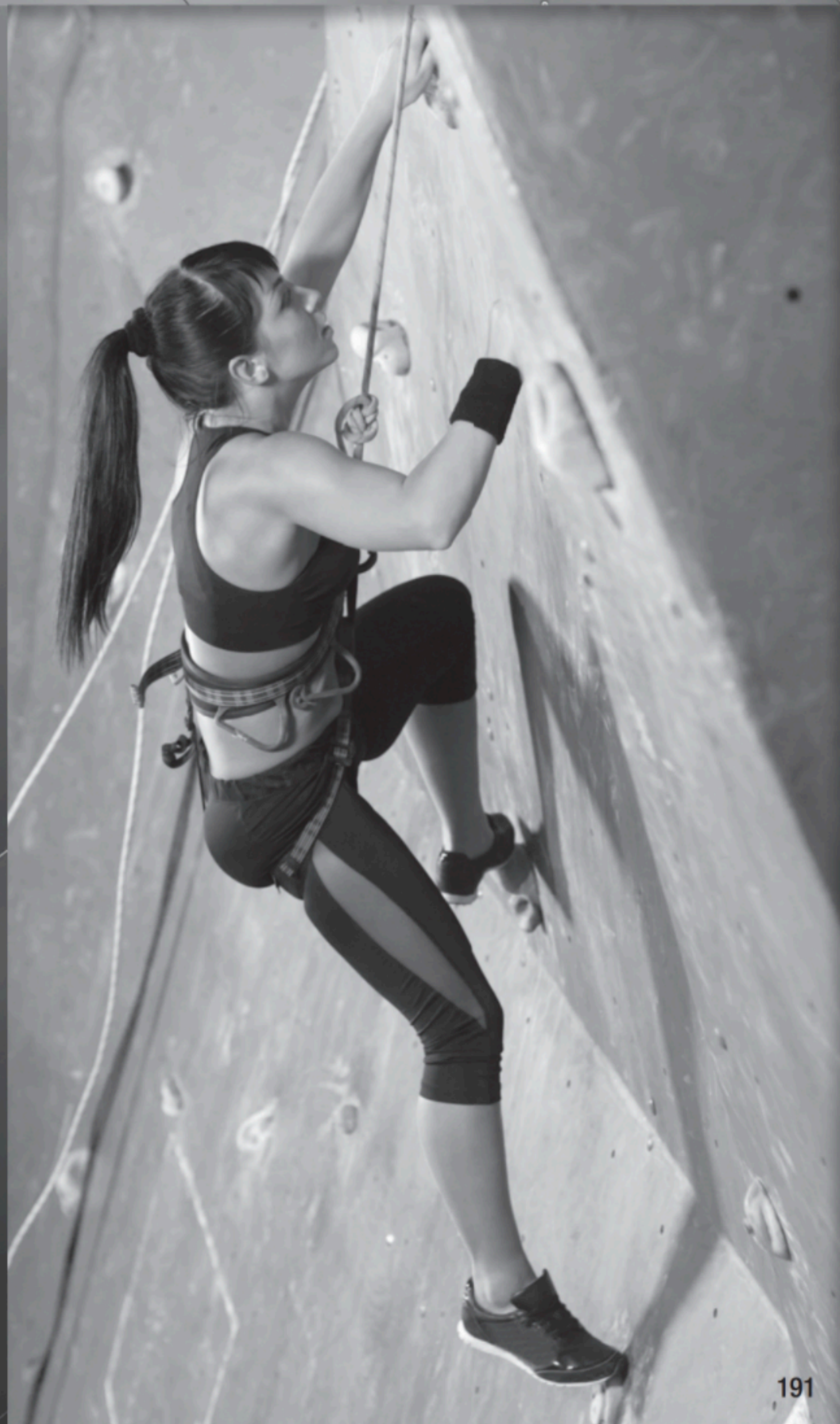
8 Capital Budgeting

KEY CONCEPTS

capital
capital budgeting
capital expenditure
current expenditure
discount rate
discounted payback period
incremental cash flow
initial cost
internal rate of return (IRR)
modified internal rate of return (MIRR)
net present value (NPV)
payback period
terminal value
weighted average cost of capital (WACC)



Introduction

In 2010, after 34 years of existence, Giants Stadium was demolished. The former home of the New York Giants and New York Jets, Giants Stadium was the site of Pelé's last game and was the venue for events as diverse as a Mass celebrated by Pope John Paul II in 1995 and Bruce Springsteen and the E Street Band's ten sold-out shows in July and August 2003. The stadium holds the record for the number of NFL games played in one venue. In addition to the Giants and Jets, the stadium also was the home of the New Jersey Generals of the United States Football League (USFL), the New York/New Jersey Knights of the World League of American Football, the New York/New Jersey Hitmen of the XFL, and the New York Sentinels of the United Football League. The Rutgers football team, the New York/New Jersey Metrostars (New York Red Bulls), and New York Cosmos (North American Soccer League [NASL]) were also tenants at the venue. Further, many international soccer matches and a variety of concerts were held at the stadium. Its initial cost was $75 million (New Jersey Sports & Exposition Authority, 2014).

When Giants Stadium was demolished, $110 million in debt was still owed on the venue (Belson, 2010). In addition to some initial costs, the costs of renovating the facility over time were passed on by politicians to the point that debt is still owed even though the stadium is now a parking lot.

This story provides a good illustration of why capital budgeting is important. When Giants Stadium was demolished, each New Jersey resident owed almost $13 for the debt on the former NFL venue. In tangible terms, the facility should be considered to have been a bad investment for the New Jersey citizens, as debt was owed at the time of its demise.

Unfortunately, this example is not uncommon. Taxpayers in King County, Washington, owed $80 million when the Kingdome was imploded in 2000 (Belson). Similar venue debt also remained when stadiums were torn down in Indianapolis and abandoned in Houston. Debt on the RCA Dome (Indianapolis) was $61 million when the building was demolished in 2008 and will not be repaid until 2021. For Houston, debt remains on the Astrodome, which opened in 1965 (Yost, 2011). Today, taxpayers still owe $32 million on the building. Although the building has not been demolished, it lacks a major tenant, as the Houston Astros (MLB) and Houston Oilers (NFL) left the venue in 1999 and 1997, respectively. Further, this type of poor financial planning is not limited to "major league" venues and major metropolitan areas. Vero Beach, Florida, still owes $17 million on a spring training baseball facility, although the Dodgers left for Glendale, Arizona, in 2009; taxpayers in Pima County, Arizona, still owe $21.3 million in stadium debt even though the Chicago White Sox and Arizona Diamondbacks moved their spring training facilities from Tucson to Phoenix.

A capital budget can help ensure that any new taxpayer-funded facility will be paid off before the end of its useful life. As you will learn in this chapter, a capital budget can also help a manager evaluate, compare, and select projects to achieve the best long-term financial return on capital investments.

DEFINING CAPITAL BUDGETING

When making investment decisions that involve fixed assets, we need to examine the purchase of **capital**—the long-term, fixed assets that are used in production. In capital budgeting we focus on these purchases and, specifically, analyze them to decide which purchases should be made. More precisely, **capital budgeting** (also known as capital investment appraisal) is the process of evaluating, comparing, and selecting capital projects to achieve the best return on investment over time. Groppelli and Nikbakht (2012) define it as investment decision making that justifies capital expenditures. This process is an important factor in the success or failure of an organization, since investments in capital (or fixed) assets affect the financial health of the organization for many years.

> **SIDEBAR** 8.A
>
> **Capital expenditures and the Americans with Disabilities Act**
>
> Capital expenditures may include expenditures on mandatory projects required by law. For example, the Americans with Disabilities Act of 1990 prohibits discrimination against individuals with disabilities with regard to employment and public accommodation (Public Law 101-336 [S. 933], 42 USCS ßß 12101 et seq.). As a result of this law, the University of Michigan agreed in 2008 to modify its football venue after the Michigan Paralyzed Veterans of America filed a federal lawsuit along with the Department of Justice over lack of accessibility. In the settlement, the university was required to make changes to Michigan Stadium restrooms and provide ramp access to bring the venue into ADA compliance. Also, the venue's wheelchair-accessible seating was modified. The modifications cost approximately $2 million (Nelson, 2008). These renovations are considered capital expenditures.

A **capital expenditure** is the use of funds to acquire capital assets that will help the organization earn future revenues or reduce future costs. Typically, several different sources of debt and/or equity financing will be used to fund a capital project (see Chapter 7). The cost to obtain capital assets is the weighted average of the cost of each of the funding sources—**weighted average cost of capital (WACC)**. Common and preferred stock, bonds, and any other form of long-term debt are included in the calculation of the project's WACC.*

Capital expenditures are long-term expenditures amortized over a period of time (Groppelli & Nikbakht). Examples of capital expenditures in sport include the purchase of a new artificial turf field for a football stadium, the purchase of a new ice resurfacer for a hockey rink, the building of a new community swimming pool, the installation of a climbing wall in a health club or college recreational center, and the construction of a stadium or arena. These expenditures require a large amount of cash, debt, and other resources that will be committed over a long period of time.

It is important to differentiate between a capital expenditure and a current expenditure. Whereas a capital expenditure is long term and amortized over time, a **current expenditure** is short term and is completely written off during the same year as the expense is incurred. Because capital expenses utilize resources over time, they are investments that require a commitment of resources today with the expectation of receiving benefits in the future. For a major Division I institution, this may mean an investment in a new basketball facility with luxury and club seating. A university will decide to invest in the facility with the hope that the facility will return new and additional revenue to the athletic department.

As stated previously, capital budgeting focuses on capital expenditures. Capital budgeting offers several benefits. First, a capital budget helps management plan the amount and timing of resources that will be needed. For example, a capital budget developed for a stadium renovation might include the timing and amounts of payments for a new $770,000 installation of FieldTurf. A team might put down a large amount at the beginning of the project and pay off the balance through smaller payments over time. A capital budget is also helpful in evaluating alternative capital expenditures. Should FieldTurf, AstroPlay, or a natural grass field be installed? The development of a capital budget will include an evaluation of these alternatives to determine which best utilizes the organization's resources.

A capital budget also focuses management's attention on cash flows. The capital budget allows the manager to identify new cash that will arise from a project and

*The formula for calculating WACC is $WACC = w_d k_d (1 - T) + w_p k_p + w_c k_c$, where w_d, w_p, and w_c are the weights of debt, preferred stock, and common equity, respectively; kd, kp, and kc are the costs of debt, preferred stock, and common equity, respectively; and T is the corporate tax rate.

compare that new cash flow to the expenditures the project demands. This information, combined with knowledge of the timing and amount of resources needed, helps management coordinate responsibility centers within the organization to ensure that all financial obligations are met.

THE PROCESS OF CAPITAL BUDGETING

To complete the capital budgeting process, financial managers use a method that comprises four distinct parts:

1. Determine the initial cost of the project or projects.
2. Determine the incremental cash flow of the project.
3. Select the capital budgeting method.
4. Conduct a post-audit analysis.

Most of the methods for completing a capital budget include the evaluation of cash flow risk (based on inflation, interest rates, and project length) and then the determination of an appropriate discount rate for use in analysis of the project. In the case of a capital budget, the **discount rate** is the required rate of return to justify an investment. After the discount rate is calculated, the asset's value to the organization is estimated on a present value basis, and the present value of expected cash inflows is compared to the cost of the project. If the present value of the project exceeds its cost, the project should be accepted and included in the organization's capital budget. Given a choice between two or more projects, managers should select the project that contributes most to the organization's net income.

These steps are outlined in detail below.

Determine the Initial Cost of the Project

The **initial cost** of a project is the actual cost of starting the project, adjusted for any installation, delivery, or packing costs; discounts to the initial price; the sale of existing equipment or machinery; and taxes. For an example of determining the initial cost of a project, let's look at the cost of replacing a natural grass football field with FieldTurf in a university football stadium.

As athletic director of a mid-major university in Ohio, you are overseeing the renovation of the football stadium. The stadium has seating for 25,500. Several prominent boosters have approached you to request the installation of an artificial turf field. They argue that by putting artificial turf in the stadium, the school could attract better recruits and thereby improve its performance on the field. Additionally, the boosters point out that several early-round high school playoff games could be played in the stadium, increasing community goodwill, generating additional revenues for the program, and creating an economic impact for the community from out-of-town spectator spending. After listening to these arguments, you decide to analyze the facts.

Based on your research on synthetic athletic fields, you decide either to install FieldTurf or to leave the natural grass field in place. FieldTurf incorporates the latest innovations in synthetic playing surfaces and has been installed by Michigan, Boston College, Nebraska, and Notre Dame. If it makes financial sense for the department, you are leaning toward installing the synthetic field, especially since there are problems with the current natural grass field, which was installed last year. Because of these problems, the university will receive a rebate of $250,000 if it chooses to replace the grass field with an artificial surface.

The first step in calculating the initial cost of the FieldTurf installation is to record the invoice price of the investment. The cost to replace the grass field with FieldTurf is \$770,000, based on the amount quoted to the university for preparation, materials, and installation.

Next, we calculate additional expenses. As the invoice price includes packing, delivery, and installation, we need not adjust for these costs. However, as mentioned above, because of problems with the current grass field, the university will receive a rebate (a discount from the initial cost) of \$250,000 if it chooses to replace the grass field with an artificial surface. Hence, the initial cost of the investment must be reduced by the \$250,000 rebate. Therefore, the initial cost of the investment is \$520,000.

Often, another adjustment is necessary for the sale of existing machinery or equipment and the tax consequences of that sale. However, in this example, the FieldTurf will replace the damaged sod in the stadium, and nothing will be sold, so no adjustment is necessary. We use the following formulae to calculate the initial cost of a project:

$$IC = IP + ATP - DTP - EQP + TOE$$

$$IC = IP + ATP - DTP - EQP - TCE$$

where IC = initial cost of the project
IP = invoice price of the new investment
ATP = adjustments to price, such as installation costs, delivery, and packing
DTP = any discounts to the initial price (IP)
EQP = revenue from the sale of existing equipment
TOE = taxes paid on the sale of equipment above book value
TCE = tax credit on the sale of equipment below book value

For the purchase of FieldTurf, recall that the invoice price of \$770,000 includes the price of the new investment and the price for delivery and installation. The university will receive a \$250,000 rebate on the installation. In this case, EQP = \$0 and TOE = \$0. (Note also that there is no tax liability or tax credit when equipment is sold at book value.) Hence,

$$IC = \$770{,}000 - \$250{,}000 - \$0 + \$0 = \$520{,}000$$

Determine the Incremental Cash Flow of the Project

After calculating the initial cost of the project, we compute its incremental cash flow. **Incremental cash flow** is the cash flow created through the implementation of a new project. It consists of any cash flow from the project that is greater than the cash flow that currently exists. The steps to determine incremental cash flow are:

1. Calculate additional net earnings (ANE) from the new project:

   $$ANE = ENEPI - ENEWP$$

   where ENEPI = estimated net earnings if the new project were included
   ENEWP = estimated net earnings without the new project

2. Calculate the additional tax benefit of the depreciation (ADT) on the new fixed asset:

   $$ADT = TAX \times DEP$$

   where TAX = tax rate
   DEP = additional depreciation of the new fixed asset

3. Calculate the incremental cash flow (ICF), by using the results of steps 1 and 2:

ICF = ANE + ADT

where ANE = additional net earnings from the new project

ADT = additional tax benefit on the new fixed asset

By using these formulae, we can calculate the incremental cash flow of the FieldTurf project. For Step 1, we must first determine the estimated net earnings without the new project (ENEWP) and the estimated net earnings with the new project (ENEPI). If the university were to keep its current natural grass field, it is estimated that the annual net earnings would be $3,300,000. With the change to FieldTurf, it is estimated that earnings would rise to $3,500,000, as additional revenues would be generated from hosting state high school playoff football games.* These additional revenues would come from facility rental fees and additional parking and concessions revenue, and they amount to $200,000 after expenses for operations are removed. Therefore, to calculate Step 1:

ANE = $3,500,000 – $3,300,000 = $200,000

As a university is a not-for-profit entity, there are no tax ramifications resulting from additional depreciation. Hence, for Step 2:

ADT = $0

Thus, the calculation for the incremental cash flow (Step 3) for this project is

ICF = $200,000 + $0 = $200,000

If, rather than a university, the organization in this example were a professional football team, Step 3 would become important. Suppose estimated net earnings without the new project for Team X are $34.5 million. The team's CFO determines that by installing FieldTurf, the team could host three college games and three state championship football games in addition to the current ten home NFL pre-season and regular season games. This additional revenue would lead to ENEPI of $40.5 million. For Step 1:

ANE = $40,500,000 – $34,500,000 = $6,000,000

As Team X is a for-profit business, the tax benefit of depreciation must be calculated. According to straight-line depreciation, the additional depreciation (DEP) is $77,000. (The cost for the FieldTurf is $770,000, and it has an estimated useful life of ten years.) At a corporate tax rate (TAX) of 35%, the calculation for Step 2 is

ADT = .35 x $77,000 = $26,950

For this project, incremental cash flow (Step 3) is

ICF = $6,000,000 + $26,950 = $6,026,950

Select the Capital Budgeting Method

Once the initial cost of the project and the project's incremental cash flows are calculated, we can complete the capital budgeting process by using any of several

*Because of higher durability and lower maintenance costs, football fields with a FieldTurf installation can be scheduled for use 4.75 times as frequently as fields with a natural grass installation (FieldTurf, 2014).

methods, including average rate of return, payback period, discounted payback period, net present value, profitability index, internal rate of return, and modified internal rate of return. Each method has advantages and disadvantages; net present value is the method most managers prefer. This chapter focuses on net present value and the two methods that are the foundation of net present value analysis: payback period and discounted payback period. We will also examine internal rate of return and modified internal rate of return.

Payback period method

The number of years required to recover a capital investment is called the **payback period**. Calculating the payback period of a project is a very basic capital budgeting tool. For any project to be accepted in a capital budget, the project's payback period must be less than the maximum acceptable payback period set by the organization. When a choice must be made between two or more alternative projects, the one with the shortest payback period should be selected.

Single-project payback period calculation. Suppose a project has an initial cost of \$52,700. Incremental cash flows are estimated to be \$22,000 in Year 1 and \$18,600, \$19,250, and \$23,000 in subsequent years. Your organization's maximum acceptable payback period is three years. As the finance manager in charge of this project, should you accept it into your department's capital budget?

To determine the answer, it is necessary to calculate the payback period. First, we list the expected cash flows:

YEAR	ICF
0	(\$52,700)
1	\$22,000
2	\$18,600
3	\$19,250
4	\$23,000

By adding the yearly incremental cash flows to the initial cost of the project, we can determine the approximate time needed to recover the project's costs.

YEAR	ICF	CUMULATIVE CASH FLOW
0	(\$52,700)	(\$52,700)
1	\$22,000	(\$30,700)
2	\$18,600	(\$12,100)
3	\$19,250	\$7,150
4	\$23,000	\$30,150

This analysis shows that the project's costs are recovered between years 2 and 3. As the payback period is less than the three years set by your organization, the project should be accepted as part of the division's capital budget. To determine a more exact payback date, notice that between years 2 and 3 the cumulative return moves from –\$12,100 to \$7,150, and during Year 3, incremental cash flow is \$19,250. We know that by Year 3 the project has reached its payback date. To determine exactly when in Year 2 the payback date is reached, we divide the amount of the last negative cumulative return by the incremental cash flow of the year the cumulative return is positive:

–\$12,100 ÷ \$19,250 = –0.629

Hence, the payback period is reached 0.629 years past Year 2, or in 2.629 years. (We disregard the fact that the value is negative.) To convert the fraction of the year to weeks, we multiply 0.629 by 52 weeks:

0.629 x 52 weeks = 32.7 weeks

The payoff period for this project is two years and 33 weeks.

Two-project payback period calculation. When choosing between two projects, we must compare the cash flows of the two projects. For example,

YEAR	PROJECT S ICF	CUMULATIVE CASH FLOW	PROJECT L ICF	CUMULATIVE CASH FLOW
0	($1,000)	($1,000)	($1,000)	($1,000)
1	$500	($500)	$100	($900)
2	$400	($100)	$300	($600)
3	$300	$200	$400	($200)
4	$100	$300	$600	$400

As always, any project must meet the maximum payback period requirement. For this organization, the maximum is three years. If both projects meet the three-year minimum, the project with the shorter payback period is preferred.

A quick analysis of each project's cumulative cash flow reveals that Project S reaches payback faster than Project L, in 2.33 years versus 3.33 years. Project S also meets the payback period maximum. Project S should be accepted into the firm's capital budget.

Advantages and disadvantages of the payback period method. Of all the methods available for capital budgeting, the payback period method is the easiest to use. Few calculations are required to determine how long it will take to recover the initial investment. The payback period method is also the easiest to understand. Most important, the method provides information on how long a firm's funds will be tied up in a project. All else being equal, projects with shorter payback periods provide more liquidity than ones with longer payback periods.

This method also has two major flaws. First, it ignores time value of money concepts (see Chapter 4), as it fails to take into account the cost of capital. It does not recognize the difference between the value of a $1,000 incremental cash flow in the first year and a $1,000 incremental cash flow in the fourth year. Second, this method ignores cash flows produced beyond the payback period. Project A may reach its payback period faster, but over the useful life of the project, Project B might increase the firm's cash flow more.

Discounted payback period method

To improve upon the payback period methodology, we may use the **discounted payback period** method. This method is similar to the payback period, with one major exception: it factors time value of money concepts into the calculation by discounting the expected cash flows at the project's initial cost of capital. (Recall that the discount rate is the rate of return a company must reach in order to justify its investment.) We use this method to determine the number of years necessary to recover the initial cost of a project, by using discounted cash flows (DCFs).

Single-project discounted payback period calculation. Suppose a project has an initial cost of $52,700. Incremental cash flows are estimated to be $22,000 in Year 1 and $18,600, $19,250, and $23,000 in subsequent years. The cost of capital is 10%. Your firm's maximum acceptable discounted payback period is three years. What is the discounted payback period for this project? How does it compare to the payback period? Should the project be accepted?

To determine the answers, we begin by examining the cash flows on a present value basis. By looking at the present value of the future cash flows, we can compare the cost of the initial outlay with those future cash flows, in today's dollars. We use the present value interest factor (see Table A.3 in the Appendix) to discount the cash flows. In Year 0, the initial cost of $52,700 is not discounted, as the value of $52,700 today is $52,700. For Year 1, we apply the discount rate of 10% to the $22,000 cash flow for that year. From Table A.3, we find that the PVIF for one year at 10% is 0.909. We also apply the discount rate to the cash flows for years 2 through 4. By adding the discounted cash flows to the initial cost of the project, we can determine the approximate time needed to recover the project's costs:

YEAR	ICF	PVIF	DCF	CUMULATIVE CASH FLOW
0	($52,700)	—	($52,700)	($52,700)
1	$22,000	0.909	$19,998	($32,702)
2	$18,600	0.826	$15,364	($17,338)
3	$19,250	0.751	$14,457	($2,881)
4	$23,000	0.683	$15,709	$12,828

Analysis of the discounted cash flows shows that the project's initial costs are recovered between years 3 and 4. Additional calculations would find that the exact payback period is 3.18 years, or three years and nine weeks. As the discounted payback period is greater than the firm's maximum payback period, the project would not be included in the capital budget.

By comparing the discounted payback period of this project to the non-discounted payback period, we can see the effect of time on the value of money. Recall that the payback period for this project is two years and 33 weeks when we do not consider this effect; it is 28 weeks later when we do.

Two-project discounted payback period calculation. When choosing between two projects, we compare the cash flows of the two projects. The following projects both have a discount rate of 10%:

PROJECT S

YEAR	ICF	PVIF	DCF	CUMULATIVE CASH FLOW
0	($1,000)	—	($1,000)	($1,000)
1	$500	0.909	$455	($545)
2	$400	0.826	$331	($241)
3	$300	0.751	$225	$11
4	$100	0.683	$68	$79

PROJECT L

YEAR	ICF	PVIF	DCF	CUMULATIVE CASH FLOW
0	($1,000)	—	($1,000)	($1,000)
1	$100	0.909	$91	($909)
2	$300	0.826	$248	($661)
3	$400	0.751	$301	($360)
4	$600	0.683	$410	$50

The project with the shorter discounted payback period should be selected for inclusion in the company's capital budget. Examining the cumulative returns, we see that Project S reaches discounted payback between years 2 and 3 (in 2.95 years, to be exact). Project L reaches discounted payback between years 3 and 4 (3.88 years). As Project S has a quicker discounted payback, it should be selected for inclusion in the capital budget over Project L.

Advantages and disadvantages of the discounted payback period method. As the discounted payback period method incorporates the time value of money into its calculation, it is a great improvement over the payback period method. It also provides information on the length of time funds will be committed to the project. However, this method, like the payback period method, does not consider the cash flows beyond the discounted payback period.

Net present value method

As previously stated, net present value is the capital budgeting method managers generally prefer for evaluating a single project or comparing two or more projects. **Net present value** (NPV) is a discounted cash flow method in which the present value of a project's future cash flows is compared to the project's initial cost. Projects are accepted if NPV is positive. Mathematically,

$$\text{NPV} = \text{present value of future cash flow} - \text{initial cost}$$

$$\text{NPV} = \sum_{t=0}^{n} \frac{CF_t}{(1+k)^t} - \text{initial cost}$$

where CF_t = the expected net cash flow in period t
k = the project's cost of capital
n = the number of periods

By using this formula, we first calculate the present value (PV) of cash flows for each year. Cash outflows are denoted by negative cash flows, and cash inflows are denoted by positive flows. Both the cash inflows and outflows of the project must be included. Up to this point, this process is the same as that for calculating a discounted payback period. Next, we sum the discounted cash flows (i.e. present values) to obtain the project's NPV. If the NPV is positive (i.e., the present value of the project's future cash flows is greater than the initial cost), the project should be accepted. If the present value is less than the initial cost (the NPV is negative), the project should be rejected. In this case, money would be lost if the project were accepted.

Two-project NPV calculation. With two (or more) projects, we calculate each project's NPV. For Project S and Project L above, the NPV of each project is the sum of the discounted cash flows. This will be the same as the final cumulative cash flow figure. The NPV of Project S is $79 and of Project L is $50. If we must choose one, we would select the project with the higher NPV (Project S) for inclusion in the capital budget. If both projects have a negative NPV, neither project would be accepted.

Single-project NPV calculation. Often, NPV analysis focuses on a single project, and the criterion for acceptance in the capital budget is that the NPV must be equal to or greater than zero.

Suppose Project T has an initial cost of $9,000 and a cost of capital of 10%. The expected useful life is four years. In years 1 through 4, the anticipated cash flows are $6,000, $4,000, $3,000, and $2,000, respectively. Should this project be recommended? To answer the question, we first calculate the discounted cash flows by using the PVIF from Appendix Table A.3:

YEAR	ICF	PVIF	DCF	CUMULATIVE CASH FLOW
0	($9,000)	—	($9,000)	($9,000)
1	$6,000	0.909	$5,454	($3,546)
2	$4,000	0.826	$3,304	($242)
3	$3,000	0.751	$2,253	$2,011
4	$2,000	0.683	$1,366	$3,377

After determining the discounted cash flow for each year, we calculate the sum of the discounted cash flows or look at the final cumulative cash flow figure. As the sum of the discounted cash flows is $3,377, Project T would be accepted into the firm's capital budget.

Another proposal, Project Z, would require an initial investment of $40,000. The cost of capital is 8%. The expected cash flows and discounted cash flows are as follows:

YEAR	ICF	PVIF	DCF	CUMULATIVE CASH FLOW
0	($40,000)	—	($40,000)	($40,000)
1	$16,000	0.926	$14,816	($25,184)
2	$12,000	0.857	$10,284	($14,900)
3	$9,000	0.794	$7,146	($7,754)
4	$7,000	0.735	$5,145	($2,609)

Because the total present value of the cash inflows, $37,391, is less than the present value of the cash outflows, $40,000, the NPV for Project Z is negative. Hence, the project is not recommended for inclusion in the organization's capital budget.

If a project has a positive NPV, it will generate cash above its debt service. Therefore, it provides the required return to shareholders, and the excess cash accrues to the shareholders. Because Project Z has a negative NPV, it would remove cash from the firm to service the project's debt. If wealth maximization is the goal, only projects that improve the firm's cash flows should be accepted.

Advantages and disadvantages of NPV. Most managers prefer to use the NPV method for capital budgeting. The method analyzes cash flows rather than net earnings, consistent with modern finance theory. Furthermore, it considers time value of money concepts, discounting cash flows by the project's cost of capital. Most important, it identifies projects with a positive NPV, which will increase the firm's value. Therefore, the owners of the firm will gain wealth.

The NPV method does have some disadvantages. One major disadvantage is that the method requires a detailed prediction of the project's future cash flows. For the hypothetical examples in this section, the useful life of each project is four years. In sport, however, the useful life of a capital investment is often much longer. For example, computing the NPV of a new stadium, such as Target Field in Minnesota, would require forecasting cash flows for the entire useful life of the stadium. Usually, this period is assumed to be 30 years. Hence, the Minnesota Ballpark Authority, owners of Target Field, had to calculate the stadium's NPV by using forecasted cash flows from 2010 until 2040. Given that stadium revenue streams have experienced massive changes over time (primarily driven by the addition of luxury suites, club seating, and personal seat licenses; Brown, Nagel, & Rascher, 2003), forecasting these revenues is extremely difficult. A second disadvantage of the NPV method is that it assumes that the discount rate will remain

Using technology to calculate NPV

The use of either a spreadsheet or a financial calculator can make the calculation of NPV easy. To illustrate, let's return to the example of replacing natural grass with artificial turf in a university football stadium.

As discussed previously, installing FieldTurf would cost $770,000. The initial cost of the investment would be only $520,000, however, as a $250,000 rebate would be applied to the invoice cost of the field. You estimate that with this field you can host three high school playoff dates per year. These games would generate $200,000 in incremental cash flow from parking, rental fees, and concession revenues, after expenses, as demonstrated earlier. The department would have to make payments on the field at an annual rate of 7%. The life of the field is estimated to be ten years.

You are now ready to decide whether to install FieldTurf or keep the stadium's current natural grass field. You will use a spreadsheet to examine the cash flows over the life of the project (see Exhibit 8.1).*

NPV can be determined in two ways. First, as discussed earlier, NPV is the sum of the discounted cash flows (see Cell E14 in Exhibit 8.1). Second, NPV can be calculated with the NPV function in Excel (see Cell B16 in Exhibit 8.1).In the NPV function's dialog box, the 7% discount rate is entered as the rate, and the series of incremental cash flows for years 1 to 10 is entered into the Value1 box. The cost of the project must be subtracted "manually" from the formula's result. From the spreadsheet analysis, you see that the NPV for the FieldTurf installation is positive, so you decide to move forward with the project.

The discounted payback period in this example is found to be two years and 50 weeks. At the end of the second year, the project will begin to create additional cash inflows that can benefit the athletic department's operations.

Finding the NPV of this project with a financial calculator is also easy. We simply enter the cash flows into the cash flow register, along with the value of the discount rate, and press the NPV key.

*Usually, financial managers use a spreadsheet to conduct capital budgeting analyses. Once a spreadsheet with formulas has been set up, values can easily be changed to show how variations would affect the project's NPV.

EXHIBIT 8.1 Calculating net present value with Excel.

	A	B	C	D	E
1	Analysis of FieldTurf				
2					
3	Time	ICF	PVIF @ 7%	DCF	Sum
4	0	$ (520,000.00)	1.000	$ (520,000.00)	$ (520,000.00)
5	1	$ 200,000.00	0.935	$ 186,915.89	$ (333,084.11)
6	2	$ 200,000.00	0.873	$ 174,687.75	$ (158,396.37)
7	3	$ 200,000.00	0.816	$ 163,259.58	$ 4,863.21
8	4	$ 200,000.00	0.763	$ 152,579.04	$ 157,442.25
9	5	$ 200,000.00	0.713	$ 142,597.24	$ 300,039.49
10	6	$ 200,000.00	0.666	$ 133,268.44	$ 433,307.93
11	7	$ 200,000.00	0.623	$ 124,549.95	$ 557,857.88
12	8	$ 200,000.00	0.582	$ 116,401.82	$ 674,259.70
13	9	$ 200,000.00	0.544	$ 108,786.75	$ 783,046.45
14	10	$ 200,000.00	0.508	$ 101,669.86	$ 884,716.31
15				=B14*C14	=D14+E13
16	NPV =	$884,716.31	=NPV(7%,B5:B14)-520000		

the same over the useful life of the project. In many instances, the cost of capital and, therefore, the discount rate change as firms refinance debt.

Internal rate of return

Internal rate of return (IRR) is the term for the discount rate at which the present value of estimated cash flows from an investment is equal to the initial cost of the investment. In other words, IRR is the discount rate at which the NPV is equal to zero. The NPV method is a more advantageous capital budgeting method than the internal rate of return. However, IRR is widely used in business, and, therefore, it is important for financial managers to understand how to calculate it (Brigham & Houston, 2012). We calculate IRR as follows:

$$\sum_{t=0}^{n} \frac{CF_t}{(1+IRR)^t} = 0$$

where CF_t = the expected net cash flow in period t

n = the number of periods

IRR = the internal rate of return

The only unknown in this equation is IRR. We simply solve for the value of IRR to find the internal rate of return.

IRR is a measure of a project's rate of profitability. A project with an IRR greater than its cost of capital is advantageous to the organization and should be accepted into the capital budget. When the IRR exceeds the cost of capital, a surplus accrues to the firm's stockholders. By accepting a project whose IRR is greater than the cost of capital, the financial manager increases shareholder wealth.

To calculate IRR with a financial calculator, enter the expected cash flows into the cash flow register and press the IRR key.

Calculating IRR with constant cash flows. If cash flows are constant over the useful life of a project, we can calculate IRR without a financial calculator or a spreadsheet. Dividing the initial cost of the project by its annual cash flow gives the present value interest factor of an annuity (PVIFA). We can look up this value in a PVIFA table (see Appendix Table A.4) to discover an approximation of IRR.

For example, suppose Project D has an expected useful life of six years and anticipated annual cash flows of $5,000. The initial cost is $20,555. If the cost of capital is 10%, should the project be accepted into the firm's capital budget?

We divide the initial cost of the project by the annual cash flow to find the PVIFA:

$$PVIFA = 20{,}555 \div 5{,}000 = 4.111$$

In the PVIFA table (Appendix Table A.4), we find that for a term of six years a PVIFA of 4.111 results from a rate of 12%; therefore, the project's IRR is 12%. As this value is greater than Project D's cost of capital (10%), the project should be accepted.

Now, suppose Project F has an initial cost of $42,560, an anticipated useful life of eight years, cost of capital of 18%, and expected cash flows of $9,800 per year. Should Project F be accepted into the company's capital budget? The PVIFA for this project is

$$PVIFA = 42{,}560 \div 9{,}800 = 4.343$$

In the PVIFA table, we find that a PVIFA of 4.343 with a term of eight years implies a rate of 16%. Project D's IRR is 16%. As this is less than the project's cost of capital, the project should not be accepted.

Calculating IRR with irregular cash flows. When cash flows are not constant, we can find IRR by trial and error with the formula given on p. 203. A financial calculator or spreadsheet software that provides financial analysis formulae is valuable for this type of calculation.

Comparing IRR to NPV. Recall the details of the analysis involving installation of FieldTurf. The initial cost of the project was $520,000, and annual incremental cash flows of $200,000 were anticipated over the ten-year useful life of the field. The project's cost of capital was 7%. What is the IRR? Does the IRR lead to a different decision than the NPV method?

By using the data entered in Exhibit 8.1, we can quickly calculate the project's IRR with Excel's IRR function (see Exhibit 8.2).

The IRR, 37%, is significantly higher than the project's cost of capital, and both the IRR and NPV methods indicate that the project should be undertaken. When a project is being considered on its own merits, the NPV and IRR methods will give the same accept or reject decision. However, when we are analyzing two or more projects in order to select one, the results of the two methods may conflict—even if both projects have positive NPVs and IRRs greater than their costs of capital. For mutually exclusive projects, the NPV method may indicate Project A should be accepted, and the IRR method may indicate Project B should be accepted. This can occur in two circumstances:

1. The projects differ greatly in financial size.
2. The projects differ greatly in the timing of cash flows.

Calculating IRR with Excel. **EXHIBIT 8.2**

	A	B	C	D	E
1	Analysis of FieldTurf				
2				= B5 * C5	= D5 + E4
3	Time	ICF	PVIF @ 7%	DCF	Sum
4	0	$ (520,000.00)	1.000	$ (520,000.00)	$ (520,000.00)
5	1	$ 200,000.00	0.935	$ 186,915.89	$ (333,084.11)
6	2	$ 200,000.00	0.873	$ 174,687.75	$ (158,396.37)
7	3	$ 200,000.00	0.816	$ 163,259.58	$ 4,863.21
8	4	$ 200,000.00	0.763	$ 152,579.04	$ 157,442.25
9	5	$ 200,000.00	0.713	$ 142,597.24	$ 300,039.49
10	6	$ 200,000.00	0.666	$ 133,268.44	$ 433,307.93
11	7	$ 200,000.00	0.623	$ 124,549.95	$ 557,857.88
12	8	$ 200,000.00	0.582	$ 116,401.82	$ 674,259.70
13	9	$ 200,000.00	0.544	$ 108,786.75	$ 783,046.45
14	10	$ 200,000.00	0.508	$ 101,669.86	$ 884,716.31
15					
16	NPV =	$884,716.31	=NPV(7%,B5:B14)-520000		
17	IRR =	37%	= IRR(B4:B14,0.4)		

It is generally accepted that when these conflicts arise, NPV is the method of evaluation that should be used (Brigham & Houston).

Modified internal rate of return

When a project involves a large cash outflow sometime during or at the end of its useful life, in addition to the cash outflow at the beginning, it is said to have non-normal cash flows. For a project with non-normal cash flows, IRR may not be usable as a capital budgeting method, because multiple IRRs may exist. Stadiums and arenas often have non-normal cash flows resulting from renovations or improvements. From 1995 to 1999, in the NFL alone, eight franchises, or 27%, played in stadiums that underwent at least $20 million in renovations during that time frame (Brown, Nagel, & Rascher).

For projects with non-normal cash flows, we recommend the **modified internal rate of return (MIRR)** for finding the rate of return. MIRR is the discount rate where the present value of the project's costs is to equal the present value of the project's terminal value (Brigham & Houston). Here, **terminal value** is the future value of the cash inflows compounded at the project's cost of capital. When the present value of the costs equals the present value of the terminal value, we have

$$PV_{costs} = \sum_{t=0}^{n} \frac{COF_t}{(1+k)^t} = \frac{TV}{(1+MIRR)^n}$$

where COF_t = the cash outflow in period t

k = the project's cost of capital

n = the number of periods

MIRR = the modified internal rate of return

PV_{costs} = the present value of costs

TV = the terminal value

In this equation, the first and second terms give the present value of the cash outflows when discounted at the cost of capital. In the rightmost term, the numerator is the compounded value of the inflows (terminal value), with the assumption that the cash inflows are reinvested at the cost of capital.

If the investment costs are all incurred during Year 0, and the first operating cash inflows occur in Year 1, then we can use the following equation for MIRR:

$$PV_{costs} = \frac{TV}{(1+MIRR)^n} = \frac{\sum_{t=1}^{n} CIF(1+k)^{n-t}}{(1+MIRR)^n}$$

Here, CIF refers to the project's cash inflows. Spreadsheet software provides a convenient method for calculating MIRR. Exhibit 8.3 shows such a calculation.

We calculate the terminal value by compounding the cash inflows at the cost of capital (7%). In a spreadsheet, we enter the formulas as shown in Exhibit 8.3. The present value of the project's cost is $520,000. We calculate the terminal value of the project by summing the future values of the expected cash inflows. We then use the RATE function to calculate MIRR (the rate of growth). We enter the present value and terminal value of the project, along with the number of periods (10), into the dialog box for the RATE function, and this gives the value of MIRR. Alternatively, we can use a financial calculator and enter the following data: N = 10, Calculating MIRR with the equation for MIRR using Excel. **EXHIBIT 8.3**

	A	B	C	D	
1			Analysis of FieldTurf		
2					
3	Time	ICF	FVIF @ 7%	Terminal Value	
4	0	$ (520,000.00)			
5	1	$ 200,000.00	1.838	$ 367,691.84	= B5 * C5
6	2	$ 200,000.00	1.718	$ 343,637.24	
7	3	$ 200,000.00	1.606	$ 321,156.30	
8	4	$ 200,000.00	1.501	$ 300,146.07	
9	5	$ 200,000.00	1.403	$ 280,510.35	
10	6	$ 200,000.00	1.311	$ 262,159.20	
11	7	$ 200,000.00	1.225	$ 245,008.60	
12	8	$ 200,000.00	1.145	$ 228,980.00	
13	9	$ 200,000.00	1.070	$ 214,000.00	
14	10	$ 200,000.00	1.000	$ 200,000.00	
15			Terminal Value =	$ 2,763,289.59	= SUM(D5:D14)
16					
17		PV of TV =	$520,000.00	= -B4	
18		NPV =	$0.00		
19					
20		MIRR =	18.18%	= RATE(A14,0,-C17,D15)	

PV = –520,000, PMT = 0, FV = 2,736,400. Press the I key, and the MIRR for the project, 18.18%, will be displayed.

A convenient method for calculating MIRR is to use Excel's MIRR function (see Exhibit 8.4).

The fact that the MIRR method assumes that cash inflows are reinvested at the cost of capital rather than at the project's IRR makes MIRR a better predictor of profitability. It provides a better estimate of a project's rate of return, and it overcomes multiple problems that arise with the IRR method when cash flows are non-normal. The MIRR method will lead to the same project selection decision as the NPV and IRR methods when we are considering two mutually exclusive projects of equal size and with the same expected useful life.

Conduct a Post-audit Analysis

The final step in the capital budgeting process is to conduct a post-audit analysis after the project has been completed. This step is often a forgotten element in the capital budgeting process. In the post-audit, we compare the project's actual results with the predicted results and attempt to explain any differences. Post-audit analyses allow managers to make improvements to the firm's forecasting techniques. Generally, the most successful organizations are ones that place great emphasis on post-audits.

EXHIBIT 8.4 Calculating MIRR with Excel's MIRR function.

	A	B	C	D	E
1	Analysis of FieldTurf				
2				= B5 * C5	= D5 + E4
3	Time	ICF	PVIF @ 7%	DCF	Sum
4	0	$ (520,000.00)	1.000	$ (520,000.00)	$ (520,000.00)
5	1	$ 200,000.00	0.935	$ 186,915.89	$ (333,084.11)
6	2	$ 200,000.00	0.873	$ 174,687.75	$ (158,396.37)
7	3	$ 200,000.00	0.816	$ 163,259.58	$ 4,863.21
8	4	$ 200,000.00	0.763	$ 152,579.04	$ 157,442.25
9	5	$ 200,000.00	0.713	$ 142,597.24	$ 300,039.49
10	6	$ 200,000.00	0.666	$ 133,268.44	$ 433,307.93
11	7	$ 200,000.00	0.623	$ 124,549.95	$ 557,857.88
12	8	$ 200,000.00	0.582	$ 116,401.82	$ 674,259.70
13	9	$ 200,000.00	0.544	$ 108,786.75	$ 783,046.45
14	10	$ 200,000.00	0.508	$ 101,669.86	$ 884,716.31
15					
16	NPV =	$884,716.31	= NPV(7%,B5:B14)-520000		
17	IRR =	37%	= IRR(B4:B14,0.4)		
18	MIRR =	18%	= MIRR(B4:B14,0.07,0.07)		

SIDEBAR 8.C

Montreal's Olympic Stadium

Olympic Stadium, part of Quebec's $2.6 billion 1976 Summer Olympic construction, was paid off in 2006. Originally, the facilities for the Olympics were to cost $250 million. Many factors led to the increase in costs, including a five-month strike that halted construction in 1975, corrupt contractors, and the government's diversion of tobacco tax dollars from the event to other governmental projects.

Surprisingly, the Montreal Olympic Games ran an operating surplus, but cost overruns at Olympic Stadium left a $1 billion debt from the stadium alone. After hosting the track and field events, as well as the opening and closing ceremonies of the 1976 Olympics, Olympic Stadium was home to the Montreal Expos from 1977 to 2004. Other events held in the venue included trade shows, monster truck rallies, concerts, and Canadian Football League games.

Over its 30-year life, the stadium needed many costly repairs. A retractable roof, called for in the original plans, never worked properly and was replaced by a permanent structure. In 1999, a part of this structure collapsed while a car show was being set up, and it was discovered that the structure could no longer withstand Montreal snowfalls. Therefore, no events could be held in the stadium from December to March. In 1991, a 55-ton concrete beam fell off the side of the stadium, leading to costly repairs and forcing the Expos to play the final month of the season on the road. Engineers determined that the stadium cannot be imploded due to its unique concrete structure. The cost to dismantle the structure would be $500 million, about half of the cost of its construction. The government is faced with the problem of generating revenue from the stadium despite its lack of a major tenant and its closure for four months of the year.

Brigham and Houston indicate that several complications can arise in the post-audit analysis. First, because of uncertainty in the forecasting of cash flows, a percentage of projects undertaken will not meet the firm's expectations. Also, projects often fail to meet expectations for reasons beyond the firm's control. See Sidebar 8.C for an example of a stadium project that had unexpected results. At times, these reasons for failure are ones that no one could realistically anticipate, such as Hurricane Katrina's effect on the sport industry along the entire Gulf Coast. It is also difficult to separate the operating results of one investment, such as a new grass or artificial field, from those of a larger system, such as a stadium. Finally, if disappointments arose because of employees' deficiencies in capital budgeting, discovering this fact will not be helpful if those responsible for entering into a project are no longer with the firm.

CONCLUSION

Capital budgeting is a process for analyzing the capital expenditures of an organization. The process involves identifying the initial cost of a capital project, determining the incremental cash flows resulting from the project's implementation, analyzing the project with one of five capital budgeting methods, and performing a post-audit analysis. All five of the capital budgeting methods discussed in this chapter provide relevant information that will be useful when a manager is selecting a project for inclusion in a firm's capital budget.

The risk and liquidity of a project are indicated by both the payback and the discounted payback method. We found in the FieldTurf case that the project reaches its discounted payback period in two years and 50 weeks. As the project has an expected useful life of ten years, the athletic director is taking a relatively small risk by entering into this fairly liquid project.

The NPV method, which indicates the present value of the dollar benefit of a project to the company, provides the best measure of a project's profitability. In the FieldTurf case, the present value benefit to the athletic department of installing the artificial turf is $884,716. The IRR method also measures profitability but expresses it as a percentage of return, which some decision makers prefer. Stating that the installation of FieldTurf will return at 37% is a convincing argument that the athletic director can present to the university's administration.

The MIRR method offers the same benefits as IRR but improves on the IRR's reinvestment assumption while avoiding the problems that IRR presents with non-normal cash flows. When cash flows are non-normal, MIRR is the best indicator of a project's rate of return. By using the MIRR method, the athletic director will find that the FieldTurf installation would provide an 18% rate of return, rather than the inflated 37% return indicated by the IRR. The MIRR method is preferred in analyses of stadiums and arenas, as these facilities often have non-normal cash flows.