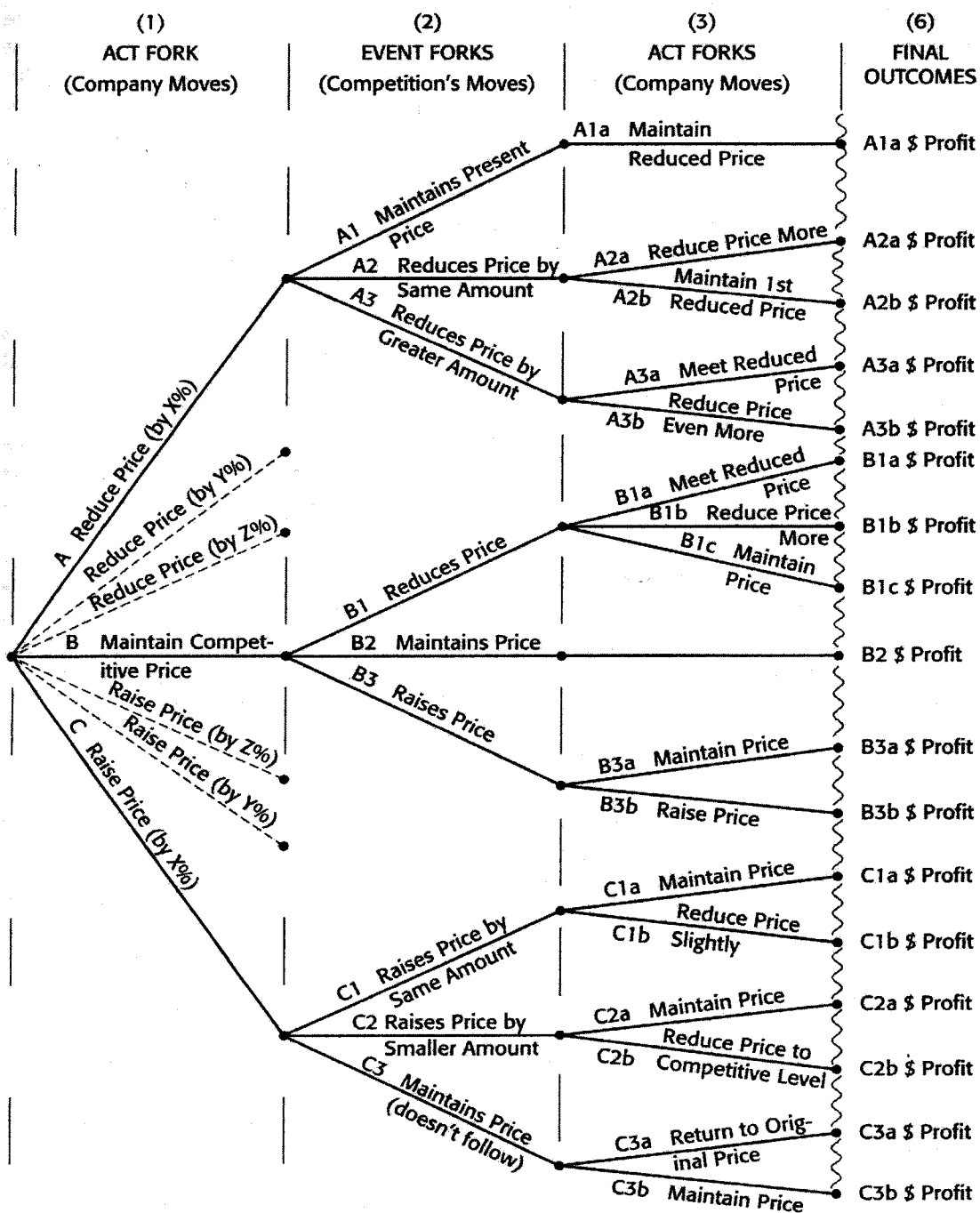
The objective of gaming in business is *to identify an optimal strategy or solution (some series of moves or acts) that will maximize gains and minimize losses—regardless of what the competition might do.*

The thought processes involved are the same as those involved in playing chess. Opponents use proposition logic to think ahead about the moves and counter-moves that they could make within the context of their respective strategies. In other words, they mentally test possible scenarios, asking, “If we were to make a certain move, how might our competition respond, and how might we then respond to the competition’s move(s)—and so on?”

The mechanics of gaming involve anticipating the future in terms of scenarios (chains or sequences of acts and events): (1) the organization’s initial alternative acts; (2) possible competitive responses to initial organizational acts; (3) subsequent organizational acts in response to competitive responses; (4) subsequent competitive reactions to organizational responses; (5) any further acts and events; and eventually (6) the final outcomes of sequences of acts and events.

For an example, see Figure 5.1 on page 109 of *N-GMD*, which is a simplified illustration of pricing strategies being considered by a company that produces a commodity.

**Figure 23: Simplified Illustration of Alternative Pricing Scenarios  
Developed Through Gaming (Propositional Logic)**



Note: Many products are differentiable in terms of factors such as design, quality, and features. However, commodities such as sugar, oil, and basic steel shapes are difficult to differentiate in any terms other than price, delivery, and service. **Figure 23** is simplified partly because it deals only with pricing. (It would be much more complicated—but more realistic—if it also dealt with other marketing factors.) It is also simplified because it does not deal with all possible acts and events.

Let us say that the company in Figure 23 is one of the low-cost producers, wants to maximize long-range profitability to the extent possible, and is considering the following basic pricing strategies:

- A. Reduce price by X% in order to gain market share (and thereby increase sales and total profit even though profit margin would be decreased to some extent).
- B. Maintain price at the present competitive level.
- C. Raise price by X% in order to increase profit margin (and thereby increase total profit, even though sales and market share would be decreased to some extent).

Note in Figure 23 that these alternative acts are depicted as an “act fork.” (Other alternatives not considered here—such as reducing or raising price by other percentages—are indicated by dashed lines in Figure 23.)

With respect to alternative pricing strategy A, the company would do well to consider how one or more competitors could possibly respond to the initial act—e.g.: (A1) maintain present price; (A2) counter by reducing price by the same amount; or (A3) counter by reducing price by a greater amount. [It should be noted that the anticipation of these possibilities should be based on an analysis of competitors’ (a) past actions; (b) apparent engineering, production, cost, marketing, and financial capabilities; and (c) apparent competitive strategies and tactics.] Notice in Figure 23 that these possible events are depicted as an “event fork,” and that event forks also follow alternative acts B and C.

After identifying possible competitive responses to each of its initial acts, the company would then do well to consider the possible ways in which it might respond to competitive reactions. For example, in response to event A2, it could (A2a) reduce price even more, or (A2b) maintain

price at the initially reduced level. (These events should also be anticipated based on the analysis of competitors.) Notice in Figure 23 that these alternative acts are depicted as an “act fork,” and that act forks also stem from the other preceding events.

Next, the company would do well to anticipate the ways in which competitors could respond to the previous company acts, and then anticipate how it could respond to their responses, and so on. (To simplify Figure 23, we have cut off the analysis following the second set of company acts.)

Finally, at the end of each chain of acts and events, the company should indicate the outcome (terminal value). In Figure 23, estimated total profit would be calculated by multiplying the resulting unit sales by the resulting profit margin per unit sold. [Note: There is usually a trade-off between market share and profitability. The net effect of increased market share (sales) at the expense of decreased profit margin—or the net effect of increased profit margin at the expense of decreased market share (sales)—depends on costs, market sensitivity to prices, and other factors.]

Where commodities are involved, the optimal strategy usually revolves around (a) becoming or remaining the lowest-cost producer; (b) charging competitive prices; and (c) offering the quickest delivery and best service possible. Such a strategy would give the company in our example the flexibility to do the following: (a) maintain its current price in its major market territory; (b) perhaps reduce price and gain sales outside its market area; (c) counter pricing challenges by competitors (and keep them intimidated); and (d) delay making price increases when costs are rising significantly throughout the industry.

It should be apparent that gaming can be extremely complicated and difficult—especially when various combinations of marketing mix factors are taken into account. Much of the difficulty can be attributed to the mental inability to visualize and keep track of all the possible scenarios. Thus, in order to use this technique effectively, it is usually necessary to draw a diagram of possible acts and events—like the visual tool, Figure 23.

Note: A diagram like Figure 23 can be developed into a decision tree that accounts for the probabilities of events occurring. Decision trees will be discussed beginning on page 110 in *N-GMD* and DM-67 in this addendum.

**Exhibit AD: An Example of a Payoff Matrix**

(1) Possible outcomes	(2) Estimated probability	Alternative Courses of Action			
		Buy 1000 Gadgets		Buy 2000 Gadgets	
		(3) Potential income <sup>a</sup>	(4) Expected value [(2) x (3)]	(5) Potential income <sup>a</sup>	(6) Expected value [(2) x (5)]
<b>Sell 1,000 Gadgets</b>	60% (.60)	\$5,000	\$3,000	\$2,000	\$1,200
<b>Sell 2,000 Gadgets</b>	40% (.40)	\$5,000 <sup>b</sup>	\$2,000	\$10,000	\$4,000
<b>Overall Expected Value:</b>			<u>\$5,000</u>		<u>\$5,200<sup>c</sup></u>

<sup>a</sup> Potential income equals total (sales) revenue minus total (purchase) cost.

<sup>b</sup> Only 1,000 gadgets would be sold, since only 1,000 would be purchased.

<sup>c</sup> The best apparent alternative -- given the data provided.

At present, applications of game theory are not as fully developed, mathematically reliable, and sophisticated as they will undoubtedly become. Even so, computerized models that utilize the type of diagram in Figure 23 have already been developed.

### Probability Theory

This is a more statistical OR approach for evaluating and comparing alternatives under conditions of conflict, uncertainty, and risk. Unlike other financial techniques and criteria, however, it expressly takes uncertainty into account.

The term "probability" refers to the estimated likelihood that some possible event will occur. For example, if one believes that an event has a 60% chance of occurring (is likely to occur 6 times out of ten), one would assign a 60% (or .60) probability to that event. [A probability is expressed as either a percent or its decimal equivalent. Probabilities range from 0% or .00 (no likelihood of occurrence) to 100% or 1.00 (a certainty of occurrence).]

Objective probabilities are either known or based on historical data. Here, one infers from experience or historical data that something is likely to happen in accordance with some predicted pattern.

Subjective probabilities are based on intuition, "gut feel," or "guesstimates."

Probability theory can be applied in conjunction with (a) a payoff matrix, and (b) a decision tree. Both of these tools are constructed during decision-making step 1-1.3 on page 105 of *N-GMD* to help make single-choice decisions with respect to alternative plans or solutions.

#### A. Payoff Matrix

This visual tool provides a tabular format for . . .

- indicating and keeping track of alternative acts (courses of action) and possible subsequent events and/or outcomes;

- b. indicating and keeping track of the estimated probabilities of possible outcomes associated with alternative courses of action;
- c. calculating and indicating the expected values of the possible outcomes of alternative courses of action; and
- d. calculating, indicating, and comparing the overall expected values of alternative courses of action.

*Example:* (See Exhibit AD on the opposite page.) Ms. Black, a purchasing manager, is deciding whether to buy 1000 or 2000 gadgets for resale. The anticipated selling price is \$8 per unit. The cost is \$3 per unit. After careful consideration, she has estimated a 60% probability that 1000 gadgets can be sold, and a 40% probability that 2000 gadgets can be sold. She has calculated the expected values shown in columns 4 and 6. Note that if she buys 1000 gadgets, her company will make \$5,000 if it sells 1000 [(1,000 x \$8) minus (1000 x \$3)]; but, because she bought only 1000, it will make the same \$5,000 even if it receives orders for 2000 [(1000 x \$8) minus (1000 x \$3)]. On the other hand, if she buys 2000 gadgets, her company will make only \$2,000 if it sells 1000 [(1000 x \$8) minus (2000 x \$3)]; but it will make \$10,000 if it sells all 2000 [(2000 x \$8) minus (2000 x \$3)]. (This simplified example does not take into account many other possible acts and events—such as the possibility of selling leftover gadgets at a lower price, or buying more gadgets in order to fill greater demand than expected.)

To find the overall expected value of each alternative (Buy 1000 or Buy 2000), Ms. Black has added the two expected values in column 4 (\$3,000 + \$2,000 = \$5,000) and column 6 (\$1,200 + \$4,000 = \$5,200). Since the overall expected value for “Buy 2000” is \$200 greater than the overall expected value for “Buy 1000,” Ms. Black’s best alternative is to buy 2000. [In effect, she has calculated weighted averages of the figures—the estimated probabilities being the “weights.” Simply adding the expected values in columns 4 and 6 is legitimate if one is “indifferent to risk” (i.e., is neither a risk taker nor a risk avoider).]

A payoff matrix has the advantages mentioned in the introductory paragraph. Its main disadvantage is that it can become rather difficult to follow when many alternatives and possible outcomes are involved.

## B. Decision Tree

A decision tree is an even more useful tool for making decisions under conditions of uncertainty and risk. It displays the same information as a payoff matrix, but does so more diagrammatically. It can display (a) the alternatives that require an immediate decision; (b) events and their estimated probabilities of occurrence; (c) future decision points (involving subsequent acts); and (d) the values of outcomes of alternatives. Because it is capable of incorporating financial techniques and several other OR techniques, it can also display, for example, gaming scenarios, positive and negative cash flows, and net present values of cash flows (at the terminal positions at the ends of branches).

The tree in **Figure 24** (page DM-69) is a diagrammatic representation of the payoff matrix in Exhibit AD.

The following are some of the most basic concepts, rules, procedures, and guidelines for constructing and using a decision tree:

1. First, draw a tree that outlines significant acts and events in a logical manner.
  - a. A tree is drawn from left to right, showing sequences of acts and events. At the left side is an initial “act fork” having a “main branch” for each major or basic alternative act. Many trees—especially those involving a “do” or “not do” decision—have only two main branches. Some trees, however, have three, four, or even more main branches.
  - b. The structure of the tree indicates the sequences of acts, events, and final outcomes involved. As in a PERT diagram, there is a distinct set or series of branches for each distinct sequence or series of acts and events. At the right end of each set of branches there is a terminal expected value (the expected value of the outcome).
  - c. When drawing a tree, several basic rules should be followed:
    1. Acts and events are usually—but not necessarily—shown on a tree in the chronological order in which they occur.

2. Act forks should not follow act forks. Combinations of acts should be shown on a single act fork.
3. Event forks can have so many branches that they become “event fans.” Event fans are dealt with using mathematical approaches that will not be discussed here.
4. Event forks or fans can follow prior event forks or fans.
5. The ends of all branches should reflect the same cut-off date, so that the corresponding terminal values will all be accurate as of the same date.

2. Fill in information on the tree.

- a. Label all acts and events (if this was not done as the tree was being drawn).
- b. Taking each event on the tree in its turn, assess/estimate the event’s probability and record the figure in parentheses (as shown in Figure 24). Probabilities are not assessed for acts—only for events. Also, the probabilities on any single event fork or fan must add up to 100% (or 1.0).

Probability assessments/estimates should be made by the most qualified engineering, production, marketing/sales, financial, human resources, and/or management personnel. As discussed in detail on pages 117 and 118 of *N-GMD*, they should make their assessments as objectively and realistically as possible, being especially careful not to (a) estimate higher than realistic probabilities because of their preferences for events or outcomes, or (b) estimate lower than realistic probabilities because of their aversions to events or outcomes.

- c. Taking each act and event on the tree in its turn, indicate the positive or negative cash flow associated with it. Estimates of cash flows should be made by the most qualified personnel, using the best data available and their own best judgment. Here, too, personnel should be careful not to underestimate or

overestimate figures because of their preferences for or aversions to acts, events, and eventual outcomes.

- d. Taking each terminal (end) point in its turn, calculate the expected (net) terminal value by adding up all the positive and negative cash flows on the route (sequence of branches) leading to that point.

3. “Solve” the tree.

- a. If the person using the tree on an organization’s behalf can make the assumption that top management and stockholders are “indifferent to risk” (are neither risk-taking nor risk-avoiding), he or she can determine the best decision by working backwards on the tree (making calculations from right to left) in the following manner:

1. At each event fork on the right-most position on the tree, multiply each terminal value at the end of that fork by the probability of the event leading to that terminal value. Then add the results. Take, for example, the lower event fork in Figure 24. The result, \$5,200, is found by multiplying \$2,000 by .60 (and getting \$1,200), multiplying \$10,000 by .40 (and getting \$4,000), and then adding \$1,200 and \$4,000.

2. Indicate the result in a box having an arrow pointing to the point of the fork—as shown in Figure 24. (In the case of Figure 24, there need be no further computations. “Buy 2000” has a value of \$200 more than “Buy 1000.”)

3. If a tree has more act and event forks than the tree in Figure 24, continue making computations from right to left. Figure 25 is such a tree. We will explain the computations for that tree below.

- b. If it is not appropriate for the person using the tree to assume organizational indifference to risk, then solving a tree mathematically is considerably more complicated. In fact, it is too complicated to explain here.



**Exhibit AD: An Example of a Payoff Matrix**

(1) Possible outcomes	(2) Estimated probability	Alternative Courses of Action			
		Buy 1000 Gadgets		Buy 2000 Gadgets	
		(3) Potential income <sup>a</sup>	(4) Expected value [(2) x (3)]	(5) Potential income <sup>a</sup>	(6) Expected value [(2) x (5)]
Sell 1,000 Gadgets	60% (.60)	\$5,000	\$3,000	\$2,000	\$1,200
Sell 2,000 Gadgets	40% (.40)	\$5,000 <sup>b</sup>	\$2,000	\$10,000	\$4,000
Overall Expected Value:			<u>\$5,000</u>		<u>\$5,200<sup>c</sup></u>

<sup>a</sup> Potential income equals total (sales) revenue minus total (purchase) cost.

<sup>b</sup> Only 1,000 gadgets would be sold, since only 1,000 would be purchased.

<sup>c</sup> The best apparent alternative -- given the data provided.

Another example: **Figure 25** is an example of a somewhat more complex decision tree. The concepts, procedures, rules, and guidelines mentioned above are reflected in its construction. This tree diagrammatically depicts the following situation:

ABC Company has an opportunity to build a prototype control unit for XYZ Company. If it worked better than the control presently being used by XYZ, XYZ would place an order for 5,000 units at a price of \$24 each (or a cash inflow totaling \$120,000). As shown on the tree, ABC's chief engineer has calculated that building the prototype would cost \$5,000 (a cash outflow). After thorough consideration, ABC's owner and president, Mr. Wilson, has estimated that there is a 50% probability that XYZ would order the units based on a successful test of the prototype. (Thus, there is a 50% probability that it would not place the order.)

As shown at the end of the "not order" branch, the terminal value would be -\$5,000 (i.e., the cost to build the prototype).

If XYZ were to order, ABC would have the two choices represented by a second act fork:

- If, trying to reduce machining costs, ABC tooled to stamp some of the control's parts at a cost of \$14,000 (a cash outflow), the stampings would either work or fail. If they worked, production costs would total \$82,000 (another cash outflow). At the end of that branch, therefore, the terminal value would be \$19,000 (or -5,000 +120,000 -14,000 -82,000). If the stampings failed, ABC would have to pay \$2,000 (a cash out-flow) for additional tooling plus another \$95,000 (a cash outflow) for production costs, thereby generating a total cash outflow of \$97,000. At the end of that branch, therefore, the terminal value would be \$4,000 (-5,000 +120,000 -14,000 -97,000). Upon consultation with his chief engineer, Mr. Wilson has estimated an 80% probability that the stampings would work, and a 20% probability that they would fail.

- b. If ABC tooled to machine all the parts, tooling would cost \$10,000 (a cash outflow) and production (an event) would cost \$95,000 (another cash outflow). At the end of that branch, therefore, the terminal value would be \$10,000 ( $-5,000 + 20,000 - 10,000 - 95,000$ ).

If Mr. Wilson decided not to build the prototype, the terminal value would be \$0 (nothing gained, nothing lost).

The basic decision: Should ABC build the prototype or not?

With all the information on the tree, all one need do is make appropriate computations, working from right to left. If Mr. Wilson were “indifferent to risk,” he would perform these calculations as follows:

First, working with the top event fork (the top two branches), he would compute the \$16,000 figure [ $\$16,000 = (.80 \times \$19,000) + (.20 \times \$4,000)$ ] and then write it in the box with an arrow pointing to the end of the “tool to stamp” act (and the point of the fork).

Next, working with the third branch from the top, he would write that branch’s \$10,000 terminal value in a box with an arrow pointing to the end of the “tool to machine” act (a point directly below the point of the event fork above). Since the fork at the end of “tool to stamp” has a \$16,000 value, but the branch at the end of “tool to machine” has only a \$10,000 value, he would write the larger \$16,000 figure in a box with an arrow pointing to the end of the “XYZ orders” event (and the point of the stamp vs. machine act fork).

Next, working with the fourth branch from the top, he would write the -\$5,000 terminal value in a box with an arrow pointing to the end of the “XYZ not order” event.

Then, he would calculate the value of “build prototype.” To do so, he would (1) multiply the “XYZ orders” value of \$16,000 by the probability of .50; (2) multiply the “XYZ not order” value of -\$5,000 by the probability of .50; (3) add the two resulting figures ( $+\$8,000 - \$2,500 = +\$5,500$ ); and (4) write the \$5,500 figure in a box with an arrow

pointing to the end of the basic act, “build prototype.”

The best choice, “build prototype,” would then be clear. Based on mathematical expectations, building the prototype would result in a value of \$5,500, while not building the prototype would result in a value of \$0.

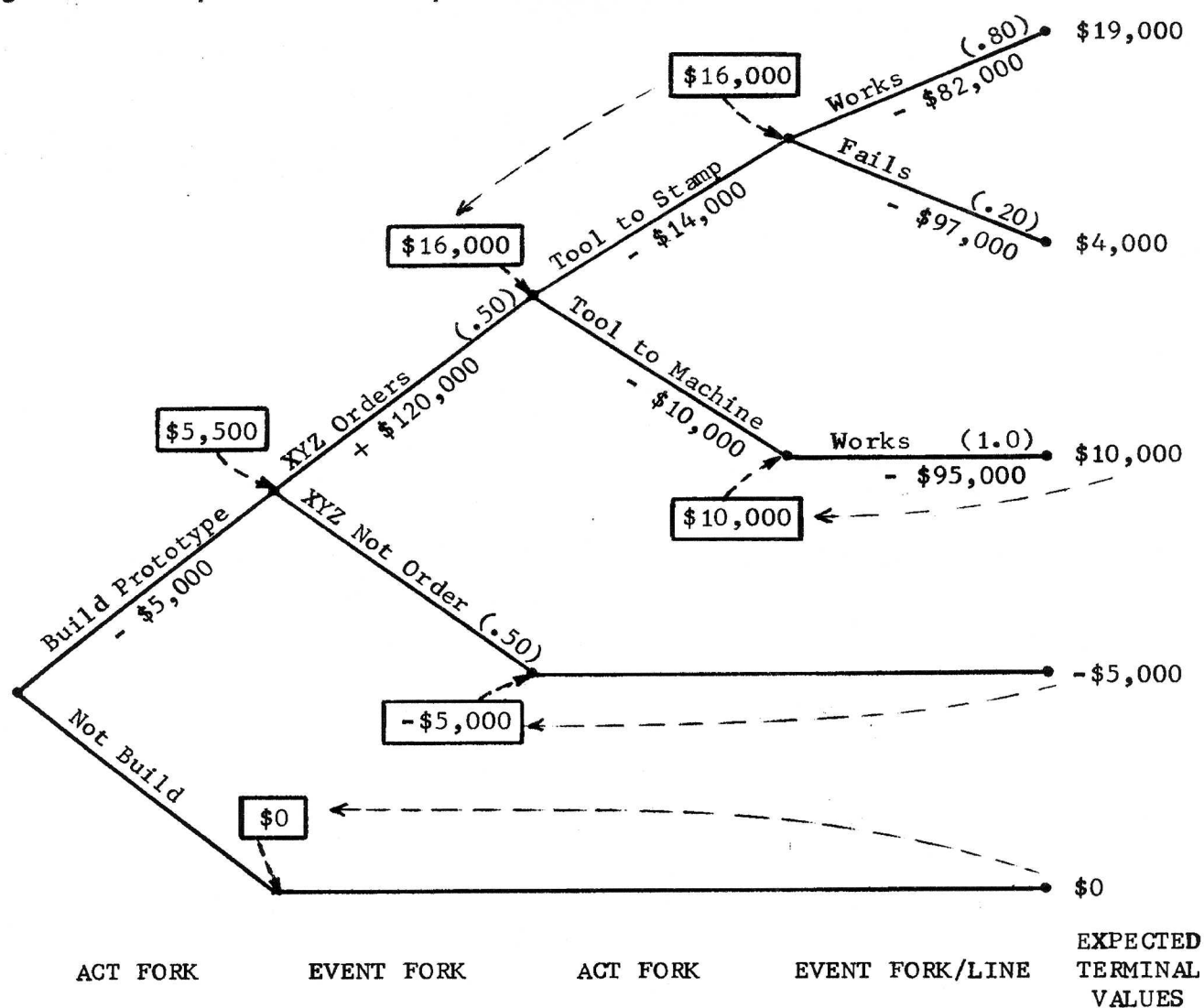
Using a decision tree has all the advantages mentioned in the introductory paragraph. Even if it is not “solved” mathematically, it still enables decision makers to visualize, keep track of, and consider all the aspects of a situation. Imagine, for example, how it would help structure, visualize, and analyze the competitive pricing situation illustrated in Figure 23.

It also has several disadvantages: First, it can be very difficult to construct and solve a tree that deals with a very complicated decision-making situation. (This particularly applies to, for example, a tree that outlines complex gaming scenarios.) Second, making a decision based solely on mathematical expectations regarding cash flows does not take account of other decision-making criteria that could be equally important in a particular situation. Third, one must learn many concepts, rules, procedures, and mathematical techniques in order to use this tool properly in any type of decision-making situation. (It would require several hundred pages to explain all of them.)

Therefore, we strongly recommend that the reader study a text on probability theory and decision trees before fully relying on this decision-making tool. A number of available texts<sup>40</sup> cover topics such as: (a) concepts and procedures involved in constructing trees; (b) the elimination of unnecessary acts, events, or scenarios; (c) the mathematical treatment of event fans; (d) the handling of “contextual cash flows”; (e) the use of net present values; (f) what to consider when assessing probabilities; (g) the use and calculation of “conditional probabilities”; and (h) the mathematical calculation of probabilities when there is not indifference to risk.

Having said that, we still recommend using this tool—at least to help structure, visualize, and gain insight into any important decision-making situation.

Figure 25: Example of a More Complex Decision Tree



### Tabular Tools for Evaluating and Comparing Alternatives

One or both of two tools—a Table of Advantages and Disadvantages and a Comparison Matrix—can be used during decision-making steps 2 through 5 on page 105 of *N-GMD* to evaluate, compare, and choose among alterna-

tive solutions to problems, alternative programs/projects, and alternative sets of goals and plans. While decision-making criteria are actually the bases for evaluating and comparing alternatives, these tools are essentially “mechanical or visual aids” for helping to organize, evaluate, and compare the criteria-related figures, ratios, and insights that have been derived through the application of financial and operations research techniques and tools.

**Exhibit AE: Example of a Table of Advantages and Disadvantages**

Alternatives	Advantages	Disadvantages
1. <b>Make Part X</b>	<ul style="list-style-type: none"> <li>a. Have control over production and quality.</li> <li>b. Assure inventory.</li> <li>c. Use excess plant space.</li> <li>d. Learn technology for future application.</li> </ul>	<ul style="list-style-type: none"> <li>a. Can buy for less than can make.</li> <li>b. Must buy several new machines.</li> <li>c. Must borrow and incur financing costs.</li> <li>d. Not know technology.</li> <li>e. High start-up and operating costs short-term.</li> <li>f. Low quality initially.</li> </ul>
2. <b>Buy Part X</b>	<ul style="list-style-type: none"> <li>a. Save money. Sources can make cheaper.</li> <li>b. Get part immediately.</li> <li>c. Are several reliable sources.</li> <li>d. Save capital for other projects.</li> <li>e. Not incur financing costs.</li> </ul>	<ul style="list-style-type: none"> <li>a. Not have control over production and quality.</li> <li>b. Not learn technology.</li> <li>c. Union react negatively.</li> <li>d. Incur added shipping damage costs</li> </ul>

Many decision-making criteria are listed in Table 5.1 on page 106 of *N-GMD*. Keep in mind that these criteria should be selected during the analysis phase of a planning process based on the identification of parameters that are key to organizational and/or unit success.

**Table 10** on the next page lists a number of decision-making criteria. We have used columns to indicate (a) those that are often used to compare alternative solutions to problems; (b) those that are often used to compare alternative programs/projects; and (c) those that are often used to compare alternative sets of goals and plans.

**Table of Advantages and Disadvantages**

This is the simplest and most often used of the two tools. (See the example in **Exhibit AE**.) It is basically a tabular format having three columns. Alternatives are listed in the first column. The advantages of each alternative are listed in the second column, which is usually titled either "Advantages," "Pros," or "Pluses." The disadvantages of each alternative are listed in the third column, which is usually titled either "Disadvantages," "Cons," or "Minuses."

Advantages, pluses, or pros are those outcomes, results, consequences, main effects, or side effects of an alternative's implementation that are considered functional, desirable, positive, good, or right—e.g., benefits, gains, or strengths. In various ways and to various degrees, they represent the fulfillment of "needs" or "wants" expressed in the decision-making criteria being used.

Disadvantages, minuses, or cons are those outcomes, results, consequences, main effects, or side effects of an alternative's implementation that are considered dysfunctional, undesirable, negative, bad, or wrong—e.g., losses, problems, dilemmas, risks, vulnerabilities, limitations, or weaknesses. In various ways and to various degrees, they represent the violation, impairment, or lack of fulfillment of "needs" or "wants" expressed in the decision-making criteria being used.

A table of advantages and disadvantages helps do all of the following:

- a. identify/anticipate significant advantages and disadvantages of alternatives;

**Table 10: Decision-Making Criteria and Their Common Uses****QUANTITATIVE / OBJECTIVE**

	SO	CP	PL		SO	CP	PL
Profitability	S	O	O	Time span to results	O	O	O
Total revenues	S	O	O	Time span of commitment	S	O	O
Total operating costs	S	O	O	Time span to reach volume	S	O	O
Cost savings	O	O	O	Contribution	S	O	
Growth		O	O	Sales break-even point	S	O	O
Return on investment (ROI)		O	O	Profit break-even point	S	O	O
Total capital expenditure		O	O	Payback period	S	O	
Installation costs		O		Net present value (NPV)		O	O
Start-up costs		O		Accounting rate of return (ARR)		O	
Retained earnings used		O	O	Profitability index (#)		O	
Debt incurred		O	O	Benefit/cost ratio	O	O	
Debt expense		O	O	Internal rate of return (IRR)		O	
Resources conserved	S	O	O	Overall expected terminal value	O	O	O
Market position	S	O	O	Liquidity	S	S	O
Unit sales	S	O	O	Working capital	S	S	O
Market share	S	O	O	Debt/equity ratio	S	S	O
Productivity	S	O	O	Inventory turnover	S	S	O
Productive capacity	S	O	O	Net worth	S	S	O
Utilization of capacity	S	O	O	Earnings per share (EPS)	S	S	O
Time span to completion	S	O	O	Stock price	S	S	O

**QUALITATIVE / SUBJECTIVE**

	SO	CP	PL		SO	CP	PL
Probability of success	O	O	O	Legal acceptability	O	O	O
Certainty of results	O	O	O	Patentability	O	O	S
Compatibility w/ other goals/plans	O	O	O	Environmental effects	O	O	O
Ease of implementation	O	O	O	Safety	O	O	O
Degree of change involved	O	O	O	Managerial development	O	S	O
Complication of current operations	O	O	O	Organizational development	O	S	O
Disruption of current operations	O	O	O	Vulnerability to . . .			
Flexibility (to modify plan)	O	O	O	Economic phenomena	O	O	O
Reversibility of action	O	O	O	Business cycles	S	O	O
Control of results	O	O	O	Seasonality of demand	S	O	O
Precedent set	O	O	O	Technological change	O	O	O
Competitiveness	O	O	O	Competitive responses	O	O	O
Diversification	S	O	O	Supply sources	O	O	O
Financial stability	S	O	O	Governmental intervention	O	O	O
Technological innovation	S	O	O	Union opposition	O	O	O
Product/service quality	O	O	O	Impact on personnel:			
Product/service innovation	O	O	O	Employee welfare	O	O	O
Effects on other products	S	O	O	Employee job satisfaction	O	O	O
Ability to service (customers)	S	O	O	Employee performance	O	O	O
Product life cycle (obsolescence)	S	O	O	Resulting relationships with . . .			
Availability of parts/materials	S	O	O	Suppliers	O	O	O
R&D know-how	S	O	O	Customers	O	O	O
Production know-how	S	O	O	Employees/union	O	O	O
Marketing know-how	S	O	O	Community	O	O	O
				Regulatory agencies	O	O	O

SO = Alternative solutions to problems; CP = Alternative capital projects;  
 PL = Alternative plans; S = Sometimes; O = Often

**Exhibit AF: Example of a Comparative Matrix**

CRITERIA / PARAMETERS	Priority/ rank	Weight factor	PROJECT A			PROJECT B			PROJECT C		
			Data	Raw score	Wghtd score	Data	Raw score	Wghtd score	Data	Raw score	Wghtd score
<b><u>Musts / Limitations / Needs</u></b>											
Highest net present value (NPV)	1	20	50,000,000	3	60	40,000,000	1	20	45,000,000	2	40
Highest benefit/cost ratio	2	19	6:1	1	19	9:1	2	38	10:1	3	57
Least debt incurred	3	18	5,000,000	1	18		3	54		3	54
<b>Sub-total score:</b>					97			112			151
<b><u>Wants</u></b>											
Shortest payback period	4	16	3 yrs.	2	32	4 yrs.	1	16	2.5 yrs.	3	48
Best L-T competitive position	5	15		3	45		1	15		2	30
Least time to completion	6	12	1 yr.	1	12	6 mo.	3	36	8 mo.	2	24
Least disruption of operations	7	10		1	10		2	20		3	30
Greatest ease of implementation	8	8		1	8		3	24		2	16
Most technological innovation	9	4		3	12		1	4		2	8
Least environmental impact	10	1		3	3		1	1		2	2
<b>Sub-total score:</b>					122			116			158
<b>Total Weighted Score:</b>					219			228			309

- b. gain insights that lead to formulating modifications (solutions) for eliminating or at least minimizing potential problems and contingencies;
- c. gain insights that lead to integrating or combining alternatives;
- d. organize and keep track of information, insights, and conclusions;
- e. evaluate alternatives, weighing their advantages against their disadvantages;
- f. compare the advantages and disadvantages of various alternatives; and
- g. choose the best alternative(s).

Steps for constructing and utilizing a table of advantages and disadvantages:

1. Set up a three-column table such as the one shown in Exhibit AE.
2. Review the decision-making criteria established during the analytic phase.
3. Based on the decision-making criteria being used, do the following for each alternative in its turn:
  - a. Identify/anticipate (“brainstorm”) all the possible outcomes, results, consequences, or effects of implementing the particular alternative.
  - b. Identify and list all its advantages and disadvantages in the appropriate columns. [As discussed on page 118 of *N-GMD*, make a conscious effort to keep personal attitudes (e.g., preferences and aversions) from impairing objectivity.]
  - c. Evaluate whether or not the alternative’s advantages outweigh its disadvantages.
4. Compare alternatives, asking these major questions: Do the overall advantages (advantages minus disadvantages) of an alternative outweigh the overall advantages of other alternatives? In other words, given all the advantages and disadvantages of various alternatives, which alternative (or combination of alternatives) best meets decision-making criteria (comes closest to maximizing benefits while minimizing undesirable or negative effects)?
5. Choose an alternative (or combination of alterna-

tives) for implementation. (Or, better yet, use the information in the table of advantages and disadvantages as inputs to a comparison matrix, and then make a decision based on the matrix.)

Using a table of advantages and disadvantages has these advantages: (a) it is simple and easy to use; (b) it induces deeper thought; (c) it enables more thorough consideration of alternatives; and (d) it helps prevent mistakes.

However, using this tool also has several disadvantages:

- a. Individuals have a tendency to write down advantages and disadvantages in a disorganized manner —e.g., as they occur to them.
- b. Although decision-making criteria are implicit in statements of advantages and disadvantages, the relative importance being attached to those criteria is not always readily apparent.
- c. Criteria-related information cannot be formatted in a manner that enables mathematical determination of the best alternative.

Many decision makers make choices based on such a table. More sophisticated decision makers use the table as a worksheet in preparation for constructing and using a Comparison Matrix.

### Comparison Matrix

This tool displays more information in a more criteria-oriented, concise, organized, and useful tabular format for evaluating and comparing alternatives.

As illustrated in **Exhibit AF**, it does all the following:

- a. It explicitly compares all alternatives in terms of the same criteria, which are listed down the left-hand column.
- b. It explicitly indicates the relative importance (priority or rank) that is being attached to each decision-making criterion.
- c. It indicates the relative weight that is being assigned to each criterion.
- d. For each criterion, it also indicates the following with respect to each alternative: relevant data; a score (relative to the other alternatives); and a weighted score.
- e. It enables computation and comparison of the alternatives’ total weighted scores.

Steps for constructing and utilizing a comparison matrix:

1. On a separate sheet of paper . . .
  - a. List all the general and specific decision-making criteria or parameters that were selected during the analytic phase.
    - \* Include any new criteria identified during the use of a table of advantages/disadvantages.
    - \* Add any other criteria that are considered applicable to the the particular decision-making situation.
  - b. Choose the criteria that will actually be used as the bases for making a decision.
    - \* Give this choice considerable thought. Using the wrong criteria can lead to making a non-optimal decision.
    - \* Select criteria within the context of long-and/or short-term goals and plans.
    - \* Limiting and very critical or key criteria can be labeled “Musts”/“Limitations”/“Needs.” Although no limiting, “cut-off,” or “Go/No Go” criteria are included in Exhibit AF, one such criterion might be: “total cost not exceed \$X.”
    - \* Important but less critical criteria can be labeled “Wants.”
    - \* In general, ten to twelve criteria are considered adequate. Using fewer than four or five does not cover enough bases. Using more than ten or twelve can overly complicate the decision-making process.
  - c. Rank the selected criteria in their (relative) order of importance.
    - \* If, for example, there are ten criteria, they can be ranked from 1 (highest priority) down to 10 (lowest priority).
    - \* The order of importance will depend upon the circumstances being faced by an individual or group. With respect to Exhibit AF, for example, a decision maker might assign a higher priority to the amount of “debt incurred” if the organization were deeply in debt and were tightly controlling capital expenditures. Another decision maker might assign a much higher priority to “environmental impact” if extremely hazardous waste materials were involved.
    - \* Ranking is not necessarily easy, but it helps to sort out trade-offs among criteria and establishes a framework for assigning weights to criteria in step 3.
2. Construct a matrix that accomodates the number of criteria and alternatives involved.
  - a. In the left column, list the selected criteria in descending order by rank—i.e., the highest priority at the top, down to the lowest priority. (The criteria can be listed in any order, but listing them in descending order makes the matrix easier to understand and use.)
  - b. In the next column to the right, indicate each criterion’s priority or rank.
  - c. Fill in concise titles for alternative projects, solutions, or sets of goals/plans across the top of the matrix.
3. Assign a weighting factor (or weight) to each criterion and write it in the appropriate column.
  - \* In general, the higher a criterion’s priority, the more weight it is given.
  - \* The simplest weighting system involves using the same number of weights as there are rankings. In other words, if there were ten criteria ranked from 1 down to 10, weights could be ranged from 10 (highest weight factor) down to 1 (lowest weight factor). Simplicity, however, can reduce precision when it does not account for small but significant differences in the importance of criteria. For example: If this system had been used in Exhibit AF, it might have been necessary to give both “NPV” and “Benefit/cost ratio” weights of 10, even though NPV was ranked slightly higher in importance than B/C ratio.
  - \* A more accurate weighting system utilizes a larger number or range of weights in order to reflect small yet significant differences in the relative importance of criteria. For example: In Exhibit AF, the range of weights has been doubled (from 10 to 20). This enables a deci-



sion maker to show that NPV (ranked # 1) is slightly more important than B/C ratio (ranked # 2). Accordingly, NPV has been given a weight of 20, and B/C ratio has been given a weight of 19.

- \* It is important to take this step before filling in data and scores for alternatives. It helps prevent personal attitudes from impairing objectivity.
- \* Weights should be determined with considerable thought. The validity of total weighted scores largely depends upon their accuracy.

4. For each criterion in its turn, . . .

- a. Fill in appropriate information in the “Data” column under each alternative.

- \* Data can be filled in for quantitative/objective criteria.
- \* Concise comments can be filled in for qualitative/subjective criteria.
- \* Filling in data or comments is not absolutely necessary. However, doing so displays key information for review by decision makers and other interested parties.

- b. Determine and fill in a (relative) “raw score” for each alternative (based on comparison of the information in the data columns under the alternatives).

- \* The most common method, which has been used in Exhibit AF, is simply to rank the alternatives. Thus, if there are three alternatives, they can be ranked from 3 (best of the alternatives) down to 1 (worst of the alternatives).
- \* A more precise method is to assign scores that reflect degrees of desirability and undesirability—e.g., +3 (most desirable), +2, +1, 0 (neutral), -1, -2, -3 (most undesirable).
- \* The most precise method is to assign scores from, say, 10 (a high score) to 1 (a low score). This method is more complicated, because it involves determining relative scores by ranging the data regarding alternatives on a scale from, say, 10 to 1. This can require some calculation and interpolation.

- \* Using the second and third methods, more than one alternative can have the same score.

- \* Like weights, scores should be determined with considerable thought, especially when using the second and third methods mentioned above. The validity of total weighted scores largely depends upon the accuracy of raw scores.

- c. Compute (and fill in) each alternative’s weighted score. Simply multiply the (raw) score for each alternative by the criterion’s weight factor.

5. Total the weighted scores in the columns under the alternatives, and then write the total weighted scores at the bottom of the matrix.

6. Choose the alternative(s) having the highest total weighted score(s).

### A “Chart of Alternatives” for Aiding Strategic/Long-Range Planning and Decision Making

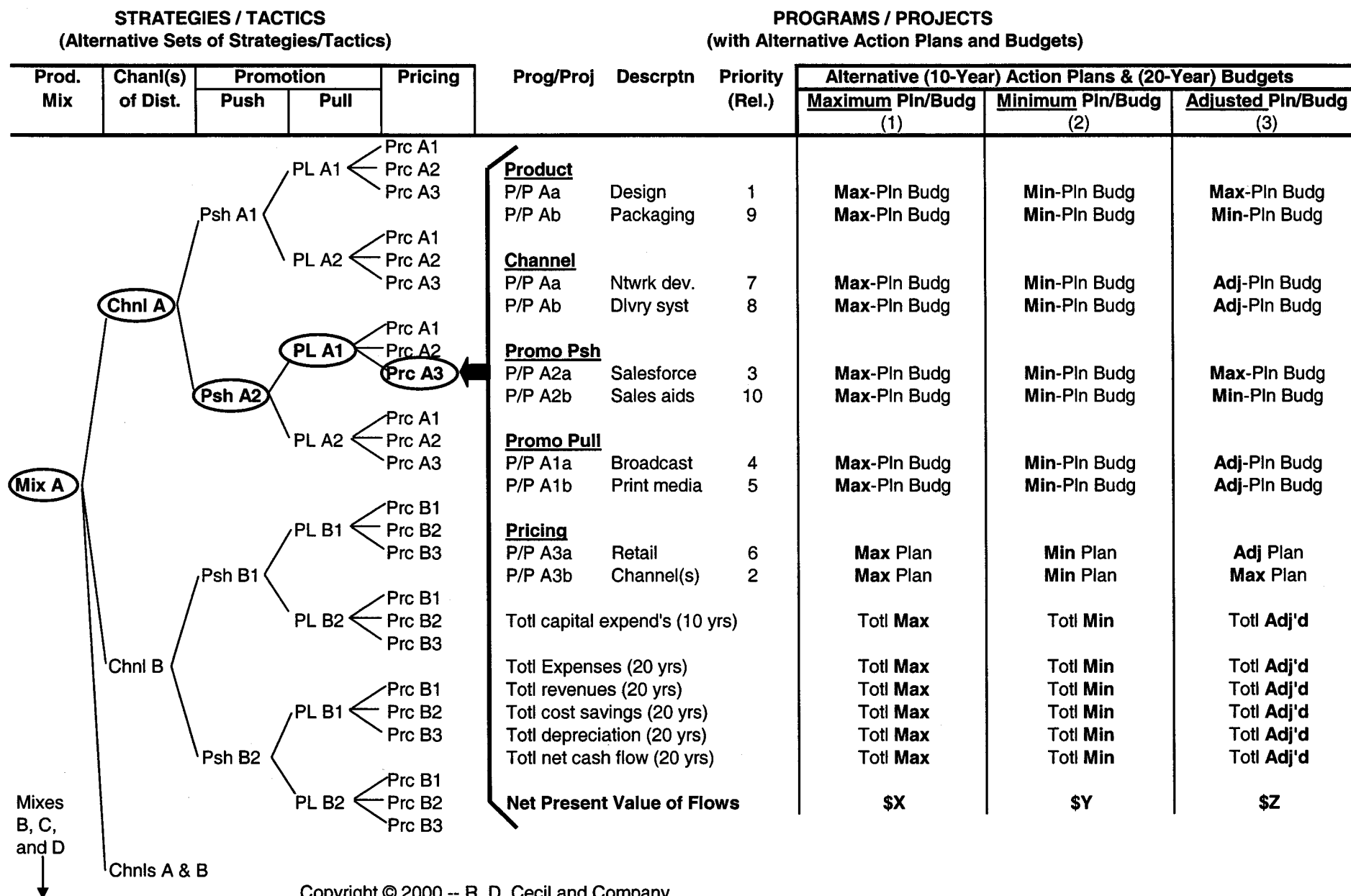
When we discuss single-choice and multiple-choice decisions, we use only annual, interim, and ad hoc decision-making situations as examples. That is because strategic/long-range planning situations are considerably more complex—especially when organizations and their units formulate alternative sets of goals and associated strategies/tactics, programs/projects, action plans, and budgets. Choosing one integrated set of alternatives from a number of possible combinations of alternatives can be extremely complicated and difficult. In such situations, we have found what we call a “chart of alternatives” to be a very useful planning and decision-making aid.

**Figure 26** on the next page is a partial and somewhat simplified example of this tool. It can be developed and used during the planning phase, and then can be used again (in conjunction with other decision-making tools) during decision-making steps at various organizational levels—in order to help deal with complexity.

More specifically, this diagram can be used to help do the following:

- a. keep track of the numerous alternatives being identified and formulated;

**Figure 26: Partial/Simplified (Marketing Dept.) Long-Range Planning "Chart of Alternatives"**  
(Involving series of multiple and single choices)



- b. identify and keep track of appropriate combinations or sets of alternatives;
- c. break down larger, more complex decisions into series of more discreet decisions;
- d. keep track of where the organization and its units are in the planning process;
- e. determine where single-choice decisions and multiple-choice decisions should be made;
- f. make (tentative) single-choice and multiple-choice decisions that reduce the number of combinations of alternatives to be evaluated and compared;
- g. identify the combinations/sets of alternatives that are to be subjected to final decision making.

**Structure of a Chart of Alternatives:** Although Figure 26 looks like a decision tree, it is not. It can be more appropriately described as a “chart or diagram of alternative combinations of acts.”

We have chosen to use a marketing department chart as an example for two reasons: First, in strategic/long-range planning, other operating areas’ strategies/tactics and programs/projects generally support market-oriented plans. Second, marketing charts tend to be the most complex, because it is necessary to integrate various strategies/tactics and programs/projects relating to the “marketing mix.”

The Strategies/Tactics columns in this example illustrate a partial “network” of combinations of alternative marketing mix strategies/tactics—i.e., product (or product mix) alternatives; distribution channel alternatives; push promotion alternatives (for getting products into channels and through channels to consumers); pull promotion alternatives (for getting consumers to the point of sale); and pricing alternatives. A complete chart of alternatives would show all combinations of strategies/tactics—not just those associated with Product Mix A (as in Figure 26).

This “network” of alternative acts can also be drawn as the initial act branches on a decision tree. For example, the top branch (act line) would be: Mix A - Channel A - Push A1 - Pull A1 - Pricing A1. An act fork involving Mix A and Channels A and B would have 24 “act lines.” If Channels A+B had also been shown, there would be another 12 “act lines” on the fork. Mix B would involve more “act lines”—and so forth.

The Programs/Projects columns essentially form a table of alternative combinations of programs/projects and accompanying action plans and budgets (for implementing selected combinations or sets of strategies/tactics).

Note that the programs/projects and plans/budgets shown in Figure 26 are associated with only one particular combination of strategies/tactics—i.e., Mix A - Channel A - Push A2 - Pull A1 - Pricing A3. A complete chart of alternatives would show the programs/projects/plans/budgets for other (selected) sets of strategies/tactics.

Also note that, for each program/project, we have shown three alternative action plans and associated budgets—i.e., a maximum plan/budget, a minimum plan/budget, and an adjusted plan/budget. As in the case of strategies/tactics, various combinations of programs/projects and their alternative plans/budgets can also be shown as “act lines” on an act fork. However, if all programs/projects were to be implemented (as we have assumed), if decisions were essentially being made concerning which combinations of plans/budgets were to be implemented, and if the alternative combinations of plans/budgets in Figure 26 were shown on an act fork, there would be 59,049 act lines on the fork. A tabular format greatly simplifies a complex act fork.

The rows at the bottom of a table (for a particular set of programs/projects associated with a particular combination of strategies/tactics) are used to indicate the financial results associated with those alternative combinations of plans/budgets.

**Using a Chart of Alternatives as a planning and decision-making tool at the unit level:** Although planners and decision makers can utilize networks and tables in a variety of ways, a marketing department might take the basic steps described below. [These steps reflect the integration of decision-making steps into the planning steps outlined in Figure 7-B on page PP-5 (or Figure 5.1b on page 71 of *N-GMD*).]

1. **Plan:** Identify/formulate alternative strategies and tactics (based on sales goals and on in-depth analyses of products, consumers, channels of distribution, competitive promotion and pricing prac-

tices, and market problems and opportunities) The formulation of each alternative strategy/tactic in each area is generally the result of making multiple choice decisions concerning ways to improve, correct, control, or otherwise influence various factors or variables. [In Figure 26, we have assumed that strategies/tactics (and programs/projects) are being formulated for a 10-year period, but that budgets are being prepared—and financial results are being projected—for at least a 20-year period.]

- a. Identify/formulate alternative product mix strategies/tactics [Due to limited page space, we have not indicated alternative mixes B, C, and D in Figure 26.]
  - b. Identify/formulate alternative distribution strategies/tactics (that involve possible channels or combinations of channels for reaching targeted consumers) [For product mix A in Figure 26, the alternatives might also include, for example, channel C and combinations A&B, A&C, B&C, and A&B&C.]
  - c. Identify/formulate alternative push promotion strategies/tactics and alternative pull promotion strategies/tactics (given alternative product mixes and alternative distribution channels) [In Figure 26, there could easily be more than two push and pull alternatives associated with each alternative combination of product mix and channel strategies/tactics.]
  - d. Identify/formulate alternative pricing strategies/tactics (given the above) [In Figure 26, strategy 1 might be “price above the competition,” strategy 2 might be “price with the competition,” and strategy 3 might be “price below the competition.”]
2. Construct a network that illustrates alternative combinations of strategies/tactics (as in Figure 26)
    - \* It may be necessary to use a poster-size sheet of paper (or even a larger surface) to show all combinations.
    - \* As in Figure 26, alpha-numeric codes may be used to represent strategies/tactics.
    - \* The various combinations can be shown on an act fork instead of a network.

3. Make a series of single-choice decisions (before proceeding to formulate programs/projects and accompanying action plans and budgets). Because of the time and complexity involved, most marketing or strategic planners will not attempt to formulate programs/projects (and accompanying action plans and budgets) for all the possible sets or combinations of strategies/tactics. Instead, keeping in mind that product, channel, promotional, and pricing strategies/tactics affect each other, they will usually screen the alternative combinations of these strategies/tactics and select certain combinations by making a series of initial/tentative single-choice decisions. (In effect, they are “pruning” less effective combinations from the network.)

- \* Because programs/projects and accompanying action plans and budgets have not yet been formulated, there are few meaningful numbers and quantitative criteria that can be used at this point. Thus, these single-choice decisions are generally made based on market analyses, simulation models, gaming scenarios, and qualitative/subjective criteria such as (a) compatibility and synergy among different types of strategies/tactics; (b) long-range competitiveness (given industry projections and gaming scenarios); and (c) flexibility to deal with foreseen and unforeseen problems and opportunities.
- \* To help evaluate and compare alternatives and make these single-choice decisions, use a tTable of advantages/disadvantages and/or a comparison matrix.
- \* With respect to Mix A in our example, decision makers have initially/tentatively chosen the following combination: Mix A - Channel A - Push A2 - Pull A1 - Price A3. (They might also choose a combination involving Mix A and Channel B.) They would then go on to do the same for combinations of strategies/tactics associated with Mix B, Mix C, and so forth.

**Take the following steps for each selected combination of strategies/tactics in its turn:**

4. Formulate broad/basic long-range programs/projects for implementing each initially selected combination of strategies/tactics. In the programs/pro-

jects column of Figure 26, we have shown only two programs/projects for each of the marketing mix areas—i.e., two for product, two for channel, and so forth. There may be more programs/projects under each area. (The various programs/projects are described in the next column to the right.)

\* The formulation of each program/project usually involves making multiple-choice decisions concerning actions to be taken with respect to improving, correcting, controlling, or otherwise influencing various factors/variables in that particular area. Because action plans and budgets have not yet been formulated, these multiple choices are generally made based on more qualitative/subjective criteria.

# Product programs/projects are often formulated with assistance from R&D personnel. Pricing programs/projects are generally formulated based on (a) production cost projections (provided by the production department); and (b) competitive pricing scenarios.

# Some programs/projects will involve capital expenditures for facilities and equipment, while others will not.

\* As indicated in Figure 26, most marketing managers will plan to implement all long-range programs/projects in order to deal with all areas of the marketing mix. (Managers in other operating areas will usually do the same with respect to all the areas that concern them.) The question, therefore, is not really “which programs/projects should be implemented over the long-term?” Rather, it is “what should the relative size and cost of each program/project be in order to maximize benefits, minimize problems, and make the most effective use of limited resources?”

\* The relative size and cost of programs/projects associated with a particular combination of strategies/tactics partly depend upon the relative *priorities* of those programs/projects. In Figure 26, the programs/projects in the various areas have been ranked from 1 (highest priority) to 10 (lowest priority).

## 5. Construct a Table of Programs/Projects (with Associated Plans/Budgets) columns (as shown in Figure 26)

\* The table in Figure 26 is a “summary table.” For example: The terms “Max-Pln Budg,” “Min-Pln Budg,” and “Adj-Pln Budg” only represent actual budgets, which are constructed on separate spreadsheets. The terms “Totl Max,” “Totl Min,” and “Totl Adj” only represent “X Years” of totals for the maximum, minimum, and adjusted columns. We recommend reconstructing the tabular format in Figure 26 on a computer spreadsheet that contains actual maximum, minimum, and adjusted budgets. The computer spreadsheet can then be used to calculate the max, min, and adj totals (for each of “X years”) at the bottom of the table. Once this has been done, the NPV for each of the three columns can be calculated and the figures can be entered on the bottom line of the table in Figure 26. (In Figure 26, only the NPV figures are actually shown.)

\* Note that alpha-numeric codes can be used to represent programs/projects associated with a particular combination of strategies/tactics.

## 6. Formulate several basic alternative long-range action plans and accompanying (cash flow) budgets for each program/project (that is associated with a selected combination of strategies/tactics)

### For each program/project in its turn . . .

a. Formulate these two basic alternative action plans: (a) a maximum plan designed to maximize results over the planning period; and (b) a minimum plan designed to produce minimum acceptable results over the period. (The adjusted plan will be formulated after the sets of max plans/budgets and min plans/budgets have been evaluated.)

b. Prepare a budget for each action plan in its turn (using a budget format similar to the one in Table 7 on page DM-44)

\* If an organization is planning for a 10-year period, it should construct cash flow budgets for a period of at least 20 years.

This accounts for at least some of the financial benefits derived from any capital expenditures made toward the end of the 10-year planning period.

- \* The figures for each year should include: (a) capital expenditures (cash out-flows) for facilities, equipment, and other assets (over the planning period of, say, 10 years); and (b) cash outflows for expenses (over, say, 20 years). (In the cases of individual marketing programs/projects, these separate budgets should not include sales revenue figures. Revenue (cash inflow) figures should be calculated later, taking into account the effects of all the marketing programs/projects working together.)
- \* It is not necessary to formulate alternative budgets for pricing programs. However, the effects of pricing programs must be taken into account when determining sales revenues (cash inflows).

7. Calculate the (yearly) total financial results of (plans)/budgets in the maximum column — and then in the minimum column [See the first paragraph under Step 5 above.]

- \* Most planners will use the “most probable” projected figures, because making calculations involving other possible figures and their probabilities is very complicated.
- a. Calculate total capital expenditures [for each of the (10) years]
- b. Calculate total expenses (including depreciation) [for each of the (20) years]
- c. Calculate total revenue [for each of the (20) years]. Multiply price times the (projected) sales volume. To determine the actual selling price, take account of pricing programs/plans involving discounts and pricing deals. To determine sales volume, estimate the sales that will result from implementing the plans associated with all the programs/projects involved. (In long-range marketing planning, it is very difficult to estimate the sales volume and revenue attributable to each particular type of program/project.)

- d. Calculate total cost savings [for each of the (20) years]
- e. Indicate total depreciation [for each of the (20) years]
- f. Calculate the total net beneficial cash flow generated [for each of the (20) years]. As in Table 7 on page DM-44, subtract expenses from revenues, add savings, and add back depreciation.
- g. Calculate the net present value of (20) years' cash flows (and enter the figure on the bottom line of the table in Figure 26) [Again, this is the only figure actually shown in the maximum and minimum (and adjusted) columns.]

8. Develop adjusted plans/budgets for each program/project (in its turn)

- \* Perform steps 6 and 7 with respect to the adjusted plans/budgets column.
- \* The adjusted column might contain adjusted budgets for all the related programs/projects. Or, as shown in Figure 26, it might contain max budgets for some (high priority) programs/projects, min budgets for some (low priority) programs/projects, and adjusted budgets for other programs/projects.
- \* Given the “benchmarks” provided by the max and min columns, the adjusted plans/budgets column can be used to play “what if” with, and to negotiate, various combinations of max, min, and adjusted budgets. Adjustments can account for the following: (a) the relative priorities of programs/projects; (b) the timing of capital expenditures; (c) guideline goals, plans, and budgets; (d) budgetary constraints; and (e) planning inputs provided by other departments.

9. Make a multiple choice decision, choosing at least two or three alternative combinations of strategies/tactics and associated programs/projects and plans/budgets for final (single-choice) decision making (at the top organizational level)

- \* To help make these choices, use a comparison matrix with criteria such as these: (a) NPV; (b) total cost; (c) total capital expenditures; (d) long-range competitiveness; (e) long-range profitability; and (f) flexibility.

**Using a Chart of Alternatives as a planning and decision-making tool at the organizational level:**

**Figure 27** on page DM-85 is a simplified example. It integrates the choices/recommendations provided by the marketing department, the production department, and other departments (whose choices/recommendations have been lumped together in order to simplify the chart). [Although Figure 27 has been structured in a network format, it can also be drawn as an act fork having 64 act lines.]

- \* Here, we have shown only two alternative combinations of marketing strategies/tactics. Each has a max-plans budget and an adjusted-plans budget (for the implementation of all programs/projects associated with each alternative combination of strategies/tactics).

Note: The max-plans budgets have been chosen for consideration because, given their projected results, it could be desirable to finance them. The adjusted-plans budgets have been chosen over the min-plans budgets, because they reflect rational adjustments based upon the consideration of tradeoffs among programs/projects and their action plans.

- \* At the ends of the marketing department's branches, we have also shown only two combinations of production strategies/tactics. For the same reasons mentioned in the note above, each has a max-plans budget and an adjusted-plans budget (for the implementation of all associated production programs/projects and plans). These strategies/tactics and associated programs/projects and plans/budgets generally involve, for example, (a) facilities/equipment; (b) the most cost-effective mix of new and old production technologies; and (c) productivity-enhancing and cost-reducing activities.

Note: Each alternative combination of production strategies/tactics and associated programs/projects and plans/budgets should be predicated on the sales volume projection associated with the marketing department branch that immediately precedes it. This means that the production department should (1) base its initial planning on initially-screened plans of the marketing department; and (2) delay making its final choices until it can base them on the final alternatives selected by the marketing department.

- \* At the ends of the production department's branches, we have shown only two alternative combinations of other departments' (integrated) strategies/tactics. And, for the same reasons mentioned above, each has a max-plans budget and an adjusted-plans budget (for the implementation of all associated programs/projects and plans). The finance department's strategies/tactics and associated programs/projects and plans/budgets generally involve the financing of capital expenditures (and other areas). The human resources department's strategies/tactics and associated programs/projects and plans/budgets generally involve procuring and training the human resources required to implement (organizational) plans. And so forth. (We have integrated all these plans on the third set of branches in order to simplify the organizational chart.)

Note: Here, each alternative combination of strategies/tactics and associated programs/projects and plans/budgets should be predicated on the sales and production volumes and the financial requirements associated with the marketing/production branches that immediately precede it. This means that other departments should (1) base their initial planning on initially-screened plans of the marketing and production departments; and (2) delay making their final choices until they can base them on the final alternatives selected by the marketing and production departments.

It is assumed that departments will have calculated the NPVs of their selected alternatives before the following steps are taken at the organizational level.

1. Construct an Organizational Chart of Alternatives

- \* Use either a network or an act fork format.

2. Enter the marketing department's, production department's, and other departments' NPV figures beneath the max and adjusted branches (as shown in Figure 27)

- \* The marketing department's NPVs are almost always positive, because they reflect revenues from sales (which are the largest if not only cash inflows). Other departments' NPVs are usually negative, because, even though they may include cost savings, they normally reflect larger cash outflows for expenses and capital expenditures.

3. Add the NPVs along each set of branches and indicate the total NPV at the end (terminal position)

4. Make a final decision as to which combination of (departmental) strategies/tactics and associated programs/projects and plans/budgets to implement

- \* Make this decision based on total NPVs — or use a comparison matrix that lists alternatives having the highest NPVs and also compares them in terms of criteria such as these: (a) long-range competitiveness; (b) long-range profitability; (c) total cost; (d) total capital expenditures; (e) financing/debt required; and (f) flexibility.

5. Modify/finalize unit/departmental and (consolidated) organizational long-range strategies/tactics, programs/projects, action plans, and budgets based on final top management decisions

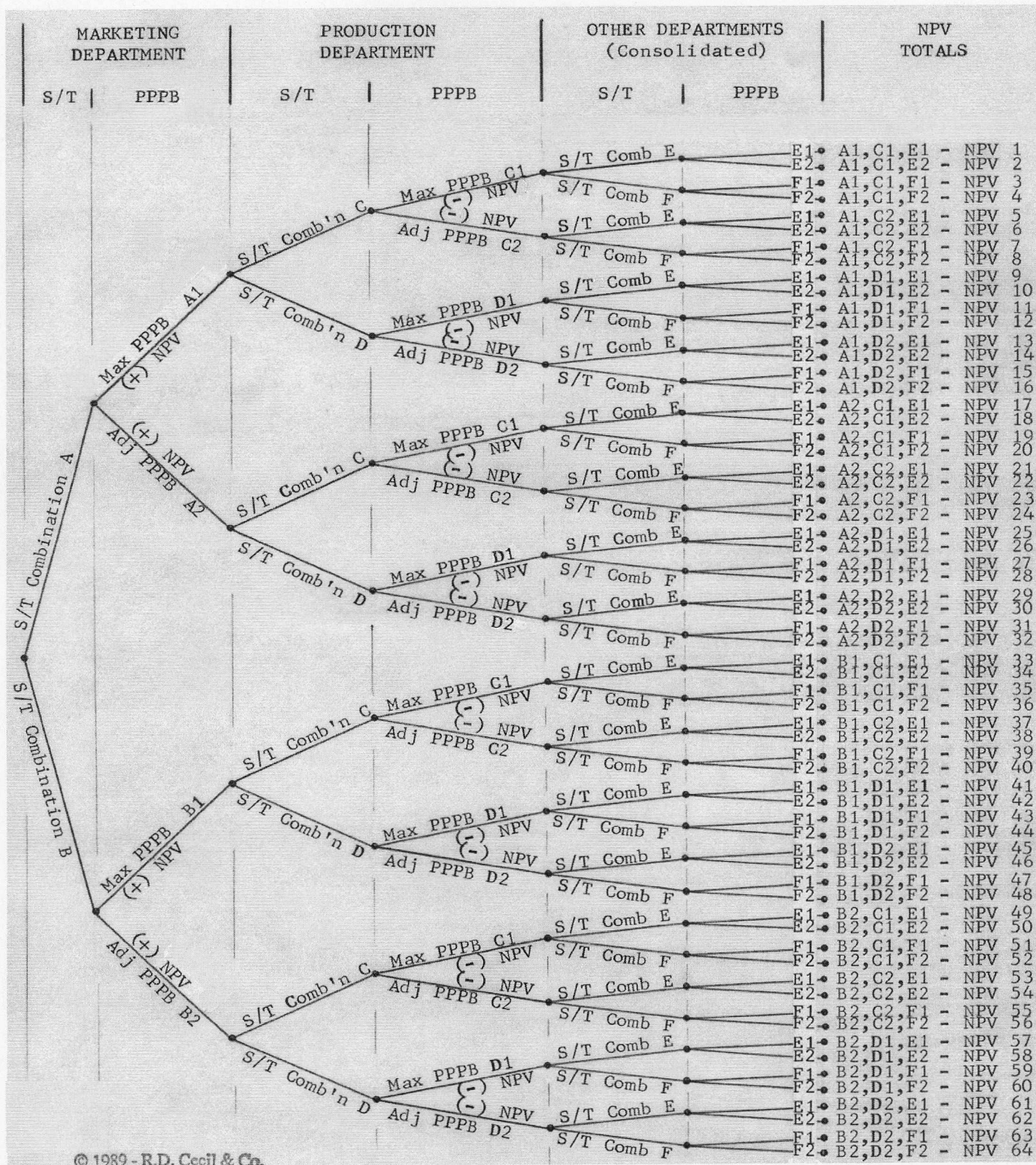
- \* Retain all planning inputs and tools so that they can be (a) updated prior to each subsequent year's annual planning process, and (b) used to help develop annual plans.



**Figure 27: Simplified Example of an Organizational Long-Range Planning "Chart of Alternatives"**  
(Based on units' recommended alternatives)

S/T = Strategies/Tactics

PPPB = Programs/Projects/Plans/Budgets



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