CHAPTER 10

Making Capital Investment Decisions

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In March 2015, Best Buy Canada closed 131 Future Shop stores in Canada—66 of them permanently while the remaining 65 reopened one week later under the Best Buy brand. The move was meant to stop the two brands from cannibalizing each other's sales, as they often were located too close to each other. At the same time, the company announced that it would invest up to $200 million over the following two years in improving website integration and customer experience.

Both the closing of Future Shop stores and the future investment represent capital budgeting decisions. In this chapter, we will investigate, in detail, capital budgeting decisions—how they are made and how to look at them objectively.

This chapter follows up on the previous one by delving more deeply into capital budgeting. In the last chapter, we saw that cash flow estimates are a critical input into a net present value analysis but didn't expand much about where these cash flows come from. We will now examine that question in some detail.

LEARNING OBJECTIVES

After studying this chapter, you should understand:

LO1 How to determine relevant cash flows for a proposed project.

LO2 How to project cash flows and determine if a project is acceptable.

LO3 How to calculate operating cash flow using alternative methods.

LO4 How to calculate the present value of a tax shield on CCA.

LO5 How to evaluate cost-cutting proposals.

LO6 How to analyze replacement decisions.

LO7 How to evaluate the equivalent annual cost of a project.

LO8 How to set a bid price for 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 show you how to "spread the numbers" for a proposed investment or project and, based on those numbers, make an initial assessment about whether or not the project should be undertaken.

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In the discussion that follows, we focus on 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 shall see, it is easy to overlook important pieces of the capital budgeting puzzle.

The following chapter will describe in detail how to evaluate the results of our discounted cash flow analysis. Also, where needed, we assume that we know the relevant required return or discount rate reflecting the risk of the project. We continue to defer discussion of this subject to Part 5.

LO1

10.1 | Project Cash Flows: A First Look

The effect of undertaking 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 or not. The most important step, therefore, is to decide which cash flows are relevant and which are not.

Relevant Cash Flows

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 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 implication—any cash flow that exists regardless of whether or not a project is undertaken is not relevant in our project evaluation.

The Stand-Alone Principle

In practice, it would be very 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 then focus only on the resulting project's 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 mini firm with its own future revenues and costs, its own assets, and, of course, its own cash flows. We are then primarily interested in comparing the cash flows from this mini firm to the cost of acquiring it. An important consequence of this approach is that we evaluate the proposed project purely on its own merits, in isolation from any other activities or projects.

Concept Questions

1. What are the relevant incremental cash flows for project evaluation?
2. What is the stand-alone principle?

LO1 10.2 | Incremental Cash Flows

We are concerned here only with those cash flows that are incremental to a project. Looking back at our general definition, it seems easy enough to decide whether a cash flow is incremental or not. Even so, there are a few situations when mistakes are easy to make. In this section, we describe some of these common pitfalls and how to avoid them.

Sunk Costs

A **sunk cost** is a cost we have already paid or have already incurred the liability to pay. This cost cannot be changed by the decision today to accept or reject a project. Put another way, the firm has to pay this cost no matter what. Based on our general definition of incremental cash flow, this cost is clearly not relevant to the decision at hand. So, we are always 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 sunk cost fallacy. For example, suppose True North Distillery Ltd. hires a financial consultant to help evaluate whether or not a line of maple sugar liqueur should be launched. When the consultant turns in the report, True North objects to the analysis because the consultant did not include the hefty consulting fee as a cost to the liqueur project.

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

A more subtle example of a cost that can sometimes be sunk is overhead. To illustrate, suppose True North Distillery is now considering building a new warehouse to age the maple sugar liqueur. Should a portion of overhead costs be allocated to the proposed warehouse project? If the overhead costs are truly sunk and independent of the project, the answer is no. An example of such an overhead cost is the cost of maintaining a corporate jet for senior executives. But if the new warehouse requires additional reporting, supervision, or legal input, these overheads should be part of the project analysis.

Opportunity Costs

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 where another division of a firm already owns some of the assets that a proposed project will be using. For example, we might be thinking of converting an old rustic water-powered mill that we bought years ago for $100,000 into upscale condominiums.

If we undertake this project, there will be no direct cash outflow associated with buying the old mill since 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 has an opportunity cost—we give up the valuable opportunity to do something else with it.

There is another issue here. Once we agree that the use of the mill has an opportunity cost, how much should the condo project be charged to account for the value of the mill? Given that we paid $100,000, it might seem 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. It's sunk. At a minimum, the opportunity cost that we charge the project is what it would sell for today (net of any selling costs) because this is the amount that we give up by using it instead of selling it.[1]

Side Effects

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, when Shoppers Drug Mart introduced fresh foods to its shelf in early 2015, Loblaw had to recognize the possibility that incremental sales from Shoppers would come at the expense of sales from its other stores. The negative impact on cash flows is called **erosion**, and the same general problem anticipated by Loblaw could occur for any multiline consumer product producer or seller.[2] 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 Walt Disney's concerns when it built Euro Disney was that the new park would drain visitors from the Florida park, a popular vacation destination for Europeans.

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There are also beneficial side 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 2003 declined to below $100 by 2014, but they weren't. What HP realized was 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.

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1 Economists sometimes use the acronym TANSTAAFL, which is short for "there ain't no such thing as a free lunch," to describe the fact that only very rarely is something truly free. Further, if the asset in question is unique, the opportunity cost might be higher because there might be other valuable projects we could undertake that would use it. However, if the asset in question is of a type that is routinely bought and sold (a used car, perhaps), the opportunity cost is always the going price in the market because that is the cost of buying another one.

2 More colourfully, erosion is sometimes called *piracy* or *cannibalism*.

Net Working Capital

Normally, a project requires that the firm invest in net working capital in addition to long-term assets. For example, a project generally needs some amount of cash on hand to pay any expenses that arise. In addition, a project needs an initial investment in inventories and accounts receivable (to cover credit sales). Some of this financing would be in the form of amounts owed to suppliers (accounts payable), but the firm has 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 do 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 from 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.

More generally, our goal in project evaluation is to compare the cash flow from a project to the cost of acquiring that project to estimate NPV. The particular mixture of debt and equity that 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 costs are unimportant; they are just something to be analyzed separately, and are included as a component of the discount rate. We cover this in later chapters.

Inflation

Because capital investment projects generally have long lives, price inflation or deflation is likely to occur during the project's life. It is possible that the impact of inflation will cancel out—changes in the price level will impact all cash flows equally—and that the required rate of return will also shift exactly with inflation. However this is unlikely, so we need to add a brief discussion of how to handle inflation.

As we explained in more detail in Chapter 7, investors form expectations of future inflation. These are included in the discount rate as investors wish to protect themselves against inflation. Rates including inflation premiums are called nominal rates. In Brazil, for example, where the inflation rate is very high, discount rates are much higher than in Canada.

Given that nominal rates include an adjustment for expected inflation, cash flow estimates must also be adjusted for inflation.[3] Ignoring inflation in estimating the cash inflows would lead to a bias against accepting capital budgeting projects. As we go through detailed examples of capital budgeting, we comment on making these inflation adjustments. Appendix 10A discusses inflation effects further.

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3 In Chapter 7, we explained how to calculate real discount rates. The term *real*, in finance and economics, means adjusted for inflation; that is, net of the inflation premium. A less common alternative approach uses real discount rates to discount real cash flows.

Capital Budgeting and Business Taxes in Canada

In Canada, various levels of government commonly offer incentives to promote certain types of capital investment that will stimulate the economy. These include grants, investment tax credits, more favourable rates for **capital cost allowance (CCA)**, and subsidized loans. Since these change a project's cash flows, they must be factored into capital budgeting analysis.

Other Issues

There are other things to be aware of. First, we are interested only in measuring cash flow, and more specifically, measuring it when it actually occurs, not when it arises in an accounting sense. Second, we are always interested in after-tax cash flow since tax payments are definitely a relevant cash outflow. In fact, whenever we write incremental cash flows, we mean after-tax incremental cash flows. Remember, however, that after-tax cash flow and accounting profit or net income are different things.

Concept Questions

1. What is a sunk cost? An opportunity cost? Provide examples of each.
2. Explain what erosion is and why it is relevant.
3. Explain why interest paid is not a relevant cash flow for project valuation.
4. Explain how consideration of inflation comes into capital budgeting.

LO1 10.3 | Pro Forma Financial Statements and Project Cash Flows

When we begin evaluating a proposed investment, we need 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.

In calculating the cash flows, we make several simplifying assumptions to avoid bogging down in technical details at the outset. First, we use straight-line depreciation as opposed to capital cost allowance. We also assume that a full year's depreciation can be taken in the first year. In addition, we construct the example so the project's market value equals its book cost when it is scrapped. Later, we address the real-life complexities of capital cost allowance and salvage values introduced in Chapter 2.

Getting Started: Pro Forma Financial Statements

Pro forma financial statements introduced in Chapter 4 are a convenient and well-understood means of summarizing much of the relevant information for a project. To prepare these statements, we need estimates of quantities such as unit sales, the selling price per unit, the variable cost per unit, and total fixed costs. We 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 boxes of laundry detergent pods per year at a price of \$4.30 per box due to a mysterious surge in demand. It costs us about \$2.50 per box to make the pods, and a new product such as this one typically has only a three-year life (perhaps because the customer base dwindles rapidly). Let's assume we require a 20% return on all new products.

Fixed operating costs for the project, including things such as rent on the production facility, would run \$12,000 per year.[4] Further, we need to invest \$90,000 in manufacturing equipment. For simplicity, we assume this \$90,000 will be 100% depreciated over the three-year life of the project in equal annual amounts.[5] Furthermore, the cost of removing the equipment roughly equals its actual value in three years, so it would be essentially worthless on a market value basis as well. Finally, the project requires a \$20,000 investment in net working capital. This amount remains constant over the life of the project. In Table 10.1, we organize these initial projections by first preparing the pro forma statements of comprehensive income.

TABLE 10.1

Projected statement of comprehensive income, laundry detergent pods project

Sales (50,000 units at \$4.30/unit)	\$215,000
Variable costs (50,000 units at \$2.50/unit)	125,000
Gross profit	\$ 90,000
Fixed costs	\$ 12,000
Depreciation (\$90,000/3)	30,000
EBIT	\$ 48,000
Taxes (40%)	19,200
Net income	\$ 28,800

Once again, notice that we have not deducted any interest expense. 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 statements of financial position 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 at zero. Notice that the total investment given here for future years is the total book or accounting value, not market value.

4 By fixed cost, we literally mean a cash outflow that occurs regardless of the level of sales. This should not be confused with some sort of accounting period charge.

5 We also assume that a full year's depreciation can be taken in the first year. Together with the use of straight-line depreciation, this unrealistic assumption smooths the exposition. We bring in real-life complications of capital cost allowance and taxes (introduced in Chapter 2) later in the chapter.

TABLE 10.2

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

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 additions to net working capital. To evaluate a project or mini firm, we need to arrive at estimates for each of these.

Once we have estimates of these three components of cash flow, we can calculate net cash flow for our mini firm just as we did in Chapter 2 for an entire firm:

$$\begin{aligned}\text{Project cash flow} = {} & \text{Project operating cash flow} \\ & - \text{Project additions to net working capital} \\ & - \text{Project capital spending}\end{aligned}$$

We consider these components next.

PROJECT OPERATING CASH FLOW To determine the operating cash flow associated with a project, recall the definition of operating cash flow:

$$\begin{aligned}\text{Operating cash flow} = {} & \text{Earnings before interest and taxes (EBIT)} \\ & + \text{Depreciation} \\ & - \text{Taxes}\end{aligned}$$

As before, taxes in our equation are taxes assuming that there is no interest expense. To illustrate the calculation of operating cash flow, we use the projected information from the laundry detergent pod project. For ease of reference, Table 10.1 contains the statement of comprehensive income.

Given this statement in Table 10.1, calculating the operating cash flow is very straightforward. As we see in Table 10.3, projected operating cash flow for the laundry detergent pod project is $58,800.

TABLE 10.3

Projected operating cash flow, laundry detergent pod project

EBIT	$48,000
Depreciation	30,000
Taxes	−19,200
Operating cash flow	$58,800

PROJECT NET WORKING CAPITAL AND CAPITAL SPENDING We now need to take care of the fixed asset and net working capital requirements. Based on our preceding statements of financial position, the firm must spend $90,000 up front for fixed assets and invest an additional $20,000 in net working capital, giving us an immediate outflow of $110,000. At the end of the project's life, the fixed assets are worthless, but the firm recovers the $20,000 tied up in working capital.[6] This leads 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 investment has to be recovered; in other words, the same number needs to appear with the opposite sign.

Project Total Cash Flow and Value

Given the information we've accumulated, we can now finish the preliminary cash flow analysis as illustrated in Table 10.4.

TABLE 10.4

Projected total cash flows, laundry detergent pod project

	Year			
	0	1	2	3
Operating cash flow	0	$58,800	$58,800	$58,800
Additions to NWC	−$ 20,000	0	0	$20,000
Capital spending	−$ 90,000	0	0	0
Total cash flow	−$110,000	$58,800	$58,800	$78,800
DCF (at 20%)	−$110,000	$49,000	$40,833	$45,602
NPV	$ 25,435			

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

$$\begin{aligned} \text{NPV} &= -\$110{,}000 + \frac{\$58{,}800}{1.20} + \frac{\$58{,}800}{1.20^2} + \frac{\$78{,}800}{1.20^3} \\ &= \$25{,}435 \end{aligned}$$

So, based on these projections, the project creates more than $25,000 in value and should be accepted. Also, the return on this investment obviously exceeds 20% (since the NPV is positive at 20%). After some trial and error, we find that the IRR works out to be about 34%. Recall that this means that up to a required return of about 34%, this project should be accepted.

In addition, if required, we could go ahead and calculate the payback and the average accounting return (AAR). Inspection of the cash flows shows that the payback on this project is just a little less than two years (check that it's about 1.85 years).[7]

From the last chapter, the AAR is average net income divided by average book value. The net income each year is $28,800. The average (in thousands) of the four book values (from Table 10.2)

6 In reality, the firm would probably recover something less than 100% of this amount because of bad debts, inventory loss, and so on. If we wanted to, we could just assume that, for example, only 90% was recovered and proceed from there.

7 We're guilty of a minor inconsistency here. When we calculated the NPV and the IRR, we assumed all the cash flows occurred at end of the year. When we calculated the payback, we assumed the cash flow occurred uniformly through the year.

for total investment is ($110 + 80 + 50 + 20)/4 = $65, so the AAR is $28,800/65,000 = 44.31%.[8] We've already seen that the return on this investment (the IRR) is about 34%. The fact that the AAR is larger illustrates again why the AAR cannot be meaningfully interpreted as the return on a project.

Concept Questions

1. What is the definition of project operating cash flow? How does this differ from net income?
2. What are the three components that make up a project's cash flow?
3. In the laundry detergent pod project, why did we add back the firm's net working capital investment in the final year?

LO1, LO4

10.4 | More on 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.

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 has not yet occurred. We show here that these possibilities are not a problem as long as we don't forget to include additions to net working capital in our analysis. This discussion emphasizes the importance and the effect of doing so.

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

Sales	$500
Costs	310
Net income	$190

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

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

8 Notice that the average total book value is not the initial total of $110,000 divided by 2. The reason is that the $20,000 in working capital doesn't depreciate. Notice that the average book value could be calculated as (beginning book value + ending book value)/2 = ($110,000 + 20,000)/2 = $65,000. Also, the ending book value is taken as $20,000 instead of zero as the NWC is returned an instant after the project ends; i.e., after three years.

Based on this information, what is total cash flow for the year? We can begin by mechanically applying what we have been discussing to come up with the answer. Operating cash flow in this particular case is the same as EBIT since there are no taxes or depreciation; thus, it equals $190. Also, notice that net working capital actually *declined* by $25, so the addition to net working capital is negative. 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:

$$\begin{aligned}\text{Total cash flow} &= \text{Operating cash flow} - \text{Additions to NWC} - \text{Capital spending}\\ &= \$190 - (-\$25) - \$0\\ &= \$215\end{aligned}$$

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 statement of comprehensive income, but accounts payable increased by $55 during the year. This means 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, cash inflows less cash outflows is $470 − 255 = $215, just as we had before. Notice that:

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

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, Combat Wombat Telestat Ltd. (CWT) reports sales of $998 and costs of $734. You have collected the following beginning and ending statement of financial position information:

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

9 If there were other accounts, we might have to make some further adjustments. For example, a net increase in inventory would be a cash outflow.

Based on these figures, what are cash inflows? Cash outflows? What happened to each? 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 we didn't replace $20 worth of inventory, so cash 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 the value of what we received from them, resulting in a $30 understatement of cash costs. Adjusting for these events, 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 of $998 − 734 is $264. Since CWT spent $20 on net working capital, the net result is a cash flow of $264 − 20 = $244, as we calculated.

Depreciation and Capital Cost Allowance

As we note elsewhere, accounting depreciation is a non-cash 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. Chapter 2 introduced the capital cost allowance (CCA) system—Canada Revenue Agency's version of depreciation. We use CCA in the example that follows.

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 earlier laundry detergent pod example. We have only added more 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, we project 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 would be priced to sell at $120 per unit to start. When the competition catches up after three years, we anticipate that the price would drop to $110.[10] The power mulcher project requires $20,000 in net working capital at the beginning. Subsequently, total net working capital at the end of each year would be about 15% of sales for that year. The variable cost per unit is $60, and total fixed costs are $25,000 per year.

10 To be consistent, these prices include an inflation estimate.

It costs about $800,000 to buy the equipment necessary to begin production. This investment is primarily in industrial equipment and falls in Class 8 with a CCA rate of 20%.[11] The equipment will actually be worth about $150,000 in eight years. The relevant tax rate is 40%, and the required return is 15%. 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 10.6.

Next, we compute the CCA on the $800,000 investment in Table 10.5. Notice how, under the half-year rule (Chapter 2), UCC is only $400,000 in Year 1.[12]

TABLE 10.5

Annual CCA, power mulcher project (Class 8, 20% rate)

Year	Beginning UCC	CCA	Ending UCC
1	$400,000	$ 80,000	$320,000
2	720,000	144,000	576,000
3	576,000	115,200	460,800
4	460,800	92,160	368,640
5	368,640	73,728	294,912
6	294,912	58,982	235,930
7	235,930	47,186	188,744
8	188,744	37,749	150,995

With this information, we can prepare the pro forma statements of comprehensive income, as shown in Table 10.6.

TABLE 10.6

Projected statements of comprehensive income, 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
CCA	80,000	144,000	115,200	92,160	73,728	58,982	47,186	37,749
EBIT	75,000	131,000	219,800	207,840	201,272	166,018	127,814	87,251
Taxes (40%)	30,000	52,400	87,920	83,136	80,509	66,407	51,126	34,901
Net income	$ 45,000	$ 78,600	$131,880	$124,704	$120,763	$ 99,611	$ 76,688	$ 52,350

11 Chapter 2 explains CCA classes.

12 Companies may purchase a capital item any time within the year, so it is assumed that they purchase it halfway through the year.

From here, computing the operating cash flows is straightforward. The results are illustrated in the first part of Table 10.7.

TABLE 10.7

Projected cash flows, power mulcher project

	Year								
	0	1	2	3	4	5	6	7	8
I. Operating Cash Flow									
EBIT		$ 75,000	$131,000	$219,800	$207,840	$201,272	$166,018	$127,814	$ 87,251
+ CCA		80,000	144,000	115,200	92,160	73,728	58,982	47,186	37,749
– Taxes		30,000	52,400	87,920	83,136	80,509	66,407	51,126	34,901
Operating cash flow		$125,000	$222,600	$247,080	$216,864	$194,491	$158,593	$123,874	$ 90,099
II. Net Working Capital									
Initial NWC	$ 20,000								
NWC increases		$ 34,000	$ 36,000	$ 18,000	–$ 750	–$ 8,250	–$ 16,500	–$ 16,500	–$ 16,500
NWC recovery									–$ 49,500
Additions to 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								
After-tax salvage									–$150,000
Capital spending	$800,000								–$150,000

ADDITIONS TO NET WORKING CAPITAL Now that we have the operating cash flows we need to determine the additions to net working capital (NWC). By assumption, NWC requirements change as sales change. In each year, we generally either add to or recover some of our project NWC. Recalling that NWC starts at $20,000 and then rises to 15% of sales, we can calculate the amount of NWC for each year as illustrated in Table 10.8.

TABLE 10.8

Additions to net working capital, power mulcher project

Year	Revenues	Net Working Capital	Increase
0		$ 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

As illustrated in Table 10.8, 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 the same way.

Remember that an increase in net working capital is a cash outflow and a decrease in net working capital is a cash inflow. This means that a negative sign in this table 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.

We show the result for additions to net working capital in the second part of Table 10.7. 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 for a total of $66,000 (the total addition to NWC is therefore –$66,000).

Finally, we have to account for the long-term capital invested in the project. In this case, we invest $800,000 at Time 0. By assumption, this equipment will be worth $150,000 at the end of the project. It will have an undepreciated capital cost of $150,995 at that time as shown in Table 10.5. As we discussed in Chapter 2, this $995 shortfall of market value below UCC creates a tax refund of $995 × 40% tax rate = $398, only if MMCC has no continuing Class 8 assets. However, we assume the company would continue in this line of manufacturing so there is no tax refund. Making this assumption is standard practice unless we have specific information about plans to close an asset class. Given our assumption, the difference of $995 stays in the asset pool, creating future tax shields.[13] The investment and salvage are shown in the third part of Table 10.7.

TOTAL CASH FLOW AND VALUE We now have all the cash flow pieces, and we put them together in Table 10.9. As previously mentioned, an increase in net working capital is a cash outflow and a decrease in net working capital is a cash inflow, and a negative sign shows working capital returning to the firm. 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.

TABLE 10.9

Projected total cash flow, power mulcher project

	Year								
	0	1	2	3	4	5	6	7	8
Operating cash flow		$125,000	$222,600	$247,080	$216,864	$194,491	$158,593	$123,874	$ 90,099
Additions to NWC	−$ 20,000	−34,000	−36,000	−18,000	750	8,250	16,500	16,500	66,000
Capital spending	− 800,000	0	0	0	0	0	0	0	150,000
Total project cash flow	−$820,000	$ 91,000	$186,600	$229,080	$217,614	$202,741	$175,093	$140,374	$306,099
Cumulative cash flow	−$820,000	−$729,000	−$542,400	−$313,320	−$ 95,706	$107,035	$282,128	$422,503	$728,602
Discounted cash flow @ 15%	−$820,000	$ 79,130	$141,096	$150,624	$124,422	$100,798	$ 75,698	$ 52,772	$100,064
NPV	$ 4,604								
IRR	15.15%								
PB	4.47								

13 We show the detailed calculations in Section 10.6.

If we sum the discounted cash flows and the initial investment, the net present value (at 15%) works out to be $4,604. This is positive, so, based on these preliminary projections, the power mulcher project is acceptable. The internal or DCF rate of return is slightly greater than 15% since the NPV is positive. It works out to be 15.15%, again indicating that the project is acceptable.[14]

Looking at the cumulative cash flows, we see that the project has almost paid back after four years, since the cumulative cash flow is almost zero at that time. As indicated, the fractional year works out to be 95,706/202,741 = .47, so the payback is 4.47 years. We can't say whether or not this is good since 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. We should begin production and marketing immediately. However, it is unlikely that this would be the case. For one thing, NPV is not that far above zero and IRR is only marginally more than the 15% required rate of return. Remember that the result of our analysis is an estimate of NPV, and we usually have less than complete confidence in our projections. This means we have more work to do. In particular, we almost surely want to evaluate the quality of our estimates. We take up this subject in the next chapter. For now, we look at alternative definitions of operating cash flow, and we illustrate some different cases that arise in capital budgeting.

Concept Questions

1. Why is it important to consider additions to net working capital in developing cash flows? What is the effect of doing so?
2. How is depreciation calculated for fixed assets under current tax law? What effect do expected salvage value and estimated economic life have on the calculated capital cost allowance?

LO3 10.5 | Alternative Definitions of Operating Cash Flow

The analysis we have been through in the previous section is quite general and can be adapted to almost 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 different definitions of project operating cash flow are commonly used, both in practice and in finance texts.

As we see, the different definitions of operating cash flow 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 sometimes leads to confusion. For this reason, we examine several of these variations next to see how they are related.

In the following discussion, keep in mind that when we speak of cash flow, we literally mean dollars in minus dollars out. This is all that we are concerned with. Different definitions

14 Appendix 10B shows how to analyze Majestic Mulch using a spreadsheet.

of operating cash flow simply amount to different ways of manipulating basic information about sales, costs, depreciation, and taxes to get a cash flow.

To begin, it will be helpful to define the following:

OCF = Project operating cash flow
S = Sales
C = Operating costs
D = Depreciation for tax purposes; i.e., CCA[15]
T_C = Corporate tax rate

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

$S = \$1{,}500$
$C = \$700$
$D = \$600$
$T_C = 40\%$

With these definitions, notice that EBIT is:

$$\begin{aligned}\text{EBIT} &= S - C - D\\ &= \$1{,}500 - 700 - 600\\ &= \$200\end{aligned}$$

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

$$\begin{aligned}\text{Taxes} &= \text{EBIT} \times T_C = (S - C - D) \times T_C\\ &= \$200 \times .40 = \$80\end{aligned}$$

When we put all of this together, project operating cash flow (OCF) is:

$$\begin{aligned}\text{OCF} &= \text{EBIT} + D - \text{Taxes}\\ &= (S - C - D) + D - (S - C - D) \times T_C \qquad [10.1]\\ &= \$200 + 600 - 80 = \$720\end{aligned}$$

If we take a closer look at this definition of OCF, we see that there are other definitions that could be used. We consider these next.

The Bottom-up Approach

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

$$\begin{aligned}\text{Project net income} &= \text{EBIT} - \text{Taxes}\\ &= (S - C - D) - (S - C - D) \times T_C\\ &= (S - C - D) \times (1 - T_C)\\ &= (\$1{,}500 - 700 - 600) \times (1 - .40)\\ &= \$200 \times .60 = \$120\end{aligned}$$

With this in mind, we can develop a slightly different and very common approach to the cash flow question by restating Equation 10.1 as follows:

$$\begin{aligned}\text{OCF} &= (S - C - D) + D - (S - C - D) \times T_C\\ &= (EBIT) \times (1 - T_C) + D \qquad [10.2]\\ &= \text{Project net income} + \text{Depreciation}\\ &= \$120 + 600 = \$720\end{aligned}$$

15 In this discussion, we use the terms *depreciation and CCA* interchangeably.

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

For the laundry detergent pod project we considered earlier in this chapter, net income was $28,800 and depreciation was $30,000, so the bottom-up calculation is:

$$\text{OCF} = \$28{,}800 + 30{,}000 = \$58{,}800$$

The Top-down Approach

A closely related, and perhaps more obvious, manipulation of our definition is to cancel the depreciation expense where possible:

$$\begin{aligned} \text{OCF} &= (S - C - D) + D - (S - C - D) \times T_C \\ &= (S - C) - (S - C - D) \times T_C \\ &= \text{Sales} - \text{Costs} - \text{Taxes} \\ &= \$1{,}500 - 700 - 80 = \$720 \end{aligned} \quad [10.3]$$

This is the top-down approach. Here we start at the top of the statement of comprehensive income 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 non-cash items such as depreciation.

For the laundry detergent pod project, the top-down cash flow can be easily calculated. With sales of $215,000, total costs (fixed plus variable) of $137,000, and a tax bill of $19,200, the OCF is:

$$\text{OCF} = \$215{,}000 - 137{,}000 - 19{,}200 = \$58{,}800$$

This is just as we had before.

The Tax Shield Approach

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

$$\begin{aligned} \text{OCF} &= (S - C - D) + D - (S - C - D) \times T_C \\ &= (S - C) \times (1 - T_C) + D \times T_C \end{aligned} \quad [10.4]$$

With our numbers, this works out to be:

$$\begin{aligned} &= (S - C) \times (1 - T_C) + D \times T_C \\ &= \$800 \times .60 + \$600 \times .40 \\ &= \$480 + 240 \\ &= \$720 \end{aligned}$$

This is just as we had before.

This approach views OCF as having two components. The first part, $(S - C) \times (1 - T_c)$, 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 $480.

The second part of OCF in this expression, $D \times T_c$, is called the **depreciation (CCA) tax shield**. We know that depreciation is a non-cash expense. The only cash flow effect from deducting depreciation is to reduce our taxes, a benefit to us. At the current 40% corporate tax rate, every dollar in CCA expense saves us 40 cents in taxes. So, in our example, the $600 in depreciation saves us $600 × .40 = $240 in taxes.

For the laundry detergent pod project, the CCA tax shield would be $30,000 × .40 = $12,000. The after-tax value for sales less costs would be ($240,000 − 162,000) × (1 − .40) = $46,800. Adding these together yields the right answer:

$$\text{OCF} = \$46{,}800 + 12{,}000 = \$58{,}800$$

This verifies this approach.

Conclusion

Table 10.10 summarizes the four approaches to computing OCF. Now that we've seen that all these definitions are the same, you're probably wondering why everybody doesn't just agree on one of them. One reason, as we see in the next section, is that different definitions are useful in different circumstances. The best one to use is whichever happens to be the most convenient for the problem at hand.

TABLE 10.10

Alternative definitions of operating cash flow

Approach	Formula
Basic	OCF = EBIT + Depreciation − Taxes
Bottom-up	OCF = Net income + Depreciation
Top-down	OCF = Sales − Costs − Taxes
Tax shield	OCF = (Sales − Costs) $(1 - T_c)$ + Depreciation × T_c

LO4

10.6 | Applying the Tax Shield Approach to the Majestic Mulch and Compost Company Project

If you look back over our analysis of MMCC, you'll see that most of the number crunching involved finding CCA, EBIT, and net income figures. The tax shield approach has the potential to save us considerable time.[16] To realize that potential, we do the calculations in a different order from Table 10.9. Instead of adding the cash flow components down the columns for each year and finding the present value of the total cash flows, we find the present values of each source of cash flow and add the present values.

The first source of cash flow is $(S - C)(1 - T_c)$ as shown for each year on the first line of Table 10.11. The figure for the first year, $93,000, is the first part of the OCF equation.

$$\begin{aligned}\text{OCF} &= (S - C)(1 - T_C) + DT_C \\ &= (360{,}000 - 180{,}000 - 25{,}000)(1 - .40) + 80{,}000(.40) \\ &= 93{,}000 + 32{,}000 = \$125{,}000\end{aligned}$$

16 This is particularly true if we set it up using a spreadsheet. See Appendix 10B.

TABLE 10.11

Tax shield solution, power mulcher project

	Year								
	0	1	2	3	4	5	6	7	8
$(S - C)(1 - T_c)$		$93,000	$165,000	$201,000	$180,000	$165,000	$135,000	$105,000	$ 75,000
Additions to NWC	−$20,000	−34,000	−36,000	−18,000	750	8,250	16,500	16,500	66,000
Capital spending	−800,000								150,000
Totals									
PV of $(S - C)(1 - T_c)$	$645,099								
PV of additions to NWC	−49,179								
PV of capital spending	−750,965								
PV of CCA tax shield	159,649								
NPV	$ 4,604								

Calculating the present value of the $93,000 for the first year and adding the present values of the other $(S - C)(1 - T_c)$ figures in Table 10.11 gives a total present value for this source of $645,099 as seen in the lower part of Table 10.11.

The second term of the OCF equation is the tax shield on CCA for the first year. Table 10.12 reproduces the first year's tax shield of $32,000 along with the corresponding tax shields for each year. The total present value of the CCA tax shield is shown as $159,649.

TABLE 10.12

PV of tax shield on CCA

	Tax Shield		
Year	CCA	.40 × CCA	PV at 15%
1	$ 80,000	$32,000	$ 27,826
2	144,000	57,600	43,554
3	115,200	46,080	30,298
4	92,160	36,864	21,077
5	73,728	29,491	14,662
6	58,982	23,593	10,200
7	47,186	18,874	7,096
8	37,749	15,100	4,936
		PV of tax shield on CCA	$159,649

The additions to net working capital and capital expenditure are essentially the same as in Table 10.9. Their present values are shown in the lower part of Table 10.11. The NPV is the sum of the present value of the four sources of cash flow. The answer, $4,604, is identical to what we found earlier in Table 10.9.

Present Value of the Tax Shield on CCA

Further time savings are possible by using a formula that replaces the detailed calculation of yearly CCA. The formula is based on the idea that tax shields from CCA continue in perpetuity as long as there are assets remaining in the CCA class.[17] This idea is important because it gives us insight into when we can apply the formula in solving a problem in practice. The formula applies when the CCA asset class (or pool) will remain open when the project is completed. As we explained earlier, it is standard practice to assume that the asset class remains open unless we have specific information to the contrary. If, however, in a special case, we find that the pool will be closed out at the end of the project's life, we should not use this formula. The pool will close only if there are no remaining assets in the class. If this happens, the annual CCA values should be calculated to determine the UCC at the end of the project. If there is a terminal loss (i.e., the salvage value is less than this UCC), then there is a further tax shield when the asset is sold. If there is a gain (i.e., the salvage value is greater than this UCC), then there will be a recapture of a portion of the tax savings.[18] To calculate the present value of the tax shield on CCA, we find the present value of an infinite stream of tax shields abstracting from two practical implications—the half-year rule for CCA and disposal of the asset. We then adjust the formula.

Our derivation uses the following terms:

I = Total capital investment in the asset that is added to the pool
d = CCA rate for the asset class
T_C = Company's marginal tax rate
r = Discount rate
S_n = Salvage or disposal value of the asset in year n
M_n = Asset life in years

Using the first part of the formula, the present value of the tax shield on MMCC's project is \$170,932, assuming the tax shield goes on in perpetuity:

$$= \frac{800{,}000(.20)(.40)}{.20 + .15} \times \frac{1 + (.5 \times .15)}{1 + .15}$$
$$= \frac{64{,}000}{.35} \times \frac{1.075}{1.15} = \$170{,}932$$

The adjustment for the salvage value is:

$$\frac{-150{,}000(.20)(.40)}{.20 + .15} \times \frac{1}{(1 + .15)^8}$$
$$= \frac{-12{,}000}{.35} \times \frac{1}{(1.15)^8} = -\$11{,}208$$

The present value of the tax shield on CCA is the sum of the two present values:

Present value of tax shield from CCA = \$170,932 + (−\$11,208) = \$159,724

Salvage Value versus UCC

There is a slight difference between this calculation for the present value of the tax shield on CCA and what we got in Table 10.12 by adding the tax shields over the project life. The difference arises

17 Strictly speaking, the UCC for a class remains positive as long as there are physical assets in the class and the proceeds from disposal of assets are less than total UCC for the class.

18 Alternatively, the formula could be applied and the end-of-project effects calculated and discounted appropriately.

whenever the salvage value of the asset differs from its UCC. When an asset is sold, the difference between its salvage value and ending UCC is not realized as gain or loss on the statement of comprehensive income immediately. It remains in the asset pool and continues to create CCA tax shields for as long as the pool exists. Hence, the formula solution is more accurate as it takes into account the future CCA on this difference. In this case, the asset was sold for $150,000 and had UCC of $150,995. The $995 left in the pool after eight years creates an infinite stream of CCA tax shields. At Time 8, this stream has a present value of [$995(.20)(.40)]/[.20 + .15] = $227.43. At Time 0, the present value of this stream at 15% is about $75. To get the precise estimate of the present value of the CCA tax shield, we need to add this to the approximation in Table 10.12: $159,649 + $75 = $159,724.

EXAMPLE 10.2

The Ogopogo Paddler

Jackson Stott of Kelowna, British Columbia, is contemplating purchasing a paddle-wheel boat that he will use to give tours of Okanagan Lake in search of the elusive Ogopogo. Stott has estimated cash flows from the tours and discounted them back over the eight-year expected life of the boat at his 20% required rate of return. The summary of his calculations follows:

Investment	−$250,000.00
Working capital	−50,000.00
PV of salvage	11,628.40
PV of NWC recovery	11,628.40
PV of after-tax operating income	251,548.33
PV of CCATS	?
NPV	?

He is struggling with the CCA tax shield calculation and is about to dump the project as it appears to be unprofitable. Is the project as unprofitable as Stott believes?

The salvage value of the boat is $50,000, the combined federal and provincial corporate tax rate in British Columbia is 43%, and the CCA rate is 15% on boats:

$$\text{PV tax shield on CCA} = \frac{[IdT_C]}{d+r} \times \frac{[1+.5r]}{1+r} - \frac{S_n d T_C}{d+r} \times \frac{1}{(1+r)^n}$$

$$\text{1st term} = \frac{(\$250{,}000 \times .15 \times .43)}{(.15+.20)} \times \frac{(1+.50 \times .20)}{(1+.20)}$$

$$= \$42{,}232.14$$

$$\text{2nd term} = \frac{(\$50{,}000 \times .15 \times .43)}{(.15+.20)} \times \frac{1}{(1+.20)^8}$$

$$= \$2{,}142.95$$

PV of CCATS = $42,232.14 − 2,142.95 = $40,089.19

The NPV of the investment is $14,894.32. Stott should pursue this venture.

Concept Questions

1. What is meant by the term *depreciation (CCA) tax shield*?
2. What are the top-down and bottom-up definitions of operating cash flow?

LO5-LO8

10.7 | Some Special Cases of Discounted Cash Flow Analysis

To finish our chapter, we look at four 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 demonstrates analysis of a replacement decision. The third case arises in choosing between equipment with different economic lives. The fourth and final case we consider comes up when a firm is involved in submitting competitive bids.

There are many other special cases that we should consider, but these four are particularly important because problems similar to these are so common. Also, they illustrate some very 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. For example, in 2015, Vale Canada, one of Canada's largest mining companies, purchased supply chain management software. Through effective material management, the software would improve procurement efficiency with lower cost.

Suppose we are considering automating some part of an existing production process currently performed manually in one of our plants. The necessary equipment costs $80,000 to buy and install. It will save $35,000 per year (pre-tax) by reducing labour and material costs. The equipment has a five-year life and is in Class 8 with a CCA rate of 20%. Due to rapid obsolescence, it will actually be worth nothing in five years. Should we do it? The tax rate is 40%, and the discount rate is 10%.

As always, the initial step in making this decision is to identify the relevant incremental cash flows. We keep track of these in the following table. First, determining the relevant capital spending is easy enough. The initial cost is $80,000 and the salvage value after five years is zero. Second, there are no working capital consequences here, so we don't need to worry about additions to net working capital.

Operating cash flows are the third component. Buying the new equipment affects our operating cash flows in two ways. First, we save $35,000 pre-tax every year. In other words, the firm's operating income increases by $35,000, so this is the relevant incremental project operating income. After taxes, this represents an annual cash flow of $21,000 as shown in the following table:

	Year					
	0	1	2	3	4	5
Investment	−$80,000					
NWC	0					
Subtotal	−80,000					
Op. income		$ 35,000	$ 35,000	$ 35,000	$ 35,000	$35,000
Taxes		14,000	14,000	14,000	14,000	14,000
Subtotal		21,000	21,000	21,000	21,000	21,000
Salvage						0
Total	−$80,000	$ 21,000	$ 21,000	$ 21,000	$ 21,000	$21,000

Second, we have a tax shield on the incremental CCA created by the new equipment. This equipment has zero salvage so the formula is simplified as shown. CCA goes on forever and the present value of the tax shield is the sum of an infinite series. The present value is $20,364.

Present value of the tax shield on the CCA:

$$PV = \frac{80{,}000(.20)(.40)}{.20 + .10} \times \frac{1 + .5(.10)}{1 + .10}$$
$$= \$20{,}364$$

We can now finish our analysis by finding the present value of the $21,000 after-tax operating savings and adding the present values. At 10%, it's straightforward to verify that the NPV here is $19,971, so we should go ahead and automate.

Present value of the after-tax operating savings:

$$PV = \$21{,}000 \times \frac{1 - \left(\frac{1}{1.10^5}\right)}{.10}$$
$$= \$21{,}000 \times 3.7908$$
$$= \$79{,}607$$

NPV	
Investment	−$80,000
Operating cash flows	79,607
PV of salvage	0
CCATS	20,364
NPV	$19,971

EXAMPLE 10.3

To Buy or Not to Buy

We are considering the purchase of a $200,000 computer-based inventory management system. It is in Class 10 with a CCA rate of 30%. The computer has a four-year life. It will be worth $30,000 at that time. The system would save us $60,000 pre-tax in inventory-related costs. The relevant tax rate is 43.5%. Since the new set-up is more efficient than our existing one, we would be able to carry less total inventory thus free $45,000 in net working capital. What is the NPV at 16%? What is the DCF return (the IRR) on this investment?

We begin by calculating the operating cash flow. The after-tax cost savings are $60,000 × (1 − .435) = $33,900.

The present value of the tax shield on the CCA is found using the formula we first used in the Majestic Mulch and Compost Company problem:

$$PV = \frac{200{,}000(.30)(.435)}{.30 + .16} \times \frac{1 + .5(.16)}{1 + .16} - \frac{30{,}000(.30)(.435)}{.30 + .16} \times \frac{1}{(1 + .16)^4}$$
$$= \$48{,}126$$

The capital spending involves $200,000 up front to buy the system. The salvage is $30,000. Finally, and this is the somewhat tricky part, the initial investment in net working capital is a $45,000 inflow because the system frees working capital. Furthermore, we 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
Investment	−$200,000				
NWC	45,000				
Subtotal	−155,000				
Operating income		$60,000	$60,000	$60,000	$60,000
Taxes		26,100	26,100	26,100	26,100
After-tax operating income		33,900	33,900	33,900	33,900
NWC returned					−45,000

NPV	
Investment	−$ 200,000
NWC recovered now	45,000
PV of Operating income	94,858
PV of salvage	16,569
PV of NWC returned	−24,853
CCATS	48,126
NPV	−$ 20,300

At 16%, the NPV is −$20,300, so the investment is not attractive. After some trial and error, we find that the NPV is zero when the discount rate is 9.36%, so the IRR on this investment is about 9.36%.[19]

Replacing an Asset

Instead of cutting costs by automating a manual production process, companies often need to decide whether it is worthwhile to enhance productivity by replacing existing equipment with newer models or more advanced technology. Suppose the promising numbers we calculated for the automation proposal encourage you to look into buying three more sets of equipment to replace older technology on your company's other production lines. Three new sets of equipment cost $200,000 to buy and install. (Your projected cost is less than the earlier $80,000 per machine because you receive a quantity discount from the manufacturer.)

This time, the analysis is more complex because you are going to replace existing equipment. You bought it four years ago for $150,000 and expect it to last for six more years. Due to rapid technological advances, the existing equipment is worth only $50,000 if sold today. The more efficient, newer technology would save you $75,000 per year in production costs over its projected six-year life.[20] These savings could be realized through reduced wastage and downtime on the shop floor.

19 This IRR is tricky to compute without a spreadsheet because the asset is sold for $30,000, which is less than its undepreciated capital cost (after four years) of $58,310. Capital cost allowance on the difference remains in the pool and goes on to infinity. For this reason, we need to solve for the CCATS by trial and error. The spreadsheet (Chapter 10, Example 10.3) is available on the text website.

20 For simplicity, we assume that both the old and new equipment have six-year remaining lives. Later, we discuss how to analyze cases in which lives differ.

If you retain the current equipment for the rest of its working life, you can expect to realize $10,000 in scrap value after six years. The new equipment, on the other hand, is saleable in the second-hand market and is expected to have a salvage value of $30,000 after six years.

With regard to working capital, the new equipment requires a greater stock of specialized spare parts but offers an offsetting reduction in wastage of work in process. On balance, no change in net working capital is predicted.

You determine that both the existing and new equipment are Class 8 assets with a CCA rate of 20%. Your firm requires a return of 15% on replacement investments and faces a tax rate of 44%. Should you recommend purchase of the new technology?

There is a lot of information here and we organize it in Table 10.13. The first cash flow is the capital outlay—and the difference between the cost of the new and the sale realization on the old equipment. To address CCA, we draw on the discussion in Chapter 2. There will still be undepreciated capital cost in the Class 8 pool because the amount we are adding to the pool (purchase price of new equipment) is greater than the amount we are subtracting (salvage on old equipment). As we are not creating a negative balance of undepreciated capital cost (recapturing CCA) or selling all the pool's assets, there are no tax adjustments to the net outlay. The incremental salvage in six years is treated in the same way.[21]

TABLE 10.13

Replacement of existing asset ($000s)

	Year						
	0	1	2	3	4	5	6
Investment	−$200						
Salvage on old	50						
NWC additions	0						
Subtotal	−150						
Op. savings		$75	$75	$75	$75	$75	$75
Taxes		33	33	33	33	33	33
Subtotal		42	42	42	42	42	42
Salvage forgone							−10
Salvage							30

NPV	
Investment	−$200,000
Salvage recovered now	50,000
PV of operating cash flows	158,948
PV of salvage forgone	−4,323
PV of salvage recovered	12,970
CCATS	33,081
NPV	$ 50,676

21 Here we are making an implicit assumption that at the end of six years the deduction of salvage will not exhaust the Class 8 pool. If this were not the case, the excess, recaptured depreciation (i.e., the amount by which salvage value exceeds the undepreciated cost of the pool to which the asset belongs), would be taxable at the firm's tax rate of 44%.

The fact that we are making a net addition to the asset pool in Class 8 simplifies calculation of the tax shield on CCA. In this common case, Canada Revenue Agency's half-year rule applies to the net addition to the asset class. So, we simply substitute the incremental outlay for C in the present value of tax shield formula. Finally, we substitute the incremental salvage for S and crank the formula:[22]

$$\begin{aligned} PV &= \frac{150{,}000(.20)(.44)}{.20 + .15} \times \frac{1 + .5(.15)}{1 + .15} - \frac{20{,}000(.20)(.44)}{.20 + .15} \times \frac{1}{(1 + .15)^6} \\ &= \$33{,}081 \end{aligned}$$

Additions to net working capital are not relevant here. After-tax operating savings are calculated in the same way as in our prior examples. Table 10.13 shows that the replacement proposal has a substantial positive NPV and seems attractive. Another example on replacement is provided in Example 10.4 below.

EXAMPLE 10.4

Replacement

Theatreplex Oleum is considering replacing a projector system in one of its cinemas. The new projector has super-holographic sound and is able to project laser-sharp images. These features would increase the attendance at the theatre and the new projector could cut repair costs dramatically. The new projector costs \$250,000 and has a useful life of 15 years, at which time it could be sold for \$20,000. The projector currently being used was purchased for \$150,000 five years ago and can be sold now for \$50,000. In 15 years, the old projector would be scrapped for \$5,000. The new projector would increase operating income by \$50,000 annually; it belongs to Class 9 for CCA calculations with a rate of 25%. Theatreplex requires a 15% return on replacement assets and the corporate tax rate is 43.5%. Should Theatreplex replace the projector?

We begin calculating the profitability of such an investment by finding the present value of the increased operating income:

$$\begin{aligned} \text{After-tax flow} &= \$50{,}000 \times (1 - .435) \\ &= \$28{,}250 \end{aligned}$$

$$\begin{aligned} PV &= \frac{\$28{,}250 \times \left(1 - \frac{1}{(1.15)^{15}}\right)}{.15} \\ &= \$28{,}250 \times 5.84737 \\ &= \$165{,}188 \end{aligned}$$

The next step is to calculate the present value of the net salvage value of the new projector:

$$\begin{aligned} PV &= \frac{\$20{,}000 - 5{,}000}{1.15^{15}} \\ &= \$1{,}843 \end{aligned}$$

The last step is to calculate the present value tax shield on the CCA:

$$\begin{aligned} PV &= \frac{200{,}000(.25)(.435)}{.25 + .15} \times \frac{1 + .5(.15)}{1 + .15} - \frac{15{,}000(.25)(.435)}{.25 + .15} \frac{1}{(1 + .15)^{15}} \\ &= 54{,}375 \times \frac{1.075}{1.15} - 4{,}078 \times \frac{1}{(1.15)^{15}} \\ &= \$50{,}829 - \$501 \\ &= \$50{,}328 \end{aligned}$$

22 The present value of tax shield formula does not adjust the salvage for the half-year rule. This means we are assuming that, while the asset class will continue beyond Year 6, no new assets will be added in that year. We make this and the other tax assumptions to illustrate common situations without bogging down in the fine points of taxes.

The NPV is found by adding these present values to the original investment:

Net investment	−$200,000
PV of increased operating income	165,188
PV of net salvage	1,843
CCATS	50,328
NPV	$ 17,359

The investment surpasses the required return on investments for Theatreplex Oleum and should therefore be pursued.

Evaluating Equipment with Different Lives

Our previous examples assumed, a bit unrealistically, that competing systems had the same life. The next problem we consider involves choosing among different possible systems, equipment, or procedures with different lives. For example, hospital managers need to decide which type of infusion pump to order for use in operating rooms to deliver anesthesia to patients undergoing surgery. Some pumps are single use while other, more expensive models last for five or seven years and carry different types of delivery tubing and maintenance costs. As always, our goal is to maximize net present value. To do this, we place the projects on a common horizon for comparison. Equivalent annual cost (EAC) is often used as a decision-making tool in capital budgeting when comparing projects of unequal life spans.

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 need whatever we buy more or less indefinitely. As a result, when it wears out, we buy another one.

We can illustrate this problem with a simple example that holds the benefits constant across different alternatives. This way we can focus on finding the least-cost alternative.[23] Imagine that 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 go with if we use a 10% 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:

$$\text{Machine A: PV} = -\$100 + -\frac{\$10}{1.1} + -\frac{10}{1.1^2} = -\$117.36$$

$$\text{Machine B: PV} = -\$140 + -\frac{\$8}{1.1} + -\frac{\$8}{1.1^2} + -\frac{\$8}{1.1^3} = -\$159.89$$

Notice that all the numbers here are costs, so they all have negative signs. If we stopped here, it might appear that A is the more attractive since the PV of the costs is less. However, all we have really discovered so far is that A effectively provides two years' worth of stamping service for

23 Alternatively, in another case, the costs could be constant and the benefits differ. Then we would maximize the equivalent annual benefit.

\$117.36, while B effectively provides three years' worth for \$159.89. These are not directly comparable because of the difference in service periods.

We need to somehow work out a cost per year for these two alternatives. To do this, we ask the question, what amount, paid each year over the life of the machine, has the same PV of costs? This amount is called the **equivalent annual cost (EAC)**.

Calculating the EAC involves finding an unknown payment amount. For example, for Machine A, we need to find a two-year ordinary annuity with a PV of −\$117.36 at 10%. Going back to Chapter 6, the two-year annuity factor is:

$$\text{Annuity factor} = \frac{\left[1 - \frac{1}{1.10^2}\right]}{.10} = 1.7355$$

For Machine A, then, we have:

$$\begin{aligned} \text{PV of costs} &= -\$117.36 = \text{EAC} \times 1.7355 \\ \text{EAC} &= -\$117.36/1.7355 \\ &= -\$67.62 \end{aligned}$$

For Machine B, the life is three years, so we first need the three-year annuity factor:

$$\text{Annuity factor} = \frac{\left[1 - \frac{1}{1.10^3}\right]}{.10} = 2.4869$$

We calculate the EAC for B just as we did for A:

$$\begin{aligned} \text{PV of costs} &= \$159.89 = \text{EAC} \times 2.4869 \\ \text{EAC} &= -\$159.89/2.4869 \\ &= -\$64.29 \end{aligned}$$

Based on this analysis, we should purchase B because it effectively costs \$64.29 per year versus \$67.62 for A. In other words, all things considered, B is cheaper. Its longer life and lower operating cost are more than enough to offset the higher initial purchase price. Using the EAC approach, hospitals make cost-effective decisions regarding similar devices using common capital investment formulas.[24]

EXAMPLE 10.5

Equivalent Annual Costs

This extended example illustrates what happens to the EAC when we consider taxes. You are evaluating two different pollution control options. A filtration system costs \$1.1 million to install and \$60,000 pre-tax annually to operate. It would have to be replaced every five years. A precipitation system costs \$1.9 million to install, but only \$10,000 per year to operate. The precipitation equipment has an effective operating life of eight years. The company rents its factory and both systems are considered leasehold improvements so straight-line capital cost allowance is used throughout, and neither system has any salvage value. Which method should we select if we use a 12% discount rate? The tax rate is 40%.

We need to consider the EACs for the two approaches because they have different service lives, and they will be replaced as they wear out. The relevant information is summarized in Table 10.14.

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24 D. R. Sinclair, "Equivalent Annual Cost: A Method for Comparing the Cost of Multi-use Medical Devices," *Canadian Anesthesiologists Society* 57 (2010), pp. 521–522.

TABLE 10.14

Equivalent annual cost

	Filtration System	Precipitation System
After-tax operating cost	−$ 36,000	−$ 6,000
Annual CCATS	88,000	95,000
Operating cash flow	$ 52,000	$ 89,000
Economic life	5 years	8 years
Annuity factor (12%)	3.6048	4.9676
Present value of operating cash flow	$ 187,450	$ 442,116
Capital spending	−$1,100,000	−$1,900,000
Total PV of costs	−$ 912,550	−$1,457,884

Notice that the operating cash flow is actually positive in both cases because of the large CCA tax shields.[25] This can occur whenever the operating cost is small relative to the purchase price.

To decide which system to purchase, we compute the EACs for both using the appropriate annuity factors:

$$\text{Filtration system:} \quad -\$912{,}550 = \text{EAC} \times 3.6048$$
$$\text{EAC} = -\$253{,}149 \text{ per year}$$
$$\text{Precipitation system:} \quad -\$1{,}457{,}884 = \text{EAC} \times 4.9676$$
$$\text{EAC} = -\$293{,}479 \text{ per year}$$

The filtration system is the cheaper of the two, so we select it. The longer life and smaller operating cost of the precipitation system are not sufficient to offset its higher initial cost.

Setting the Bid Price

Early on, we used discounted cash flow to evaluate a proposed new product. A somewhat different and very 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 saw 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 that you underbid. In this section, we look at how to set the bid price to avoid the winner's curse. The procedure we describe is useful any time we have to set a price on a product or service.

To illustrate how to set a bid price, imagine that 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.

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.

25 We ignore the half-year rule for simplicity here. Also note that it is possible to rework Example 10.5 (and reach the same answer) treating the EAC as equivalent annual cash flows. In this case, the inflows have minus signs and the EAC is positive.

Suppose we can buy the truck platforms for $10,000 each. The facilities we need can be leased for $24,000 per year. The labour and material cost to do the modification works out to be about $4,000 per truck. Total cost per year would thus be:

$$\$24{,}000 + 5 \times (\$10{,}000 + 4{,}000) = \$94{,}000$$

We need to invest $60,000 in new equipment. This equipment falls in Class 8 with a CCA rate of 20%. It would be worth about $5,000 at the end of the four years. We also need to invest $40,000 in raw materials inventory and other working capital items. The relevant tax rate is 43.5%. What price per truck should we bid if we require a 20% 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 after-tax salvage value is simply $5,000, assuming as usual that at the end of four years, other assets remain in Class 8. Furthermore, we have to invest $40,000 today in working capital. We get this back in four years.

We can't determine the after-tax operating income just yet because we don't know the sales price. The present value of the tax shield on CCA works out to be $11,438. The calculations are in Table 10.15 along with the other data. With this in mind, here is the key observation; the lowest possible price we can profitably charge results in a zero NPV at 20%. The reason is, at that price we earn exactly the required 20% on our investment.

TABLE 10.15

Setting the bid price

	Cash Flow	Year	PV at 20%
Capital spending	−$60,000	0	−$60,000
Salvage	5,000	4	2,411
Additions to NWC	−40,000	0	−40,000
	40,000	4	19,290
After-tax operating income	(S −94,000)(1− .435)	1–4	?
Tax shield on CCA			$11,438
NPV			$0

$$\text{PV} = \frac{60{,}000(.20)(.435)}{.20 + .20} \times \frac{1 + .5(.20)}{1 + .20} - \frac{5{,}000(.20)(.435)}{.20 + .20} \times \frac{1}{(1 + .20)^4}$$
$$= \$11{,}438$$

Given this observation, we first need to determine what the after-tax operating income must be for the NPV to be equal to zero. To do this, we calculate the present values of the salvage and return of net working capital in Table 10.15 and set up the NPV equation:

$$\text{NPV} = 0 = -\$60{,}000 + 2{,}411 - 40{,}000 + 19{,}290$$
$$+ \text{PV(annual after-tax incremental operating income)} + 11{,}438$$

$$\text{PV (annual after-tax incremental operating income)} = \$66{,}861$$

Since this represents the present value of an annuity, we can find the annual "payments":

$$\text{PV (annuity)} = \$66{,}861 = \frac{P\left[1 - \frac{1}{1.20^4}\right]}{.20}$$
$$P = \$25{,}828$$

The annual incremental after-tax operating income is \$25,828. Using a little algebra we can solve for the necessary sales proceeds, S:

$$
\begin{aligned}
\$25{,}828 &= (S - 94{,}000)(1 - .435) \\
\$45{,}713 &= S - 94{,}000 \\
S &= \$139{,}713
\end{aligned}
$$

Since the contract is for five trucks, this represents \$27,943 per truck. If we round this up a bit, it looks like we need to bid about \$28,000 per truck. At this price, were we to get the contract, our return would be a bit more than 20%.

Concept Questions

1. Under which circumstances do we have to worry about unequal economic lives? How do you interpret the EAC?
2. In setting a bid price, we used a zero NPV as our benchmark. Explain why this is appropriate.

Summary and Conclusions

This chapter describes how to put together a discounted cash flow analysis. In it, we covered the following:

1. The identification of relevant project cash flows. We discussed project cash flows and described how to handle some issues that often come up, including sunk costs, opportunity costs, financing costs, net working capital, and erosion.
2. Preparing and using pro forma or projected financial statements. We showed how such financial statement information is useful in coming up with projected cash flows, and we also looked at some alternative definitions of operating cash flow.
3. The role of net working capital and depreciation in project cash flows. We saw that including the additions to net working capital was important because it adjusted for the discrepancy between accounting revenues and costs and cash revenues and costs. We also went over the calculation of capital cost allowance under current tax law.
4. Some special cases using discounted cash flow analysis. Here we looked at four special issues: cost-cutting investments, replacement decisions, the unequal lives problem, and how to set a bid price.

The discounted cash flow analysis we've covered here is a standard tool in the business world. It is a very powerful tool, so care should be taken in its use. The most important thing is to get the cash flows identified in a way that makes economic sense. This chapter gives you a good start on learning to do this.

Key | Terms

capital cost allowance (CCA)	equivalent annual cost (EAC)	pro forma financial statements
depreciation (CCA) tax shield	erosion	stand-alone principle
	incremental cash flows	sunk cost
	opportunity cost	

Chapter Review Problems and Self-Test

These problems give you some practice with discounted cash flow analysis. The answers follow.

1. **Capital Budgeting for Project X** Based on the following information for Project X, should we undertake the venture? To answer, first prepare a pro forma statement of comprehensive income for each year. Second, calculate the operating cash flow. Finish the problem by determining total cash flow and then calculating NPV assuming a 20% required return. Use a 40% tax rate throughout. For help, look back at our examples in the chapter.

   Project X is a new type of audiophile-grade stereo amplifier. We think we can sell 500 units per year at a price of $10,000 each. Variable costs per amplifier run about $5,000 per unit, and the product should have a four-year life. We require a 20% return on new products such as this one.

   Fixed costs for the project run $610,000 per year. Further, we need to invest $1,100,000 in manufacturing equipment. This equipment belongs to class 8 for CCA purposes. In four years, the equipment can be sold for its UCC value. We would have to invest $900,000 in working capital at the start. After that, net working capital requirements would be 30% of sales.

2. **Calculating Operating Cash Flow** Mater Pasta Ltd. has projected a sales volume of $1,432 for the second year of a proposed expansion project. Costs normally run 70% of sales, or about $1,002 in this case. The capital cost allowance will be $80, and the tax rate is 40%. What is the operating cash flow? Calculate your answer using the top-down, bottom-up, and tax shield approaches described in the chapter.

3. **Spending Money to Save Money** For help on this one, refer back to the computerized inventory management system in Example 10.3. Here, we're contemplating a new, mechanized welding system to replace our current manual system. It costs $600,000 to get the new system. The cost will be depreciated at a 30% CCA rate. Its expected life is four years. The system would actually be worth $100,000 at the end of four years.

   We think the new system could save us $180,000 per year pre-tax in labour costs. The tax rate is 44%. What is the NPV of buying the new system? The required return is 15%.

Answers to Self-Test Problems

1. To develop the pro forma statements of comprehensive income, we need to calculate the depreciation for each of the four years. The relevant CCA percentages, allowances, and UCC values for the first four years are:

Year	CCA Rate	Eligible UCC	Allowance	Ending UCC
1	20.0%	$550,000	$110,000	$990,000
2	20.0	990,000	198,000	792,000
3	20.0	792,000	158,400	633,600
4	20.0	633,600	126,720	506,880

The projected statements of comprehensive income, therefore, are as follows:

	Year			
	1	*2*	*3*	*4*
Sales	$5,000,000	$5,000,000	$5,000,000	$5,000,000
Variable costs	2,500,000	2,500,000	2,500,000	2,500,000
Fixed costs	610,000	610,000	610,000	610,000
CCA deduction	110,000	198,000	158,400	126,720
EBIT	$1,780,000	$1,692,000	$1,731,600	$1,763,280
Taxes (40%)	712,000	676,800	692,640	705,312
Net income	$1,068,000	$1,015,200	$1,038,960	$1,057,968

Based on this information, the operating cash flows are:

	Year			
	1	*2*	*3*	*4*
EBIT	$1,780,000	$1,692,000	$1,731,600	$1,763,280
CCA deduction	110,000	198,000	158,400	126,720
Taxes	−712,000	−676,800	−692,640	−705,312
Operating cash flow	$1,178,000	$1,213,200	$1,197,360	$1,184,688

We now have to worry about the non-operating cash flows. Net working capital starts at $900,000 and then rises to 30% of sales, or $1,500,000. This is a $600,000 addition to net working capital.

Finally, we have to invest $1,100,000 to get started. In four years, the market and book value of this investment would be identical, $506,880. Under our usual going-concern assumption, other Class 8 assets remain in the pool. There are no tax adjustments needed to the salvage value.

When we combine all this information, the projected cash flows for Project X are:

	Year				
	0	*1*	*2*	*3*	*4*
Operating cash flow		$1,178,000	$1,213,200	$1,197,360	$1,184,688
Additions to NWC	−$ 900,000	−600,000			1,500,000
Capital spending	−1,100,000				506,880
Total cash flow	−$2,000,000	$ 578,000	$1,213,200	$1,197,360	$3,191,568

With these cash flows, the NPV at 20% is:

$$\begin{aligned} \text{NPV} &= -\$2{,}000{,}000 + \frac{578{,}000}{1.2} + \frac{1{,}213{,}200}{1.2^2} + \frac{1{,}197{,}360}{1.2^3} + \frac{3{,}191{,}568}{1.2^4} \\ &= \$1{,}556{,}227 \end{aligned}$$

So this project appears quite profitable.

2. We begin by calculating the project's EBIT, its tax bill, and its net income.

$$\begin{aligned} \text{EBIT} &= \$1{,}432 - 1{,}002 - 80 = \$350 \\ \text{Taxes} &= \$350 \times .40 = \$140 \\ \text{Net income} &= \$350 - 140 = \$210 \end{aligned}$$

With these numbers, operating cash flow is:

$$\begin{aligned} \text{OCF} &= \text{EBIT} + D - \text{Taxes} \\ &= \$350 + 80 - 140 \\ &= \$290 \end{aligned}$$

Using the other OCF definitions, we have:

$$\begin{aligned} \text{Tax shield OCF} &= (S - C) \times (1 - .40) + D \times .40 \\ &= (\$1{,}432 - \$1{,}002) \times .60 + 80 \times .40 \\ &= \$290 \\ \text{Bottom-up OCF} &= \text{Net income} + D \\ &= \$210 + 80 \\ &= \$290 \\ \text{Top-down OCF} &= S - C - \text{Taxes} \\ &= \$1{,}432 - 1{,}002 - 140 \\ &= \$290 \end{aligned}$$

As expected, all of these definitions produce exactly the same answer.

3. The \$180,000 pre-tax saving gives an after-tax amount of:

$$(1 - .44) \times \$180{,}000 = \$100{,}800$$

The present value of this four-year annuity amounts to:

$$\begin{aligned} \text{PV} &= \$100{,}800 \times \frac{\left(1 - \frac{1}{1.15^4}\right)}{.15} \\ &= \$100{,}800 \times 2.8550 \\ &= \$287{,}782 \end{aligned}$$

The present value of the tax shield on the CCA is:

$$\begin{aligned} \text{PV} &= \frac{600{,}000(.30)(.44)}{.15 + .30} \times \frac{(1 + .5(.15))}{1 + .15} - \frac{100{,}000(.30)(.44)}{.15 + .30} \times \frac{1}{(1.15)^4} \\ &= 164{,}522 - 16{,}771 \\ &= \$147{,}750 \end{aligned}$$

The only flow left undiscounted is the salvage value of the equipment. The present value of this flow is:

$$\begin{aligned} \text{PV} &= \$100{,}000 \times \frac{1}{1.15^4} \\ &= \$100{,}000 \times .5718 \\ &= \$57{,}175 \end{aligned}$$

There are no working capital consequences, so the NPV is found by adding these three flows and the initial investment.

Investment	−$600,000
PV of labour savings	287,782
PV of salvage	57,175
CCATS	147,750
NPV	−$107,293

You can verify that the NPV is −$107,293, and the return on the new welding system is only about 5.4%. The project does not appear to be profitable.

Concepts Review and Critical Thinking Questions

1. **(LO1)** In the context of capital budgeting, what is an opportunity cost?
2. **(LO1)** In our capital budgeting examples, we assumed that a firm would recover all of the working capital invested in a project. Is this a reasonable assumption? When might it not be valid?
3. **(LO7)** When is EAC analysis appropriate for comparing two or more projects? Why is this method used? Are there any implicit assumptions required by this method that you find troubling? Explain.
4. **(LO1)** "When evaluating projects, we're concerned with only the relevant incremental after-tax cash flows. Therefore, because depreciation is a non-cash expense, we should ignore its effects when evaluating projects." Critically evaluate this statement.
5. **(LO1)** A major textbook publisher has an existing finance textbook. The publisher is debating whether or not to produce an "essentialized" version, meaning a shorter (and lower-priced) book. What are some of the considerations that should come into play?

In 2008, Indigo Books & Music Inc. launched a new chain called Pistachio selling stationery, gifts, home décor, and organic apothecary items.

6. **(LO1)** In evaluating the decision to start Pistachio, under what circumstances might Indigo Books & Music have concluded that erosion was irrelevant?
7. **(LO1)** In evaluating Pistachio, what do you think Indigo needs to assume regarding the profit margins that exist in this market? Is it likely they will be maintained when others enter this market?

Questions and Problems

Basic (Questions 1–34)

1. **Relevant Cash Flows (LO1)** White Oak Garden Inc. is looking at setting up a new manufacturing plant in London, Ontario, to produce garden tools. The company bought some land six years ago for $3.5 million in anticipation of using it as a warehouse and distribution site, but the company has since decided to rent these facilities from a competitor instead. If the land were sold today, the company would net $3.9 million. The company wants to build its new manufacturing plant on this land; the plant will cost $16.72 million to build, and the site requires $850,000 worth of grading before it is suitable for construction. What is the proper cash flow amount to use as the initial investment in fixed assets when evaluating this project? Why?

2. **Relevant Cash Flows (LO1)** Nilestown Corp. currently sells 30,000 motor homes per year at $73,000 each, and 14,000 luxury motor coaches per year at $120,000 each. The company wants to introduce a new portable camper to fill out its product line; it hopes to sell 25,000 of these campers per year at $19,000 each. An independent consultant has determined that if Nilestown introduces the new campers, it should boost the sales of its existing motor homes by 2,700 units per year, and reduce the sales of its motor coaches by 1,300 units per year. What is the amount to use as the annual sales figure when evaluating this project? Why?

3. **Calculating Projected Net Income (LO1)** A proposed new investment has projected sales of $635,000. Variable costs are 44% of sales, and fixed costs are $193,000; depreciation is $54,000. Prepare a pro forma statement of comprehensive income assuming a tax rate of 35%. What is the projected net income?

4. **Calculating OCF (LO3)** Consider the following statement of comprehensive income:

Sales	$713,500
Costs	497,300
Depreciation	87,400
EBIT	?
Taxes (34%)	?
Net income	?

   Fill in the missing numbers and then calculate the OCF. What is the CCA tax shield?

5. **OCF from Several Approaches (LO3)** A proposed new project has projected sales of $164,000, costs of $87,000, and CCA of $15,200. The tax rate is 35%. Calculate operating cash flow using the four different approaches described in the chapter and verify that the answer is the same in each case.

6. **Calculating Net Income (LO1)** A proposed new investment has projected sales in Year 5 of $940,000. Variable costs are 41% of sales and fixed costs are $147,000. CCA for the year will be $104,000. Prepare a projected statement of comprehensive income, assuming a 35% tax rate.

7. **Calculating Depreciation (LO1, 2)** A new electronic process monitor costs $990,000. This cost could be depreciated at 30% per year (Class 10). The monitor would actually be worthless in five years. The new monitor would save $460,000 per year before taxes and operating costs. If we require a 15% return, what is the NPV of the purchase? Assume a tax rate of 40%.

8. **NPV and NWC Requirements (LO2)** In the previous question, suppose the new monitor also requires us to increase net working capital by $47,200 when we buy it. Further suppose that the monitor could actually be worth $100,000 in five years. What is the new NPV?

9. **NPV and CCA (LO2)** In the previous question, suppose the monitor was assigned a 25% CCA rate. All the other facts are the same. Will the NPV be larger or smaller? Why? Calculate the new NPV to verify your answer.

10. **Identifying Relevant Costs (LO1)** Rick Bardles and Ed James are considering building a new bottling plant to meet expected future demand for their new line of tropical coolers. They are considering putting it on a plot of land they have owned for three years. They are analyzing the idea and comparing it to some others. Bardles says, "Ed, when we do this analysis, we should put in an amount for the cost of the land equal to what we paid for it. After all, it did cost us a pretty penny." James retorts, "No, I don't care how much it cost—we have already paid for it. It is what they call a sunk cost. The cost of the land shouldn't be considered." What would you say to Bardles and James?

11. **Calculating Salvage Value[26] (LO4)** Consider an asset that costs $730,000 and can be depreciated at 20% per year (Class 8) over its eight-year life. The asset is to be used in a five-year project; at the end of the project, the asset can be sold for $192,000. If the relevant tax rate is 40%, what is the after-tax cash flow from the sale of the asset? You can assume that there will be no assets left in the class in six years.

12. **Identifying Cash Flows (LO2)** Last year, Lambeth Pizza Corporation reported sales of $102,000 and costs of $43,500. The following information was also reported for the same period:

	Beginning	Ending
Accounts receivable	$45,120	$38,980
Inventory	53,500	59,140
Accounts payable	68,320	75,250

Based on this information, what was Lambeth's change in net working capital for last year? What was the net cash flow?

13. **Calculating Project OCF (LO3)** Hubrey Home Inc. is considering a new three-year expansion project that requires an initial fixed asset investment of $3.9 million. The fixed asset falls into Class 10 for tax purposes (CCA rate of 30% per year), and at the end of the three years can be sold for a salvage value equal to its UCC. The project is

26 Recall that terminal losses and recapture in CCA calculations were covered in Chapter 2.

estimated to generate $2,650,000 in annual sales, with costs of $840,000. If the tax rate is 35%, what is the OCF for each year of this project?

14. **Calculating Project NPV (LO2)** In the previous problem, supposed the required return on the project is 12%. What is the project's NPV?

15. **Calculating Project Cash Flow from Assets (LO1, 2)** In the previous problem, suppose the project requires an initial investment in net working capital of $300,000 and the fixed asset will have a market value of $210,000 at the end of the project. What is the project's Year 0 net cash flow? Year 1? Year 2? Year 3? What is the new NPV?

16. **NPV Applications (LO1, 2)** We believe we can sell 90,000 home security devices per year at $150 per piece. They cost $130 to manufacture (variable cost). Fixed production costs run $215,000 per year. The necessary equipment costs $785,000 to buy and would be depreciated at a 25% CCA rate. The equipment would have a zero salvage value after the five-year life of the project. We need to invest $140,000 in net working capital up front; no additional net working capital investment is necessary. The discount rate is 19%, and the tax rate is 35%. What do you think of the proposal?

17. **Identifying Cash Flows (LO2)** Suppose a company has $15,200 in sales during a quarter. Over the quarter, accounts receivable increased by $9,500. What were cash collections?

18. **Stand-Alone Principle (LO1)** Suppose a financial manager is quoted as saying, "Our firm uses the stand-alone principle. Since we treat projects like minifirms in our evaluation process, we include financing costs, because financing costs are relevant at the firm level." Critically evaluate this statement.

19. **Relevant Cash Flows (LO1)** Kilworth Plexiglass Inc. is looking to set up a new manufacturing plant to produce surfboards. The company bought some land seven years ago for $7.2 million in anticipation of using it as a warehouse and distribution site, but the company decided to rent the facilities from a competitor instead. The land was appraised last week for $962,000. The company wants to build its new manufacturing plant on this land; the plant will cost $25 million to build, and the site requires an additional $586,000 in grading before it will be suitable for construction. What is the proper cash flow amount to use as the initial investment in fixed assets when evaluating this project? Why?

20. **Relevant Cash Flows (LO1)** Melrose Motorworks Corp. currently sells 23,000 compact cars per year at $14,690 each, and 38,600 luxury sedans at $43,700 each. The company wants to introduce a new mid-sized sedan to fill out its product line; it hopes to sell 28,500 of the cars per year at $33,600 each. An independent consultant has determined that if Melrose introduces the new cars, it should boost the sales of its existing compacts by 12,500 units per year while reducing the unit sales of its luxury sedans by 8,200 units per year. What is the annual cash flow amount to use as the sales figure when evaluating this project? Why?

21. Project Evaluation (LO1, 2) Fox Hollow Franks is looking at a new system with an installed cost of $540,000. This equipment is depreciated at a rate of 20% per year (Class 8) over the project's five-year life, at the end of which the sausage system can be sold for $80,000. The sausage system will save the firm $170,000 per year in pre-tax operating costs, and the system requires an initial investment in net working capital of $29,000. If the tax rate is 34% and the discount rate is 10%, what is the NPV of this project?

22. Project Evaluation (LO1, 2) Your firm is contemplating the purchase of a new $425,000 computer-based order entry system. The PVCCATS is $91,209, and the machine will be worth $30,000 at the end of the five-year life of the system. You will save $130,000 before taxes per year in order-processing costs and you will be able to reduce working capital by $60,000 (this is a one-time reduction). If the tax rate is 35%, what is the IRR for this project?

23. Project Evaluation (LO1, 2) In the previous problem, suppose your required return on the project is 11%, your pre-tax cost savings are now $150,000 per year, and the machine can be depreciated at 30% (Class 10). Will you accept the project? What if the pre-tax savings are only $100,000 per year? At what level of pre-tax cost savings would you be indifferent between accepting the project and not accepting it?

24. Calculating a Bid Price (LO8) We have been requested by a large retailer to submit a bid for a new point-of-sale credit checking system. The system would be installed, by us, in 89 stores per year for three years. We would need to purchase $1,300,000 worth of specialized equipment. This will be depreciated at a 20% CCA rate. We will sell it in three years, at which time it will be worth about half of what we paid for it. Labour and material cost to install the system is about $96,000 per site. Finally, we need to invest $340,000 in working capital items. The relevant tax rate is 36%. What price per system should we bid if we require a 20% return on our investment? Try to avoid the winner's curse.

25. Alternative OCF Definitions (LO3) Next year, Byron Corporation estimates that they will have $425,000 in sales, $96,000 in operating costs, and their corporate tax rate will be 35%. Undepreciated capital costs (UCC) will be $375,000 and the CCA rate will be 20%.

a. What is estimated EBIT for next year?

b. Using the bottom-up approach, what is the operating cash flow?

c. Using the tax shield method, what is the operating cash flow?

26. Alternating OCF Definitions (LO3) The Arva Logging Company is considering a new logging project in Ontario, requiring new equipment with a cost of $280,000. For the upcoming year, they estimate that the project will produce sales of $650,000 and $490,000 in operating costs. The CCA rate will be 25% and their net profits will be taxed at a corporate rate of 38%. Use the top-down approach and the tax shield approach to calculate the operating cash flow for the first year of the project for the Arva Logging Company.

27. **EAC (LO7)** Lobo is a leading manufacturer of positronic brains, a key component in robots. The company is considering two alternative production methods. The costs and lives associated with each are:

Year	Method 1	Method 2
0	$6,700	$9,900
1	400	620
2	400	620
3	400	620
4		620

Assuming that Lobo will not replace the equipment when it wears out, which should it buy? If Lobo will replace the equipment, which should it buy ($r = 13\%$)? Ignore depreciation and taxes in answering.

28. **Calculating Cash Flows and EAC (LO7)** In the previous question, suppose all the costs are before taxes and the tax rate is 39%. Both types of equipment would be depreciated at a CCA rate of 25% (Class 9), and would have no value after the project. What are the EACs in this case? Which is the preferred method?

29. **Calculating EAC (LO7)** A five-year project has an initial fixed asset investment of $270,000, an initial NWC investment of $25,000, and an annual OCF of −$42,000. The fixed asset is fully depreciated over the life of the project and has no salvage value. If the required return is 11%, what is this project's equivalent annual cost, or EAC?

30. **Calculating EAC (LO7)** You are evaluating two different silicon wafer milling machines. The Techron I costs $270,000, has a three-year life, and has pre-tax operating costs of $69,000 per year. The Techron II costs $475,000, has a five-year life, and has pre-tax operating costs of $36,000 per year. Both milling machines are in Class 8 (CCA rate of 20% per year). Assume a salvage value of $45,000. If your tax rate is 35% and your discount rate is 10%, compute the EAC for both machines. Which do you prefer? Why?

31. **Calculating EAC (LO7)** You are considering two different methods for constructing a new warehouse site. The first method would use prefabricated building segments, would have an initial cost of $6.5 million, would have annual maintenance costs of $150,000, and would last for 25 years. The second alternative would employ a new carbon-fibre panel technology, would have an initial cost of $8.2 million, would have maintenance costs of $650,000 every ten years, and is expected to last 40 years. Both buildings would be in CCA Class 1 (at a rate of 4%) and it is expected that each would have a salvage value equivalent to 25% of its construction cost at the end of its useful life. The discount rate the firm uses in evaluating projects is 11%. The tax rate is 35%. What is the annual cost for each option, and which would you pick?

32. **Calculating EAC (LO7)** A seven-year project has an initial investment of $550,000 and an annual operating cost of $32,000 in the first year. The operating costs are expected to increase at the rate of inflation, which is projected at 2% for the life of the project. The investment is in Class 7 for CCA purposes, and will therefore be depreciated at 15% annually. The salvage value at the end of the project will be $98,000. The firm's discount rate is 11%, and the company falls in the 35% tax bracket. What is the EAC for the investment?

33. Calculating a Bid Price (LO8) Komoka Enterprises needs someone to supply it with 140,000 cartons of machine screws per year to support its manufacturing needs over the next five years, and you've decided to bid on the contract. It will cost you $940,000 to install the equipment necessary to start production. The equipment will be depreciated at 30% (Class 10), and you estimate that it can be salvaged for $85,000 at the end of the five-year contract. Your fixed production costs will be $435,000 per year, and your variable production costs should be $15.10 per carton. You also need an initial net working capital of $90,000. If your tax rate is 35% and you require a 12% return on your investment, what bid price should you submit?

34. Cost-Cutting Proposals (LO5) Caradoc Machine Shop is considering a four-year project to improve its production efficiency. Buying a new machine press for $410,000 is estimated to result in $150,000 in annual pre-tax cost savings. The press falls into Class 8 for CCA purposes (CCA rate of 20% per year), and it will have a salvage value at the end of the project of $55,000. The press also requires an initial investment in spare parts inventory of $20,000, along with an additional $3,100 in inventory for each succeeding year of the project. If the shop's tax rate is 35% and its discount rate is 9%, should Caradoc buy and install the machine press?

Intermediate (Questions 35–45)

35. Cash Flows and NPV (LO2) We project unit sales for a new household-use laser-guided cockroach search and destroy system as follows:

Year	Unit Sales
1	93,000
2	105,000
3	128,000
4	134,000
5	87,000

The new system will be priced to sell at $380 each.

The cockroach eradicator project will require $1,800,000 in net working capital to start, and total net working capital will rise to 15% of the change in sales. The variable cost per unit is $265, and total fixed costs are $1,200,000 per year. The equipment necessary to begin production will cost a total of $24 million. This equipment is mostly industrial machinery and thus qualifies for CCA at a rate of 20%. In five years, this equipment will actually be worth about 20% of its cost.

The relevant tax rate is 35%, and the required return is 18%. Based on these preliminary estimates, what is the NPV of the project?

36. Replacement Decisions (LO6) An officer for a large construction company is feeling nervous. The anxiety is caused by a new excavator just released onto the market. The new excavator makes the one purchased by the company a year ago obsolete. As a result, the market value for the company's excavator has dropped significantly, from $600,000 a year ago to $50,000 now. In ten years, it would be worth only $3,000. The new excavator costs only $950,000 and would increase operating revenues by $90,000 annually. The new equipment has a ten-year life and expected salvage value of $175,000. What should the officer do? The tax rate is 35%, the CCA rate, 25% for both excavators, and the required rate of return for the company is 14%.

37. **Replacement Decisions (LO6)** A university student painter is considering the purchase of a new air compressor and paint gun to replace an old paint sprayer. (Both items belong to Class 9 and have a 25% CCA rate.) These two new items cost $12,000 and have a useful life of four years, at which time they can be sold for $1,600. The old paint sprayer can be sold now for $500 and could be scrapped for $250 in four years. The entrepreneurial student believes that operating revenues will increase annually by $8,000. Should the purchase be made? The tax rate is 22% and the required rate of return is 15%.

38. **Different Lives (LO7)** The Tempo Golf and Country Club in London, Ontario, is evaluating two different irrigation system options. An underground automatic irrigation system will cost $9.2 million to install and $80,000 pre-tax annually to operate. It will not have to be replaced for 20 years. An aboveground system will cost $6.8 million to install, but $190,000 per year to operate. The aboveground equipment has an effective operating life of nine years. The country club leases its land from the city and both systems are considered leasehold improvements; as a result, straight-line capital cost allowance is used throughout, and neither system has any salvage value. Which method should we select if we use a 13% discount rate? The tax rate is 39%.

39. **Comparing Mutually Exclusive Projects (LO1, 2)** Mapleton Enterprises Inc. is evaluating alternative uses for a three-story manufacturing and warehousing building that it has purchased for $975,000. The company could continue to rent the building to the present occupants for $75,000 per year. These tenants have indicated an interest in staying in the building for at least another 15 years. Alternatively, the company could make leasehold improvements to modify the existing structure to use for its own manufacturing and warehousing needs. Mapleton's production engineer feels the building could be adapted to handle one of two new product lines. The cost and revenue data for the two product alternatives follow.

	Product A	Product B
Initial cash outlay for building modifications	$102,000	$192,250
Initial cash outlay for equipment	382,000	456,000
Annual pre-tax cash revenues (generated for 15 years)	323,100	396,000
Annual pre-tax cash expenditures (generated for 15 years)	174,700	235,700

The building will be used for only 15 years for either product A or product B. After 15 years, the building will be too small for efficient production of either product line. At that time, Mapleton plans to rent the building to firms similar to the current occupants. To rent the building again, Mapleton will need to restore the building to its present layout. The estimated cash cost of restoring the building if product A has been undertaken is $19,200; if product B has been produced, the cash cost will be $129,250. These cash costs can be deducted for tax purposes in the year the expenditures occur.

Mapleton will depreciate the original building shell (purchased for $975,000) at a CCA rate of 5%, regardless of which alternative it chooses. The building modifications fall into CCA Class 13 and are depreciated using the straight-line method over a 15-year life. Equipment purchases for either product are in Class 8 and have a CCA rate of 20%. The firm's tax rate is 36%, and its required rate of return on such investments is 16%.

For simplicity, assume all cash flows for a given year occur at the end of the year. The initial outlays for modifications and equipment will occur at $t = 0$, and the restoration outlays will occur at the end of year 15. Also, Mapleton has other profitable ongoing operations that are sufficient to cover any losses.

Which use of the building would you recommend to management?

40. **Valuation of the Firm (LO1, 2)** The Mosley Wheat Company (MWC) has wheat fields that currently produce annual profits of $1,100,000. These fields are expected to produce average annual profits of $820,000 in real terms forever. MWC has no depreciable assets, so the annual cash flow is also $820,000. MWC is an all-equity firm with 385,000 shares outstanding. The appropriate discount rate for its stock is 16%. MWC has an investment opportunity with a gross present value of $1,900,000. The investment requires a $1,400,000 outlay now. MWC has no other investment opportunities. Assume all cash flows are received at the end of each year. What is the price per share of MWC?

41. **Comparing Mutually Exclusive Projects (LO4)** Kingsmill Industrial Systems Company (KISC) is trying to decide between two different conveyor belt systems. System A costs $290,000, has a four-year life, and requires $80,000 in pre-tax annual operating costs. System B costs $375,000, has a six-year life, and requires $74,000 in pre-tax annual operating costs. Both systems are to be depreciated at 30% per year (Class 10) and will have no salvage value. Whichever project is chosen, it will not be replaced when it wears out. If the tax rate is 34% and the discount rate is 8%, which project should the firm choose?

42. **Comparing Mutually Exclusive Projects (LO4)** Suppose in the previous problem that KISC always needs a conveyor belt system; when one wears out, it must be replaced. Which project should the firm choose now?

43. **Calculating a Bid Price (LO8)** Consider a project to supply 100 million postage stamps per year to Canada Post for the next five years. You have an idle parcel of land available that cost $850,000 five years ago; if you sold the land today, it would net you $1,080,000 after tax. If you sold the land five years from now, the land can be sold again for a net $1,150,000 after tax. You will need to install $4.6 million in new manufacturing plant and equipment to actually produce the stamps. The equipment qualifies for a CCA rate of 30% and can be sold for $400,000 at the end of the project. You will also need $600,000 in initial net working capital for the project, and an additional investment of $50,000 every year thereafter. Your production costs are 0.45 cents per stamp, and you have fixed costs of $1,200,000 per year. If your tax rate is 34% and your required return on this project is 12%, what bid price should you submit on the contract?

44. **Replacement with Unequal Lives (LO7)** BIG Industries needs computers. Management has narrowed the choices to the SAL 5000 and the DET 1000. It would need 12 SALs. Each SAL costs $15,900 and requires $1,850 of maintenance each year. At the end of the computer's six-year life, BIG expects to be able to sell each one for $1,300. On the other hand, BIG could buy ten DETs. DETs cost $19,000 each and each machine requires $1,700 maintenance every year. They last for four years and have no resale value. Whichever model BIG chooses, it will buy that model forever. Ignore tax effects, and assume that maintenance costs occur at year-end. Which model should BIG buy if the cost of capital is 15%?

45. **Replacement with Unequal Lives (LO7)** KISS 92.5 is considering the replacement of its old, fully depreciated sound mixer. Two new models are available. Mixer X has a cost of $743,000, a six-year expected life, and after-tax cash flow savings of $296,000 per year. Mixer Y has a cost of $989,000, a ten-year life, and after-tax cash flow of $279,000 per year. No new technological developments are expected. The cost of capital is 12%. Should KISS 92.5 replace the old mixer with X or Y?

Challenge (Questions 46–53)

46. **Abandonment Decisions (LO1, 2)** For some projects, it may be advantageous to terminate the project early. For example, if a project is losing money, you might be able to reduce your losses by scrapping out the assets and terminating the project, rather than continuing to lose money all the way through to the project's completion. Consider the following project of Norman Clapper Inc. The company is considering a four-year project to manufacture clap-command garage door openers. This project requires an initial investment of $7 million with a CCA of 40% over the project's life. An initial investment in net working capital of $2 million is required to support spare parts inventory; this cost is fully recoverable whenever the project ends. The company believes it can generate $5 million in pre-tax revenues with $2.5 million in total pre-tax operating costs. The tax rate is 39% and the discount rate is 13%. The market value of the equipment over the life of the project is as follows:

Year	Market Value (Millions)
1	$5.00
2	4.74
3	2.60
4	0.00

a. Assuming Norman Clapper operates this project for four years, what is the NPV?

b. Now compute the project NPV assuming the project is abandoned after only one year, after two years, and after three years. What economic life for this project maximizes its value to the firm? What does this problem tell you about not considering abandonment possibilities when evaluating projects?

47. **Capital Budgeting Renovations (LO1, 2)** Suppose we are thinking about renovating a leased office. The renovations would cost $364,000. The renovations will be depreciated straight-line to zero over the five-year remainder of the lease.

The new office would save us $36,000 per year in heating and cooling costs. Also, absenteeism should be reduced and the new image should increase revenues. These last two items would result in increased operating revenues of $43,000 annually. The tax rate is 36%, and the discount rate is 13%. Strictly from a financial perspective, should the renovations take place?

48. **Calculating Required Savings (LO5, 8)** A proposed cost-saving device has an installed cost of $620,000. It is in Class 8 (CCA rate = 20%) for CCA purposes. It will actually function for five years, at which time it will have no value. There are no working capital consequences from the investment, and the tax rate is 35%.

a. What must the pre-tax cost savings be for us to favour the investment? We require an 11% return. (*Hint*: This one is a variation on the problem of setting a bid price.)

b. Suppose the device will be worth $90,000 in salvage (before taxes). How does this change your answer?

49. **Cash Flows and Capital Budgeting Choices (LO1, 2)** Dexter Company has recently completed a $1.3 million, two-year marketing study. Based on the results, Dexter has estimated that 19,600 of its new RUR-class robots could be sold annually over the next eight years at a price of $45,900 each. Variable costs per robot are $35,000 and fixed costs total $39.1 million.

Start-up costs include $96.5 million to build production facilities, $7.2 million in land, and $19.2 million in net working capital. The $96.5 million facility is made up of a building valued at $16 million that will belong to CCA Class 3 and $80.5 million of manufacturing equipment (belonging to CCA Class 8). Class 3 has a CCA rate of 5%, while Class 8 has a rate of 20%. At the end of the project's life, the facilities (including the land) will be sold for an estimated $27.9 million; assume the building's value will be $8.7 million. The value of the land is not expected to change.

Finally, start-up would also entail fully deductible expenses of $4.6 million at Year 0. Dexter is an ongoing, profitable business and pays taxes at a 39% rate. Dexter uses a 17% discount rate on projects such as this one. Should Dexter produce the RUR-class robots?

50. **Project Evaluation (LO2)** Aylmer-in-You (AIY) Inc. projects unit sales for a new opera tenor emulation implant as follows:

Year	Unit Sales
1	107,000
2	123,000
3	134,000
4	156,000
5	95,500

Production of the implants will require $800,000 in net working capital to start and additional net working capital investments each year equal to 40% of the projected sales increase for the following year. (Because sales are expected to fall in Year 5, there is no NWC cash flow occurring for Year 4.) Total fixed costs are $192,000 per year, variable production costs are $295 per unit, and the units are priced at $395 each. The equipment needed to begin production has an installed cost of $19.5 million. Because the implants are intended for professional singers, this equipment is considered industrial machinery and thus falls into Class 8 for tax purposes (20%). In five years, this equipment can be sold for about 30% of its acquisition cost. AIY is in the 40% marginal tax bracket and has a required return on all its projects of 23%. Based on these preliminary project estimates, what is the NPV of the project? What is the IRR?

51. **Calculating Required Savings (LO5)** A proposed cost-saving device has an installed cost of $645,000. The device will be used in a five-year project, but is classified as manufacturing and processing equipment for tax purposes. The required initial net working capital investment is $55,000, the marginal tax rate is 35%, and the project discount rate is 9%. The device has an estimated Year 5 salvage value of $75,000. What level of pre-tax cost savings do we require for this project to be profitable? The CCA rate is 20%.

52. **Replacement Decisions (LO6)** Suppose we are thinking about replacing an old computer with a new one. The old one cost us $1,300,000 one year ago; the new one will cost $1,560,000. The new machine will be in CCA Class 10 (30%). It will probably be worth about $300,000 after five years.

The old computer belongs to CCA Class 10 (30%). If we don't replace it now, we will have to replace it in two years. We can sell it now for $420,000; in two years, it will probably be worth $120,000. The new machine will save us $290,000 per year in maintenance costs. The tax rate is 38% and the discount rate is 12%.

a. Suppose we consider only whether or not we should replace the old computer now without worrying about what's going to happen in two years. What are the relevant cash flows? Should we replace it or not? (*Hint*: Consider the net change in the firm's after-tax cash flows if we do the replacement.)

b. Suppose we recognize that if we don't replace the computer now, we will be replacing it in two years. Should we replace now or should we wait? (*Hint:* What we effectively have here is a decision either to "invest" in the old computer (by not selling it) or to invest in the new one.) Notice that the two investments have unequal lives.

53. **Financial Break-Even Analysis (LO8)** To solve the bid price problem presented in the text, we set the project NPV equal to zero and found the required price using the definition of OCF. Thus the bid price represents a financial break-even level for the project. This type of analysis can be extended to many other types of problems.

a. In Problem 33, assume that the price per carton is $23 and find the project NPV. What does your answer tell you about your bid price? What do you know about the number of cartons you can sell and still break even? How about your level of costs?

b. Solve Problem 33 again with the price still at $23 but find the quantity of cartons per year that you can supply and still break even.

c. Repeat (b) with a price of $23 and a quantity of 140,000 cartons per year, and find the highest level of fixed costs you could afford and still break even.

MINI CASE

As a financial analyst at Glencolin International (GI) you have been asked to evaluate two capital investment alternatives submitted by the production department of the firm. Before beginning your analysis, you note that company policy has set the cost of capital at 15% for all proposed projects. As a small business, GI pays corporate taxes at the rate of 35%.

The proposed capital project calls for developing new computer software to facilitate partial automation of production in GI's plant. Alternative A has initial software development costs projected at $194,000, while Alternative B would cost $336,000. Software development costs would be capitalized and qualify for a capital cost allowance (CCA) rate of 30%. In addition, IT would hire a software consultant under either alternative to assist in making the decision whether to invest in the project for a fee of $17,000 and this cost would be expensed when it is incurred.

To recover its costs, GI's IT department would charge the production department for the use of computer time at the rate of $394 per hour and estimates that it would take 182 hours of computer time per year to run the new software under either alternative. GI owns all its computers and does not currently operate them at capacity. The information technology (IT) plan calls for this excess capacity to continue in the future. For security reasons, it is company policy not to rent excess computing capacity to outside users.

If the new partial automation of production is put in place, expected savings in production cost (before tax) are projected as follows:

Year	Alternative A	Alternative B
1	$86,000	$118,000
2	86,000	130,000
3	67,000	106,000
4	56,000	98,000
5	39,000	59,000

As the capital budgeting analyst, you are required to answer the following in your memo to the production department:

a) Calculate the net present value of each of the alternatives. Which would you recommend?

b) The CFO suspects that there is a high risk that new technology will render the production equipment and this automation software obsolete after only three years. Which alternative would you now recommend? (Cost savings for Years 1 to 3 would remain the same.)

c) GI could use excess resources in its Engineering department to develop a way to eliminate this step of the manufacturing process by the end of year 3. The salvage value of the equipment (including any CCA and tax impact) would be $52,000 at the end of Year 3, $37,000 at the end of Year 4, and zero after five years. Should Engineering develop the solution and remove the equipment before the five years are up? Which alternative? When?

INTERNET APPLICATION QUESTIONS

1. From time to time, governments at various levels provide tax incentives to promote capital investments in key industries. The Province of Manitoba introduced the Mining & Exploration Tax Incentives program in the form of bonus tax credits (on top of normal deductions). Information on this program is found in the following release: gov.mb.ca/ctt/invest/busfacts/govt/min_taxc.html.

   Explain how this incentive will affect new exploration activity. Is it possible that such tax incentives alter the NPV of a project?

2. In addition to NPV and IRR, Economic Value Added (EVA®) analysis (sternvaluemanagement.com/proprietary-tools-value-creation) has emerged as a popular tool for capital budgeting and valuation. EVA was developed and is patented by Stern Value Management (sternvaluemanagement.com). Explain the mechanics of EVA and show its equivalence to NPV. Provide at least two reasons that EVA and NPV may differ in implementation.

3. General Motors expected the capital expansion of its Ingersoll, Ontario, assembly plant to total $800 million (CDN). The plant would become a manufacturing location of the next generation Chevrolet Equinox. Information on General Motors Canada's expansion plan can be found at media.gm.ca/media/ca/en/gm/news.detail.html/content/Pages/news/ca/en/2015/Feb/0212_CAMI.html. Assuming annual production of 300,000 vehicles, profit of $5,000 on the Equinox, an 8-year production horizon, and a 15% discount rate, do you think General Motors made a good investment decision? What other factors need to be considered? Why?

APPENDIX 10A

More on Inflation and Capital Budgeting

This text states that interest rates can be expressed in either nominal or real terms. For example, suppose the nominal interest rate is 12% and inflation is expected to be 8% next year. Then the real interest rate is approximately:

$$\text{Real rate} = \text{Nominal rate} - \text{Expected inflation rate} = 12\% - 8\% = 4\%.$$

Similarly, cash flows can be expressed in either nominal or real terms. Given these choices, how should one express interest rates and cash flows when performing capital budgeting?

Financial practitioners correctly stress the need to maintain consistency between cash flows and discount rates. That is, nominal cash flows must be discounted at the nominal rate. Real cash flows must be discounted at the real rate. The NPV is the same when cash flows are expressed in real quantities. The NPV is always the same under the two different approaches.

Because both approaches always yield the same result, which one should be used? Students will be happy to learn the following rule: use the approach that is simpler. In the Shields Electric case, nominal quantities produce a simpler calculation. That is because the problem gave us nominal cash flows to begin with.

However, firms often forecast unit sales per year. They can easily convert these forecasts to real quantities by multiplying expected unit sales each year by the product price at Date 0. (This assumes the price of the product rises at exactly the rate of inflation.) Once a real discount rate is selected, NPV can easily be calculated from real quantities. Conversely, nominal quantities complicate the example, because the extra step of converting all real cash flows to nominal cash flows must be taken.

EXAMPLE 10A.1

Real or Nominal?

Shields Electric forecasts the following nominal cash flows on a particular project:

	Date		
	0	***1***	***2***
Cash Flow	−$1,000	$600	$650

The nominal interest rate is 14%, and the inflation rate is forecast to be 5%. What is the value of the project?

Using Nominal Quantities The NPV can be calculated as:

$$\$26.47 = -\$1{,}000 + \frac{\$600}{1.14} + \frac{\$650}{(1.14)^2}$$

The project should be accepted.

Using Real Quantities The real cash flows are:

	Date		
	0	***1***	***2***
Cash Flow	−$1,000	$571.43	$589.57
		$\left(\frac{\$600}{1.05}\right)$	$\left(\frac{\$650}{(1.05)^2}\right)$

The real interest rate is approximately 9% (14% − 5%); precisely it is 8.57143%.[27]

The NPV can be calculated as:

$$\$26.47 = -\$1{,}000 + \frac{\$571.32}{1.0857143} + \frac{\$589.57}{(1.0857143)^2}$$

27 The exact calculation is 8.57143% = (1.14/1.05) − 1. It is explained in Chapter 12.

Concept Questions

1. What is the difference between the nominal and the real interest rate?
2. What is the difference between nominal and real cash flows?

Appendix Questions and Problems

A.1. Repeat Question 27, assuming that all cash flows and discount rates provided are nominal rates, and that the inflation rate is 3%. What are the real cash flows and the real rate of return? What is the new EAC for the production methods if inflation is taken into account?

APPENDIX 10B

Capital Budgeting with Spreadsheets

Spreadsheets are almost essential for constructing a capital budgeting framework or for using pro forma financial statements. Table 10B.2 is an example of a capital budgeting framework, using the data from the Majestic Mulch and Compost Company. The framework is completely integrated; changing one of the input variables at the top reformulates the whole problem. This is useful for sensitivity calculations as it would be tedious to recalculate each column in the framework by hand.

The highlighted cells exhibit the more complicated procedures in the framework. The first, E16, is the CCA calculation. An IF statement is used to make a decision on what year it is so that the half-year effect can be taken into consideration. The second, G32, calculates the changes in net working capital. It is computed as 15% of the current year's sales less 15% of the previous year's sales. In Year 1, however, the initial net working capital is subtracted instead. The last cell, L53, simply discounts the future cash flows back to Year 0 dollars.

A well-designed capital budgeting framework allows most inputs to be easily changed, simplifying sensitivity calculations. We now turn our attention to a simple sensitivity calculation, to explain the usefulness of spreadsheets.

Table 10B.1 shows two sensitivity tables; one varies the initial investment and the other varies the discount rate. Notice in the first that if the initial investment runs over budget by as little as $25,000, it makes the whole project unprofitable. The second sensitivity analysis demonstrates that the project is even more sensitive to discount rate fluctuations.

Spreadsheets are invaluable in problems such as these; they decrease the number of silly errors and make all values easier to check. They also allow for what-if analyses such as these.

Recall that many problems in each chapter are labelled with an arrow as Spreadsheet Problems. For some good practice at capital budgeting on a spreadsheet, we suggest that you consider completing Problem 50 in particular.

TABLE 10B.1

Sensitivity analysis

Initial Investment	NPV	Discount Rate	NPV
Base case	$ 4,604	15.0%	$ 4,604
$750,000	44,626	10.0	177,240
775,000	24,615	12.5	84,796
800,000	4,604	15.0	4,604
825,000	−15,407	17.5	−65,319
850,000	−35,418	20.0	−126,589

TABLE 10B.2

Capital budgeting framework

	A	B	C	D	E	F	G	H	I	J	K	L
1	**The Majestic Mulch and Compost Company**											
2												
3	Input variables:											
4	Tax rate		40.0%		Discount rate		15.0%					
5	CCA rate		20.0%		NWC as a % of sale		15.0%					
6	Initial investment		$800,000									
7												
8												
9						**Statements of comprehensive income**						
10	**Year**				1	2	3	4	5	6	7	8
11	Unit price (Table 10.5)				$ 120	$ 120	$ 120	$ 110	$ 110	$ 110	$ 110	$ 110
12	Unit sales (Table 10.5)				3,000	5,000	6,000	6,500	6,000	5,000	4,000	3,000
13	Revenues (Unit price × Unit sales)				$360,000	$600,000	$720,000	$715,000	$660,000	$550,000	$440,000	$330,000
14	Variable costs ($60 × Unit sales)				180,000	300,000	360,000	390,000	360,000	300,000	240,000	180,000
15	Fixed costs				25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000
16	CCA				80,000	144,000	115,200	92,160	73,728	58,982	47,186	37,749
17	EBIT (Revenues − (Costs + CCA))				$ 75,000	$131,000	$219,800	$207,840	$201,272	$166,018	$127,814	$ 87,251
18	Taxes (EBIT × 40%)				30,000	52,400	87,920	83,136	80,509	66,407	51,126	34,901
19	Net income (EBIT – taxes)				$ 45,000	$ 78,600	$131,880	$124,704	$120,763	$ 99,611	$ 76,688	$ 52,351
20												
21												
22						**Projected cash flows**						
23	**Year**			0	1	2	3	4	5	6	7	8
24	**Operating cash flows**											
25	EBIT				$ 75,000	$131,000	$219,800	$207,840	$201,272	$166,018	$127,814	$ 87,251
26	CCA				80,000	144,000	115,200	92,160	73,728	58,982	47,186	37,749
27	Taxes				30,000	52,400	87,920	83,136	80,509	66,407	51,126	34,901
28	Op. cash flow (tax shield approach)				$125,000	$222,600	$247,080	$216,864	$194,491	$158,593	$123,874	$ 90,099
29												
30	**Net working capital**											
31	Initial NWC			$ 20,000								
32	NWC Increases				$ 34,000	36,000	$ 18,000	$ (750)	$ (8,250)	$(16,500)	$(16,500)	$(16,500)
33	NWC recovery											$(49,500)
34	Add'ns to NWC			$ 20,000	$ 34,000	$ 36,000	$ 18,000	$ (750)	$ (8,250)	$(16,500)	$(16,500)	$(66,000)
35												
36												
37												
38												
39												
40						**Capital Spending (Table 10.8)**						
41	Initial inv.			$800,000								
42	After-tax salvage											$(150,000)
43	Net cap. spending			$800,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$(150,000)
44												
45	**Year**			0	1	2	3	4	5	6	7	8
46	Total project cash flow (OCF − Capital spending − Add'ns to NWC)											
47				$(820,000)	$ 91,000	$ 186,600	$ 229,080	$217,614	$202,741	$175,093	$140,374	$306,099
48												
49	Cumulative cash flow											
50				$(820,000)	$(729,000)	$(542,400)	$(313,320)	$(95,706)	$107,035	$282,128	$422,503	$728,602
51												
52	Discounted cash flow (@15%)											
53				$(820,000)	$ 79,130	$ 141,096	$ 150,624	$124,422	$100,798	$ 75,698	$ 52,772	$100,064
54												
55	NPV			$ 4,604								
56												
57	IRR			15.15%	Cash flows	Cell formulas						
58					$(820,000)	E16: = IF(E10=1,$C$6/2*$C$5,($C$6 − SUM(D16:$E$16))*$C$5)						
59					$ 91,000	G32: = (G13*$G$5)−(F13*$G$5)						
60					$186,600	L53: = L47/((1 + $G$4)^L45)						
61					$229,080							
62					$217,614							
63					$202,741							
64					$175,093							
65					$140,374							
66					$306,099							

APPENDIX 10C

Deriving the Tax Shield on CCA Formula

We can use the dividend valuation formula from Chapter 8 to derive the present value of the CCA tax shield. Recall that when dividends grow at a constant rate, g, the stock price is:

$$P_0 = \frac{D_1}{r - g}$$

To apply this to the tax shield problem, we recognize that the formula can be generalized for any growing perpetuity where, for example, Payment 3 = (Payment 2) × (1 + g):

$$\text{PV} = \frac{\text{1st payment}}{\text{(Discount rate)} + \text{(Growth rate)}}$$

Since we are temporarily ignoring the half-year rule, the growth rate in CCA payments is equal to ($-d$). The declining UCC value implies negative growth. Thus, to account for the decline, the growth rate equals ($-d$). For example, in Table 10.13:

$$\text{CCA}_3 = \text{CCA}_2(1 + (-d))$$
$$\text{CCA}_3 = 144{,}000(1 + (-.20))$$
$$\text{CCA}_3 = 144{,}000(.8) = 115{,}200$$

Given the growth rate as ($-d$), we need the first payment to complete the formula. This is the first year's tax shield IdT_c. We can now complete the formula:

$$\text{PV(CCA tax shield)} = \frac{\text{1st payment}}{\text{(Discount rate)} - \text{(Growth rate)}} = \frac{IdT_C}{r - (-d)} = \frac{IdT_C}{r + d}$$

The next step is to extend the formula to adjust for CRA's half-year rule. This rule implies that a firm adds one-half of the incremental capital cost of a new project in Year 1 and the other half in Year 2. The result is that we now calculate the present value of the tax shield in two parts. The present value of the stream starting the first year is simply one-half of the original value:

$$\text{PV of 1st half} = 1/2\,\frac{IdT_C}{r + d}$$

The PV of the second half (deferred one year) is the same quantity (bracketed term) discounted back to time zero. The total present value of the tax shield on CCA under the half-year rule is the sum of the two present values:

$$\text{PV tax shield on CCA} = 1/2\,\frac{IdT_C}{r + d} + \frac{1/2\,\frac{IdT_C}{r + d}}{1 + r}$$

With a little algebra we can simplify the formula:

$$\text{PV} = \left[1 + \frac{1}{1+r}\right] = \left[\frac{1+r+1}{1+r}\right] 1/2 \frac{IdT_C}{r+d} \frac{1/2IdT_C}{r+d}$$

$$\text{PV} = \left[\frac{1+.5r}{1+r}\right]\frac{IdT_C}{r+d}$$

The final adjustment for salvage value begins with the present value in the salvage year, n of future tax shields beginning in Year $n + 1$:

$$\frac{S_n dT_c}{d+r}$$

We discount this figure back to today and subtract it to get the complete formula:[28]

$$\text{PV tax shield on CCA} = \frac{[IdT_c]}{d + r} \times \frac{[1 + .5r]}{1+r} - \frac{S_n dT_c}{d+r} \times \frac{1}{(1+r)^n} \qquad [10C.1]$$

28 By not adjusting the salvage value for the half-year rule, we assume there will be no new investment in year *n*.