Making Capital Investment Decisions 10

IS THERE GREEN IN GREEN? General Electric (GE) thinks so. Through its "Ecomagination" program, the company planned to double research and development spending on green products. By 2009, GE had invested over $5 billion in its Ecomagination program, and it announced it would invest another $10 billion from 2011 to 2015. As an example, GE's Next Evolution® Series Locomotive required over $600 million in development, but it allows railroads to move one ton of freight more than 480 miles with a single gallon of fuel. GE's green initiative seems to be paying off. Revenue from green products has totaled more than $130 billion since its launch in 2005, with $25 billion in 2012 alone. Even further, revenues from Ecomagination products were growing at twice the rate of the rest of the company's revenues. The company's internal commitment to green reduced its energy consumption by 32 percent from its 2004 baseline by 2012, and the company reduced its water consumption by 46 percent from its 2006 baseline, another considerable cost savings.

As you no doubt recognize from your study of the previous chapter, GE's decision to develop and market green technology represents a capital budgeting decision. In this chapter, we further investigate such decisions, how they are made, and how to look at them objectively.

This chapter follows up on our previous one by delving more deeply into capital budgeting. We have two main tasks. First, recall that in the last chapter, we saw that cash flow estimates are the critical input in a net present value analysis, but we didn't say much about where these cash flows come from; so we will now examine this question in some detail. Our second goal is to learn how to critically examine NPV estimates, and, in particular, how to evaluate the sensitivity of NPV estimates to assumptions made about the uncertain future.

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Learning Objectives

After studying this chapter, you should understand:

LO1 How to determine the relevant cash flows for a proposed project.
LO2 How to determine if a project is acceptable.
LO3 How to set a bid price for a project.
LO4 How to evaluate the equivalent annual cost of a project.

So far, we've covered various parts of the capital budgeting decision. Our task in this chapter is to start bringing these pieces together. In particular, we will show you how to "spread the numbers" for a proposed investment or project and, based on those numbers, make an initial assessment about whether the project should be undertaken.

In the discussion that follows, we focus on the process of setting up a discounted cash flow analysis. From the last chapter, we know that the projected future cash flows are the key element in such an evaluation. Accordingly, we emphasize working with financial and accounting information to come up with these figures.

In evaluating a proposed investment, we pay special attention to deciding what information is relevant to the decision at hand and what information is not. As we will see, it is easy to overlook important pieces of the capital budgeting puzzle.

We will wait until the next chapter to describe in detail how to go about evaluating the results of our discounted cash flow analysis. Also, where needed, we will assume that we know the relevant required return, or discount rate. We continue to defer in-depth discussion of this subject to Part 5.

10.1 Project Cash Flows: A First Look

The effect of taking a project is to change the firm's overall cash flows today and in the future. To evaluate a proposed investment, we must consider these changes in the firm's cash flows and then decide whether they add value to the firm. The first (and most important) step, therefore, is to decide which cash flows are relevant.

RELEVANT CASH FLOWS

incremental cash flows
The difference between a firm's future cash flows with a project and those without the project.

What is a relevant cash flow for a project? The general principle is simple enough: A relevant cash flow for a project is a change in the firm's overall future cash flow that comes about as a direct consequence of the decision to take that project. Because the relevant cash flows are defined in terms of changes in, or increments to, the firm's existing cash flow, they are called the **incremental cash flows** associated with the project.

The concept of incremental cash flow is central to our analysis, so we will state a general definition and refer back to it as needed:

The incremental cash flows for project evaluation consist of *any and all* changes in the firm's future cash flows that are a direct consequence of taking the project.

This definition of incremental cash flows has an obvious and important corollary: Any cash flow that exists regardless of *whether or not* a project is undertaken is *not* relevant.

THE STAND-ALONE PRINCIPLE

stand-alone principle
The assumption that evaluation of a project may be based on the project's incremental cash flows.

In practice, it would be cumbersome to actually calculate the future total cash flows to the firm with and without a project, especially for a large firm. Fortunately, it is not really necessary to do so. Once we identify the effect of undertaking the proposed project on the firm's cash flows, we need focus only on the project's resulting incremental cash flows. This is called the **stand-alone principle**.

What the stand-alone principle says is that once we have determined the incremental cash flows from undertaking a project, we can view that project as a kind of “minifirm” with its own future revenues and costs, its own assets, and, of course, its own cash flows. We will then be primarily interested in comparing the cash flows from this minifirm to the cost of acquiring it. An important consequence of this approach is that we will be evaluating the proposed project purely on its own merits, in isolation from any other activities or projects.

Concept Questions

10.1a What are the relevant incremental cash flows for project evaluation?
10.1b What is the stand-alone principle?

10.2 Incremental Cash Flows

We are concerned here with only cash flows that are incremental and that result from a project. Looking back at our general definition, we might think it would be easy enough to decide whether a cash flow is incremental. Even so, in a few situations it is easy to make mistakes. In this section, we describe some common pitfalls and how to avoid them.

SUNK COSTS

sunk cost
A cost that has already been incurred and cannot be removed and therefore should not be considered in an investment decision.

A **sunk cost**, by definition, is a cost we have already paid or have already incurred the liability to pay. Such a cost cannot be changed by the decision today to accept or reject a project. Put another way, the firm will have to pay this cost no matter what. Based on our general definition of incremental cash flow, such a cost is clearly not relevant to the decision at hand. So, we will always be careful to exclude sunk costs from our analysis.

That a sunk cost is not relevant seems obvious given our discussion. Nonetheless, it's easy to fall prey to the fallacy that a sunk cost should be associated with a project. For example, suppose General Milk Company hires a financial consultant to help evaluate whether a line of chocolate milk should be launched. When the consultant turns in the report, General Milk objects to the analysis because the consultant did not include the hefty consulting fee as a cost of the chocolate milk project.

Who is correct? By now, we know that the consulting fee is a sunk cost: It must be paid whether or not the chocolate milk line is actually launched (this is an attractive feature of the consulting business).

OPPORTUNITY COSTS

opportunity cost
The most valuable alternative that is given up if a particular investment is undertaken.

When we think of costs, we normally think of out-of-pocket costs—namely those that require us to actually spend some amount of cash. An **opportunity cost** is slightly different; it requires us to give up a benefit. A common situation arises in which a firm already owns some of the assets a proposed project will be using. For example, we might be thinking of converting an old rustic cotton mill we bought years ago for $100,000 into upmarket condominiums.

If we undertake this project, there will be no direct cash outflow associated with buying the old mill because we already own it. For purposes of evaluating the condo project, should we then treat the mill as "free"? The answer is no. The mill is a valuable resource used by the project. If we didn't use it here, we could do something else with it. Like what? The obvious answer is that, at a minimum, we could sell it.

Using the mill for the condo complex thus has an opportunity cost: We give up the valuable opportunity to do something else with the mill.[1]

There is another issue here. Once we agree that the use of the mill has an opportunity cost, how much should we charge the condo project for this use? Given that we paid $100,000, it might seem that we should charge this amount to the condo project. Is this correct? The answer is no, and the reason is based on our discussion concerning sunk costs.

The fact that we paid $100,000 some years ago is irrelevant. That cost is sunk. At a minimum, the opportunity cost that we charge the project is what the mill would sell for today (net of any selling costs) because this is the amount we give up by using the mill instead of selling it.[2]

SIDE EFFECTS

erosion
The cash flows of a new project that come at the expense of a firm's existing projects.

Remember that the incremental cash flows for a project include all the resulting changes in the *firm's* future cash flows. It would not be unusual for a project to have side, or spillover, effects, both good and bad. For example, in 2014, the time between the theatrical release of a feature film and the release of the DVD had shrunk to 17 weeks compared to 29 weeks in 1998, although several studios have shorter times. This shortened release time was blamed for at least part of the decline in movie theater box office receipts. Of course, retailers cheered the move because it was credited with increasing DVD sales. A negative impact on the cash flows of an existing product from the introduction of a new product is called **erosion**.[3] In this case, the cash flows from the new line should be adjusted downward to reflect lost profits on other lines.

In accounting for erosion, it is important to recognize that any sales lost as a result of launching a new product might be lost anyway because of future competition. Erosion is relevant only when the sales would not otherwise be lost.

Side effects show up in a lot of different ways. For example, one of The Walt Disney Company's concerns when it built Euro Disney (now known as Disneyland Paris) was that the new park would drain visitors from the Florida park, a popular vacation destination for Europeans.

There are beneficial spillover effects, of course. For example, you might think that Hewlett-Packard would have been concerned when the price of a printer that sold for $500 to $600 in 1994 declined to below $100 by 2014, but such was not the case. HP realized that the big money is in the consumables that printer owners buy to keep their printers going, such as ink-jet cartridges, laser toner cartridges, and special paper. The profit margins for these products are substantial.

NET WORKING CAPITAL

Normally a project will require that the firm invest in net working capital in addition to long-term assets. For example, a project will generally need some amount of cash on hand to pay any expenses that arise. In addition, a project will need an initial investment in inventories and accounts receivable (to cover credit sales). Some of the financing for this will be in the form of amounts owed to suppliers (accounts payable), but the firm will have to supply the balance. This balance represents the investment in net working capital.

It's easy to overlook an important feature of net working capital in capital budgeting. As a project winds down, inventories are sold, receivables are collected, bills are paid, and cash balances can be drawn down. These activities free up the net working capital originally invested. So the firm's investment in project net working capital closely resembles a loan. The firm supplies working capital at the beginning and recovers it toward the end.

FINANCING COSTS

In analyzing a proposed investment, we will *not* include interest paid or any other financing costs such as dividends or principal repaid because we are interested in the cash flow generated by the assets of the project. As we mentioned in Chapter 2, interest paid, for example, is a component of cash flow to creditors, not cash flow from assets.

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More generally, our goal in project evaluation is to compare the cash flow from a project to the cost of acquiring that project in order to estimate NPV. The particular mixture of debt and equity a firm actually chooses to use in financing a project is a managerial variable and primarily determines how project cash flow is divided between owners and creditors. This is not to say that financing arrangements are unimportant. They are just something to be analyzed separately. We will cover this in later chapters.

OTHER ISSUES

There are some other things to watch out for. First, we are interested only in measuring cash flow. Moreover, we are interested in measuring it when it actually occurs, not when it accrues in an accounting sense. Second, we are always interested in *aftertax* cash flow because taxes are definitely a cash outflow. In fact, whenever we write *incremental cash flows,* we mean aftertax incremental cash flows. Remember, however, that aftertax cash flow and accounting profit, or net income, are entirely different things.

Concept Questions

10.2a What is a sunk cost? An opportunity cost?

10.2b Explain what erosion is and why it is relevant.

10.2c Explain why interest paid is not a relevant cash flow for project evaluation.

10.3 Pro Forma Financial Statements and Project Cash Flows

The first thing we need when we begin evaluating a proposed investment is a set of pro forma, or projected, financial statements. Given these, we can develop the projected cash flows from the project. Once we have the cash flows, we can estimate the value of the project using the techniques we described in the previous chapter.

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GETTING STARTED: PRO FORMA FINANCIAL STATEMENTS

pro forma financial statements
Financial statements projecting future years' operations.

Pro forma financial statements are a convenient and easily understood means of summarizing much of the relevant information for a project. To prepare these statements, we will need estimates of quantities such as unit sales, the selling price per unit, the variable cost per unit, and total fixed costs. We will also need to know the total investment required, including any investment in net working capital.

To illustrate, suppose we think we can sell 50,000 cans of shark attractant per year at a price of $4 per can. It costs us about $2.50 per can to make the attractant, and a new product such as this one typically has only a three-year life (perhaps because the customer base dwindles rapidly). We require a 20 percent return on new products.

Fixed costs for the project, including such things as rent on the production facility, will run $12,000 per year.[4] Further, we will need to invest a total of $90,000 in manufacturing equipment. For simplicity, we will assume that this $90,000 will be 100 percent depreciated over the three-year life of the project.[5] Furthermore, the cost of removing the equipment will roughly equal its actual value in three years, so it will be essentially worthless on a market value basis as well. Finally, the project will require an initial $20,000 investment in net working capital, and the tax rate is 34 percent.

TABLE 10.1

Projected Income Statement, Shark Attractant Project

Sales (50,000 units at $4/unit)	$200,000
Variable costs ($2.50/unit)	125,000
	$ 75,000
Fixed costs	12,000
Depreciation ($90,000/3)	30,000
EBIT	$ 33,000
Taxes (34%)	11,220
Net income	$ 21,780

TABLE 10.2
Projected Capital Requirements, Shark Attractant Project

	Year			
	0	1	2	3
Net working capital	$ 20,000	$20,000	$20,000	$20,000
Net fixed assets	90,000	60,000	30,000	0
Total investment	$110,000	$80,000	$50,000	$20,000

In Table 10.1, we organize these initial projections by first preparing the pro forma income statement. Once again, notice that we have *not* deducted any interest expense. This will always be so. As we described earlier, interest paid is a financing expense, not a component of operating cash flow.

We can also prepare a series of abbreviated balance sheets that show the capital requirements for the project as we've done in Table 10.2. Here we have net working capital of $20,000 in each year. Fixed assets are $90,000 at the start of the project's life (Year 0), and they decline by the $30,000 in depreciation each year, ending up at zero. Notice that the total investment given here for future years is the total book, or accounting, value, not market value.

At this point, we need to start converting this accounting information into cash flows. We consider how to do this next.

PROJECT CASH FLOWS

To develop the cash flows from a project, we need to recall (from Chapter 2) that cash flow from assets has three components: operating cash flow, capital spending, and changes in net working capital. To evaluate a project, or minifirm, we need to estimate each of these.

Once we have estimates of the components of cash flow, we will calculate cash flow for our minifirm just as we did in Chapter 2 for an entire firm:

Project cash flow = Project operating cash flow − Project change in net working capital − Project capital spending

We consider these components next.

Project Operating Cash Flow To determine the operating cash flow associated with a project, we first need to recall the definition of operating cash flow:

Operating cash flow = Earnings before interest and taxes + Depreciation − Taxes

TABLE 10.3

Projected Income Statement, Abbreviated, Shark Attractant Project

Sales	$200,000
Variable costs	125,000
Fixed costs	12,000
Depreciation	30,000
EBIT	$ 33,000
Taxes (34%)	11,220
Net income	$ 21,780

TABLE 10.4
Projected Operating Cash Flow, Shark Attractant Project

EBIT	$33,000
Depreciation	+ 30,000
Taxes	− 11,220
Operating cash flow	$51,780

TABLE 10.5
Projected Total Cash Flows, Shark Attractant Project

	Year			
	0	1	2	3
Operating cash flow		$51,780	$51,780	$51,780
Changes in NWC	−$ 20,000			+ 20,000
Capital spending	− 90,000			
Total project cash flow	−$110,000	$51,780	$51,780	$71,780

To illustrate the calculation of operating cash flow, we will use the projected information from the shark attractant project. For ease of reference, Table 10.3 repeats the income statement in more abbreviated form.

Given the income statement in Table 10.3, calculating the operating cash flow is straightforward. As we see in Table 10.4, projected operating cash flow for the shark attractant project is $51,780.

Project Net Working Capital and Capital Spending We next need to take care of the fixed asset and net working capital requirements. Based on our balance sheets, we know that the firm must spend $90,000 up front for fixed assets and invest an additional $20,000 in net working capital. The immediate outflow is thus $110,000. At the end of the project's life, the fixed assets will be worthless, but the firm will recover the $20,000 that was tied up in working capital.[6] This will lead to a $20,000 *inflow* in the last year.

On a purely mechanical level, notice that whenever we have an investment in net working capital, that same investment has to be recovered; in other words, the same number needs to appear at some time in the future with the opposite sign.

PROJECTED TOTAL CASH FLOW AND VALUE

Given the information we've accumulated, we can finish the preliminary cash flow analysis as illustrated in Table 10.5.

Now that we have cash flow projections, we are ready to apply the various criteria we discussed in the last chapter. First, the NPV at the 20 percent required return is:

$$\text{NPV} = -\$110{,}000 + 51{,}780/1.2 + 51{,}780/1.2^2 + 71{,}780/1.2^3 = \$10{,}648$$

Based on these projections, the project creates over $10,000 in value and should be accepted. Also, the return on this investment obviously exceeds 20 percent (because the NPV is positive at 20 percent). After some trial and error, we find that the IRR works out to be about 25.8 percent.

In addition, if required, we could calculate the payback and the average accounting return, or AAR. Inspection of the cash flows shows that the payback on this project is just a little over two years (verify that it's about 2.1 years).[7]

From the last chapter, we know that the AAR is average net income divided by average book value. The net income each year is $21,780. The average (in thousands) of the four book values (from Table 10.2) for total investment is ($110 + 80 + 50 + 20)/4 = $65. So the AAR is $21,780/65,000 = 33.51 percent.[8] We've already seen that the return on this investment (the IRR) is about 26 percent. The fact that the AAR is larger illustrates again why the AAR cannot be meaningfully interpreted as the return on a project.

Concept Questions

10.3a What is the definition of project operating cash flow? How does this differ from net income?

10.3b For the shark attractant project, why did we add back the firm's net working capital investment in the final year?

10.4 More about Project Cash Flow

In this section, we take a closer look at some aspects of project cash flow. In particular, we discuss project net working capital in more detail. We then examine current tax laws regarding depreciation. Finally, we work through a more involved example of the capital investment decision.

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A CLOSER LOOK AT NET WORKING CAPITAL

In calculating operating cash flow, we did not explicitly consider the fact that some of our sales might be on credit. Also, we may not have actually paid some of the costs shown. In either case, the cash flow in question would not yet have occurred. We show here that these possibilities are not a problem as long as we don't forget to include changes in net working capital in our analysis. This discussion thus emphasizes the importance and the effect of doing so.

Suppose that during a particular year of a project we have the following simplified income statement:

Sales	$500
Costs	310
Net income	$190

Depreciation and taxes are zero. No fixed assets are purchased during the year. Also, to illustrate a point, we assume that the only components of net working capital are accounts receivable and payable. The beginning and ending amounts for these accounts are as follows:

	Beginning of Year	End of Year	Change
Accounts receivable	$880	$910	+$30
Accounts payable	550	605	+ 55
Net working capital	$330	$305	−$25

Based on this information, what is total cash flow for the year? We can first just mechanically apply what we have been discussing to come up with the answer. Operating cash flow in this particular case is the same as EBIT because there are no taxes or depreciation; thus, it equals $190. Also, notice that net working capital actually *declined* by $25. This just means that $25 was freed up during the year. There was no capital spending, so the total cash flow for the year is:

$$\text{Total cash flow} = \text{Operating cash flow} - \text{Change in NWC} - \text{Capital spending} = \$190 - (225) - 0 = \$215$$

Now, we know that this $215 total cash flow has to be "dollars in" less "dollars out" for the year. We could therefore ask a different question: What were cash revenues for the year? Also, what were cash costs?

To determine cash revenues, we need to look more closely at net working capital. During the year, we had sales of $500. However, accounts receivable rose by $30 over the same time period. What does this mean? The $30 increase tells us that sales exceeded collections by $30. In other words, we haven't yet received the cash from $30 of the $500 in sales. As a result, our cash inflow is $500 − 30 = $470. In general, cash income is sales minus the increase in accounts receivable.

Cash outflows can be similarly determined. We show costs of $310 on the income statement, but accounts payable increased by $55 during the year. This means that we have not yet paid $55 of the $310, so cash costs for the period are just $310 − 55 = $255. In other words, in this case, cash costs equal costs less the increase in accounts payable.[9]

Putting this information together, we calculate that cash inflows less cash outflows are $470 − 255 = $215, just as we had before. Notice that:

$$\begin{aligned}\text{Cash flow} &= \text{Cash inflow} - \text{Cash outflow}\\ &= (\$500 - 30) - (310 - 55)\\ &= (\$500 - 310) - (30 - 55)\\ &= \text{Operating cash flow} - \text{Change in NWC}\\ &= \$190 - (-25)\\ &= \$215\end{aligned}$$

IN THEIR OWN WORDS . . .

Samuel Weaver on Capital Budgeting at the Hershey Company

The capital program at The Hershey Company and most Fortune 500 or Fortune 1,000 companies involves a three-phase approach: planning or budgeting, evaluation, and postcompletion reviews.

The first phase involves identification of likely projects at strategic planning time. These are selected to support the strategic objectives of the corporation. This identification is generally broad in scope with minimal financial evaluation attached. Projects are classified as new product, cost savings, capacity expansion, etc. As the planning process focuses more closely on the short-term plans (or budgets), major capital expenditures are discussed more rigorously. Project costs are more closely honed, and specific projects may be reconsidered.

Each project is then individually reviewed and authorized. Planning, developing, and refining cash flows underlie capital analysis at Hershey. Once the cash flows have been determined, the application of capital evaluation techniques such as those using net present value, internal rate of return, and payback period is routine. Presentation of the results is enhanced using sensitivity analysis, which plays a major role for management in assessing the critical assumptions and resulting impact.

The final phase relates to postcompletion reviews in which the original forecasts of the project's performance are compared to actual results and/or revised expectations.

Capital expenditure analysis is only as good as the assumptions that underlie the project. The old cliché of GIGO (garbage in, garbage out) applies in this case. Incremental cash flows primarily result from incremental sales or margin improvements (cost savings). For the most part, a range of incremental cash flows can be identified from marketing research or engineering studies. However, for a number of projects, correctly discerning the implications and the relevant cash flows is analytically challenging. For example, when a new product is introduced and is expected to generate millions of dollars' worth of sales, the appropriate analysis focuses on the incremental sales after accounting for cannibalization of existing products.

One of the problems that we face at Hershey deals with the application of net present value, NPV, versus internal rate of return, IRR. NPV offers us the correct investment indication when dealing with mutually exclusive alternatives. However, decision makers at all levels sometimes find it difficult to comprehend the result. Specifically, an NPV of, say, $535,000 needs to be interpreted. It is not enough to know that the NPV is positive or even that it is more positive than an alternative. Decision makers seek to determine a level of "comfort" regarding how profitable the investment is by relating it to other standards.

Although the IRR may provide a misleading indication of which project to select, the result is provided in a way that can be interpreted by all parties. The resulting IRR can be mentally compared to expected inflation, current borrowing rates, the cost of capital, an equity portfolio's return, and so on. An IRR of, say, 18 percent is readily interpretable by management. Perhaps this ease of understanding is why surveys indicate that many Fortune 500 or Fortune 1,000 companies use the IRR method (in conjunction with NPV) as a primary evaluation technique.

In addition to the NPV versus IRR problem, there are a limited number of projects for which traditional capital expenditure analysis is difficult to apply because the cash flows can't be determined. When new computer equipment is purchased, an office building is renovated, or a parking lot is repaved, it is essentially impossible to identify the cash flows, so the use of traditional evaluation techniques is limited. These types of "capital expenditure" decisions are made using other techniques that hinge on management's judgment.

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More generally, this example illustrates that including net working capital changes in our calculations has the effect of adjusting for the discrepancy between accounting sales and costs and actual cash receipts and payments.

EXAMPLE 10.1 Cash Collections and Costs

For the year just completed, the Combat Wombat Telestat Co. (CWT) reports sales of $998 and costs of $734. You have collected the following beginning and ending balance sheet information:

	Beginning	Ending
Accounts receivable	$100	$110
Inventory	100	80
Accounts payable	100	70
Net working capital	$100	$120

Based on these figures, what are cash inflows? Cash outflows? What happened to each account? What is net cash flow?

Sales were $998, but receivables rose by $10. So cash collections were $10 less than sales, or $988. Costs were $734, but inventories fell by $20. This means that we didn't replace $20 worth of inventory, so costs are actually overstated by this amount. Also, payables fell by $30. This means that, on a net basis, we actually paid our suppliers $30 more than we received from them, resulting in a $30 understatement of costs. Adjusting for these events, we calculate that cash costs are $734 − 20 + 30 = $744. Net cash flow is $988 − 744 = $244.

Finally, notice that net working capital increased by $20 overall. We can check our answer by noting that the original accounting sales less costs (= $998 − 734) are $264. In addition, CWT spent $20 on net working capital, so the net result is a cash flow of $264 − 20 = $244, as we calculated.

DEPRECIATION

accelerated cost recovery system (ACRS)
A depreciation method under U.S. tax law allowing for the accelerated write-off of property under various classifications.

As we note elsewhere, accounting depreciation is a noncash deduction. As a result, depreciation has cash flow consequences only because it influences the tax bill. The way that depreciation is computed for tax purposes is thus the relevant method for capital investment decisions. Not surprisingly, the procedures are governed by tax law. We now discuss some specifics of the depreciation system enacted by the Tax Reform Act of 1986. This system is a modification of the **accelerated cost recovery system (ACRS)** instituted in 1981.

Modified ACRS Depreciation (MACRS) Calculating depreciation is normally mechanical. Although there are a number of *ifs, ands,* and *buts* involved, the basic idea under MACRS is that every asset is assigned to a particular class. An asset's class establishes its life for tax purposes. Once an asset's tax life is determined, the depreciation for each year is computed by multiplying the cost of the asset by a fixed percentage.[10] The expected salvage value (what we think the asset will be worth when we dispose of it) and the expected economic life (how long we expect the asset to be in service) are not explicitly considered in the calculation of depreciation.

Some typical depreciation classes are given in Table 10.6, and associated percentages (as specified by the IRS) are shown in Table 10.7.[11]

A nonresidential real property, such as an office building, is depreciated over 31.5 years using straight-line depreciation. A residential real property, such as an apartment building, is depreciated straight-line over 27.5 years. Remember that land cannot be depreciated.[12]

TABLE 10.6
Modified ACRS Property Classes

Class	Examples
Three-year	Equipment used in research
Five-year	Autos, computers
Seven-year	Most industrial equipment

TABLE 10.7
Modified ACRS Depreciation Allowances

	Property Class		
Year	Three-Year	Five-Year	Seven-Year
1	33.33%	20.00%	14.29%
2	44.45	32.00	24.49
3	14.81	19.20	17.49
4	7.41	11.52	12.49
5		11.52	8.93
6		5.76	8.92
7			8.93
8			4.46

To illustrate how depreciation is calculated, we consider an automobile costing $12,000. Autos are normally classified as five-year property. Looking at Table 10.7, we see that the relevant figure for the first year of a five-year asset is 20 percent.[13] The depreciation in the first year is thus $12,000 × .20 = $2,400. The relevant percentage in the second year is 32 percent, so the depreciation in the second year is $12,000 × .32 = $3,840, and so on. We can summarize these calculations as follows:

Year	MACRS Percentage	Depreciation
1	20.00%	.2000 × $12,000 = $ 2,400.00
2	32.00	.3200 × 12,000 = 3,840.00
3	19.20	.1920 × 12,000 = 2,304.00
4	11.52	.1152 × 12,000 = 1,382.40
5	11.52	.1152 × 12,000 = 1,382.40
6	5.76	.0576 × 12,000 = 691.20
	100.00%	$12,000.00

Notice that the MACRS percentages sum up to 100 percent. As a result, we write off 100 percent of the cost of the asset, or $12,000 in this case.

Book Value versus Market Value In calculating depreciation under current tax law, the economic life and future market value of the asset are not an issue. As a result, the book value of an asset can differ substantially from its actual market value. For example, with our $12,000 car, book value after the first year is $12,000 less the first year's depreciation of $2,400, or $9,600. The remaining book values are summarized in Table 10.8. After six years, the book value of the car is zero.

Suppose we wanted to sell the car after five years. Based on historical averages, it would be worth, say, 25 percent of the purchase price, or .25 × $12,000 = $3,000. If we actually sold it for this, then we would have to pay taxes at the ordinary income tax rate on the difference between the sale price of $3,000 and the book value of $691.20. For a corporation in the 34 percent bracket, the tax liability would be .34 × $2,308.80 = $784.99.[14]

TABLE 10.8
MACRS Book Values

Year	Beginning Book Value	Depreciation	Ending Book Value
1	$12,000.00	$2,400.00	$9,600.00
2	9,600.00	3,840.00	5,760.00
3	5,760.00	2,304.00	3,456.00
4	3,456.00	1,382.40	2,073.60
5	2,073.60	1,382.40	691.20
6	691.20	691.20	.00

The reason taxes must be paid in this case is that the difference between market value and book value is "excess" depreciation, and it must be "recaptured" when the asset is sold. What this means is that, as it turns out, we overdepreciated the asset by $3,000 − 691.20 = $2,308.80. Because we deducted $2,308.80 too much in depreciation, we paid $784.99 too little in taxes, and we simply have to make up the difference.

Notice that this is *not* a tax on a capital gain. As a general (albeit rough) rule, a capital gain occurs only if the market price exceeds the original cost. However, what is and what is not a capital gain is ultimately up to taxing authorities, and the specific rules can be complex. We will ignore capital gains taxes for the most part.

Finally, if the book value exceeds the market value, then the difference is treated as a loss for tax purposes. For example, if we sell the car after two years for $4,000, then the book value exceeds the market value by $1,760. In this case, a tax saving of .34 × $1,760 = $598.40 occurs.

EXAMPLE 10.2 MACRS Depreciation

The Staple Supply Co. has just purchased a new computerized information system with an installed cost of $160,000. The computer is treated as five-year property. What are the yearly depreciation allowances? Based on historical experience, we think that the system will be worth only $10,000 when Staple gets rid of it in four years. What are the tax consequences of the sale? What is the total aftertax cash flow from the sale?

The yearly depreciation allowances are calculated by just multiplying $160,000 by the five-year percentages found in Table 10.7:

Year	MACRS Percentage	Depreciation	Ending Book Value
1	20.00%	.2000 × $160,000 = $ 32,000	$128,000
2	32.00	.3200 × 160,000 = 51,200	76,800
3	19.20	.1920 × 160,000 = 30,720	46,080
4	11.52	.1152 × 160,000 = 18,432	27,648
5	11.52	.1152 × 160,000 = 18,432	9,216
6	5.76	.0576 × 160,000 = 9,216	0
	100.00%	$160,000	

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Notice that we have also computed the book value of the system as of the end of each year. The book value at the end of Year 4 is $27,648. If Staple sells the system for $10,000 at that time, it will have a loss of $17,648 (the difference) for tax purposes. This loss, of course, is like depreciation because it isn't a cash expense.

What really happens? Two things. First, Staple gets $10,000 from the buyer. Second, it saves .34 × $17,648 = $6,000 in taxes. So, the total aftertax cash flow from the sale is a $16,000 cash inflow.

AN EXAMPLE: THE MAJESTIC MULCH AND COMPOST COMPANY (MMCC)

At this point, we want to go through a somewhat more involved capital budgeting analysis. Keep in mind as you read that the basic approach here is exactly the same as that in the shark attractant example used earlier. We have just added some real-world detail (and a lot more numbers).

MMCC is investigating the feasibility of a new line of power mulching tools aimed at the growing number of home composters. Based on exploratory conversations with buyers for large garden shops, MMCC projects unit sales as follows:

Year	Unit Sales
1	3,000
2	5,000
3	6,000
4	6,500
5	6,000
6	5,000
7	4,000
8	3,000

The new power mulcher will sell for $120 per unit to start. When the competition catches up after three years, however, MMCC anticipates that the price will drop to $110.

The power mulcher project will require $20,000 in net working capital at the start. Subsequently, total net working capital at the end of each year will be about 15 percent of sales for that year. The variable cost per unit is $60, and total fixed costs are $25,000 per year.

It will cost about $800,000 to buy the equipment necessary to begin production. This investment is primarily in industrial equipment, which qualifies as seven-year MACRS property. The equipment will actually be worth about 20 percent of its cost in eight years, or .20 × $800,000 = $160,000. The relevant tax rate is 34 percent, and the required return is 15 percent. Based on this information, should MMCC proceed?

Operating Cash Flows There is a lot of information here that we need to organize. The first thing we can do is calculate projected sales. Sales in the first year are projected at 3,000 units at $120 apiece, or $360,000 total. The remaining figures are shown in Table 10.9.

Next, we compute the depreciation on the $800,000 investment in Table 10.10. With this information, we can prepare the pro forma income statements, as shown in Table 10.11. From here, computing the operating cash flows is straightforward. The results are illustrated in the first part of Table 10.13.

TABLE 10.9
Projected Revenues, Power Mulcher Project

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Year	Unit Price	Unit Sales	Revenues
1	$120	3,000	$360,000
2	120	5,000	600,000
3	120	6,000	720,000
4	110	6,500	715,000
5	110	6,000	660,000
6	110	5,000	550,000
7	110	4,000	440,000
8	110	3,000	330,000

TABLE 10.10
Annual Depreciation, Power Mulcher Project

Year	MACRS Percentage	Depreciation	Ending Book Value
1	14.29%	.1429 × $800,000 = $114,320	$685,680
2	24.49	.2449 × 800,000 = 195,920	489,760
3	17.49	.1749 × 800,000 = 139,920	349,840
4	12.49	.1249 × 800,000 = 99,920	249,920
5	8.93	.0893 × 800,000 = 71,440	178,480
6	8.92	.0892 × 800,000 = 71,360	107,120
7	8.93	.0893 × 800,000 = 71,440	35,680
8	4.46	.0446 × 800,000 = 35,680	0
	100.00%	$800,000	

TABLE 10.11 Projected Income Statements, Power Mulcher Project

	Year							
	1	2	3	4	5	6	7	8
Unit price	$ 120	$ 120	$ 120	$ 110	$ 110	$ 110	$ 110	$ 110
Unit sales	3,000	5,000	6,000	6,500	6,000	5,000	4,000	3,000
Revenues	$360,000	$600,000	$720,000	$715,000	$660,000	$550,000	$440,000	$330,000
Variable costs	180,000	300,000	360,000	390,000	360,000	300,000	240,000	180,000
Fixed costs	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000
Depreciation	114,320	195,920	139,920	99,920	71,440	71,360	71,440	35,680
EBIT	$ 40,680	$ 79,080	$195,080	$200,080	$203,560	$153,640	$103,560	$ 89,320
Taxes (34%)	13,831	26,887	66,327	68,027	69,210	52,238	35,210	30,369
Net income	$ 26,849	$ 52,193	$128,753	$132,053	$134,350	$101,402	$ 68,350	$ 58,951

Change in NWC Now that we have the operating cash flows, we need to determine the changes in NWC. By assumption, net working capital requirements change as sales change. In each year, MMCC will generally either add to or recover some of its project net working capital. Recalling that NWC starts out at $20,000 and then rises to 15 percent of sales, we can calculate the amount of NWC for each year as shown in Table 10.12.

As illustrated, during the first year, net working capital grows from $20,000 to .15 × $360,000 = $54,000. The increase in net working capital for the year is thus $54,000 − 20,000 = $34,000. The remaining figures are calculated in the same way.

TABLE 10.12

Changes in Net Working Capital, Power Mulcher Project

Year	Revenues	Net Working Capital	Cash Flow
0		$ 20,000	−$20,000
1	$360,000	54,000	− 34,000
2	600,000	90,000	− 36,000
3	720,000	108,000	− 18,000
4	715,000	107,250	750
5	660,000	99,000	8,250
6	550,000	82,500	16,500
7	440,000	66,000	16,500
8	330,000	49,500	16,500

TABLE 10.13
Projected Cash Flows, Power Mulcher Project

	Year								
	0	1	2	3	4	5	6	7	8
I. Operating Cash Flow									
EBIT		$ 40,680	$ 79,080	$195,080	$200,080	$203,560	$153,640	$103,560	$ 89,320
Depreciation		114,320	195,920	139,920	99,920	71,440	71,360	71,440	35,680
Taxes		− 13,831	− 26,887	− 66,327	− 68,027	− 69,210	− 52,238	− 35,210	− 30,369
Operating cash flow		$141,169	$248,113	$268,673	$231,973	$205,790	$172,762	$139,790	$ 94,631
II. Net Working Capital									
Initial NWC	−$ 20,000								
Change in NWC		−$ 34,000	−$ 36,000	−$ 18,000	$ 750	$ 8,250	$ 16,500	$ 16,500	$ 16,500
NWC recovery									49,500
Total change in NWC	−$ 20,000	−$ 34,000	−$ 36,000	−$ 18,000	$ 750	$ 8,250	$ 16,500	$ 16,500	$ 66,000
III. Capital Spending									
Initial outlay	−$800,000								
Aftertax salvage									$105,600
Capital spending	−$800,000								$105,600

Remember that an increase in net working capital is a cash outflow, so we use a negative sign in this table to indicate an additional investment that the firm makes in net working capital. A positive sign represents net working capital returning to the firm. Thus, for example, $16,500 in NWC flows back to the firm in Year 6. Over the project's life, net working capital builds to a peak of $108,000 and declines from there as sales begin to drop off.

We show the result for changes in net working capital in the second part of Table 10.13. Notice that at the end of the project's life, there is $49,500 in net working capital still to be recovered. Therefore, in the last year, the project returns $16,500 of NWC during the year and then returns the remaining $49,500 at the end of the year for a total of $66,000.

TABLE 10.14 Projected Total Cash Flows, Power Mulcher Project

	Year								
	0	1	2	3	4	5	6	7	8
Operating cash flow		$141,169	$248,113	$268,673	$231,973	$205,790	$172,762	$139,790	$ 94,631
Change in NWC	−$ 20,000	− 34,000	− 36,000	− 18,000	750	8,250	16,500	16,500	66,000
Capital spending	− 800,000								105,600
Total project cash flow	−$820,000	$107,169	$212,113	$250,673	$232,723	$214,040	$189,262	$156,290	$266,231
Cumulative cash flow	−$820,000	−$712,831	−$500,718	−$250,045	−$ 17,322	$196,718	$385,980	$542,270	$808,501
Discounted cash flow @ 15%	− 820,000	93,190	160,388	164,822	133,060	106,416	81,823	58,755	87,031
Net present value (15%) = $65,485									
Internal rate of return = 17.24%									
Payback = 4.08 years									

Capital Spending Finally, we have to account for the long-term capital invested in the project. In this case, MMCC invests $800,000 at Year 0. By assumption, this equipment will be worth $160,000 at the end of the project. It will have a book value of zero at that time. As we discussed earlier, this $160,000 excess of market value over book value is taxable, so the aftertax proceeds will be $160,000 × (1 − .34) = $105,600. These figures are shown in the third part of Table 10.13.

Total Cash Flow and Value We now have all the cash flow pieces, and we put them together in Table 10.14. If you notice, the project cash flows each year are the same as the cash flow from assets that we calculated in Chapter 3. In addition to the total project cash flows, we have calculated the cumulative cash flows and the discounted cash flows. At this point, it's essentially plug-and-chug to calculate the net present value, internal rate of return, and payback.

If we sum the discounted flows and the initial investment, the net present value (at 15 percent) works out to be $65,485. This is positive, so, based on these preliminary projections, the power mulcher project is acceptable. The internal, or DCF, rate of return is greater than 15 percent because the NPV is positive. It works out to be 17.24 percent, again indicating that the project is acceptable.

Looking at the cumulative cash flows, we can see that the project has almost paid back after four years because the table shows that the cumulative cash flow is almost zero at that time. As indicated, the fractional year works out to be $17,322/214,040 = .08, so the payback is 4.08 years. We can't say whether or not this is good because we don't have a benchmark for MMCC. This is the usual problem with payback periods.

Conclusion This completes our preliminary DCF analysis. Where do we go from here? If we have a great deal of confidence in our projections, there is no further analysis to be done. MMCC should begin production and marketing immediately. It is unlikely that this will be the case. It is important to remember that the result of our analysis is an estimate of NPV, and we will usually have less than complete confidence in our projections. This means we have more work to do. In particular, we will almost surely want to spend some time evaluating the quality of our estimates. We will take up this subject in the next chapter. For now, we look at some alternative definitions of operating cash flow, and we illustrate some different cases that arise in capital budgeting.

Concept Questions

10.4a Why is it important to consider changes in net working capital in developing cash flows? What is the effect of doing so?

10.4b How is depreciation calculated for fixed assets under current tax law? What effects do expected salvage value and estimated economic life have on the calculated depreciation deduction?

10.5 Alternative Definitions of Operating Cash Flow

The analysis we went through in the previous section is quite general and can be adapted to just about any capital investment problem. In the next section, we illustrate some particularly useful variations. Before we do so, we need to discuss the fact that there are different definitions of project operating cash flow that are commonly used, both in practice and in finance texts.

As we will see, the different approaches to operating cash flow that exist all measure the same thing. If they are used correctly, they all produce the same answer, and one is not necessarily any better or more useful than another. Unfortunately, the fact that alternative definitions are used does sometimes lead to confusion. For this reason, we examine several of these variations next to see how they are related.

In the discussion that follows, keep in mind that when we speak of cash flow, we literally mean dollars in less dollars out. This is all we are concerned with. Different definitions of operating cash flow simply amount to different ways of manipulating basic information about sales, costs, depreciation, and taxes to get at cash flow.

For a particular project and year under consideration, suppose we have the following estimates:

Sales = \$1,500
Costs = \$700
Depreciation = \$600

With these estimates, notice that EBIT is:

EBIT = Sales − Costs − Depreciation = \$1,500 − 700 − 600 = \$200

Once again, we assume that no interest is paid, so the tax bill is:

Taxes = EBIT × T = \$200 × .34 = \$68

where T, the corporate tax rate, is 34 percent.

When we put all of this together, we see that project operating cash flow, OCF, is:

OCF = EBIT + Depreciation − Taxes = \$200 + 600 − 68 = \$732

There are some other ways to determine OCF that could be (and are) used. We consider these next.

THE BOTTOM-UP APPROACH

Because we are ignoring any financing expenses, such as interest, in our calculations of project OCF, we can write project net income as:

Project net income = EBIT − Taxes = $200 − 68 = $132

If we simply add the depreciation to both sides, we arrive at a slightly different and very common expression for OCF:

$$\begin{aligned} \text{OCF} &= \text{Net income} + \text{Depreciation} \\ &= \$132 + 600 \\ &= \$732 \end{aligned} \qquad \textbf{[10.1]}$$

This is the *bottom-up* approach. Here, we start with the accountant's bottom line (net income) and add back any noncash deductions such as depreciation. It is crucial to remember that this definition of operating cash flow as net income plus depreciation is correct only if there is no interest expense subtracted in the calculation of net income.

For the shark attractant project, net income was $21,780 and depreciation was $30,000, so the bottom-up calculation is:

OCF = $21,780 + 30,000 = $51,780

This is exactly the same OCF we had previously.

THE TOP-DOWN APPROACH

Perhaps the most obvious way to calculate OCF is:

$$\begin{aligned} \text{OCF} &= \text{Sales} - \text{Costs} - \text{Taxes} \\ &= \$1{,}500 - 700 - 68 = \$732 \end{aligned} \qquad \textbf{[10.2]}$$

This is the *top-down* approach, the second variation on the basic OCF definition. Here, we start at the top of the income statement with sales and work our way down to net cash flow by subtracting costs, taxes, and other expenses. Along the way, we simply leave out any strictly noncash items such as depreciation.

For the shark attractant project, the operating cash flow can be readily calculated using the top-down approach. With sales of $200,000, total costs (fixed plus variable) of $137,000, and a tax bill of $11,220, the OCF is:

OCF = $200,000 − 137,000 − 11,220 = $51,780

This is just as we had before.

THE TAX SHIELD APPROACH

The third variation on our basic definition of OCF is the *tax shield* approach. This approach will be useful for some problems we consider in the next section. The tax shield definition of OCF is:

$$\text{OCF} = (\text{Sales} - \text{Costs}) \times (1 - T) + \text{Depreciation} \times T \qquad \textbf{[10.3]}$$

where T is again the corporate tax rate. Assuming that T = 34%, the OCF works out to be:

OCF = ($1,500 − 700) × .66 + 600 × .34 = $528 + 204 = $732

This is just as we had before.

This approach views OCF as having two components. The first part is what the project's cash flow would be if there were no depreciation expense. In this case, this would-have-been cash flow is $528.

depreciation tax shield
The tax saving that results from the depreciation deduction, calculated as depreciation multiplied by the corporate tax rate.

The second part of OCF in this approach is the depreciation deduction multiplied by the tax rate. This is called the **depreciation tax shield**. We know that depreciation is a noncash expense. The only cash flow effect of deducting depreciation is to reduce our taxes, a benefit to us. At the current 34 percent corporate tax rate, every dollar in depreciation expense saves us 34 cents in taxes. So, in our example, the $600 depreciation deduction saves us $600 × .34 = $204 in taxes.

For the shark attractant project we considered earlier in the chapter, the depreciation tax shield would be $30,000 × .34 = $10,200. The aftertax value for sales less costs would be ($200,000 − 137,000) × (1 − .34) = $41,580. Adding these together yields the value of OCF:

OCF = $41,580 + 10,200 = $51,780

This calculation verifies that the tax shield approach is completely equivalent to the approach we used before.

CONCLUSION

Now that we've seen that all of these approaches are the same, you're probably wondering why everybody doesn't just agree on one of them. One reason, as we will see in the next section, is that different approaches are useful in different circumstances. The best one to use is whichever happens to be the most convenient for the problem at hand.

Concept Questions

10.5a What are the top-down and bottom-up definitions of operating cash flow?

10.5b What is meant by the term *depreciation tax shield?*

10.6 Some Special Cases of Discounted Cash Flow Analysis

To finish our chapter, we look at three common cases involving discounted cash flow analysis. The first case involves investments that are primarily aimed at improving efficiency and thereby cutting costs. The second case we consider comes up when a firm is involved in submitting competitive bids. The third and final case arises in choosing between equipment options with different economic lives.

We could consider many other special cases, but these three are particularly important because problems similar to these are so common. Also, they illustrate some diverse applications of cash flow analysis and DCF valuation.

EVALUATING COST-CUTTING PROPOSALS

One decision we frequently face is whether to upgrade existing facilities to make them more cost-effective. The issue is whether the cost savings are large enough to justify the necessary capital expenditure.

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For example, suppose we are considering automating some part of an existing production process. The necessary equipment costs $80,000 to buy and install. The automation will save $22,000 per year (before taxes) by reducing labor and material costs. For simplicity, assume that the equipment has a five-year life and is depreciated to zero on a straight-line basis over that period. It will actually be worth $20,000 in five years. Should we automate? The tax rate is 34 percent, and the discount rate is 10 percent.

As always, the first step in making such a decision is to identify the relevant incremental cash flows. First, determining the relevant capital spending is easy enough. The initial cost is $80,000. The aftertax salvage value is $20,000 × (1 − .34) = $13,200 because the book value will be zero in five years. Second, there are no working capital consequences here, so we don't need to worry about changes in net working capital.

Operating cash flows are the third component to consider. Buying the new equipment affects our operating cash flows in two ways. First, we save $22,000 before taxes every year. In other words, the firm's operating income increases by $22,000, so this is the relevant incremental project operating income.

Second (and it's easy to overlook this), we have an additional depreciation deduction. In this case, the depreciation is $80,000/5 = $16,000 per year.

Because the project has an operating income of $22,000 (the annual pretax cost saving) and a depreciation deduction of $16,000, taking the project will increase the firm's EBIT by $22,000 − 16,000 = $6,000, so this is the project's EBIT.

Finally, because EBIT is rising for the firm, taxes will increase. This increase in taxes will be $6,000 × .34 = $2,040. With this information, we can compute operating cash flow in the usual way:

EBIT	$ 6,000
+ Depreciation	16,000
− Taxes	2,040
Operating cash flow	$19,960

So, our aftertax operating cash flow is $19,960.

It might be somewhat more enlightening to calculate operating cash flow using a different approach. What is actually going on here is very simple. First, the cost savings increase our pretax income by $22,000. We have to pay taxes on this amount, so our tax bill increases by .34 × $22,000 = $7,480. In other words, the $22,000 pretax saving amounts to $22,000 × (1 − .34) = $14,520 after taxes.

Second, the extra $16,000 in depreciation isn't really a cash outflow, but it does reduce our taxes by $16,000 × .34 = $5,440. The sum of these two components is $14,520 + 5,440 = $19,960, just as we had before. Notice that the $5,440 is the depreciation tax shield we discussed earlier, and we have effectively used the tax shield approach here.

We can now finish our analysis. Based on our discussion, here are the relevant cash flows:

	Year					
	0	1	2	3	4	5
Operating cash flow		$19,960	$19,960	$19,960	$19,960	$19,960
Capital spending	−$80,000					13,200
Total cash flow	−$80,000	$19,960	$19,960	$19,960	$19,960	$33,160

At 10 percent, it's straightforward to verify that the NPV here is $3,860, so we should go ahead and automate.

EXAMPLE 10.3 To Buy or Not to Buy

We are considering the purchase of a $200,000 computer-based inventory management system. It will be depreciated straight-line to zero over its four-year life. It will be worth $30,000 at the end of that time. The system will save us $60,000 before taxes in inventory-related costs. The relevant tax rate is 39 percent. Because the new setup is more efficient than our existing one, we will be able to carry less total inventory and thus free up $45,000 in net working capital. What is the NPV at 16 percent? What is the DCF return (the IRR) on this investment?

We can first calculate the operating cash flow. The aftertax cost savings are $60,000 × (1 − .39) = $36,600. The depreciation is $200,000/4 = $50,000 per year, so the depreciation tax shield is $50,000 × .39 = $19,500. Operating cash flow is thus $36,600 + 19,500 = $56,100 per year.

The capital spending involves $200,000 up front to buy the system. The aftertax salvage is $30,000 × (1 − .39) = $18,300. Finally, and this is the somewhat tricky part, the initial investment in net working capital is a $45,000 *inflow* because the system frees up working capital. Furthermore, we will have to put this back in at the end of the project's life. What this really means is simple: While the system is in operation, we have $45,000 to use elsewhere.

To finish our analysis, we can compute the total cash flows:

	Year				
	0	1	2	3	4
Operating cash flow		$56,100	$56,100	$56,100	$56,100
Change in NWC	$ 45,000				− 45,000
Capital spending	− 200,000				18,300
Total cash flow	−$155,000	$56,100	$56,100	$56,100	$29,400

At 16 percent, the NPV is −$12,768, so the investment is not attractive. After some trial and error, we find that the NPV is zero when the discount rate is 11.48 percent, so the IRR on this investment is about 11.5 percent.

SETTING THE BID PRICE

Early on, we used discounted cash flow analysis to evaluate a proposed new product. A somewhat different (and common) scenario arises when we must submit a competitive bid to win a job. Under such circumstances, the winner is whoever submits the lowest bid.

There is an old joke concerning this process: The low bidder is whoever makes the biggest mistake. This is called the winner's curse. In other words, if you win, there is a good chance you underbid. In this section, we look at how to go about setting the bid price to avoid the winner's curse. The procedure we describe is useful anytime we have to set a price on a product or service.

As with any other capital budgeting project, we must be careful to account for all relevant cash flows. For example, industry analysts estimated that the cost of materials and assembly of Microsoft's Xbox One is $471. At a retail price of $499, Microsoft loses money on each Xbox One it sells after fixed costs are included. Why would a manufacturer sell at a price that guarantees a loss? Microsoft believes that profits lie in the sale of game software. Of course, Sony doesn't fare much better. The PS4 costs $381 to make per console with a retail price of $399.

To illustrate how to go about setting a bid price, imagine we are in the business of buying stripped-down truck platforms and then modifying them to customer specifications for resale. A local distributor has requested bids for five specially modified trucks each year for the next four years, for a total of 20 trucks in all.

We need to decide what price per truck to bid. The goal of our analysis is to determine the lowest price we can profitably charge. This maximizes our chances of being awarded the contract while guarding against the winner's curse.

Suppose we can buy the truck platforms for $10,000 each. The facilities we need can be leased for $24,000 per year. The labor and material cost to do the modification works out to be about $4,000 per truck. Total cost per year will thus be $24,000 + 5 × (10,000 + 4,000) = $94,000.

We will need to invest $60,000 in new equipment. This equipment will be depreciated straight-line to a zero salvage value over the four years. It will be worth about $5,000 at the end of that time. We will also need to invest $40,000 in raw materials inventory and other working capital items. The relevant tax rate is 39 percent. What price per truck should we bid if we require a 20 percent return on our investment?

We start by looking at the capital spending and net working capital investment. We have to spend $60,000 today for new equipment. The aftertax salvage value is $5,000 × (1 − .39) = $3,050. Furthermore, we have to invest $40,000 today in working capital. We will get this back in four years.

We can't determine the operating cash flow just yet because we don't know the sales price. Thus, if we draw a time line, here is what we have so far:

	Year				
	0	1	2	3	4
Operating cash flow		+OCF	+OCF	+OCF	+OCF
Change in NWC	−$ 40,000				$40,000
Capital spending	− 60,000				3,050
Total cash flow	−$100,000	+OCF	+OCF	+OCF	+OCF + $43,050

With this in mind, note that the key observation is the following: The lowest possible price we can profitably charge will result in a zero NPV at 20 percent. At that price, we earn exactly 20 percent on our investment.

Given this observation, we first need to determine what the operating cash flow must be for the NPV to equal zero. To do this, we calculate the present value of the $43,050 non-operating cash flow from the last year and subtract it from the $100,000 initial investment:

$$\$100,000 - 43,050/1.20^4 = \$100,000 - 20,761 = \$79,239$$

Once we have done this, our time line is as follows:

	Year				
	0	1	2	3	4
Total cash flow	−$79,239	+OCF	+OCF	+OCF	+OCF

As the time line suggests, the operating cash flow is now an unknown ordinary annuity amount. The four-year annuity factor for 20 percent is 2.58873, so we have:

$$\text{NPV} = 0 = -\$79,239 + \text{OCF} \times 2.58873$$

This implies that:

$$\text{OCF} = \$79,239/2.58873 = \$30,609$$

So the operating cash flow needs to be $30,609 each year.

We're not quite finished. The final problem is to find out what sales price results in an operating cash flow of \$30,609. The easiest way to do this is to recall that operating cash flow can be written as net income plus depreciation (the bottom-up definition). The depreciation here is \$60,000/4 = \$15,000. Given this, we can determine what net income must be:

Operating cash flow = Net income + Depreciation
\$30,609 = Net income + \$15,000
Net income = \$15,609

From here, we work our way backward up the income statement. If net income is \$15,609, then our income statement is as follows:

Sales	?
Costs	\$94,000
Depreciation	15,000
Taxes (39%)	?
Net income	\$15,609

We can solve for sales by noting that:

Net income = (Sales − Costs − Depreciation) × (1 − T)
\$15,609 = (Sales − \$94,000 − \$15,000) × (1 − .39)
Sales = \$15,609/.61 + 94,000 + 15,000
= \$134,589

Sales per year must be \$134,589. Because the contract calls for five trucks per year, the sales price has to be \$134,589/5 = \$26,918. If we round this up a bit, it looks as though we need to bid about \$27,000 per truck. At this price, were we to get the contract, our return would be just over 20 percent.

EVALUATING EQUIPMENT OPTIONS WITH DIFFERENT LIVES

The final problem we consider involves choosing among different possible systems, equipment setups, or procedures. Our goal is to choose the most cost-effective. The approach we consider here is necessary only when two special circumstances exist. First, the possibilities under evaluation have different economic lives. Second, and just as important, we will need whatever we buy more or less indefinitely. As a result, when it wears out, we will buy another one.

We can illustrate this problem with a simple example. Imagine we are in the business of manufacturing stamped metal subassemblies. Whenever a stamping mechanism wears out, we have to replace it with a new one to stay in business. We are considering which of two stamping mechanisms to buy.

Machine A costs \$100 to buy and \$10 per year to operate. It wears out and must be replaced every two years. Machine B costs \$140 to buy and \$8 per year to operate. It lasts for three years and must then be replaced. Ignoring taxes, which one should we choose if we use a 10 percent discount rate?

In comparing the two machines, we notice that the first is cheaper to buy, but it costs more to operate and it wears out more quickly. How can we evaluate these trade-offs? We can start by computing the present value of the costs for each:

Machine A: $PV = -\$100 + -10/1.1 + -10/1.1^2 = -\$117.36$
Machine B: $PV = -\$140 + -8/1.1 + -8/1.1^2 = -8/1.1^3 = -\$159.89$

equivalent annual cost (EAC)
The present value of a project's costs calculated on an annual basis.