CHAPTER

4

Capital Budgeting

LEARNING OBJECTIVES

After completing this chapter, you should be able to answer the following questions:

1. Why do most capital budgeting methods focus on cash flows?
2. What is measured by the payback period?
3. How are the net present value and profitability index of a project measured?
4. How is the internal rate of return on a project computed? What does it measure?
5. How do taxation and depreciation methods affect cash flows?
6. What are the underlying assumptions and limitations of each capital project evaluation method?
7. How do managers rank investment projects?
8. How is risk considered in capital budgeting analysis?
9. How and why should management conduct a postinvestment audit of a capital project?
10. (Appendix 1) How are present values calculated?
11. (Appendix 2) What are the advantages and disadvantages of the accounting rate of return method?

INTRODUCING

Amazon.com

http://www.amazon.com

In a few short years, Amazon.com has evolved from an idea to the best-known firm on the Internet. The firm's president, Jeff Bezos, commands the attention of Wall Street and the financial press. On the morning of September 28, 1999, Amazon.com planned to make an "announcement significantly affecting the world of e-commerce." The following day, Mr. Bezos stepped up to a podium in the Sheraton Hotel in New York.

"Sixteen months ago Amazon.com was a place where you could find books," Bezos began, hands folded behind his back as he paced the stage. "Tomorrow Amazon.com will be a place where you can find anything." With that, he introduced the latest installment of the Amazon potboiler: the serialization story of one company's ambitious plan to take over the world—the e-commerce world that is.

Throughout 1999, Amazon.com has been on the move. On average it has announced a major initiative every six weeks. In February it bought 46% of Drugstore.com. In March it launched online auctions—two days after rival eBay announced a secondary stock offering. In May the company took a 35% piece of HomeGrocer.com. In June, 54% of Pets.com. In July, 49% of Gear.com. That same month Amazon opened two new online shops: toys and electronics. October's announcement was Z-shops (an online mall) and All Product Search (a product browser).

Forget about Amazon.com as the Wal-Mart of the Web. Bezos is aiming for something even bigger. So big, in fact, that it hasn't been invented yet. "I get asked a lot, Are you trying to be the Wal-Mart of the Web?" says Bezos. "The truth is, we're not trying to be the Anything of the Web. We're genetically pioneers. Everybody here wants to do something completely new. I wake up every morning trying to make sure I can confound journalists and pundits who try to encapsulate us in an eight-second sound bite."

In Bezos' vision, Amazon.com will be the center of the e-commerce universe. Books, pet food, tennis shoes, banjos; whatever e-shoppers want, they can buy it, or locate it, on Amazon.com. Picture Amazon as an octopus, its tentacles reaching out all over the Web. The potential payoff is huge. Investors certainly think so. After Amazon announced Z-shops and All Product Search, its stock rose 23%, to $80 a share. "This is so big, so important, that you have to be invested in it," says Morris Mark, a portfolio manager who added to his Amazon stake after the announcement.

SOURCE: Katrina Brooker, "Amazon vs. Everybody," *Fortune* (November 8, 1999), pp. 120–128. © 1999 Time Inc. Reprinted by permission.

Amazon.com's future will be determined by the success of the investments it is making today. Although the risks may be large, the potential payoff is proportionate. Choosing the assets in which an organization will invest is one of the most important business decisions of managers. In almost every organization, investments must be made in some short-term working capital assets, such as merchandise inventory, supplies, and raw material. Organizations must also invest in **capital assets** that are used to generate future revenues; cost savings; or distribution, service, or production capabilities. A capital asset can be a tangible fixed asset (such as a piece of machinery or a building) or an intangible asset (such as a capital lease or a patent).

capital asset

The acquisition of capital assets is often part of the solution to many of the issues discussed in this text. For example, the improvement of quality may depend on the acquisition of new technology and investment in training programs. Reengineering of business processes often involves investment in higher technology; and mergers and acquisitions involve decisions to invest in other companies. These examples illustrate capital asset decisions.

Financial managers, assisted by cost accountants, are responsible for capital budgeting. **Capital budgeting** is "a process for evaluating proposed long-range projects or courses of future activity for the purpose of allocating limited resources."[1]

capital budgeting

[1] Institute of Management Accountants (formerly National Association of Accountants), *Statements on Management Accounting Number 2: Management Accounting Terminology* (Montvale, N.J.: NAA, June 1, 1983), p. 14.

The process includes planning for and preparing the capital budget as well as reviewing past investments to assess and enhance the effectiveness of the process. The capital budget presents planned annual expenditures for capital projects for the near term (tomorrow to 5 years from now) and summary information for the long term (6 to 10 years). The capital budget is a key instrument in implementing organizational strategies.

Capital budgeting involves comparing and evaluating alternative projects within a budgetary framework. A variety of criteria are applied by managers and accountants to evaluate the feasibility of alternative projects. Although financial criteria are used to assess virtually all projects, today more firms are also using nonfinancial criteria. The nonfinancial criteria are critical to the assessment of activities that have financial benefits that are difficult to quantify. For example, high-technology investments and investments in research and development (R&D) are often difficult to evaluate using only financial criteria. One firm in the biotechnology industry uses nine criteria to evaluate the feasibility of R&D projects. These criteria are presented in Exhibit 14–1.

By evaluating potential capital projects using a portfolio of criteria, managers can be confident that all possible costs and contributions of projects have been considered. Additionally, the multiple criteria allow for a balanced evaluation of short- and long-term benefits, the fit with existing technology, and the roles of projects in both marketing and cost management. For this biotechnology company, the use of multiple criteria ensures that projects will be considered from the perspectives of strategy, marketing, cost management, quality, and technical feasibility.

Note that one of the criteria in Exhibit 14–1 is financial rate of return on investment. Providing information about the financial returns of potential capital projects is one of the important tasks of cost accountants. This chapter discusses a variety of techniques that are used in businesses to evaluate the potential financial costs and contributions of proposed capital projects. Several of these techniques are based on an analysis of the amounts and timing of project cash flows.

USE OF CASH FLOWS IN CAPITAL BUDGETING

1

Why do most capital budgeting methods focus on cash flows?

cash flow

Capital budgeting investment decisions can be made using a variety of techniques including payback period, net present value, profitability index, internal rate of return, and accounting rate of return. All but the last of these methods focus on the amounts and timing of **cash flows** (receipts or disbursements of cash). Cash receipts include the revenues from a capital project that have been earned and collected, savings generated by the project's reductions in existing operating costs, and any cash inflow from selling the asset at the end of its useful life. Cash dis-

EXHIBIT 14–1

Project Evaluation Criteria—R&D Projects

1. Potential for proprietary position.
2. Balance between short-term and long-term projects and payoffs.
3. Potential for collaborations and outside funding.
4. Financial rate of return on investment.
5. Need to establish competency in an area.
6. Potential for spin-off projects.
7. Strategic fit with the corporation's planned and existing technology, manufacturing capabilities, marketing and distribution systems.
8. Impact on long-term corporate positioning.
9. Probability of technical success.

SOURCE: Suresh Kalahnanam and Suzanne K. Schmidt, "Analyzing Capital Investments in New Products," *Management Accounting* (January 1996), pp. 31–36. Reprinted from *Management Accounting.* Copyright by Institute of Management Accountants, Montvale, N.J.

bursements include asset acquisition expenditures, additional working capital investments, and costs for project-related direct materials, direct labor, and overhead.

Any investment made by an organization is expected to earn some type of return, such as interest, cash dividends, or operating income. Because interest and dividends are received in cash, accrual-based operating income must be converted to a cash basis for comparison purposes. Remember that accrual accounting recognizes revenues when earned, not when cash is received, and recognizes expenses when incurred regardless of whether a liability is created or cash is paid. Converting accounting income to cash flow information puts all investment returns on an equivalent basis.

Interest cost is a cash outflow associated with debt financing and is not part of the project selection process. The funding of projects is a financing, not an investment, decision. A **financing decision** is a judgment regarding the method of raising capital to fund an investment. Financing is based on the entity's ability to issue and service debt and equity securities. On the other hand, an **investment decision** is a judgment about which assets to acquire to achieve an entity's stated objectives. Cash flows generated by the two types of decisions should not be combined. Company management must justify the acquisition and use of an asset prior to justifying the method of financing that asset.

financing decision

investment decision

Including receipts and disbursements caused by financing with other project cash flows conceals a project's true profitability because financing costs relate to the total entity. The assignment of financing costs to a specific project is often arbitrary, which causes problems in comparing projects that are to be acquired with different financing sources. In addition, including financing effects in an investment decision creates a problem in assigning responsibility. Investment decisions are typically made by divisional managers, or by top management after receiving input from divisional managers. Financing decisions are typically made by an organization's treasurer in conjunction with top management.

Cash flows from a capital project are received and paid at different points in time over the project's life. Some cash flows occur at the beginning of a period, some during the period, and some at the end. To simplify capital budgeting analysis, most analysts assume that all cash flows occur at a specific, single point in time—either at the beginning or end of the time period in which they actually occur. The following example illustrates how cash flows are treated in capital budgeting situations.

CASH FLOWS ILLUSTRATED

Assume that a variety of capital projects are being considered by eRAGs, a small company selling electronic versions of books and magazines on the Internet. One investment being considered by eRAGs is the acquisition of an Internet company, Com.com, that markets electronic advertising to other firms selling Internet products and services.

eRAGs' expected acquisition costs and expected cash income and expenses associated with the acquisition appear in Exhibit 14–2. This detailed information can be simplified to a net cash flow for each year. For eRAGs, the project generates a net negative flow in the first year and net positive cash flows thereafter. This cash flow information for eRAGs can be illustrated through the use of a time line.

Time Lines

A **time line** visually illustrates the points in time when cash flows are expected to be received or paid, making it a helpful tool for analyzing cash flows of a capital investment proposal. Cash inflows are shown as positive amounts on a time line and cash outflows are shown as negative amounts.

time line

EXHIBIT 14–2

e-RAGs' Com.com Acquisition Decision Information

CASH OUTFLOWS (000s)

Due diligence costs:	$ 500 (to be incurred immediately)
Acquisition cost:	8,200 (to be incurred immediately)
Cost to reorganize	700 (to be incurred in year 1)

CASH INFLOWS (000s)

Cash sales less cash operating costs:	
Year 1	$1,900
Year 2	2,500
Year 3	3,400
Year 4	2,900
Year 5	1,800
Year 6	1,500
Year 7	900

Note: After year 7, it is expected that competitive services will render the investment in Com.com worthless.

The following time line represents the cash flows from eRAGs' potential investment in Com.com.

End of period	0	1	2	3	4	5	6	7
Inflows	$ 0	+$1,900	+$2,500	+$3,400	+$2,900	+$1,800	+$1,500	+$ 900
Outflows	− 8,700	− 700	− 0	− 0	− 0	− 0	− 0	− 0
Net cash flow	−$8,700	+$1,200	+$2,500	+$3,400	+$2,900	+$1,800	+$1,500	+$ 900

On a time line, the date of initial investment represents time point 0 because this investment is made immediately. Each year after, the initial investment is represented as a full time period, and periods serve only to separate the timing of cash flows. Nothing is presumed to happen during a period. Thus, for example, cash inflows each year from royalties earned are shown as occurring at the end of, rather than during, the time period. A less conservative assumption would show the cash flows occurring at the beginning of the period.

2

What is measured by the payback period?

payback period

Payback Period

The information on timing of net cash flows is an input to a simple and often-used capital budgeting technique called **payback period**. This method measures the time required for a project's cash inflows to equal the original investment. At the end of the payback period, a company has recouped its investment.

In one sense, payback period measures a dimension of project risk by focusing on the timing of cash flows. The assumption is that the longer it takes to recover the initial investment, the greater is the project's risk because cash flows in the more distant future are more uncertain than relatively current cash flows. Another reason for concern about long payback periods relates to capital reinvestment. The faster that capital is returned from an investment, the more rapidly it can be invested in other projects.

Payback period for a project having unequal cash inflows is determined by accumulating cash flows until the original investment is recovered. Thus, using the information shown in Exhibit 14–2 and the time line presented earlier, the Com.com investment payback period must be calculated using a yearly cumulative total of inflows as follows:

Year	Annual Amount	Cumulative Total
0	−$8,700	−$8,700
1	+ 1,200	− 7,500
2	+ 2,500	− 5,000
3	+ 3,400	− 1,600
4	+ 2,900	+ 1,300
5	+ 1,900	+ 3,200
6	+ 2,500	+ 5,700
7	+ 900	+ 6,600

At the end of the third year, all but $1,600 of the initial investment of $8,700 has been recovered. The $2,900 inflow in the fourth year is assumed to occur evenly throughout the year. Therefore, it should take approximately 0.55 ($1,600 ÷ $2,900) of the fourth year to cover the rest of the original investment, giving a payback period for this project of 3.55 years (or slightly less than 3 years and 7 months).

When the cash flows from a project are equal each period (an **annuity**), the payback period is determined as follows:

annuity

$$\text{Payback Period} = \text{Investment} \div \text{Annuity}$$

Assume for a moment that an investment being considered by eRAGs requires an initial investment of $10,000 and is expected to generate equal annual cash flows of $4,000 in each of the next 5 years. In this case, the payback period would be equal to the $10,000 net investment cost divided by $4,000 or 2.5 years (2 years and 6 months).

Company management typically sets a maximum acceptable payback period as one of the financial evaluation criteria for capital projects. If eRAGs has set four years as the longest acceptable payback period, this project would be acceptable under that criterion. As indicated in the accompanying News Note, companies have a bias of investing in projects with a quick payoff. The News Note also highlights the government's role in funding longer term investments.

GENERAL BUSINESS  **NEWS NOTE**

Dear Uncle Sam: Please Send Money

It may sound strange to hear a Silicon Valley executive credit the birth of such industries as the Internet and local-area networks to the prescience of the U.S. government. But in many cases it is the government that has provided the seeds, and industry that has provided the water and light, to cultivate the technological innovations that are improving the nation's economy and quality of life. Unfortunately, from 1987 to 1995, federal investment in basic research sank by 2.6% per year. As a fraction of gross domestic product, the federal investment in research and development is about half of what it was 30 years ago.

Meanwhile, the information technology sector alone has more than doubled its annual R&D investment over the last 10 years to a current level of $30 billion. In this searing-hot competitive environment, however, most of these expenditures must be allocated to short-term product development. It isn't feasible for the private sector to assume responsibility for long-term, high-risk research when shareholders require solid quarterly returns on investment.

A newly released study by the Council on Competitiveness confirms these findings and highlights both the long-term returns from, and the dangers of being complacent about, the U.S. investment in R&D. For every dollar spent on basic research, we can expect a 50 cents per year increase in national output.

SOURCE: Adapted from Eric A. Benhamou, "R&D Needs Washington's Support," *The Wall Street Journal* (June 17, 1999), p. A26.

Most companies use payback period as only one way of financially judging an investment project. After being found acceptable in terms of payback period, a project is subjected to evaluation by other financial capital budgeting techniques. A second evaluation is usually performed because the payback period method ignores three things: inflows occurring after the payback period has been reached, the company's desired rate of return, and the time value of money. These issues are incorporated into the decision process using discounted future cash flows.

DISCOUNTING FUTURE CASH FLOWS

Money has a time value associated with it; this value is created because interest is paid or received on money.[2] For example, the receipt of $1 today has greater value than the same sum received one year from today because money held today can be invested to generate a return that will cause it to accumulate to more than $1 over time. This phenomenon encourages the use of discounted cash flow techniques in most capital budgeting situations to account for the time value of money.

discounting

Discounting future cash flows means reducing them to present value amounts by removing the portion of the future values representing interest. This "imputed" amount of interest is based on two considerations: the length of time until the cash flow is received or paid and the rate of interest assumed. After discounting, all future values associated with a project are stated in a common base of current dollars, also known as their **present values**. Cash receipts and disbursements occurring at the beginning of a project (time 0) are already stated in their present values and are not discounted.

present value

Information on capital projects involves the use of estimates; therefore, having the best possible estimates of all cash flows (such as initial project investment) is extremely important. Care should be taken also to include all potential future inflows and outflows. To appropriately discount cash flows, managers must estimate the rate of return on capital required by the company in addition to the project's cost and cash flow estimates. This rate of return is called the **discount rate** and is used to determine the imputed interest portion of future cash receipts and expenditures. The discount rate should equal or exceed the company's **cost of capital** (COC), which is the weighted average cost of the various sources of funds (debt and stock) that comprise a firm's financial structure.[3] For example, if a company has a COC of 10 percent, it costs an average of 10 percent of each capital dollar annually to finance investment projects. To determine whether a capital project is a worthwhile investment, this company should generally use a minimum rate of 10 percent to discount its projects' future cash flows.

discount rate

cost of capital

A distinction must be made between cash flows representing a return *of* capital and those representing a return *on* capital. A **return of capital** is the recovery of the original investment or the return of principal, whereas a **return on capital** is income and equals the discount rate multiplied by the investment amount. For example, $1 invested in a project that yields a 10 percent rate of return will grow to a sum of $1.10 in one year. Of the $1.10, $1 represents the return of capital and $0.10 represents the return on capital. The return on capital is computed for each period of the investment life. For a company to be better off by making an investment, a project must produce cash inflows that exceed the investment made and the cost of capital. To determine whether a project meets a company's desired rate of return, one of several discounted cash flow methods can be used.

return of capital
return on capital

[2] The time value of money and present value computations are covered in Appendix 1 of this chapter. These concepts are essential to understanding the rest of this chapter; be certain they are clear before continuing.
[3] All examples in this chapter use an assumed discount rate or cost of capital. The computations required to find a company's cost of capital rate are discussed in any principles of finance text.

DISCOUNTED CASH FLOW METHODS

Three discounted cash flow techniques are the net present value method, the profitability index, and the internal rate of return. Each of these methods is defined and illustrated in the following subsections.

3

How are the net present value and profitability index of a project measured?

Net Present Value Method

net present value method

The **net present value method** determines whether the rate of return on a project is equal to, higher than, or lower than the desired rate of return. Each cash flow from the project is discounted to its present value using the rate specified by the company as the desired rate of return. The total present value of all cash outflows of an investment project subtracted from the total present value of all cash inflows yields the **net present value** (NPV) of the project. Exhibit 14–3 presents net present value calculations, assuming the use of a 12 percent discount rate. The cash flow data are taken from Exhibit 14–2.

net present value

The factors used to compute the net present value are obtained from the present value tables provided in Appendix A at the end of the text. Each period's cash flow is multiplied by a factor obtained from Table 1 (PV of $1) for 12 percent and the appropriate number of periods designated for the cash flow. Table 2 in Appendix A is used to discount annuities rather than single cash flows and its use is demonstrated in later problems.

The net present value of the Com.com investment is $815,000. The NPV represents the net cash benefit or net cash cost to a company acquiring and using the proposed asset. If the NPV is zero, the actual rate of return on the project is equal to the required rate of return. If the NPV is positive, the actual rate is greater than the required rate. If the NPV is negative, the actual rate is less than the required rate of return. Note that the exact rate of return is not indicated under the NPV method, but its relationship to the desired rate can be determined. If all estimates about the investment are correct, the Com.com investment being considered by eRAGs will provide a rate of return greater than 12 percent.

Had eRAGs chosen any rate other than 12 percent and used that rate in conjunction with the same facts, a different net present value would have resulted. For example, if eRAGs set 15 percent as the discount rate, a NPV of $8,000 would have resulted for the project (see Exhibit 14–4). Net present values at other selected discount rates are given in Exhibit 14–4. The computations for these values are made in a manner similar to those at 12 and 15 percent. (To indicate your understanding of the NPV method, you may want to prove these computations.)

EXHIBIT 14–3

Net Present Value Calculation for Com.com Investment

		DISCOUNT RATE = 12%				
Cash Flow	Time	a Amount	×	b Discount Factor	=	c Present Value
Initial investment	t_0	$(8,700)		1.0000		$(8,700)
Year 1 net cash flow	t_1	1,200		0.8929		1,071
Year 2 net cash flow	t_2	2,500		0.7972		1,993
Year 3 net cash flow	t_3	3,400		0.7118		2,420
Year 4 net cash flow	t_4	2,900		0.6355		1,843
Year 5 net cash flow	t_5	1,800		0.5674		1,021
Year 6 net cash flow	t_6	1,500		0.5066		760
Year 7 net cash flow	t_7	900		0.4524		407
Net Present Value						$ 815

EXHIBIT 14–4

Net Present Value Calculation for Com.com Investment

		DISCOUNT RATE = 15%				
Cash Flow	Time	a Amount	×	b Discount Factor	=	c Present Value
Initial investment	t_0	$(8,700)		1.0000		$(8,700)
Year 1 net cash flow	t_1	1,200		0.8696		1,044
Year 2 net cash flow	t_2	2,500		0.7561		1,890
Year 3 net cash flow	t_3	3,400		0.6575		2,235
Year 4 net cash flow	t_4	2,900		0.5718		1,658
Year 5 net cash flow	t_5	1,800		0.4972		895
Year 6 net cash flow	t_6	1,500		0.4323		648
Year 7 net cash flow	t_7	900		0.3759		338
Net Present Value						$ 8

Net present value with 5% discount rate: $3,202
Net present value with 10% discount rate: $1,419
Net present value with 20% discount rate: $(1,121)

The table in Exhibit 14–4 indicates that the NPV is not a single, unique amount, but is a function of several factors. First, changing the discount rate while holding the amounts and timing of cash flows constant affects the NPV. Increasing the discount rate causes the NPV to decrease; decreasing the discount rate causes NPV to increase. Second, changes in estimated amounts and/or timing of cash inflows and outflows affect the net present value of a project. Effects of cash flow changes on the NPV depend on the changes themselves. For example, decreasing the estimate of cash outflows causes NPV to increase; reducing the stream of cash inflows causes NPV to decrease. When amounts and timing of cash flows change in conjunction with one another, the effects of the changes are determinable only by calculation.

The net present value method, although not providing the actual rate of return on a project, provides information on how that rate compares with the desired rate. This information allows managers to eliminate from consideration any project producing a negative NPV because it would have an unacceptable rate of return. The NPV method can also be used to select the best project when choosing among investments that can perform the same task or achieve the same objective.

The net present value method should not, however, be used to compare independent projects requiring different levels of initial investment. Such a comparison favors projects having higher net present values over those with lower net present values without regard to the capital invested in the project. As a simple example of this fact, assume that eRAGs could spend $200,000 on Investment A or $40,000 on Investment B. Investment A's and B's net present values are $4,000 and $2,000, respectively. If only NPVs were compared, the company would conclude that Investment A was a "better" investment because it has a larger NPV. However, Investment A provides an NPV of only 2 percent ($4,000 ÷ $200,000) on the investment, whereas Investment B provides a 5 percent ($2,000 ÷ $40,000) NPV. Logically, organizations should invest in projects that produce the highest return per investment dollar. Comparisons of projects requiring different levels of investment are made using a variation of the NPV method known as the profitability index.

Profitability Index

profitability index

The **profitability index** (PI) is a ratio comparing the present value of a project's net cash inflows to the project's net investment. The PI is calculated as

PI = Present Value of Net Cash Flows ÷ Net Investment

The present value of net cash flows equals the PV of future cash inflows minus the PV of future cash outflows. The PV of net cash inflows represents an output measure of the project's worth, whereas the net investment represents an input measure of the project's cost. By relating these two measures, the profitability index gauges the efficiency of the firm's use of capital. The higher the index, the more efficient is the capital investment.

The following information illustrates the calculation and use of a profitability index. eRAGs is considering two investments: a training program for employees costing $720,000 and a series of Internet servers costing $425,000. Corporate managers have computed the present values of the investments by discounting all future expected cash flows at a rate of 12 percent. Present values of the expected net cash inflows are $900,000 for the training program and $580,000 for the servers. Dividing the PV of the net cash inflows by initial cost gives the profitability index for each investment. Subtracting asset cost from the present value of the net cash inflows provides the NPV. Results of these computations are shown below.

	PV of Inflows	Cost	Profitability Index	NPV
Training program	$900,000	$720,000	1.25	$180,000
Server package	580,000	425,000	1.36	155,000

Although the training program's net present value is higher, the profitability index indicates that the server package is a more efficient use of corporate capital.[4] The higher PI reflects a higher rate of return on the server package than on the training program. The higher a project's PI, the more profitable is that project per investment dollar.

If a capital project investment is made to provide a return on capital, the profitability index should be equal to or greater than 1.00, the equivalent of an NPV equal to or greater than 0. Like the net present value method, the profitability index does not indicate the project's expected rate of return. However, another discounted cash flow method, the internal rate of return, provides the expected rate of return to be earned on an investment.

Internal Rate of Return

4

How is the internal rate of return on a project computed? What does it measure?

internal rate of return

A project's **internal rate of return** (IRR) is the discount rate that causes the present value of the net cash inflows to equal the present value of the net cash outflows. It is the project's expected rate of return. If the IRR is used to determine the NPV of a project, the NPV is zero. By examining Exhibits 14–3 and 14–4, it is apparent that eRAGs investment in Com.com would generate an IRR very close to 15 percent because a discount rate of 15 percent resulted in an NPV very close to $0.

The following formula can be used to determine net present value:

$$\begin{aligned} \text{NPV} &= -\text{Investment} + \text{PV of Cash Inflows} - \text{PV of Cash Outflows other than the investment} \\ &= -\text{Investment} + \text{Cash Inflows (PV Factor)} - \text{Cash Outflows (PV Factor)} \end{aligned}$$

Capital project information should include the amounts of the investment, cash inflows, and cash outflows. Thus, the only missing data in the preceding formula are the present value factors. These factors can be calculated and then be found in the present value tables. The interest rate with which the factors are associated is

[4] Two conditions must exist for the profitability index to provide better information than the net present value method. First, the decision to accept one project must require that the other project be rejected. The second condition is that availability of funds for capital acquisitions is limited.

the internal rate of return. The internal rate of return is most easily computed for projects having equal annual net cash flows. When an annuity exists, the NPV formula can be restated as follows:

$$\begin{aligned}\text{NPV} &= -\text{Net Investment} + \text{PV of Annuity Amount}\\ &= -\text{Net Investment} + (\text{Cash Flow Annuity Amount} \times \text{PV Factor})\end{aligned}$$

The investment and annual cash flow amounts are known from the expected data and net present value is known to be zero at the IRR. The IRR and its present value factor are unknown. To determine the internal rate of return, substitute known amounts into the formula, rearrange terms, and solve for the unknown (the PV factor):

$$\begin{aligned}\text{NPV} &= -\text{Net Investment} + (\text{Annuity} \times \text{PV Factor})\\ 0 &= -\text{Net Investment} + (\text{Annuity} \times \text{PV Factor})\\ \text{Net Investment} &= (\text{Annuity} \times \text{PV Factor})\\ \text{Net Investment} \div \text{Annuity} &= \text{PV Factor}\end{aligned}$$

The solution yields a present value factor for the number of annuity periods corresponding to the project's life at an interest rate equal to the internal rate of return. Finding this factor in the PV of an annuity table and reading the interest rate at the top of the column in which the factor is found provides the internal rate of return.

To illustrate an IRR computation for a project with a simple annuity, information in Exhibit 14–5 pertaining to eRAGs' potential investment in a quality control system is used. The quality control system would be installed immediately and would generate cost savings over the five-year life of the system. The system has no expected salvage value.

The NPV equation is solved for the present value factor.

$$\begin{aligned}\text{NPV} &= -\text{Net Investment} + (\text{Annuity} \times \text{PV Factor})\\ \$0 &= -\$99{,}560 + (\$29{,}000 \times \text{PV Factor})\\ \$99{,}560 &= (\$29{,}000 \times \text{PV Factor})\\ \$99{,}560 \div \$29{,}000 &= \text{PV Factor}\\ 3.43 &= \text{PV Factor}\end{aligned}$$

The PV of an ordinary annuity table (Table 2, Appendix A) is examined to find the internal rate of return. A present value factor is a function of time and the discount rate. In the table, find the row representing the project's life (in this case, five periods). Look across the table in that row for the PV factor found upon solving the equation. In row 5, a factor of 3.4331 appears under the column headed 14 percent. Thus, the internal rate of return for this machine is very near 14 percent. Using interpolation, a computer program, or a programmable calculator the exact

EXHIBIT 14–5

Information Pertaining to Quality Control System

	Cash Flow
Cost of software and hardware (t_0)	−$85,000
Installation cost (t_0)	− 14,560
Operating savings (t_1–t_5)	+ 29,000

IRR can be found.[5] A computer program indicates the IRR of the quality control system is 13.9997 percent.

Exhibit 14–6 plots the net present values that result from discounting the quality control system cash flows at various rates of return. For example, the NPV at 4 percent is $28,407 and the NPV at 15 percent is −$2,041. (These computations are not provided here, but can be performed by discounting the $29,000 annual cash flows and subtracting $99,560 of investment cost.)

The internal rate of return is located on the graph's horizontal axis at the point where the NPV equals zero (13.9997 percent). Note that the graph reflects an inverse relationship between rates of return and NPVs. Higher rates yield lower present values because, at the higher rates, fewer dollars need to be currently invested to obtain the same future value.

Manually finding the IRR of a project that produces unequal annual cash flows is more complex and requires an iterative trial-and-error process. An initial estimate is made of a rate believed to be close to the IRR and the NPV is computed. If the resulting NPV is negative, a lower rate is estimated (because of the inverse relationship mentioned above) and the NPV is computed again. If the NPV is positive, a higher rate is tried. This process is continued until the net present value equals zero, at which time the internal rate of return has been found.

The project's internal rate of return is then compared with management's preestablished **hurdle rate**, which is the rate of return specified as the lowest acceptable return on investment. Like the discount rate mentioned earlier, this rate should generally be at least equal to the cost of capital. In fact, the hurdle rate is commonly the discount rate used in computing net present value amounts. If a project's IRR is equal to or greater than the hurdle rate, the project is considered viable from a financial perspective. As indicated in the following passage, hurdle rates are no longer simply an American concept.

hurdle rate

> *Faced with higher capital costs, Japanese managers are beginning to embrace such previously little-known Western concepts as "hurdle rates" and "required rates of return." That's a big switch for executives who once concerned themselves only with market share. Said Tsunehiko Ishibashi, general manager of finance for Mitsubishi Kasei, a major petrochemical company: "As a result of the higher cost of capital, the profitability standards for new investments must be raised."*[6]

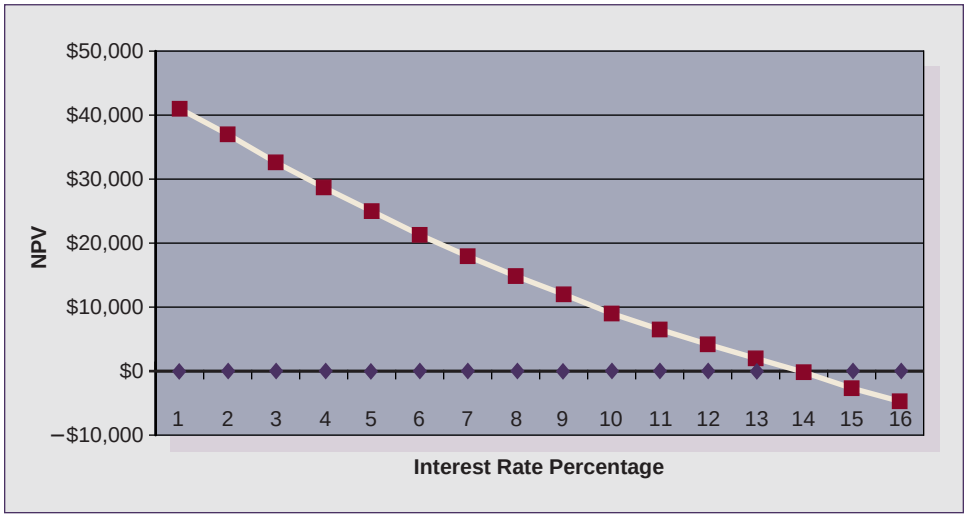


EXHIBIT 14–6

NPV by Various Discount Rates

[5] Interpolation is the process of finding a term between two other terms in a series.
[6] John J. Curran, "Japan Tries to Cool Money Mania," *Fortune* (January 28, 1991), p. 66.

The internal rate of return on an investment must clear the company's designated hurdle rate. That hurdle rate will be raised as the company's cost of debt and equity capital increases.

The higher the internal rate of return, the more financially attractive is the investment proposal. In choosing among alternative investments, however, managers cannot look solely at the internal rates of return on projects. The rates do not reflect the dollars involved. An investor would normally rather have a 10 percent return on $1,000 than a 100 percent return on $10!

Using the internal rate of return has three drawbacks. First, when uneven cash flows exist, the iterative process is inconvenient. Second, unless present value tables are available that provide factors for fractional interest rates, finding the precise IRR on a project is difficult. These two problems can be eliminated with the use of a computer or a programmable calculator. The last problem is that it is possible to find several rates of return that will make the net present value of the cash flows equal zero. This phenomenon usually occurs when there are net cash inflows in some years and net cash outflows in other years of the investment project's life (other than time 0).

In performing discounted cash flow analyses, accrual-based accounting information sometimes needs to be converted to cash flow data. One accrual that deserves special attention is depreciation. Although depreciation is not a cash flow item, it has cash flow implications because of its deductibility for income tax purposes.

THE EFFECT OF DEPRECIATION ON AFTER-TAX CASH FLOWS

5

How do taxation and depreciation methods affect cash flows?

Income taxes are an integral part of the business environment and decision-making process in our society. Tax planning is a central part of management planning and has a large impact on overall business profitability. Managers typically make decisions only after examining how company taxes will be affected by those decisions. In evaluating capital projects, managers should use after-tax cash flows to determine project acceptability.

Note that depreciation expense is not a cash flow item. Although no funds are paid or received for it, depreciation on capital assets, similar to interest on debt, affects cash flows by reducing a company's tax obligation. Thus, depreciation provides a **tax shield** against the payment of taxes. The tax shield produces a **tax benefit** equal to the amount of taxes saved (the depreciation amount multiplied by the tax rate). The concepts of tax shield and tax benefit are shown on the following income statements. The tax rate is assumed to be 40 percent.

tax shield
tax benefit

No Depreciation Deduction Income Statement		Depreciation Deduction Income Statement	
Sales	$250,000	Sales	$250,000
Cost of goods sold	(175,000)	Cost of goods sold	(175,000)
Gross margin	$ 75,000	Gross margin	$ 75,000
Expenses other than depreciation	(37,500)	Expenses other than depreciation	(37,500)
Depreciation expense	0	Depreciation expense	(37,500)
Income before taxes	$ 37,500	Income before tax	$ 0
Tax expense (40%)	(15,000)	Tax expense (40%)	0
Net income	$ 22,500	Net income	$ 0

The tax shield is the depreciation expense amount of $37,500. The tax benefit is the difference between $15,000 of tax expense on the first income statement and $0 of tax expense on the second income statement. The tax benefit is also equal to the 40 percent tax rate multiplied by the depreciation tax shield of $37,500, or $15,000. Because taxes are reduced by $15,000, the pattern of cash flows is improved.

It is the depreciation for purposes of computing income taxes rather than the amount used for financial accounting purposes that is relevant in discounted cash flow analysis. Income tax laws regarding depreciation deductions are subject to revision. In making their analyses of capital investments, managers should use the most current tax regulations for depreciation. Different depreciation methods may have significant impacts on after-tax cash flows. For a continuously profitable business, an accelerated method of depreciation, such as the modified accelerated cost recovery system (MACRS), allowed for U.S. tax computations, will produce higher tax benefits in the early years of asset life than will the straight-line method. These higher tax benefits will translate into a higher net present value over the life of the investment project.

Changes in the availability of depreciation methods or in the length of an asset's depreciable life may dramatically affect projected after-tax cash flows and also affect the net present value, profitability index, and internal rate of return expected from the capital investment. Because capital projects are analyzed and evaluated before investments are made, managers should be aware of the inherent risk of tax law changes. Original assumptions made about the depreciation method or asset life may not be valid by the time an investment is actually made and an asset is placed into service. However, once purchased and placed into service, an asset can generally be depreciated using the method and tax life allowed when the asset was placed into service regardless of the tax law changes occurring after that time.

Changes may also occur in the tax rate structure. Rate changes may be relatively unpredictable. For example, the maximum federal corporate tax rate for many years was 46 percent; the Tax Reform Act of 1986 lowered this rate to 34 percent, and the present top marginal U.S. tax rate is 35 percent.[7] A tax rate reduction lowers the tax benefit provided by depreciation because the impact on cash flow is lessened. Tax law changes (such as asset tax-life changes) can cause the expected outcomes of the capital investment analysis to vary from the project's actual outcomes.[8]

To illustrate such variations, assume that eRAGs is considering investing in a new Internet site. The site will require an investment of $540,000 in computer hardware and software. Assume these assets have a 10-year economic life and would produce expected net annual cash income of $110,000. Assume the company's after-tax cost of capital is 11 percent. Further assume that corporate assets are depreciated on a straight-line basis for tax purposes.[9]

[7] Surtaxes that apply to corporations may drive the top marginal rate above 35 percent for certain income brackets.
[8] Additionally, managers should be careful to consider effects of both applicable foreign and state tax laws.
[9] To simplify the presentation, the authors have elected to ignore a tax rule requirement called the half-year (or mid-quarter) convention that applies to personal assets and a mid-month convention that applies to most real estate improvements. Under tax law, only a partial year's depreciation may be taken in the year an asset is placed into service. The slight difference that such a tax limitation would make on the amounts presented is immaterial for purposes of illustrating these capital budgeting concepts.

In late 2000, prior to making the Internet site investment, eRAGs' cost accountant, Jill Flowers, calculated the project's net present value. The results of her calculations are shown in Exhibit 14–7 under Situation A. Note that depreciation is added to income after tax to obtain the amount of after-tax cash flow. Even though depreciation is deductible for tax purposes, it is still a noncash expense. The present value amounts are obtained by multiplying the after-tax cash flows by the appropriate PV of an annuity factor from Table 2 in Appendix A at the end of the text.

The NPV evaluation technique indicated the acceptability of the capital investment. At the time of Ms. Flowers' analysis, eRAGs' tax rate was 30 percent and the tax laws allowed a 10-year depreciable life on this property.

EXHIBIT 14–7

Internet Site Investment Analyses

ASSUMED FACTS

Initial investment	$540,000
Expected annual before-tax cash flows	110,000
Straight-line depreciation (10 years)	54,000
Expected economic life	10 years

Situation A: Tax rate of 30% (actual rate in effect)
Situation B: Tax rate of 25%
Situation C: Tax rate of 40%

	SITUATIONS		
	A	B	C
YEARS 1–10			
Before-tax cash flow	$110,000	$110,000	$110,000
Depreciation	(54,000)	(54,000)	(54,000)
Income before tax	$ 56,000	$ 56,000	$ 56,000
Tax	(16,800)	(14,000)	(22,400)
Net income	$ 39,200	$ 42,000	$ 33,600
Depreciation	54,000	54,000	54,000
Cash flow after tax	$ 93,200	$ 96,000	$ 87,600

SITUATION A—NPV CALCULATIONS ASSUMING AN 11% DISCOUNT RATE

Cash Flow	Time	Amount	Discount Factor	Present Value
Investment	t_0	$(540,000)	1.0000	$(540,000)
Annual inflows	t_1–t_{10}	93,200	5.8892	548,873
Net Present Value				$ 8,873

SITUATION B—NPV CALCULATIONS ASSUMING AN 11% DISCOUNT RATE

Cash Flow	Time	Amount	Discount Factor	Present Value
Investment	t_0	$(540,000)	1.0000	$(540,000)
Annual inflows	t_1–t_{10}	96,000	5.8892	565,363
Net Present Value				$ 25,363

SITUATION C—NPV CALCULATIONS ASSUMING AN 11% DISCOUNT RATE

Cash Flow	Time	Amount	Discount Factor	Present Value
Investment	t_0	$(540,000)	1.0000	$(540,000)
Annual inflows	t_1–t_{10}	87,800	5.8892	517,072
Net Present Value				$ (22,928)

Because Ms. Flowers was concerned about proposed changes in the U.S. tax rate, she also analyzed the project assuming that tax rates changed. Exhibit 14–7 shows the different after-tax cash flows and net present values that result if the same project is subjected to either a 25 percent (Situation B) or 40 percent (Situation C) tax rate.

This example demonstrates the expected NPV change when a different tax rate is used. If the tax rate changes to either 25 or 40 percent, the NPV changes. A decrease in the tax rate makes the Internet site a more acceptable investment, based on its net present value, and an increase in the tax rate has the opposite effect.

Understanding how depreciation and taxes affect the various capital budgeting techniques will allow managers to make the most informed decisions about capital investments.[10] Well-informed managers are more likely to have confidence in capital investments made by the company if they can justify the substantial resource commitment required. That justification is partially achieved by considering whether a capital project fits into strategic plans. To be confident of their conclusions, managers must also comprehend the assumptions and limitations of each capital budgeting method.

ASSUMPTIONS AND LIMITATIONS OF METHODS

6

What are the underlying assumptions and limitations of each capital project evaluation method?

As summarized in Exhibit 14–8, each financial capital budget evaluation method has its own underlying assumptions and limitations. To maximize benefits of the capital budgeting process, managers should understand the similarities and differences of the various methods and use several techniques to evaluate a project.

All of the methods have two similar limitations. First, except to the extent that payback indicates the promptness of the investment recovery, none of the methods provides a mechanism to include management preferences with regard to the timing of cash flows. This limitation can be partially overcome by discounting cash flows occurring further in the future at higher rates than those in earlier years, assuming that early cash flows are preferred. Second, all the methods use single, deterministic measures of cash flow amounts rather than probabilities. This limitation can be minimized through the use of probability estimates of cash flows. Such estimates can be input into a computer program to determine a distribution of answers for each method under various conditions of uncertainty.

THE INVESTMENT DECISION

Management must identify the best asset(s) for the firm to acquire to fulfill the company's goals and objectives. Making such an identification requires answers to the following four subhead questions.

Is the Activity Worthy of an Investment?

A company acquires assets when they have value in relation to specific activities in which the company is engaged. For example, Amazon.com invests heavily in product and service development because that is the primary path to new revenues (the activity). Before making decisions to acquire assets, company management must be certain that the activity for which the assets will be needed is worthy of an investment.

[10] These examples have all considered the investment project as a purchase. If a leasing option exists, the classification of the lease as operating or capital will affect the amounts deductible for tax purposes. A good illustration of this is provided in "The Lease vs. Purchase Decision," by Ralph L. Benke, Jr., and Charles P. Baril in *Management Accounting* (March 1990), pp. 42–46.

ASSUMPTIONS	LIMITATIONS
Payback Method	
■ Speed of investment recovery is the key consideration. ■ Timing and size of cash flows are accurately predicted. ■ Risk (uncertainty) is lower for a shorter payback project.	■ Cash flows after payback are ignored. ■ Cash flows and project life in basic method are treated as deterministic without explicit consideration of probabilities. ■ Time value of money is ignored. ■ Cash flow pattern preferences are not explicitly recognized.
Net Present Value	
■ Discount rate used is valid. ■ Timing and size of cash flows are accurately predicted. ■ Life of project is accurately predicted. ■ If the shorter lived of two projects is selected, the proceeds of that project will continue to earn the discount rate of return through the theoretical completion of the longer lived project.	■ Cash flows and project life in basic method are treated as deterministic without explicit consideration of probabilities. ■ Alternative project rates of return are not known. ■ Cash flow pattern preferences are not explicitly recognized. ■ IRR on project is not reflected.
Profitability Index	
■ Same as NPV. ■ Size of PV of net inflows relative to size of present value of investment measures efficient use of capital.	■ Same as NPV. ■ A relative answer is given but dollars of NPV are not reflected.
Internal Rate of Return	
■ Hurdle rate used is valid. ■ Timing and size of cash flows are accurately predicted. ■ Life of project is accurately predicted. ■ If the shorter lived of two projects is selected, the proceeds of that project will continue to earn the IRR through the theoretical completion of the longer lived project.	■ The IRR rather than dollar size is used to rank projects for funding. ■ Dollars of NPV are not reflected. ■ Cash flows and project life in basic method are treated as deterministic without explicit consideration of probabilities. ■ Cash flow pattern preferences are not explicitly recognized. ■ Multiple rates of return can be calculated on the same project.
Accounting Rate of Return (Presented in Appendix 2 of this chapter)	
■ Effect on company accounting earnings relative to average investment is key consideration. ■ Size and timing of increase in company earnings, investment cost, project life, and salvage value can be accurately predicted.	■ Cash flows are not considered. ■ Time value of money is not considered. ■ Earnings, investment, and project life are treated as deterministic without explicit consideration of probabilities.

EXHIBIT 14–8

Assumptions and Limitations of Capital Budgeting Methods

An activity's worth is measured by cost-benefit analysis. For most capital budgeting decisions, costs and benefits can be measured in monetary terms. If the dollars of benefits exceed the dollars of costs, then the activity is potentially worthwhile. In some cases, though, benefits provided by capital projects are difficult to quantify. However, difficulty in quantification is no reason to exclude benefits from capital budgeting analyses. In most instances, surrogate quantifiable measures can be obtained for qualitative benefits. For example, benefits from investments in day care centers for employees' children may be estimable based on the reduction in employee time off and turnover. At a minimum, managers should attempt to subjectively include such benefits in the analytical process.

In other circumstances, management may know in advance that the monetary benefits of the capital project will not exceed the costs, but the project is essential for other reasons. For example, a company may consider renovating the employee workplace with new carpet, furniture, paint, and artwork. The renovation would

not make employee work any easier or safer, but would make it more comfortable. Such a project may be deemed "worthy" regardless of the results of a cost-benefit analysis. Companies may also invest in unprofitable products to maintain market share of a product group, and, therefore, protect the market position of profitable products. One of the most difficult investments to evaluate is technology, which is addressed in the accompanying News Note.

Which Assets Can Be Used for the Activity?

The determination of available and suitable assets to conduct the intended activity is closely related to the evaluation of the activity's worth. Management must have an idea of how much the needed assets will cost to determine whether the activity should be pursued. As shown in Exhibit 14–9, management should gather the following specific monetary and nonmonetary information for each asset to make this determination: initial cost, estimated life and salvage value, raw material and labor requirements, operating costs (both fixed and variable), output capability, service availability and costs, maintenance expectations, and revenues to be generated (if any). As mentioned in the previous section, information used in a capital project analysis may include surrogate, indirect measures. Management must have both quantitative and qualitative information on each asset and recognize that some projects are simply more crucial to the firm's future than others. This point is illustrated in the News Note below.

Of the Available Assets for Each Activity, Which Is the Best Investment?

Using all available information, management should select the best asset from the candidates and exclude all others from consideration. In most instances, a company has a standing committee to discuss, evaluate, and approve capital projects. In judging capital project acceptability, this committee should recognize that two types of capital budgeting decisions must be made: screening and preference decisions.

GENERAL BUSINESS  **NEWS NOTE**

Technology: What's It Worth?

Remember the promises of expert systems, the paperless office, and other hype that technology created? Is technology all sizzle and no substance, or can technology re-gain its credibility? One of the ways of re-establishing confidence is by managing technology investments and by having realistic measurements that are meaningful to your business.

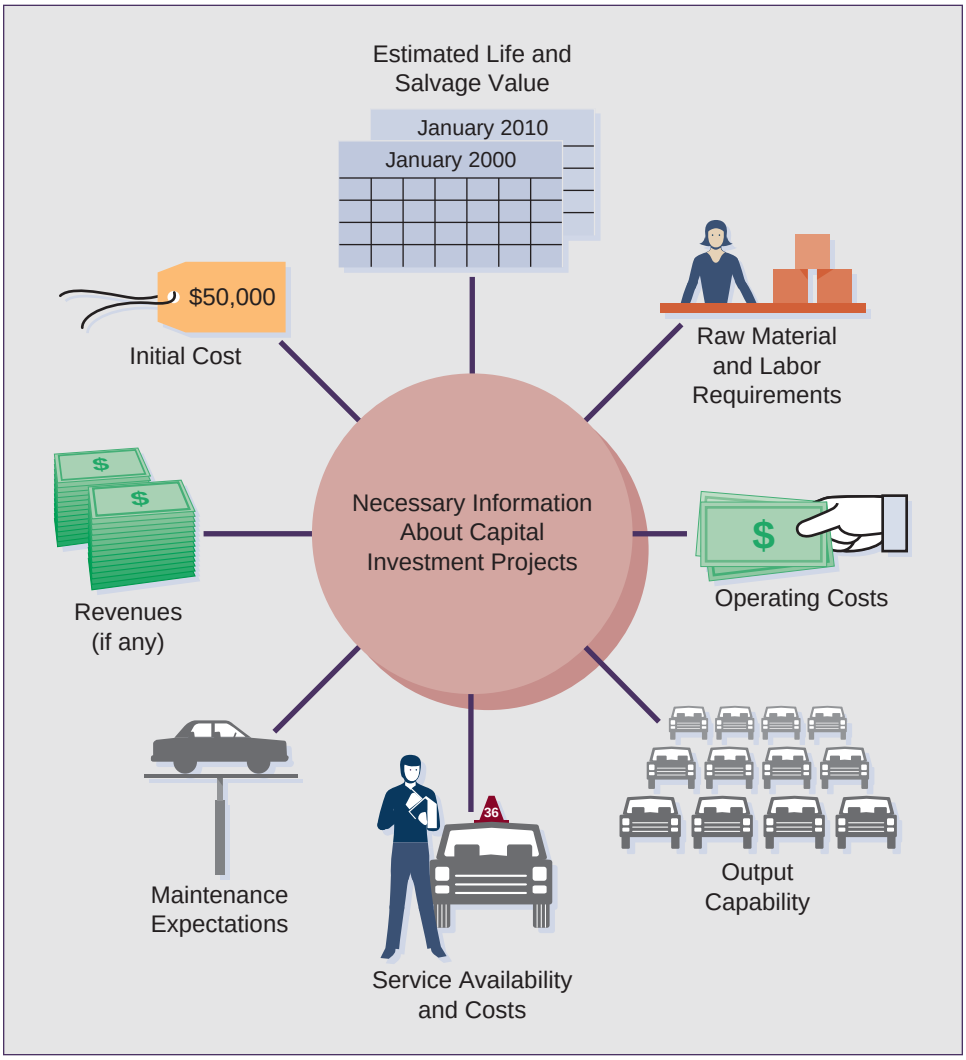
Evaluating the benefits of technology is not easy for two reasons. We know that information itself is useless unless it assists in making better decisions that could not have been made without the use of that information. What makes investment in technology difficult to measure is that having all the information available before making a decision guarantees only information overload, not the right decision. As well, the value of technology depends on what the business goals are that it is supporting, and to what degree technology is instrumental in achieving these goals.

You can't measure the value of information by examining the size of the disk storage, the number of PCs in the organization, the boxes of reports printed, or on-line queries processed, because none of these items is valuable until they are used in the business. More money spent on technology does not guarantee more value to the business: it is how technology is used that matters, not how much it costs. Expensive technology that only automates the existing manual processes will not add value to the business unless it provides additional benefits that do not exist in the manual environment.

SOURCE: Reprinted from an article, "Managing Technology Investments," appearing in *CMA Management Magazine* (formerly *CMA Magazine*) by Catherine A. Bovie, July/August 1998 (pp. 15–18), with permission of CMA Canada.

EXHIBIT 14–9

Capital Investment Information



screening decision

preference decision

A **screening decision** determines whether a capital project is desirable based on some previously established minimum criterion or criteria. If the project does not meet the minimum standard(s), it is excluded from further consideration. The second decision is a **preference decision** in which projects are ranked according to their impact on the achievement of company objectives.

Deciding which asset is the best investment requires the use of one or several of the evaluation techniques discussed previously. Some techniques may be used to screen the projects as to acceptability; other techniques may be used to rank the projects in order of preferability. Although different companies use different techniques for screening and ranking purposes, payback period is commonly used only for screening decisions. The reasons for this choice are that payback focuses only on the short run and does not consider the time value of money. The remaining techniques may be used to screen or rank capital projects.

Of the "Best Investments" for All Worthwhile Activities, in Which Ones Should the Company Invest?

Although many worthwhile investment activities exist, each company has limited resources available and must allocate them in the most profitable manner. Therefore, after choosing the best asset for each activity, management must decide which

activities and assets to fund. Investment activities may be classified as mutually exclusive, independent, or mutually inclusive.

mutually exclusive project

Mutually exclusive projects fulfill the same function. One project will be chosen from such a group, causing all others to be excluded from further consideration because they would provide unneeded or redundant capability. A proposal under consideration may be to replace a current asset with one that provides the same basic capabilities. If the company keeps the old asset, it will not buy the new one; if the new one is purchased, the old asset will be sold. Thus, the two assets are mutually exclusive. For example, if a bakery decided to buy a new delivery truck, it would no longer need its existing truck. The existing truck would be sold to help finance the new truck.

independent project

Other investments may be **independent projects** because they have no specific bearing on one another. For example, the acquisition of an office microcomputer system is not related to the purchase of a factory machine. These project decisions are analyzed and accepted or rejected independently of one another. Although limited resources may preclude the acquisition of all acceptable projects, the projects themselves are not mutually exclusive.

mutually inclusive project

Management may be considering certain investments that are all related to a primary project, or **mutually inclusive projects**. In a mutually inclusive situation, if the primary project is chosen, all related projects are also selected. Alternatively, rejection of the primary project will dictate rejection of the others. For example, when a firm chooses to invest in new technology, investing in an employee training program for the new technology may also be necessary.

Exhibit 14–10 shows a typical investment decision process in which a company is determining the best way to provide transportation for its sales force. Answers to the four questions asked in the subheadings to this section are provided for the transportation decision.

To ensure that capital funds are invested in the best projects available, managers must carefully evaluate all projects and decide which ones represent the most effective and efficient use of resources—a difficult determination. The evaluation

EXHIBIT 14–10

Typical Investment Decision Process

Activity—Provide transportation for a sales force of 10 people.

1. Is the activity worthy of an investment?
   Yes; this decision is based on an analysis of the cost of providing transportation in relationship to the dollars of gross margin to be generated by the sales force.
2. Which assets can be used for the activity?
   Available: Bus passes, bicycles, motorcycles, automobiles (purchased), automobiles (leased), automobiles (currently owned), small airplanes.
   Infeasible: Bus passes, bicycles, and motorcycles are rejected as infeasible because of inconvenience and inability to carry a reasonable quantity of merchandise; airplanes are rejected as infeasible because of inconvenience and lack of proximity of landing sites to customers.
   Feasible: Various types of automobiles to be purchased (assume asset options A through G); various types of leasing arrangements (assume availability of leases 1 through 5); current fleet.
   Gather all relevant quantitative and qualitative information on all feasible assets (assets A–G; leases 1–5; current fleet).
3. Which asset is the best investment?
   Compare all relevant information and choose the best asset candidate from the purchase group (assume Asset D) and the lease group (assume Lease 2).
4. Which investment should the company make?
   Compare the best asset candidate from the purchase group (Asset D) and the lease group (Lease 2); this represents a mutually exclusive, multiple-candidate project decision. The best candidate is found to be type D assets. Compare the type D assets to current fleet; this is a mutually exclusive, replacement project. The best investment is to sell the old fleet and purchase a new fleet of 10 type D automobiles.

process should consider activity priorities, cash flows, and risk of all projects. Projects should then be ranked in order of their acceptability. Ranking may be required for both independent projects and mutually exclusive projects. Ranking mutually exclusive projects is required to select the best project from the set of alternatives. Ranking independent projects is required to efficiently allocate scarce capital to competing uses.

RANKING MULTIPLE CAPITAL PROJECTS

7

How do managers rank investment projects?

When managers are faced with an accept/reject decision for a single asset, all time-value-of-money evaluation techniques will normally point to the same decision alternative. A project is acceptable under the NPV method when it has a nonnegative net present value. Acceptability of a capital asset is also indicated by a profitability index (PI) of 1.00 or more. Because the PI is an adaptation of the NPV method, these two evaluation techniques will always provide the same accept/reject decision.

To be acceptable using the IRR model, a capital acquisition must have an internal rate of return equal to or greater than the specified hurdle rate. The IRR method gives the same accept/reject decision as the NPV and PI methods if the hurdle rate and the discount rate used are the same.

More often, however, managers are faced with choosing among multiple projects. Multiple project decisions require that a selection ranking be made. This section of the chapter considers the use of the net present value, profitability index, and internal rate of return techniques for ranking mutually exclusive projects. Payback period also can be used to rank multiple projects. However, it does not provide as much useful information as NPV, PI, and IRR, because cash flows beyond the payback period are ignored.

Managers can use results from the evaluation techniques to rank projects in descending order of acceptability. For the NPV and PI methods, rankings are based, respectively, on magnitude of NPV and PI index. Although based on the same figures, the NPV and PI methods will not always provide the same order of ranking because the former is a dollar measure and the latter is a percentage. When the internal rate of return is used, rankings of multiple projects are based on expected rate of return. Rankings provided by the IRR method will not always be in the same order as those given by the NPV or PI methods.

reinvestment assumption

Conflicting results arise because of differing underlying **reinvestment assumptions** of the three methods. The reinvestment assumption presumes cash flows released during a project's life are reinvested until the end of the project's life. The NPV and PI techniques assume that released cash flows are reinvested at the discount rate which, at minimum, should be the cost of capital (COC). The IRR method assumes reinvestment of released cash flows can be made at the expected internal rate of return, which may be substantially higher than the COC. If it is, the IRR method may provide a misleading indication of project success because additional projects may not be found that have such a high return.

Three situations are discussed in the following subsections to illustrate conflicting rankings of multiple projects. In each situation the weighted average cost of capital is the discount rate used to compute NPV as well as the hurdle rate against which to measure IRR.

Multiple Projects—Equal Lives, Constant Cash Flows, Unequal Investments

eRAGs has gathered the following information pertaining to two potential projects. One project under consideration is the purchase of software that would improve the efficiency of processing customer orders. The other investment being contemplated

is a customer service training program for the sales staff. Data on these projects are as follows:

	Software	Training Program
Investment	$390,000	$80,000
Annual after-tax cash flows	$ 64,000	$14,000
Asset life	10 years	10 years
Cost of capital	9%	9%

Note that in this example an assumed COC of 9 percent is used as the discount rate. The time lines, NPV, and PI computations appear in Exhibit 14–11 for both projects. The amounts on the time lines are shown in thousands of dollars. The IRR is approximated from the present value of an annuity table (Table 2, Appendix A), and the actual rate can be found using a computer or programmable calculator.

The net present value model indicates that the better investment for eRAGs is the software with a NPV of $11,843. However, in applying the profitability index or internal rate of return models, the training program would be selected because it has a higher PI and a higher IRR. Because these projects do not serve the same purpose, company management would most likely evaluate the selection based on priority needs rather than results of specific capital project evaluations. In the absence of a need to ration capital, eRAGs may invest in both projects.

EXHIBIT 14–11

Multiple Projects; Conflicting Rankings

SOFTWARE (000s)

End of period	0	1	2	3	4	5	6	7	8	9	10
Inflows		+64	+64	+64	+64	+64	+64	+64	+64	+64	+64
Outflows	(390)										

Cash Flow	Time	Amount	Discount Factor	Present Value
Investment	t_0	$(400,000)	1.0000	$(390,000)
Annual inflows	t_1–t_{10}	64,000	6.2788	401,843
Net Present Value				$ 11,843

PI = $401,843 ÷ $390,000 = 1.03

IRR factor = $390,000 ÷ $64,000 = 6.0938 (annuity for 10 periods)

The IRR is approximately 10.19%; calculator computations verify this finding.

TRAINING PROGRAM (000s)

End of period	0	1	2	3	4	5	6	7	8	9	10
Inflows		+14	+14	+14	+14	+14	+14	+14	+14	+14	+14
Outflows	(80)										

Cash Flow	Time	Amount	Discount Factor	Present Value
Investment	t_0	$(80,000)	1.0000	$(80,000)
Annual inflows	t_1–t_{10}	14,000	6.2788	87,903
Net Present Value				$ 7,903

PI = $87,903 ÷ $80,000 = 1.099

IRR factor = $80,000 ÷ $14,000 = 5.7143 (annuity for 10 periods)

The IRR is approximately 11.73%; calculator computations verify this finding.

Multiple Projects—Unequal Lives, Constant but Unequal Cash Flows, Unequal Investments

The second illustration of conflicting rankings again compares the software and training programs but with a new set of assumptions. The cost of capital is still assumed to be 9 percent. The facts now reflect different lives and different investment and annual cash flows.

	Software	Training Program
Investment	$800,000	$591,500
Annual after-tax cash flows	210,000	110,000
Asset life	5 years	8 years

The time lines for the two investments are as follows:

Software (000s)

End of period	0	1	2	3	4	5
Inflows		+210	+210	+210	+210	+210
Outflow	(800)					

Training Program (000s)

End of period	0	1	2	3	4	5	6	7	8
Inflows		+110	+110	+110	+110	+110	+110	+110	+110
Outflow	(591.5)								

The net present value, profitability index, and internal rate of return are calculated for each investment, and the calculated results are shown in Exhibit 14–12. If the net present value or profitability index method is used, the training program would be selected by eRAGs. If the internal rate of return method is used to choose between the two projects, the software appears to be the better investment.

EXHIBIT 14–12

Multiple Projects; Conflicting Rankings

SOFTWARE

Cash Flow	Time	Amount	Discount Factor	Present Value
Investment	t_0	$(800,000)	1.0000	$(800,000)
Annual inflows	t_1–t_5	210,000	3.8897	816,837
Net Present Value				$ 16,837

PI = $816,837 ÷ $800,000 = 1.02

IRR factor = $800,000 ÷ $210,000 = 3.8095 (annuity for 5 periods)

The IRR is approximately 9.81%; calculator computations verify this finding.

TRAINING PROGRAM

Cash Flow	Time	Amount	Discount Factor	Present Value
Investment	t_0	$(591,500)	1.0000	$(591,500)
Annual inflows	t_1–t_8	110,000	5.5348	608,828
Net Present Value				$ 17,328

PI = $608,828 ÷ $591,500 = 1.03

IRR factor = $591,500 ÷ $110,000 = 5.3773 (annuity for 5 periods)

The IRR is approximately 9.78%; calculator computations verify this finding.

Rankings using the internal rate of return are misleading because of the reinvestment assumption. The IRR method assumes that the cash inflows of $210,000 each year from the software investment will be reinvested at a rate of 9.81 percent; the $110,000 of cash flows from the training program are assumed to be reinvested at 9.78 percent. The NPV method, however, assumes reinvestment of the cash flows at the cost of capital of 9 percent, which is a more reasonable rate of return. The NPV computations show the training program to be the better investment.

A formal method is available for choosing the better investment. For eRAGs' management to select the better investment, the difference in the annual cash flows between the software and training program investments must first be determined. The cash flow differences are then evaluated as if they resulted from a separate investment opportunity. Because the software package requires a higher investment than the training program, the software package is used as the comparison base. The investment opportunity resulting from the cash flow differences is referred to here as *project difference.* If project difference provides a positive net present value, the software investment is ranked higher than the training program. This higher ranking is assigned because the additional investment required for the software is more than compensated for by the additional cash flows. If project difference shows a negative net present value, the training program is the better investment. The NPV of project difference is negative as shown in Exhibit 14–13 using present value factors from Table 2, Appendix A.

Multiple Projects—Equal Lives, Equal Investments, Unequal Cash Flows

eRAGs' management is interested in two additional projects: a joint venture to develop a new Web site that would market classic comic books and a marketing research study for a large traditional retailer. The research study is somewhat unique in that no payment would be received from the large retailer until the completion of the project. The company's cost of capital and discount rate are 9 percent. This

EXHIBIT 14–13

Net Present Value of Project Difference

NET CASH FLOWS

End of Period	Software	Training Program	Project Difference
0	$(800,000)	$(591,500)	$(208,500)
1	210,000	110,000	+100,000
2	210,000	110,000	+100,000
3	210,000	110,000	+100,000
4	210,000	110,000	+100,000
5	210,000	110,000	+100,000
6	0	110,000	(110,000)
7	0	110,000	(110,000)
8	0	110,000	(110,000)

NET PRESENT VALUE CALCULATION—PROJECT DIFFERENCE

Cash Flow	Time	Amount	Discount Factor	Present Value
Investment	t_0	$(208,500)	1.0000	$(208,500)
Annual inflows	t_1–t_5	100,000	3.8897	388,970
Annual inflow	t_6	(110,000)	0.5963	(65,593)
Annual inflow	t_7	(110,000)	0.5470	(60,170)
Annual inflow	t_8	(110,000)	0.5019	(55,209)
Net Present Value				$ (502)

set of projects illustrates another conflicting ranking situation; the relevant project data follow:

	Joint Venture	Research Study
Investment	$1,000,000	$1,000,000
Life	5 years	5 years
Net cash inflows		
Year 1	$ 360,000	$ 0
Year 2	360,000	0
Year 3	360,000	0
Year 4	360,000	0
Year 5	360,000	2,400,000

Using the same approach as presented in Exhibit 14–13, the following schedule computes a net present value for a project difference between the projects:

Period	Joint Venture	Research Study	Project Difference
0	$(1,000,000)	$(1,000,000)	$ 0
1	360,000	0	360,000
2	360,000	0	360,000
3	360,000	0	360,000
4	360,000	0	360,000
5	360,000	2,400,000	(2,040,000)

NET PRESENT VALUE CALCULATION—PROJECT DIFFERENCE

Cash Flow	Time	Amount	Discount Factor	Present Value
Investment	t_0	$ 0	1.0000	$ 0
Annual inflows	t_1–t_4	360,000	3.2397	1,166,292
Annual outflow	t_5	(2,040,000)	0.6499	(1,325,796)
Net Present Value				$ (159,504)

Because the NPV of project difference is negative, the research study is the preferred investment.

Exhibit 14–14 presents the net present value, profitability index, and internal rate of return computations for these projects. The investment in the joint venture has the higher IRR, but the research study has a higher NPV and PI. The best selection depends on assumptions made about the future reinvestment rate applied to each of the $360,000 cash flows from the joint venture.

Fisher rate

The point of indifference between the two projects occurs when the $360,000 annuity can be discounted at a certain rate (the **Fisher rate**) to equal $2,400,000 discounted for five years at that same rate. That rate is 14.43 percent and is calculated by solving for a discount rate that causes the net present values of the two projects to be equal. If worked manually, repeated trials are used; however, a computer or programmable calculator can be used to find this rate quickly.

For reinvestment rates above 14.43 percent, the joint venture generates a higher net present value. For reinvestment rates below 14.43 percent, the research study is the superior investment.

The preceding situations demonstrate that different capital budgeting evaluation methods often provide different rankings of projects. Because of this possibility, managers should select one primary evaluation method for capital projects. The critical question is whether higher cash flows or a higher rate of return is preferable. The answer is that higher present cash flows are always preferable to higher rates of return.

The net present value method is considered theoretically superior to the internal rate of return in evaluating capital projects for two reasons. First, the reinvestment assumption of the IRR method is less realistic than that of the NPV method. Second, when a project has both positive and negative net annual cash flows

EXHIBIT 14–14

Comparison of Investment Projects

JOINT VENTURE
DISCOUNT RATE = 9%

Cash Flow	Time	Amount	Discount Factor	Present Value
Investment	t_0	$(1,000,000)	1.0000	$(1,000,000)
Annual inflows	t_1–t_5	360,000	3.8897	1,400,292
Net Present Value				$ 400,292

PI = $1,400,292 ÷ $1,000,000 = 1.40

IRR factor = $1,000,000 ÷ $360,000 = 2.7778 (annuity for 5 periods)

The IRR is approximately 23.44%; calculator computations verify this finding.

RESEARCH STUDY
DISCOUNT RATE = 9%

Cash Flow	Time	Amount	Discount Factor	Present Value
Investment	t_0	$(1,000,000)	1.0000	$(1,000,000)
Annual inflows	t_1–t_8	2,400,000	0.6499	1,599,760
Net Present Value				$ 599,760

PI = $1,599,760 ÷ $1,000,000 = 1.60

The IRR is approximately 19.14%; calculator computations verify this finding.

during its life, there is the arithmetic possibility that projects will have multiple internal rates of return.

In addition, the net present value technique measures project results in dollars rather than rates, and dollar results are the objective of investment. To illustrate the problem that could occur by relying solely on the internal rate of return method, consider the following question: As discussed earlier, would a manager rather receive a 100 percent return on a $1 investment or a 10 percent return on a $100 investment? The answer indicates the fallacy of focusing only on rates of return.

Although useful as a measure of evaluation under some circumstances, the profitability index is subject to the same concern as presented in the previous paragraph. Because monetary results are the objective of investments and the PI is expressed as a rate rather than as dollars, it can, if used by itself, lead to incorrect decisions. Taken together with other tools, however, the profitability index is a measure of capital efficiency and can assist decision makers in their financial investment analyses.

RANKING PROJECTS UNDER CAPITAL RATIONING

Managers rank capital projects to select those projects providing the greatest return on company investment. A company often finds that it has the opportunity to invest in more acceptable projects than it has money. In fact, most companies operate under some measure of **capital rationing**, which means that there is an upper dollar constraint on the amount of capital available to commit to capital asset acquisition.[11] When capital rationing exists, the selection of investment projects must fall

capital rationing

[11] Many publicly traded companies have the luxury of being able to obtain additional capital through new issuances of debt or stock. This possibility may limit the degree to which they are subject to capital rationing but does not eliminate it. Nonpublicly traded companies operate under much more strict rationing of capital resources.

within the capital budget limit. In these circumstances, the NPV model may not produce rankings that maximize the value added to the firm, because it does not consider differences in investment amount.

Capital rationing is illustrated by the following situation. Assume that eRAGs has a capital budget of $7,500,000 and is considering the various investment projects listed in Exhibit 14–15. By all quantitative measures except NPV, Project 1 should be eliminated if the firm has only $7,500,000 available in the capital budget. Its NPV is larger than only Project 2, but deletion of Project 2 will not permit inclusion of any other project. The firm would need $8.1 million to complete all six projects and only $7.5 million is available. Because it does not help to eliminate Project 2, the project that would otherwise produce the smallest company NPV and return based on either the PI or IRR technique (Project 1) should be eliminated. Relatively speaking, Project 2 is of much less interest than Projects 3, 4, 5, and 6. Project 2 does meet minimum quantitative standards though.

Based on PIs, the attractiveness of the projects, in descending order, is 6, 4, 2, 5, and 3. Based on IRRs, the preferences would be 5, 3, 6, 4, and 2. Based on NPVs, the ranking would be 6, 5, 4, 3, and 2.

Although managers should select one primary evaluation technique, the eRAGs example shows that capital project evaluation should not be performed using only one method. Each evaluation tool should be used in conjunction with others, not to the exclusion of others. Each method provides valuable information. Even the nondiscounting technique of payback period can be helpful to management by indicating the quickness of return of investment.

In making their preference decisions, many company managers set ranking categories for projects such as those shown in Exhibit 14–16. Projects are first screened and placed into an appropriate category. Monetary resources are allocated to projects in a top-to-bottom fashion. Within each category, projects are usually ranked using net present value and profitability index techniques. Management's goal should be to select those projects that, within budget constraints, will maximize net present value to the firm. Selecting projects based solely on their internal rate of return rankings without consideration of the net present values may be incorrect.[12]

Regardless of the capital budgeting evaluation techniques used, managers must remember that the results provided are based on estimates of future events. The fact that estimates are involved indicates that a risk is associated with the decision. All project estimates should be carefully understood and analyzed using sound judgment. Capital project proposals are being "sold" by their sponsors using different reasons under different conditions.

EXHIBIT 14–15

Potential Investment Projects

Project	Project Cost	PI	IRR	NPV
1. Product research	$1,000,000	1.15	12%	$ 145,712
2. Computer upgrades	100,000	1.43	17	43,214
3. Employee training	1,200,000	1.41	24	495,888
4. Safety enhancements	1,800,000	1.45	20	801,365
5. Service automation	2,000,000	1.42	24	839,481
6. Purchase patents	2,000,000	1.62	20	1,233,902
Total cost of projects	$8,100,000			

[12] If the set of projects is very large, the selection of projects may require the use of integer programming techniques, which are outside the scope of this text.

EXHIBIT 14–16

Ranking Categories for Capital Projects

CATEGORY 1—REQUIRED BY LEGISLATION

This category would include such items as pollution control equipment that has been mandated by law. Most companies can ill afford the fines or penalties that can be assessed for lack of installation; however, these capital acquisitions may not meet the company's minimum established economic criteria.

CATEGORY 2—ESSENTIAL TO OPERATIONS

This category would include capital assets without which the primary functions of the organization could not continue. This category could include new purchases of capital assets or replacements of broken or no longer usable assets. For example, the purchase of a kiln for a ceramics manufacturer would fall into this category.

CATEGORY 3—NONESSENTIAL BUT INCOME GENERATING

This category would include capital assets that would improve operations of the organization by providing cost savings or supplements to revenue. Robots in an automobile manufacturer would be included in this group.

CATEGORY 4—OPTIONAL IMPROVEMENTS

Items in this category would be those that do not provide any cost savings or revenue increases but would make operations run more smoothly or improve working conditions. The purchase of computer hardware or software that is faster than that currently being used and the installation of a microwave oven in the employees' lounge would be included here.

CATEGORY 5—MISCELLANEOUS

This category exists for "pet projects" that might be requested. Such acquisitions may be more for the benefit of a single individual and not the organization as a whole. Such projects may not even be related to organizational objectives. The installation of new carpeting in a manager's office could be an example of this group of investments. Items in this category will normally be chosen only when the organization has substantial, unencumbered resources at its disposal.

COMPENSATING FOR RISK IN CAPITAL PROJECT EVALUATION

8

How is risk considered in capital budgeting analysis?

When choosing among multiple projects, managers must consider the **risk** or uncertainty associated with each project. In accounting, risk reflects uncertainty about differences between the expected and actual future returns from an investment. For example, the purchase of a $100,000, 10 percent treasury note would provide a virtually risk-free return of $10,000 annually because treasury notes are backed by the full faith and credit of the U.S. government. If the same $100,000 were used to purchase stock, the returns could range from −100 percent (losing the entire investment) to an abnormally high return. The potential for extreme variability makes the stock purchase a much more risky investment than the treasury note.

risk

For Internet companies, one of the key variables to success is getting on-line shoppers to access the companies' sites. One of the important variables influencing shopper traffic is advertising. For Internet companies, advertising is a capital investment—and a risky one. This is illustrated in the News Note on page 628.

http://www.yr.com
http://www.covad.com

Managers considering a capital investment should understand and compensate for the degree of risk involved in that investment. A manager may use three approaches to compensate for risk: the judgmental method, the risk-adjusted discount rate method, and sensitivity analysis. These methods do not eliminate risk, but they do help managers understand and evaluate risk in the decision-making process.

NEWS NOTE GENERAL BUSINESS

Advertising—How Much Is Enough?

Dustin Grosse is sitting on the edge of his seat in a conference room at the ad agency Young & Rubicam in San Francisco. Grosse is the brand manager for Covad, a Silicon Valley company that sells high-speed access to the Internet, and he is about to review Y&R's final cuts of two television commercials. They will be the centerpiece of a $40 million, yearlong, coast-to-coast marketing campaign designed to trumpet little-known Covad as a broadband leader. A lot is at stake, especially when you consider that Covad's sales for the past 12 months totaled just over $20 million, or half its marketing budget.

Most net firms have wielded wacky, even dark humor to set themselves apart. Outpost.com showed gerbils shooting out from a cannon, while one Beyond.com ad features a buck-naked man working at home via the Net. Covad flirted with off-the-wall stuff, but Bob Roblin, Covad's executive vice president, believes milder comedy will appeal more to a mainstream audience.

If Roblin is right, the upside for Covad could be enormous. Beyond reaching consumers and businesses, Covad's campaign must make a big splash with Internet service providers. Covad is a wholesaler, with no direct retail relationship with its customers. If the campaign stimulates a groundswell of demand for Covad DSL, more ISPs will be driven to seek a partnership with the access provider which will boost the top line, thus achieving the ultimate, measurable goal of all the advertising.

SOURCE: Edward Robinson, "The $20 Million Company . . . and Its $40 Million Ad Campaign," *Fortune* (November 8, 1999), pp. 315–316. © 1999 Time Inc. Reprinted by permission.

Judgmental Method

judgmental method

The **judgmental method** of risk adjustment allows the decision makers to use logic and reasoning to decide whether a project provides an acceptable rate of return in relation to its risk. The decision maker is presented with all available information for each project, including the payback period, NPV, PI, and IRR. After reviewing the information, the decision maker chooses from among acceptable projects based on personal judgment of the risk-to-return relationship. The judgmental approach provides no formal process for adjusting data for the risk element.

Risk-Adjusted Discount Rate Method

risk-adjusted discount rate method

A more formal method of taking risk into account requires making adjustments to the discount or hurdle rate. Under the **risk-adjusted discount rate method**, the decision maker increases (decreases) the rate used for discounting future cash inflows (outflows) to compensate for increased risk. As the discount rate is increased (decreased), the present values of the cash flows are reduced (increased). Therefore, larger cash inflows are required to "cover" the investment and provide an acceptable rate of return. Changes in the discount rate should be reflective of the degree of cash flow variability and timing, other investment opportunities, and corporate objectives. If the internal rate of return is being used for project evaluation, the risk-adjusted discount rate method would increase the hurdle rate against which the IRR is compared for higher risk projects.

Assume that the management of eRAGs is considering developing a new Internet service. The company would operate the service for 10 years and then sell it at the end of those 10 years. Estimates of the development cost and annual cash flows for the service are as follows:

Initial development cost	$1,500,000
After-tax net cash flows	
Years 1–5	200,000
Years 6–10	300,000
Year 10 (sale)	600,000

eRAGs management uses its 9 percent cost of capital as the discount rate in evaluating capital projects under the NPV method. However, Pierre Stellar, a board member, feels that above-normal risk is created in this endeavor by two factors. First, revenues realized through service fees may differ from those planned. Second, the market value of the service in 10 years may vary substantially from the estimate of $600,000.

Mr. Stellar wants to compensate for these risk factors by using a 15 percent discount rate rather than the 9 percent cost of capital rate. Determination of the amount of adjustment to make to the discount rate (from 9 to 15 percent, for example) is most commonly an arbitrary one. Thus, even though a formal process is used to compensate for risk, the process still involves a degree of judgment on the part of the project evaluators. Exhibit 14–17 presents the NPV computations using both discount rates. When the discount rate is adjusted upward, the NPV of the project is lowered and, in this case, shows the project to be unacceptable.

The same type of risk adjustment can be used for payback period or accounting rate of return (Appendix 2). If the payback method is being used, managers may choose to shorten the maximum allowable payback period to compensate for increased risk. This adjustment assumes that cash flows occurring in the more distant future are more risky than those occurring in the near future. If the accounting rate of return (ARR) method is used, managers may increase the preestablished acceptable rate against which the ARR is compared to compensate for risk. Another way in which risk can be included in the decision process is through the use of sensitivity analysis.

Sensitivity Analysis

sensitivity analysis

Sensitivity analysis is a process of determining the amount of change that must occur in a variable before a different decision would be made. In a capital budgeting situation, the variable under consideration could be the discount rate, annual net cash flows, or project life. Sensitivity analysis looks at this question: What if a variable is different from that originally expected?

Except for the initial purchase price, all information used in capital budgeting is estimated. Use of estimates creates the possibility of introduction of errors, and sensitivity analysis identifies an "error range" for the various estimated values over

EXHIBIT 14–17

Product Development Evaluation

NPV USING 9% DISCOUNT RATE

Cash Flow	Time	Amount	Discount Factor	Present Value
Investment	t_0	$(1,500,000)	1.0000	$(1,500,000)
Annual inflows	t_1–t_5	200,000	3.8897	777,940
Annual inflows	t_1–t_6	300,000	2.5280	758,400
Final inflow	t_6	600,000	0.4224	253,440
Net Present Value				$ 289,780

NPV USING 15% DISCOUNT RATE

Cash Flow	Time	Amount	Discount Factor	Present Value
Investment	t_0	$(1,500,000)	1.0000	$(1,500,000)
Annual inflows	t_1–t_5	200,000	3.3522	670,440
Annual inflows	t_1–t_6	300,000	1.6666	499,980
Final inflow	t_6	600,000	0.2472	148,320
Net Present Value				$ (181,260)

which the project will still be acceptable. The following sections consider how sensitivity analysis relates to the discount rate, cash flows, and life of the asset.

RANGE OF THE DISCOUNT RATE

A capital project providing a rate of return equal to or greater than the discount or hurdle rate is considered an acceptable investment. But returns from a project are not certain because, for instance, the cost of capital may increase due to increases in interest rates on new issues of debt. Sensitivity analysis allows a company to determine what increases may occur in the estimated cost of capital before a project becomes unacceptable. The upper limit of increase in the discount rate is the project's internal rate of return. At the IRR, a project's net present value is zero; therefore, the present value of the cash inflows equals the present value of cash outflows. As long as the IRR for a project is equal to or above the cost of capital, the project will be acceptable.

To illustrate use of sensitivity analysis, eRAGs's Internet site investment project (Situation A), analyzed earlier in Exhibit 14–7 using an 11 percent discount rate, is reconsidered:

After-tax cash flows for 10 years discounted at 11% (93,200 × 5.8892)	$548,873
Initial investment	(540,000)
NPV	$ 8,873

The project provides a positive net present value and is considered an acceptable investment candidate.

The eRAGs management team wants to know how high the discount rate can rise before the project would become unacceptable. To find the upper limit of the discount rate, the present value factor for an annuity of 10 periods at the unknown interest rate is computed as follows:

$$\text{Cash flow} \times \text{PV factor} = \text{Investment}$$
$$\$93{,}200 \times \text{PV factor} = \$540{,}000$$
$$\text{PV factor} = 5.7940$$

Using the PV factor, the IRR is found to be 11.39 percent. As long as eRAGs' cost of capital is less than or equal to 11.39 percent, this project will be acceptable. As the discount rate is increased toward the project's IRR, the project becomes less desirable. These calculations assume that the cash flows and project life have been properly estimated.

RANGE OF THE CASH FLOWS

Another factor sensitive to changes in estimation is the investment's projected cash flows. eRAGs' data for the Internet site investment project from Exhibit 14–7 (Situation A) are also used to illustrate how to determine the range of acceptable cash flows. Company management wants to know how small the net cash inflows can be and still have the project remain desirable. This determination requires that the present value of the cash flows for 10 periods, discounted at 11 percent, be equal to or greater than the investment cost. The PV factor for 10 periods at 11 percent is 5.8892. The equation from the preceding section can be used to find the lowest acceptable annuity:

$$\text{Cash flow} \times \text{PV factor} = \text{Investment}$$
$$\text{Cash flow} \times 5.8892 = \$540{,}000$$
$$\text{Cash flow} = \$540{,}000 \div 5.8892$$
$$\text{Cash flow} = \$91{,}693$$

As long as the net annual cash flow equals or exceeds $91,693, the Internet site project will be financially acceptable.

RANGE OF THE LIFE OF THE ASSET

Asset life is related to many factors, some of which, like the quantity and timing of maintenance on equipment, are controllable. Other factors, such as technological advances and actions of competitors, are noncontrollable. An error in the estimated life will change the number of periods from which cash flows are to be derived. These changes could affect the accept/reject decision for a project. The eRAGs Internet site example is used to demonstrate how to find the minimum length of time the cash flows must be received from the project for it to be acceptable. The solution requires setting the present value of the cash flows discounted at 11 percent equal to the investment. This computation yields the PV factor for an unknown number of periods:

$$\text{Cash flow} \times \text{PV factor} = \text{Investment}$$
$$\$93{,}200 \times \text{PV factor} = \$540{,}000$$
$$\text{PV factor} = 5.7940$$

Review the present value of an annuity table in Appendix A under the 11 percent interest column to find the 5.7940 factor. The project life is approximately 9 years and 9 months.[13] If the project cash flows were to stop at any point before 9 years and 9 months, the project would be unacceptable.

Sensitivity analysis does not reduce the uncertainty surrounding the estimate of each variable. It does, however, provide management with a sense of the tolerance for estimation errors by providing upper and lower ranges for selected variables. The above presentation simplistically focuses on single changes in each of the variables. If all factors change simultaneously, the above type of sensitivity analysis is useless. More advanced treatments of sensitivity analysis, which allow for simultaneous ranging of all variables, can be found under the topic of simulation in an advanced mathematical modeling text.

POSTINVESTMENT AUDIT

9

How and why should management conduct a postinvestment audit of a capital project?

postinvestment audit

In a **postinvestment audit** of a capital project, information on actual project results is gathered and compared to expected results. This process provides a feedback or control feature to both the persons who submitted and those who approved the original project information. Comparisons should be made using the same technique or techniques used originally to determine project acceptance. Actual data should be extrapolated to future periods where such information would be appropriate. In cases where significant learning or training is necessary, start-up costs of the first year may not be appropriate indicators of future costs. Such projects should be given a chance to stabilize before making the project audit.

As the size of the capital expenditure increases, a postinvestment audit becomes more crucial. Although an audit cannot change a past investment decision, it can pinpoint areas of project operations that are out of line with expectations so that problems can be corrected before they get out of hand.

Secondarily, an audit can provide feedback on the accuracy of the original estimates for project cash flows. Sometimes, project sponsors may be biased in favor of their own projects and provide overly optimistic forecasts of future revenues or cost savings. Individuals providing unrealistic estimates should be required to explain all major variances. Knowing that postinvestment audits will be made may cause project sponsors to provide realistic cash flow forecasts in their capital requests.

[13] This solution was found by interpolating.

Performing a postinvestment audit is not an easy task. The actual information may not be in the same form as were the original estimates, and some project benefits may be difficult to quantify. Project returns fluctuate considerably over time, so results gathered at a single point may not be representative of the project. But, regardless of the difficulties involved, postinvestment audits provide management with information that can help to make better capital investment decisions in the future.

REVISITING

Amazon.com

http://www.amazon.com

Amazon.com is the bellwether of the big Internet retailers. Many Internet investors are looking at Amazon.com to see the future of the battle between traditional retail sales and Internet retailing.

There is a tremendous amount of wealth at stake along with Amazon's future. Although its sales are meager compared to any of the nation's major retailers, its market value eclipses nearly all of them. For example, in 1999 its market cap was twice as big as that of Sears, five times bigger than Kmart's, 17 times bigger than Barnes & Nobles.

How will the Amazon story end? Will it win the race? Conquer the world? Bezos himself isn't sure. "I don't want to give the impression that our future success is assured. I believe the opposite. I believe our future success is not assured," he says, adding with a grin, "If you look at the history of pioneers, it's not good." He even seems fascinated by his own cliffhanger. Everywhere he goes, Bezos carries a small digital camera. "I try to take at least one picture a day so that I'll have some hope 50 years from now of reconstructing my life."

Right now, there seem to be two possible conclusions to the Amazon story. Ending No. 1 goes like this: In ten years Amazon becomes so huge, so omnipresent, that it will be hard to imagine that it started out as a tiny bookseller way back in 1995. Ending No. 2, equally believable: Amazon is undone by its own ambitions and winds up as a footnote in the history of business. In the meantime, Amazon watchers await the next big move.

SOURCE: Katrina Brooker, "Amazon vs. Everybody," *Fortune* (November 8, 1999), pp. 120–128. © 1999 Time Inc. Reprinted by permission.

CHAPTER SUMMARY

Capital budgeting is concerned with evaluating long-range projects involving the acquisition, operation, and disposition of one or more capital assets. Various criteria are employed to evaluate potential projects. Among the financial criteria used are payback period, net present value (NPV), profitability index (PI), and internal rate of return (IRR).

The payback period is the length of time needed for a firm to recoup its investment from the cash inflows of a project. If a project's payback period is less than a preestablished maximum, the project is acceptable. This method ignores the time value of money and all cash flows beyond the payback period.

Net present value, profitability index, and internal rate of return are discounted cash flow methods. As such, these methods require management to discount a project's cash inflows and outflows using a desired rate of return. The minimum rate at which the discount rate should be set is the cost of capital. Managers may compensate for a project's above-normal risk by using a discount rate that is higher than the cost of capital.

Under the NPV method, the total present value of future cash flows is reduced by the current investment to derive the net present value. If the NPV is equal to

or greater than zero, the project provides a rate of return equal to or greater than the discount rate. A nonnegative NPV makes the project acceptable for investment.

The profitability index equals the present value of the net cash flows divided by the investment cost. The profitability index is considered an indicator of the company's efficiency in its use of capital. Revenue-producing projects should have a PI of 1.00 or more.

The internal rate of return method computes the rate of return expected on the investment project. The IRR is equal to the discount rate at which the net present value of all cash flows equals zero. If the internal rate of return of a project exceeds management's desired hurdle rate, the project is acceptable.

Each capital project evaluation technique is based on certain assumptions and, therefore, has certain limitations. To compensate for these limitations, managers subject capital projects to more than one evaluation technique.

Depreciation expense and changes in tax rates affect after-tax cash flows. The tax rates and allowable depreciation methods estimated when the investment is analyzed may not be the same as when the project is implemented. Such changes can cause a significant difference in the actual net present value and internal rate of return amounts from those originally estimated on the project.

Management should select investment projects that will help to achieve the organization's objectives and provide the maximum return on capital resources utilized. The company must determine whether the activities in which it wishes to engage are worthy of an investment and which assets can be used for those activities. Then, decisions must be made about the best investment to accept from those available. These decisions require that investment projects be ranked as to their desirability in relationship to one another.

Often the NPV, PI, and IRR computations will produce the same rankings of multiple investment projects. In some situations, however, the NPV, PI, and IRR methods produce different project rankings. The primary reason for differences is the underlying assumption of each method regarding the reinvestment rate of cash flows released during the life of the project. The NPV and PI methods assume reinvestment at the discount rate, whereas the IRR method assumes reinvestment at the internal rate of return provided by the project. The assumption of the NPV and PI methods is more likely to be realized than that of the IRR method.

Capital rationing indicates that management has imposed a spending limit in the capital budget. When capital rationing exists, the NPV model may provide the best first-cut ranking of projects in which the returns to the firm will be maximized. Projects can also be listed in descending order of their PI and IRR rates of return. Only projects having an IRR in excess of the weighted average cost of capital should be considered and then only to the extent of the budget. In addition, managers need to consider legal requirements as well as the goals and objectives of the firm when ranking projects. Categorization of projects is a useful way to rank investments.

Different risks can be associated with each capital project. Risk is defined as uncertainty about the expected returns from an asset. Project risk can be assessed and included in decision making judgmentally, or more formally, by calculating a risk-adjusted discount/hurdle rate. Sensitivity analysis can also be employed to compensate for risk by calculating a range for each of the variables (discount rate, cash flows, and life of project) in a capital budgeting problem. Sensitivity analysis assists management in determining the effect on project outcome of a change in the estimate of one or more of the critical variables in deriving the accept/reject conclusion about the project.

After a capital project is accepted and implemented, a postinvestment audit should be undertaken to compare actual results with expected results. The audit will help managers identify and correct any problems that may exist, evaluate the accuracy of estimates used for the original investment decision, and help improve the forecasts of future investment projects.

APPENDIX 1

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How are present values calculated?

Time Value of Money

future value

The time value of money can be discussed in relationship to either its future or its present value. **Future value** (FV) refers to the amount to which a sum of money invested at a specified interest rate will grow over a specified number of time periods. Present value (PV) is the amount that future cash flows are worth currently, given a specified rate of interest.[14] Thus, future and present values depend on three things: (1) amount of the cash flow, (2) rate of interest, and (3) timing of the cash flow. Only present values are discussed in this appendix because they are most relevant to the types of management decisions discussed in this text.

Future and present values are related. A present value is a future value discounted back the same number of periods at the same rate of interest. The rate of return used in present value computations is called the discount rate.

simple interest
compound interest

In computing future and present values, simple or compound interest may be used. **Simple interest** means that interest is earned only on the original investment or principal amount. **Compound interest** means that interest earned in prior periods is added to the original investment so that, in each successive period, interest is earned on both principal and interest. The time between each interest computation is called the **compounding period**. The more often interest is compounded, the higher is the actual rate of interest being received relative to the stated rate. The following discussion is based on use of compound interest, because most transactions use this method.

compounding period

Interest rates are typically stated in annual terms. To compensate for more frequent compounding periods, the number of years is multiplied by the number of compounding periods per year and the annual interest rate is divided by the number of compounding periods per year.

Present Value of a Single Cash Flow

Assume that Charlotte Moore's bank pays interest at 10 percent per year. Charlotte wants to accumulate $30,000 in five years to attend graduate school and wants to know what amount to invest now to achieve that goal. The formula to solve for the present value is

$$PV = \frac{FV}{(1 + i)^n}$$

where
PV = present value of a future amount
FV = future value of a current investment
i = interest rate per compounding period
n = number of compounding periods

Substituting known values into the formula gives the following:

$$PV = \frac{\$30{,}000}{(1 + 0.10)^5}$$

$$PV = \frac{\$30{,}000}{1.61}$$

$$PV = \$18{,}634$$

[14] Interest can be earned or owed, received or paid. To simplify the discussion for definitional purposes, the topic of interest is viewed only from the inflow standpoint.

In capital budgeting analyses, many future value amounts need to be converted to present values. Rather than using the formula $[1 \div (1 + i)^n]$ to find PVs, a table of factors for the present value of $1 (Table 1) for a variety of "i" and "n" values is provided in Appendix A at the end of the text for ease of computation. Such factors are also available in programmable calculators, making the use of tables unnecessary.

Present Value of an Annuity

An annuity is a cash flow (either positive or negative) that is repeated over consecutive periods. For an **ordinary annuity**, the first cash flow occurs at the end of each period. In contrast, the cash flows for an **annuity due** occur at the beginning of each period.

ordinary annuity
annuity due

To illustrate the computation of the present value of an annuity, consider the following situation. Judy and Jerry Jamison are planning for their daughter's college education. Their daughter, Janice, will need $20,000 per year for the next four years. The Jamison's want to know how much to invest currently at 8 percent so that Janice can withdraw $20,000 per year. The following diagram presents the situation:

Time period	t_0	t_1	t_2	t_3	t_4
Future value		$20,000	$20,000	$20,000	$20,000
Present value	?				

The present value of each single cash flow can be found using 8 percent factors in Table 1 as follows:

PV of first receipt: $20,000 × 0.9259	$18,518
PV of second receipt: $20,000 × 0.8573	17,146
PV of third receipt: $20,000 × 0.7938	15,876
PV of fourth receipt: $20,000 × 0.7350	14,700
Total present value of future cash flows	$66,240

The present value factor for an ordinary annuity can also be determined by adding the present value factors for all periods having a future cash flow. Table 2 in Appendix A provides present value of ordinary annuity factors for various interest rates and time periods. From this table, the factor of 3.3121 can be obtained and multiplied by $20,000 to yield $66,242, or approximately the same result as above. (The difference is caused by decimal-fraction rounding.)

APPENDIX 2

Accounting Rate of Return

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What are the advantages and disadvantages of the accounting rate of return method?

accounting rate of return

The **accounting rate of return** (ARR) measures the rate of earnings obtained on the average capital investment over a project's life. This evaluation method is consistent with the accounting model and uses profits shown on accrual-based financial statements. It is the one evaluation technique that is not based on cash flows. The formula to compute the accounting rate of return is

$$\text{ARR} = \text{Average Annual Profits from Project} \div \text{Average Investment in Project}$$

Investment refers to project cost as well as any other costs needed for working capital items (such as inventory) for project support. Investment cost, salvage value, and working capital released at the end of the project's life are summed and divided

by 2 to obtain the average investment over the life of the project.[15] The cost and working capital needed represent the initial investment and the salvage value and working capital released represent the ending investment.

The following information pertains to a new service line being considered by eRAGs. The information is used to illustrate after-tax calculation of the ARR.

Beginning investment:	
Initial cost of equipment and software	$80,000
Additional working capital needed for the service line	40,000
Return over life of project:	
Average increase in profits after taxes	20,000
Return at end of project:	
Salvage value of equipment and software in 10 years (end of life of project)	8,000
Working capital released at the end of 10 years	40,000

Solving the formula for the accounting rate of return gives

$$\begin{aligned} \text{ARR} &= \$20{,}000 \div [(\$120{,}000 + \$48{,}000) \div 2] \\ &= \$20{,}000 \div \$84{,}000 \\ &= \underline{\underline{23.81\%}} \end{aligned}$$

The 23.81 percent ARR on this project can be compared with a preestablished hurdle rate set by management. This hurdle rate may not be the same as the desired discount rate because the data used in calculating the accounting rate of return do not represent cash flow information. The ARR hurdle rate may be set higher than the discount rate because the discount rate automatically compensates for the time value of money. In addition, the 23.81 percent ARR for this project should be compared with ARRs on other projects under investment consideration by the RAGs to see which projects have the higher accounting rates of return.

KEY TERMS

accounting rate of return (p. 635)
annuity (p. 605)
annuity due (p. 635)
capital asset (p. 601)
capital budgeting (p. 601)
capital rationing (p. 625)
cash flow (p. 602)
compound interest (p. 634)
compounding period (p. 634)
cost of capital (p. 606)
discount rate (p. 606)
discounting (p. 606)
financing decision (p. 603)
Fisher rate (p. 624)
future value (p. 634)
hurdle rate (p. 611)
independent project (p. 619)
internal rate of return (p. 609)
investment decision (p. 603)
judgmental method (of risk adjustment) (p. 628)
mutually exclusive project (p. 619)
mutually inclusive project (p. 619)
net present value (p. 607)
net present value method (p. 607)
ordinary annuity (p. 635)
payback period (p. 604)
postinvestment audit (p. 631)
preference decision (p. 618)
present value (p. 606)
profitability index (p. 608)
reinvestment assumption (p. 620)
return of capital (p. 606)
return on capital (p. 606)
risk (p. 627)
risk-adjusted discount rate method (p. 628)
screening decision (p. 618)

[15] Sometimes ARR is computed using initial cost rather than average investment as the denominator. Such a computation ignores the return of funds at the end of the project life and is less appropriate than the computation shown.

sensitivity analysis (p. 629)
simple interest (p. 634)
tax benefit (of depreciation) (p. 612)
tax shield (of depreciation) (p. 612)
time line (p. 603)

SOLUTION STRATEGIES

Prepare a time line to illustrate all moments in time when cash flows are expected. The discount rate used should be the cost of capital.

Payback Period

1. For projects with an equal annual cash flow:

$$\text{Payback Period} = \text{Investment} \div \text{Annuity}$$

2. For projects with unequal annual cash flows:

Sum the annual cash flows until investment is reached to find payback period.

If payback period is equal to or less than a preestablished maximum number of years, the project is acceptable.

Net Present Value

− Investment made currently (always valued at a factor of 1.000)
+ PV of future cash inflows or cost savings
− PV of future cash outflows
= NPV

If NPV is equal to or greater than zero, the project is expected to return a rate equal to or greater than the discount rate and the project is acceptable.

Profitability Index

+ PV of future cash inflows or cost savings
− PV of future cash outflows
= PV of net cash flows

$$\text{PI} = \frac{\text{PV of Net Cash Flows}}{\text{PV of Net Investment}}$$

If PI is 1.00 or greater, the project is expected to return a rate equal to or greater than the discount rate and the project is acceptable.

Internal Rate of Return

1. *For projects with equal annual cash flows:*

$$\text{PV Factor} = \frac{\text{Net Investment}}{\text{Annuity}}$$

Find the PV factor (or the one closest to it) in the table on the row for the number of periods of the cash flows. The percentage at the top of the column where this factor is found will approximate the IRR. (*Note:* For projects with equal annual cash flows, this factor is also equal to the payback period.)

2. *For projects with unequal annual cash flows:* Make an estimate of rate provided by project; compute NPV. If NPV is positive (negative), try a higher (lower) rate until the NPV is zero.

Compare IRR to the discount or preestablished hurdle rate. If the IRR equals or is greater than the hurdle rate, the project is acceptable.

Tax Benefit of Depreciation = Depreciation Amount × Tax Rate

Accounting Rate of Return

ARR = Average Annual Profits from Project ÷ Average Investment in Project

Average Investment = (Beginning Investment + Recovery of Investment at End of Project Life) ÷ 2

Compare calculated ARR to hurdle ARR. If the calculated ARR is equal to or greater than the hurdle ARR, the project is acceptable.

Basic Concepts of Capital Budgeting Techniques

	Payback	NPV	PI	IRR	ARR
Uses time value of money?	No	Yes	Yes	Yes	No
Specifies a rate of return?	No	No	No	Yes	Yes
Uses cash flows?	Yes	Yes	Yes	Yes	No
Considers returns during life of project?	No	Yes	Yes	Yes	Yes
Uses discount rate in calculation?	No	Yes	Yes	No*	No*

*Discount rate is not used in the calculation, but it may be used as the hurdle rate.

DEMONSTRATION PROBLEM

Chesapeake Chandlery is considering the development of on-line sales of its boating products. The necessary inventory and distribution capabilities are already in place; however, the company would invest $800,000 to develop the necessary on-line storefront. The investment would have an expected economic life of six years with an expected salvage value of $25,000 at the end of its life.

At the end of the fourth year, the firm anticipates it would spend $80,000 for on-line advertising and updating of its Web site. This amount would be fully deductible for tax purposes in the year incurred. Management requires that investments of this type be recouped in four years or less. The pretax increase in income is expected to be $175,000 in each of the first four years and $132,000 in each of the next two years. The company's discount rate is 10 percent; its tax rate is 30 percent; and the investment would be depreciated for tax purposes using the straight-line method with no consideration of salvage value over a period of five years.

Required:

a. Prepare a time line for displaying cash flows. Be certain to consider the effects of taxes.
b. Calculate the after-tax payback period.
c. Calculate the after-tax net present value on the project.
d. Discuss the appropriateness of making such an investment.

Solution to Demonstration Problem

a.

End of period	0	1	2	3	4	5	6
Investment	−$800,000						
Operating inflows[1]		$122,500	$122,500	$122,500	$122,500	$92,400	$92,400
Depreciation[2]		48,000	48,000	48,000	48,000	48,000	
Operating outflows[3]					−56,000		
Salvage value[4]							17,500

[1]$175,000 × (1 − 0.30) = $122,500
$132,000 × (1 − 0.30) = $92,400
[2]($800,000 ÷ 5) × 0.30 = $48,000
[3]$80,000 × (1 − 0.30) = $56,000
[4]$25,000 × (1 − 0.30) = $17,500
Note that all proceeds received from the sale of the equipment are taxable because the entire cost of the equipment was depreciated. Expected salvage value is ignored in computing depreciation deductions for tax purposes.

b.

Year	Annual Flow	Cumulative Flow
0	$(800,000)	$(800,000)
1	170,500	(629,500)
2	170,500	(459,000)
3	170,500	(288,500)
4	114,500	(174,000)
5	140,400	(33,600)
6	109,900	76,300

The payback is complete in 5.31 years or in April in the last year. The portion of the sixth year (0.31) required to complete the payback is equal to $33,600 ÷ $109,900.

c.

Cash Flow	Time	Amount	Discount Factor	Present Value
Investment	t_0	$(800,000)	1.0000	$(800,000)
Annual flow	t_1–t_3	170,500	2.4869	424,016
Annual flow	t_4	114,500	0.6830	78,204
Annual flow	t_5	140,400	0.6209	87,174
Annual flow	t_6	109,900	0.5645	62,039
Net present value				$ 148,567

d. The project is unacceptable based on the payback period and fails to qualify based on the NPV criterion as well. Accordingly, from strictly a financial perspective, the project is not acceptable. However, nonquantitative factors must be considered. These factors may include effects on competitive position and ability to adopt future technological advances.

QUESTIONS

1. What is a capital asset? How is it distinguished from other assets?
2. Why do firms use multiple criteria when evaluating potential capital investments?
3. Why do capital budgeting evaluation methods use cash flows rather than accounting income?
4. Why are cash flows related to financing not included in evaluating a capital project?
5. Why are time lines helpful in evaluating capital projects?
6. What does the payback method measure? What are its major weaknesses?
7. Why is the time value of money important in capital budgeting? Which evaluation methods use this concept? Which do not?
8. Differentiate between a return *of* capital and a return *on* capital.

9. What is measured by the net present value of a potential project? If the net present value of a project equals zero, is it an acceptable project? Explain.
10. Will the NPV amount determined in the capital budgeting process be the same amount as that which actually occurs after a project is undertaken? Why or why not?
11. How is the profitability index related to the NPV method? What does the PI measure?
12. Under what circumstance will the PI exceed 1? Discuss the rationale for your answer.
13. What is measured by the internal rate of return? When is a project considered acceptable using this method?
14. What is the relationship between NPV and IRR? Why does this relationship hold true?
15. Depreciation does not represent a cash flow. Why, then, is it important in capital budgeting evaluation techniques that use discounted cash flows?
16. What is the difference between the tax shield of depreciation and the tax benefit of depreciation?
17. What are four questions that managers should ask when choosing the investment proposals to be funded?
18. How would managers rank projects using each of the following methods: net present value, profitability index, internal rate of return, payback period, and accounting rate of return?
19. Why should managers use several techniques to rank capital projects? Which technique should be used as the primary evaluator and why?
20. Why does capital rationing exist, and how do managers consider it when ranking capital projects?
21. How is risk defined in capital budgeting analysis? List several aspects of a project in which risk is involved and how risk can affect the net present value of a project.
22. How is sensitivity analysis used in capital budgeting?
23. Why are postinvestment audits performed? When should they be performed?
24. *(Appendix 1)* What is meant by the term *time value of money?* Why is a present value always less than the future value to which it relates?
25. *(Appendix 1)* How does an annuity differ from a single cash flow?
26. *(Appendix 2)* How is the accounting rate of return computed? How does this rate differ from the discount rate and the internal rate of return?

EXERCISES

27. *(Terminology)* Match the numbered item on the right with the lettered item on the left.

a. Annuity	**1.** A measure of the time that will elapse until an initial investment is recouped.
b. Cost of capital	**2.** A decision regarding what type of capital will be used to fund an investment.
c. Financing decision	**3.** A cash flow that is repeated in consecutive periods.
d. Investment decision	**4.** Present value of cash inflows less present value of cash outflows.
e. Judgmental method	**5.** A method of evaluating risk.
f. Mutually exclusive projects	**6.** A decision in which accepting one project requires acceptance of another.
g. Mutually inclusive projects	
h. Net present value	
i. Payback period	
j. Present value	

7. A future amount that has been discounted to the present.
8. A decision in which the acceptance of one project implies the rejection of others.
9. A decision about which assets a firm will acquire.
10. The discount rate often used in investment analysis.

28. *(Terminology)* Match the numbered item on the right with the lettered item on the left.

a. Capital asset
b. Compound interest
c. Discount rate
d. Future value
e. Hurdle rate
f. Internal rate of return
g. Profitability index
h. Return of capital
i. Return on capital
j. Risk

1. Effect of uncertainty.
2. Recapture of the original investment.
3. Sum plus its accumulated interest.
4. Interest earned on interest.
5. Discount rate that causes the NPV to equal $0.
6. Benchmark for evaluating the internal rate of return on a project.
7. Rate used to find the present value of a future amount.
8. Interest.
9. Long-lived asset.
10. Derivation of NPV used to compare projects of unequal size.

29. *(Payback period)* Cimarron Manufacturing is considering the purchase of new production technology. The new technology would require an initial investment of $750,000 and have an expected life of 10 years. At the end of its life, the equipment would have no value. By installing the new equipment, the firm's annual labor and quality costs would decline by $150,000.

a. Compute the payback period for this investment (ignore tax).
b. Assume, now, that the annual cost savings would vary according to the following schedule:

	Annual Cost Savings
Years 1–5	$ 75,000
Years 6–10	100,000

Compute the payback period under the revised circumstances (ignore tax).

30. *(Payback)* John's Clothing Store is considering a new product line: umbrellas and rain gear. The new product line would require an investment of $20,000 in equipment and fixtures and $40,000 in working capital. Store managers expect the following pattern of net cash inflows from the new product line over the life of the investment.

Year	Amount
1	$ 5,000
2	9,000
3	16,000
4	18,000
5	15,000
6	14,000
7	12,000

a. Compute the payback period for the proposed new product line. If John's requires a four-year pretax payback on its investments, should the company invest in the new product line? Explain. *(continued)*

b. Should John's use any other capital project evaluation methods before making an investment decision? Explain.

31. *(NPV)* Seattle Fish Processing Company is considering the installation of an automated product handling system. The initial cost of such a system would be $400,000. This system would generate labor cost savings over its 10-year life as follows:

Years	Annual Labor Cost Savings
1–2	$70,000
3–5	85,000
6–8	86,400
9–10	62,000

The system will have no salvage at the end of its 10-year life, and the company uses a discount rate of 12 percent. What is the pretax net present value of this potential investment?

32. *(NPV)* Atlanta Industrial has been approached by one of its customers about producing 400,000 special-purpose parts for a new farm implement product. The parts would be required at a rate of 50,000 per year for eight years. To provide these parts, Atlanta Industrial would need to acquire several new production machines. These machines would cost $500,000 in total. The customer has offered to pay Atlanta Industrial $50 per unit for the parts. Managers at Atlanta Industrial have estimated that, in addition to the new machines, the company would incur the following costs to produce each part:

Direct labor	$ 8
Direct material	10
Variable overhead	4
Total	$22

In addition, annual fixed out-of-pocket costs would be $40,000. The new machinery would have no salvage value at the end of its eight-year life. The company uses a discount rate of 8 percent to evaluate capital projects.

a. Compute the net present value of the machine investment (ignore tax).

b. Based on the NPV computed in part (a), is the machine a worthwhile investment? Explain.

c. Aside from the NPV, what other factors should Atlanta Industrial's managers consider when making the investment decision?

33. *(PI)* Texas Flooring is interested in purchasing a computer and software that would allow its salespeople to demonstrate to customers how a finished carpet installation would appear. Managers have estimated the cost of the computer, software, and peripheral equipment to be $30,000. Based on this cost, the managers have determined that the net present value of the investment is $5,000. Compute the profitability index of the investment (ignore tax).

34. *(PI)* The Omaha Transit Authority (OTA) is considering adding a new bus route. To add the route, OTA would be required to purchase a new bus, which would have a life of 10 years and cost $250,000. If the new bus is purchased, OTA managers expect that net cash inflows from bus ridership would rise by $44,000 per year for the life of the bus. The OTA uses an 8 percent required rate of return for evaluating capital projects. No salvage value is expected from the bus at the end of its life.

a. Compute the profitability index of the bus investment (ignore tax).

b. Should the OTA buy the new bus?

c. What is the minimum acceptable value for the profitability index for an investment to be acceptable?

35. *(IRR)* Island Paradise is considering adding a new dock to its marina facilities to accommodate larger yachts. The facilities would cost $140,000 and would generate $18,200 annually in new cash inflows. The expected life of the facilities would be eight years, and there would be no expected salvage value. The firm's cost of capital and discount rate are 10 percent.
- **a.** Calculate the internal rate of return for the proposed improvement (round to the nearest whole percent; ignore tax).
- **b.** Based on your answer to part (a), should the company build the dock?
- **c.** How much annual cash inflow would be required for the project to be minimally acceptable?

36. *(Multiple methods)* Indiana Furniture Mart is considering buying a delivery truck at a cost of $52,000. Presently, the store relies on a delivery service to deliver its products to area customers. The truck is expected to last six years and have a $7,500 salvage value. Annual operating savings (in delivery costs) are expected to be $14,000 for each of the first two years, $11,000 for each of the next two years, and $9,000 for the last two years. The company's cost of capital is 10 percent and this rate was set as the discount rate.
- **a.** Calculate the payback period (ignore tax).
- **b.** Calculate the net present value (ignore tax).
- **c.** Calculate the profitability index (ignore tax).

37. *(Multiple methods)* Toys for Big Boys is considering purchasing a robot to apply shrink wrap packaging to some of its products. The robot will cost $2,300,000 and will produce annual labor and quality cost savings of $300,000. The robot is expected to last 11 years and have no salvage value. For this project answer the following questions.

- **a.** What is the payback period (ignore tax)?
- **b.** If Toys for Big Boys' discount rate is 10 percent, what is the net present value (ignore tax)?
- **c.** Using a 10 percent discount rate, what is the profitability index (ignore tax)?
- **d.** What is the internal rate of return (to the nearest percent) (ignore tax)?

38. *(Depreciation)* Kansas System Solutions operates consulting offices in three Midwest locations. The firm is presently considering an investment in a new mainframe computer and communication software. The computer would cost $1,000,000 and have an expected life of eight years. For tax purposes, the computer can be depreciated using the straight-line method over five years. No salvage value is recognized in computing depreciation expense and no salvage is expected at the end of the life of the equipment. The company's cost of capital is 10 percent and its tax rate is 35 percent.
- **a.** Compute the present value of the depreciation tax benefit if the company uses the straight-line depreciation method.
- **b.** Compute the present value of the depreciation tax benefit assuming the company uses the double declining balance method of depreciation with a five-year life.
- **c.** Why is the depreciation tax benefit computed in part (b) larger than that computed in part (a)?

39. *(Alternative depreciation methods; NPV)* Chicago Hydraulic is considering an investment in computer-based production technology as part of a business reengineering process. The necessary equipment, installation, and training will cost $40,000,000, have a life of eight years, and generate annual net before-tax cash flows from operations of $8,400,000. The technology will have no value at the end of its eight-year estimated life. The company's tax rate is 30 percent, and its cost of capital is 8 percent.
- **a.** If Chicago Hydraulic uses straight-line depreciation for tax purposes, is the project acceptable using the net present value method? *(continued)*

b. Assume the tax law allows the company to take accelerated annual depreciation on this asset in the following manner:

Years 1–2	23 percent of cost
Years 3–8	9 percent of cost

What is the net present value of the project? Is it acceptable?

c. Recompute parts (a) and (b), assuming the tax rate is increased to 50 percent.

40. *(Tax effects of asset sale)* Delta Mechanical Systems purchased a material conveyor system three years ago. Now, the company is going to sell the system and acquire more advanced technology. Data relating to this equipment follow:

Market value now	$15,000
Original cost	24,000
Book value now, for tax purposes	8,000
Book value now, for financial accounting purposes	15,000
Corporate tax rate	40%

a. How much depreciation has been claimed on the conveyor system for tax purposes? For financial accounting purposes?

b. What will be the after-tax cash flow from the sale of this asset?

c. What will be the after-tax cash flow from the sale of the asset if its market value is only $6,000?

41. *(Project ranking)* Two independent potential capital projects are under evaluation by Bird & Company. Project 1 costs $400,000, will last 10 years, and will provide an annual annuity of after-tax cash flows of $85,000. Project 2 will cost $600,000, last 10 years, and provide an annual annuity of $110,000 in annual after-tax cash flows.

a. At what discount rate would management be indifferent between these two projects?

b. What is this indifference rate called?

c. If the firm's cost of capital is 10 percent, which project would be ranked higher?

42. *(Uncertain annual cash flow)* Jones and Associates, CPAs, is considering the installation of a new system for electronically filing tax returns. The initial cost of the system would be $25,000. The expected life of the technology is five years.

a. Given that the company's cost of capital is 12 percent, how much annual increase in cash flows is necessary to minimally justify the investment?

b. Based on your answer to part (a), what would be the payback period for this investment?

43. *(Uncertain project life)* Jake's Exercise Products Inc. is evaluating a potential investment project that would have an initial cost of $400,000 and will return $150,000 annually for six years. The company's cost of capital is 9 percent. Assume that the company is fairly certain regarding the initial cost and the annual return of $150,000, but uncertain as to how many years the $150,000 cash flows will be realized. How many years must the project generate cash flows of $150,000 to be minimally acceptable (ignore tax)?

44. *(Uncertain cash flow; uncertain discount rate)* Quixote Wind Systems manufactures wind-powered electricity generators. The company is considering investing in new technology to allow storage of wind-generated power in batteries. Initial cost of the technology is expected to be $1,200,000. The investment is expected to increase after-tax cash flows by $204,000 for 12 years. The company uses its 9 percent cost of capital rate to discount cash flows for purposes of capital budgeting.

a. What is the lowest acceptable annual cash flow that would allow this project to be considered acceptable (ignore tax)?
b. Assume the company is uncertain as to its actual cost of capital. What is the maximum the company's cost of capital could be (rounded to the nearest whole percent) and still allow this project to be considered acceptable (ignore tax)?

45. *(Appendix 1)* You have just invested $13,000 in a bank account that guarantees to pay you 12 percent interest, compounded annually. At the end of five years, how much money will have accumulated in your investment account (ignore tax)?

46. *(Appendix 1)* You have just purchased a new car. Assume you made a down payment of $8,000 and financed the balance of the purchase cost on an installment credit plan. According to the credit agreement, you agreed to pay $1,200 per month for a period of 36 months. If the credit agreement was based on a monthly interest rate of 1 percent, what was the cost of the car?

47. *(Appendix 1)* Use the tables in Appendix A to determine the answers to the following questions.
a. Elijah Santos wishes to have $50,000 in six years. He can make an investment today that will earn 8 percent each year, compounded annually. What amount of investment should he make to achieve his goal (ignore tax)?
b. Frederick Frazier is going to receive $200,000 on his 50th birthday, 15 years from today. Frederick has the opportunity to invest money today in a government-backed security paying 8 percent, compounded semiannually. How much would he be willing to receive today instead of the $200,000 in 15 years (ignore tax)?
c. Marshall Dillon has $60,000 today that he intends to use as a down payment on a house. How much money did Marshall invest 10 years ago to have $60,000 now, if his investment earned 11 percent compounded annually (ignore tax)?
d. Pat Sawhack is the host of a television game show that gives away thousands of dollars each day. One prize on the show is an annuity, paid to the winner, in equal installments of $210,000 at the end of each year for the next five years. If the winner has an investment opportunity to earn 8 percent, semiannually, what present amount would the winner take in exchange for the annuity (ignore tax)?
e. Ginger is going to be paid modeling fees for the next 10 years as follows: year 1, $30,000; year 2, $50,000; year 3, $60,000; years 4–8, $100,000; year 9, $70,000; and year 10, $45,000. Ginger can invest her money at 8 percent, compounded annually. What is the present value of her future modeling fees (ignore tax)?
f. Your friend has just won the lottery. The lottery will pay her $200,000 per year for the next five years. If this is the only asset owned by your friend, is she a millionaire (one who has a net worth of $1,000,000 or more)? Explain (ignore tax).

48. *(Appendix 2)* Allison Aftercare operates a rehabilitation center for individuals with physical disabilities. The company is considering the purchase of a new piece of equipment that costs $750,000, has a life of five years, and has no salvage value. The company depreciates its assets on a straight-line basis. The expected annual cash flow on a before-tax basis for this piece of equipment is $250,000. Allison requires that an investment be recouped in less than five years and have an accounting rate of return (pretax) of at least 18 percent.
a. Compute the payback period and the accounting rate of return for this piece of equipment (ignore taxes).
b. Is the equipment an acceptable investment for Allison? Explain.

49. *(Appendix 2; comprehensive)* Kopy Korner is evaluating the purchase of a state-of-the-art desktop publishing system that costs $50,000. The company's controller has estimated that the system will generate $16,000 of annual cash receipts for six years. At the end of that time, the system will have no salvage value. The controller also has estimated that cash operating costs will be $2,000 annually. The company's tax rate is expected to be 35 percent during the life of the asset, and the company uses straight-line depreciation.

a. Determine the annual after-tax cash flows from the project.
b. Determine the after-tax payback period for the project.
c. Determine the after-tax accounting rate of return for the project. (Assume tax and financial accounting depreciation are equal.)

50. *(Comprehensive)* Hollywood Games operates a video arcade in the Lincoln Mall. The owner of Hollywood Games, Joe Lynch, is considering acquiring a new "centerpiece" video machine. The cost of the new equipment would be $60,000. The equipment would have an expected life of five years and no salvage value. Straight-line depreciation would be used for both financial and tax purposes.

Mr. Lynch expects the new machine to generate an additional $25,000 per year in net, pretax cash flows. The cost of capital and tax rate for Mr. Lynch are 10 and 28 percent, respectively.

a. Determine the after-tax cash flows from the new machine.
b. Determine the net present value of the machine.
c. Determine the accounting income of the machine.
d. Determine the accounting rate of return and the payback period on an after-tax basis.

http://www.gm.com

51. *(Technology acquisition)* In 1996 General Motors announced that it was preparing to invest $850 million to update its metal-stamping operations. The new metal-stamping operations would be more flexible and less labor intensive than current equipment. GM's Metal Fabricating Division expected to reduce employment of hourly workers by 30,000 and salaried workers by 4,000.

Much of the new investment would be spent on modern transfer presses. Unlike some of GM's older presses, such units accept different dies, or forms for shaping sheet metal. As Japanese automakers proved, such flexible machinery is much more efficient, because it allows an auto maker to alter its production mix to match what's selling and to compensate for breakdowns.

SOURCE: Adapted from Rebecca Blumenstein, "GM to Spend $850 Million to Update Its Sheet-Metal Stamping Operations," *The Wall Street Journal* (May 21, 1996), p. A12.

a. Assume that the only justification for upgrading the metal-stamping machinery is the labor costs to be saved; also, assume the average pay of the 34,000 workers to be displaced by the upgraded machinery is $25,000. Compute the payback period for the upgrade project (ignore tax).
b. The two major financial dimensions of the upgrade project mentioned in the news article were the initial cost of $850 million and the labor cost savings. Prepare a brief oral report in which you identify other cost savings and other costs of the upgrade project.

52. *(Change in investment assumption)* Lenin's Linen provides laundered items to various commercial and service establishments in a large metropolitan city. Lenin's is scheduled to acquire new cleaning equipment in mid-2001 that should provide some operating efficiencies. The new equipment would enable Lenin's to increase the volume of laundry it handles without any increase in labor costs. In addition, the estimated maintenance costs in terms of pounds of laundry would be reduced slightly with the new equipment.

The new equipment was justified on the basis not only of reduced cost but also of expected increase in demand starting in late 2001. However, since the original forecast was prepared, several potential new customers have either

delayed or discontinued their own expansion plans in the market area that is serviced by Lenin's. The most recent forecast indicates that no great increase in demand can be expected until late 2002 or early 2003.

Identify and explain the factors that Lenin's should consider in deciding whether to delay the investment in the new cleaning equipment. In the presentation of your response, distinguish between those factors that tend to indicate that the investment should be made as scheduled versus those that tend to indicate that the investment should be delayed. *(CMA adapted)*

53. *(Links between short- and long-term operations)* Drug companies rely on their research activities as the primary source of future revenues and profits. The capital budget is the principal tool used to allocate resources to research activities.

In 1996 Merck & Co., a giant in the drug industry, unveiled a list of its products in early development stages. The products included drugs to treat major maladies such as arthritis and cancer. Analysts who were present at the unveiling were unimpressed. Some of the analysts commented that it was not Merck's long-term prospects that were in question; rather, "its short-term pipeline contains no clear breakthroughs. That poses potential problems for the bottom line, because the company's core products—cardiovascular drugs—face increasing competition, and several new drugs have fallen short of expectations."

http://www.merck.com

SOURCE: Adapted from Robert Langreth, "Drug Pipeline at Merck Gets Weak Review," *The Wall Street Journal* (May 22, 1996), p. B6.

Prepare a written report in which you explain how short-term operations and plans are linked to long-term operations and plans. This report should be directed at an audience that is expected to have little knowledge of formal business planning systems. The major point to be explained in your report is why stock analysts would meet Merck's announcement of an aggressive R&D program with apathy because success of current operations is marginal.

54. *(Capital budget)* Find the home page of the Institute of Management Accountants (IMA). From the home page, locate articles addressing the processes of budgeting. Among these materials is a discussion of the master budget and its component budgets including the capital budget. Read these materials and write a summary of how the capital budget affects, and is affected by, the other budgets that comprise the master budget.

55. *(Application of discounting methods)* Several of the capital budgeting techniques presented in this chapter depend on discounted cash flow concepts. These concepts are applied in business in a variety of settings. Select a business that relies on discounted cash flow analysis, such as a bond investor, and prepare an oral report on how the firm applies discounting methods to manage the business.

56. *(Application of discounting methods)* In the opening and closing vignettes, the point is made that Amazon.com has a huge market value relative to its actual cash flows. Using the concept of net present value, discuss what investors must be expecting about the future of Amazon.com to rationalize the extraordinary relationship between current market value of the company and current cash flows.

57. *(Application of discounting methods)* In recent years, the stock price averages, e.g., Dow Jones Industrial average, have shown sensitivity to changes in interest rates. Based on your understanding of the factors that determine stock price, and how future cash flows are discounted, prepare a brief oral report in which you explain why stock prices should be sensitive to changes in interest rates.

58. *(Product life-cycle applications)* Different accounting and finance tools can be used to control costs as the product life cycle advances through its stages. With this thought in mind, discuss whether capital budgeting as a cost control tool would be relatively more important to an established firm or a .com firm.

PROBLEMS

59. *(Time line; payback; NPV)* Black Hills Souvenir Show is considering expanding its building so it can stock additional merchandise for travelers and tourists. Store manager Allison Crowe anticipates that building expansion costs would be $90,000. Although Ms. Crowe would need to invest in additional inventory, her suppliers are willing to provide inventory on a consignment basis. Annual incremental fixed cash costs for the store expansion are expected to be as follows:

Year	Amount
1	$ 5,550
2	7,200
3	7,200
4	7,200
5	7,950
6	9,450
7	9,750
8	11,250

Ms. Crowe estimates that annual cash inflows could be increased by $120,000 from the additional merchandise sales. The firm's contribution margin is typically 20 percent of sales. Because of uncertainty about the future, Ms. Crowe does not want to consider any cash flows after eight years. The firm uses a 10 percent discount rate.

a. Construct a time line for the investment.
b. Determine the payback period (ignore tax).
c. Calculate the net present value of the project (ignore tax).

60. *(Time line; payback; NPV)* Fred's Freightline is considering the purchase of a new van to replace an existing truck. The van would cost $35,000 and would have a life of seven years with no salvage value at that time. The truck could be sold currently for $4,000; alternatively, if it is kept, it will have a remaining life of seven years with no salvage value. By purchasing the van, Fred's would anticipate operating cost savings as follows:

Year	Amount
1	$6,300
2	7,100
3	7,200
4	7,000
5	7,000
6	7,100
7	7,200

Fred's cost of capital and capital project evaluation rate is 12 percent.

a. Construct a time line for the purchase of the van.
b. Determine the payback period (ignore tax).
c. Calculate the net present value of the van (ignore tax).

61. *(Payback; IRR)* Ted's Bookkeeping Service prepares tax returns for individuals and small businesses. The firm employs four professional people in the tax practice. Currently, all tax returns are prepared on a manual basis. The firm's owner, Ted Moore, is considering purchasing a computer system that would allow the firm to service all its existing clients with only three employees. To evaluate the feasibility of the computerized system, Ted has gathered the following information:

Initial cost of the hardware and software	$32,000
Expected salvage value in 4 years	$0
Annual depreciation	$8,000
Annual operating costs	$4,500
Annual labor savings	$25,000
Expected life of the computer system	4 years

Ted has determined that he will invest in the computer system if its pretax payback period is less than 3.5 years and its pretax IRR exceeds 12 percent.

a. Compute the payback period for this investment. Does the payback meet Ted's criterion? Explain.

b. Compute the IRR for this project to the nearest percent. Based on the computed IRR, is this project acceptable to Ted?

62. *(NPV; PI)* Houston Storage provides warehousing services for industrial firms. Usual items stored include records, inventory, and waste items. The company is evaluating more efficient methods of moving inventory items into and out of storage areas. One vendor has proposed to sell Houston Storage a conveyor system that would offer high-speed routing of inventory items. The required equipment would have an initial cost of $2,500,000 including installation. The vendor has indicated that the machinery would have an expected life of seven years, with an estimated salvage value of $200,000. Below are estimates of the annual labor savings as well as the additional costs associated with the operation of the new equipment:

Annual labor cost savings (14 workers)	$465,000
Annual maintenance costs	20,000
Annual property taxes	14,000
Annual insurance costs	22,000

a. Assuming the company's cost of capital is 9 percent, compute the NPV of the investment in the conveyor equipment (ignore tax).

b. Based on the NPV, should the company invest in the new machinery?

c. Compute the profitability index for this potential investment (ignore tax).

d. What other factors should the company consider in evaluating this investment?

63. *(NPV; PI; payback; IRR)* Custom Driveways provides custom paving of sidewalks and driveways for residential and commercial customers. One of the most labor-intensive aspects of the paving operation is the preparation and mixing of materials. Joe Click, corporate engineer, has learned of a new computerized technology to mix (and monitor mixing of) materials. According to information received by Mr. Click, the cost of the required equipment would be $280,000, and the equipment would have an expected life of seven years. If purchased, the new equipment would replace manually operated equipment. Data relating to the old and new mixing equipment follow:

	OLD TECHNOLOGY
Original cost	$25,000
Present book value	$15,000
Annual cash operating costs	$75,000
Current market value	$6,000
Market value in 7 years	$0
Remaining useful life	7 years

	NEW TECHNOLOGY
Cost	$280,000
Annual cash operating costs	$15,000
Market value in 7 years	$0
Useful life	7 years

a. Assume that the cost of capital in this company is 12 percent, which is the rate to be used in a discounted cash flow analysis. Compute the net present value and profitability index of investing in the new machine. Ignore taxes. Should the machine be purchased? Why or why not?
b. Compute the payback period for the investment in the new machine. Ignore taxes.
c. Rounding to the nearest whole percentage, compute the internal rate of return for the machine investment.

64. *(NPV; taxes)* The manager of Crain Street Cold Storage is considering the installation of a new refrigerated storage room. She has learned that the installation would require an initial cash outlay of $780,000. The installation would have an expected life of 20 years with no salvage value. The installation would increase annual labor and maintenance costs by $75,000. The firm's cost of capital is estimated to be 11 percent, and its tax rate is 30 percent. The storage room is expected to generate net annual cash revenues (before tax, labor, and maintenance costs) of $172,000.
a. Using straight-line depreciation, calculate the after-tax net present value of the storage room.
b. Based on your answer to part (a), is this investment financially acceptable? Explain.
c. What is the minimum amount by which net annual cash revenues must increase to make this an acceptable investment?

65. *(After-tax cash flows; payback; NPV; PI; IRR)* Forrester Fashions is considering the purchase of computerized clothes designing software. The software is expected to cost $160,000, have a useful life of five years, and have a zero salvage value at the end of its useful life. Assume tax regulations permit the following depreciation patterns for this asset:

Year	Percent Deductible
1	20
2	32
3	19
4	15
5	14

The company's tax rate is 30 percent, and its cost of capital is 8 percent. The software is expected to generate the following cash savings and cash expenses:

Year	Cash Savings	Cash Expenses
1	$60,000	$ 9,000
2	67,000	7,000
3	72,000	13,000
4	60,000	8,000
5	49,000	5,000

a. Prepare a time line presenting the after-tax operating cash flows.
b. Determine the following on an after-tax basis: payback period, net present value, profitability index, and internal rate of return.

66. *(NPV; project ranking; risk)* Florida Financial Consultants is expanding operations, and the firm's president, Ms. Hillary Rose, is trying to make a decision about new office space. The following are Ms. Rose's options:

Maple Commercial Plaza	5,000 square feet; cost, $800,000; useful life, 10 years; salvage, $400,000
High Tower	20,000 square feet; cost, $3,400,000; useful life, 10 years; salvage, $1,500,000

If the Maple Commercial Plaza is purchased, the company will occupy all of the space. If High Tower is purchased, the extra space will be rented for $620,000 per year. If purchased, either building will be depreciated on a straight-line basis. For tax purposes, the buildings would be depreciated assuming a 25-year life. By purchasing either building, the company will save $210,000 annually in rental payments. All other costs of the two purchases (such as land cost) are expected to be the same. The firm's tax rate is 40 percent.

a. Determine the before-tax net cash flows from each project for each year.
b. Determine the after-tax cash flows from each project for each year.
c. Determine the net present value for each project if the cost of capital for Florida Financial Consultants is 11 percent. Which purchase is the better investment based on the NPV method?
d. Ms. Rose is concerned about the ability to rent the excess space in High Tower for the 10-year period. To compute the NPV for that portion of the project's cash flows, she has decided to use a discount rate of 20 percent to compensate for risk. Compute the NPV and determine which investment is more acceptable.

67. *(NPV; PI; IRR; Fisher rate)* Scrooge Investments, which has a cost of capital of 12 percent, is evaluating two mutually exclusive projects (A and B), which have the following projections:

	Project A	Project B
Investment	$96,000	$160,000
After-tax cash flows	$25,600	$30,400
Asset life	6 years	10 years

a. Determine the net present value, profitability index, and internal rate of return for Projects A and B.
b. Using the answers to part (a), which is the more acceptable project? Why?
c. What is the Fisher rate for the two projects?

68. *(Capital rationing)* Following are the capital projects being considered by the management of UpTown Productions:

Project	Cost	Annual After-Tax Cash Flows	Number of Years
Film studios	$18,000,000	$2,800,000	15
Cameras and equipment	3,200,000	800,000	8
Land improvement	5,000,000	1,180,000	10
Motion picture #1	17,800,000	4,970,000	5
Motion picture #2	11,400,000	3,920,000	4
Motion picture #3	7,800,000	2,100,000	7
Corporate aircraft	2,400,000	770,000	5

Assume that all projects have no salvage value and that the firm uses a discount rate of 10 percent. Company management has decided that only $25,000,000 can be spent in the current year for capital projects.

a. Determine the net present value, profitability index, and internal rate of return for each of the seven projects.
b. Rank the seven projects according to each method used in part (a).
c. Indicate how you would suggest to the management of Uptown Production that the money be spent. What would be the total net present value of your selected investments?

69. *(Sensitivity analysis)* A 50-room motel is for sale in Houston and is being considered by the Lone Star Motel Chain as an investment. The current owners indicate that the occupancy of the motel averages 80 percent each day of the year that the motel is open. The motel is open 300 days per year. Each room

rents for $75 per day, and variable cash operating costs are $10 per day that the room is occupied. Fixed annual cash operating costs are $100,000.

An acquisition price of $2,000,000 is being offered by Lone Star. The chain plans on keeping the motel for 14 years and then disposing of it. Because the market for motels is so difficult to predict, Lone Star estimates the salvage value to be zero at the time of disposal. Depreciation will be taken on a straight-line basis for tax purposes. In making the following computations, assume that there will be no tax consequences of the sale in 14 years. The chain's tax rate is estimated at 35 percent for all years.

a. Determine the after-tax net present value of the motel to Lone Star, assuming a cost of capital rate of 13 percent.

b. What is the highest level that the discount rate can be and still allow this project to be considered acceptable by Lone Star? If this discount rate exceeds the highest rate shown in the table (20 percent), simply state this fact and provide supporting computations and reasons.

c. How small can the net after-tax cash flows be and still allow the project to be considered acceptable by Lone Star, assuming a cost of capital rate of 13 percent?

d. What is the shortest number of years for which the net after-tax cash flows can be received and still have the project be considered acceptable?

e. Assume that the answer to part (c) is $217,425. If all costs remain as they are currently stated and the motel continues to stay open 300 days per year, approximately how many rooms would have to be rented each night to achieve this level of cash flows?

70. *(Postinvestment audit)* Ten years ago, based on a before-tax NPV analysis, Johnson Wholesaling decided to add a new product line. The data used in the analysis were as follows:

Discount rate	12%
Life of product line	10 years
Annual sales increase:	
Years 1–4	$125,000
Years 5–8	$175,000
Years 9–10	$100,000
Annual fixed cash costs	$20,000
Contribution margin ratio	40%
Cost of production equipment	$125,000
Investment in working capital	$10,000
Salvage value	$0

Because the product line was discontinued this year, corporate managers decided to conduct a postinvestment audit to assess the accuracy of their planning process. Accordingly, the actual cash flows generated from the product line were estimated to be as follows:

Actual Investment	
Production equipment	$120,000
Working capital	17,500
Total	$137,500
Actual Revenues	
Years 1–4	$110,000
Years 5–8	$200,000
Years 9–10	$105,000
Actual Fixed Cash Costs	
Years 1–4	$15,000
Years 5–8	$17,500
Years 9–10	$25,000
Actual contribution margin ratio	35%
Actual salvage value	$5,000
Actual cost of capital	12%

a. Determine the projected NPV on the product line investment.
b. Determine the NPV of the project based on the postinvestment audit.
c. Identify the factors that are most responsible for the differences between the projected NPV and the postinvestment audit NPV.

71. *(Appendix 2; payback; NPV)* Caldwell Department Stores is a growing business that is presently considering adding a new product line. The firm would be required by the manufacturer to incur setup costs of $1,600,000 to handle the new product line. Caldwell has estimated that the product line would have an expected life of eight years. Following is a schedule of revenues and annual fixed operating expenses (including $200,000 of annual depreciation on the investment) associated with the new product line. Variable costs are estimated to average 65 percent of revenues. All revenues are collected as earned. All expenses shown, except for the included amount of straight-line depreciation, are paid in cash when incurred.

Year	Revenues	Expenses
1	$ 720,000	$360,000
2	800,000	320,000
3	960,000	320,000
4	1,280,000	360,000
5	1,600,000	320,000
6	1,600,000	320,000
7	1,120,000	320,000
8	680,000	280,000

The company has a cost of capital of 13 percent. Management uses this rate in discounting cash flows for evaluating capital projects.
a. Calculate the accounting rate of return (ignore tax).
b. Calculate the payback period (ignore tax).
c. Calculate the net present value (ignore tax).

72. *(Comprehensive; Appendix 2)* The management of Custom Metalworks is evaluating a proposal to purchase a new turning lathe as a replacement for a less efficient piece of similar equipment that would then be sold. The cost of the new lathe including delivery and installation is $700,000. If the equipment is purchased, Custom Metalworks will incur $20,000 of costs in removing the present equipment and revamping service facilities. The present equipment has a book value of $400,000 and a remaining useful life of 10 years. Due to new technical improvements that have made the equipment outmoded, it presently has a resale value of only $160,000.

Management has provided you with the following comparative manufacturing cost tabulation:

	Present Equipment	New Equipment
Annual production in units	400,000	500,000
Cash revenue from each unit	$1.20	$1.20
Annual costs:		
Labor	$120,000	$100,000
Depreciation (10% of asset book value or cost)	40,000	70,000
Other cash operating costs	192,000	80,000

Management believes that if the equipment is not replaced now, the company must wait seven years before replacement is justified. The company uses a 12 percent discount or hurdle rate in evaluating capital projects and expects all capital project investments to recoup their costs within five years.

Both pieces of equipment are expected to have a negligible salvage value at the end of 10 years.

a. Determine the net present value of the new equipment (ignore tax).
b. Determine the internal rate of return on the new equipment (ignore tax).
c. Determine the payback period for the new equipment (ignore tax).
d. Determine the accounting rate of return for the new equipment (ignore tax).
e. Determine whether the company should keep the present equipment or purchase the new lathe.

CASES

73. *(Investment financing)* HMG Corporation is a for-profit health-care provider that operates three hospitals. One of these hospitals, Metrohealth, plans to acquire new X-ray equipment. Management has already decided the equipment will be cost beneficial and will enhance the technology available in the outpatient diagnostic laboratory. Before Metrohealth prepares the requisition to corporate headquarters for the purchase, Paul Monden, Metrohealth's controller, has to prepare an analysis to compare financing alternatives.

The equipment is a Supraimage X-ray 400 machine priced at $1,000,000, including shipping and installation; it would be delivered January 2, 2001. Under the tax regulations, this machine qualifies as "qualified technological equipment" with a five-year recovery period. It will be depreciated over five years for tax purposes using the double-declining balance method, with a switch to the straight-line method at a point in time to maximize the depreciation deduction. The machine will have no salvage value at the end of five years. The three financing alternatives Metrohealth is considering are described next.

1. *Finance Internally:* HMG Corporation would provide Metrohealth with the funds to purchase the equipment. The supplier would be paid on the day of delivery.

2. *Finance with a Bank Loan:* Metrohealth could obtain a bank loan to finance 90 percent of the equipment cost at 10 percent annual interest, with five annual payments of $237,420 each due at the end of each year, with the first payment due on December 31, 2001. The loan amortization schedule is presented next.

Metrohealth would provide the remaining $100,000, which would be paid on delivery.

Year	Beginning Balance	Payment	Interest	Principal Reduction
1	$900,000	$237,420	$90,000	$147,420
2	752,580	237,420	75,258	162,162
3	590,418	237,420	59,042	178,378
4	412,040	237,420	41,204	196,216
5	215,824	237,420	21,596	215,824

3. *Lease from a Lessor:* The equipment could be leased from MedLeasing, with an initial payment of $50,000 due on equipment delivery and five annual payments of $220,000 each, commencing on December 31, 2001. At the option of the lessee, the equipment can be purchased at the fair market value at lease termination (the lessor is currently estimating a 30 percent salvage value).

The lease satisfies the requirements to be an operating lease for both FASB and income tax purposes. This means that all lease payments are deductible for tax purposes each year. Because of expected technological changes in medical equipment, Metrohealth would not plan to purchase the X-ray equipment at the end of the lease commitment.

Both HMG Corporation and Metrohealth have an effective income tax rate of 40 percent, an incremental borrowing rate of 10 percent, and an after-tax corporate hurdle rate of 12 percent. Income taxes are paid at the end of the year.

a. Prepare a present value analysis as of January 1, 2001, of the expected after-tax cash flows for each of the three financing alternatives available to Metrohealth to acquire the new X-ray equipment. As part of your present value analysis, (1) justify the discount rates you used and (2) identify the financing alternative most advantageous to Metrohealth.

b. Discuss the qualitative factors Paul Monden should include for management consideration before a final decision is made regarding the financing of this new equipment. *(CMA adapted)*

74. *(NPV)* Michigan Motor Company is considering a proposal to acquire new manufacturing equipment. The new equipment has the same capacity as the current equipment but will provide operating efficiencies in direct and indirect labor, direct material usage, indirect supplies, and power. Consequently, the savings in operating costs are estimated to be $150,000 annually.

The new equipment will cost $300,000 and will be purchased at the beginning of the year when the project is started. The equipment dealer is certain that the equipment will be operational during the second quarter of the year it is installed. Therefore, 60 percent of the estimated annual savings can be obtained in the first year. Michigan Motor will incur a one-time expense of $30,000 to transfer the production activities from the old equipment to the new equipment. No loss of sales will occur, however, because the plant is large enough to install the new equipment without disrupting operations of the current equipment. The equipment dealer states that most companies use a 4-year life when depreciating this equipment.

The current equipment has been fully depreciated and is carried in the accounts at zero book value. Management has reviewed the condition of the current equipment and has concluded that it can be used an additional four years. Michigan Motor would receive $5,000 net of removal costs if it elected to buy the new equipment and dispose of its current equipment at this time.

Michigan Motor currently leases its manufacturing plant. The annual lease payments are $60,000. The lease, which will have four years remaining when the equipment installation would begin, is not renewable. Michigan Motor would be required to remove any equipment in the plant at the end of the lease. The cost of equipment removal is expected to equal the salvage value of either the old or the new equipment at the time of removal.

The company uses the sum-of-the-years'-digits depreciation method for tax purposes. A full-year's depreciation is taken in the first year an asset is put into use.

The company is subject to a 40 percent income tax rate and requires an after-tax return of at least 12 percent on an investment.

a. Calculate the annual incremental after-tax cash flows for Michigan Motor Company's proposal to acquire the new manufacturing equipment.

b. Calculate the net present value of Michigan Motor's proposal to acquire the new manufacturing equipment using the cash flows calculated in part (a) and indicate what action Michigan Motor's management should take. Assume all recurring cash flows occur at the end of the year. *(CMA adapted)*

75. *(Postinvestment audit)* Smyth Brothers Inc. has formal policies and procedures to screen and approve capital projects. Proposed capital projects are classified as one of the following types:

1. Expansion requiring new plant and equipment

2. Expansion by replacement of present equipment with more productive equipment

3. Replacement of old equipment with new equipment of similar quality

All expansion projects and replacement projects that will cost more than $50,000 must be submitted to the top management capital investment committee for approval. The investment committee evaluates proposed projects considering the costs and benefits outlined in the supporting proposal and the long-range effects on the company.

The projected revenue and/or expense effects of the projects, once operational, are included in the proposal. Once a project is accepted, the committee approves an expenditure budget for the project from its inception until it becomes operational. The expenditures required each year for the expansions or replacements are also incorporated into Smyth Brothers' annual budget procedure. The budgeted revenue and/or cost effects of the projects, for the periods in which they become operational, are incorporated into the five-year forecast.

Smyth Brothers Inc. does not have a procedure for evaluating projects once they have been implemented and become operational. The vice president of finance has recommended that Smyth Brothers establish a postcompletion audit program to evaluate its capital expenditure projects.

a. Discuss the benefits a company could derive from a postcompletion audit program for capital expenditure projects.

b. Discuss the practical difficulties in collecting and accumulating information that would be used to evaluate a capital project once it becomes operational. *(CMA adapted)*

REALITY CHECK

76. *Traditionally, capital budgeting in health care has tended to focus on projected financial returns from investments. To justify the commitment of capital resources, a proposed investment must be shown to provide sufficient benefits in the form of additional revenues or reduced expenses. A hospital, for example, might invest in an automated drug-dispensing system if forecasted savings from reduced labor and supplies are greater than the initial outlay for the equipment. Present-value calculations are used to weigh immediate costs against eventual benefits over the life of an investment.*

This approach, however, discourages strategic investments in areas where long-term benefits are difficult to measure in financial terms, such as investing in healthcare technologies to improve quality of care or patient satisfaction. Upgrading diagnostic equipment, for example, may be seen as a way to enhance revenues over the long term based on the rationale that patients and physicians are drawn to healthcare organizations that demonstrate a commitment to providing high-quality care. The problem with such an investment from a traditional capital-budgeting perspective is that it is difficult to predict when this benefit will occur or how large it will be. Similarly, capital investments whose objectives are to attract physicians or boost an organization's market share eventually may increase revenues or reduce costs, but are hard to justify solely in terms of short-term financial benefits.

SOURCE: Catherine E. Kleinmuntz and Don N. Kleinmuntz, "A Strategic Approach to Allocating Capital in Healthcare Organizations," *Healthcare Financial Management* (April 1999), p. 52.

a. Assume, as the article states, that health-care entities tend to not invest in *strategic investments in areas where long-term benefits are difficult to measure in financial terms.* Should these firms invest in certain assets even if they cannot measure the outcomes financially? Explain.

b. As an accountant, how could you contribute to the quality of investment analysis of a health-care provider?

77. In February 1996, the German firm, Jos. L. Meyer GmbH was negotiating for the right to build ships in the United States. The family-owned German shipbuilder, which specializes in cruise ships, gas tankers and other complex, labor-intensive vessels would employ as many as 2,000 workers at the U.S. shipyard where wages and benefit rates would be significantly lower than in Germany.

Under the plan being negotiated, Meyer Werft (as the company is known) would invest $60 million in the Philadelphia yard and seek additional private and public funding of about $300 million. The money would be used to enclose one of the yard's huge drydocks and to fund worker retraining and facility improvements.

SOURCE: Adapted from Daniel Machalaba, "Germany's Meyer Werft Seeks to Build Ships at Philadelphia's Naval Yard," *The Wall Street Journal* (February 16, 1996), p. A4.

a. For labor-intensive operations, such as shipbuilding, how would labor quality considerations affect capital budgeting (and location) decisions of firms with global operations?

b. In addition to labor rates, what other factors might be considered in global firms' location decisions for new capital investment?

78. In the United States, companies generally respond to economic downturns by reducing spending on capital projects. A frequently observed strategy is to delay investment in new capital projects and products and to cut spending on research and development activities, advertising, and customer-service activities.

a. In economic downturns how can companies cut costs and activities without affecting quality or service?

b. What are the likely effects of short-term cost-cutting strategies such as those outlined above on long-term profitability and quality control?

79. *Dial Corp., a one-time bus company that in 1996 sold everything from soap to nuts, said it would separate into consumer products and services concerns, splitting a company with about $3 billion in current stock market value.*

The Phoenix-based company's consumer businesses, with revenue in 1995 of about $1.3 billion, would continue to operate under the Dial name. Its diverse airline-catering, convention, travel and money-order businesses, among others, would operate as a separate, as-yet-unnamed unit that in 1995 had revenue of about $2.2 billion.

Dial joined a host of U.S. companies that decided that the sum of the parts is worth more than the whole. Companies that announced or completed spin-offs include AT&T Corp., ITT Corp., Minnesota Mining & Manufacturing Co., Dun & Bradstreet Corp., and Melville Corp. The stocks of companies that announce spin-offs outperform the overall stock market, according to a J.P. Morgan & Co. study.

http://www.dialcorp.com

http://www.att.com
http://www.mmm.com
http://www.dnb.com
http://www.jpmorgan.com

SOURCE: Adapted from Steven Lipin, "Dial to Split into Two Companies," *The Wall Street Journal* (February 16, 1996), p. A3.

a. The conglomerate form of business is perhaps the most difficult to manage in terms of directing new capital investments. Spin-offs can be likened to "undoing" a prior capital investment in a business. What ethical obligation do managers of conglomerates have to stockholders in the event that a higher stock price could be obtained if a business was spun off rather than held?

b. What obligation do managers have to employees who are affected by spin-offs?

80. Although they should be considered independently, often the investing and financing decisions are considered together.

It's easy to understand the allure of auto leasing: Consumers make lower monthly payments; dealers gain volume, move expensive inventory—and keep customers. So it's not surprising to find that one of every three new cars on the road today is leased.

The truth is, dealers have profited more from leasing than from selling. An Atlanta-based leasing expert says, "On a sale a dealer makes about $1,200 to $1,500 in profit. On a lease, it might be $2,500 or $3,000." That's fine, he notes, "unless it's done deceptively."

SOURCE: Deanna Oxender Burgess, "Buy or Lease: The Eternal Question," *Journal of Accountancy* (April 1999), p. 25. Reprinted with permission from the *Journal of Accountancy.* Copyright (2000) by American Institute of CPAs. Opinions of the authors are their own and do not necessarily reflect policies of the AICPA.

Complex lease contracts combined with hidden costs complicate the decision to lease or buy. Only recently have key lease terms such as the cost of the car been disclosed to consumers. Laws in a handful of states, as well as Federal Reserve Board Regulation M, which became effective in October 1997, and leasing data available on the Internet are prompting dealers to make increased disclosures. Unfortunately, some fees, including the interest rate the dealer uses to calculate the lease payment, known in the industry as the money factor, still remain unknown to the consumer.

a. Discuss why some consumers might find leasing a car to be more appealing than purchasing one.

b. Even if not required by law, is the practice of not disclosing lease information ethical? Discuss.

c. As an accountant, how could you aid a client in a car-buying situation?