CHAPTER NINE

Depreciation and Corporate Taxes

Know What It Costs to Own a Piece of Equipment: A Hospital Pharmacy Gets a Robotic Helper[1] When most patients at Kirkland's Evergreen Hospital Medical Center are asleep, the robot comes to life. Its machinery thumps like a heart beating as it moves around the hospital pharmacy, preparing prescriptions. In a little more than an hour, he'll ready 1,500 doses of medication.

Ernie, or Evergreen Robot Noticeably Improving Efficiency, is a new $3 million addition to [the] pharmacy staff. The robot uses bar codes to match each drug dispensed with an electronic patient profile, helping prevent errors, said Bob Blanchard, pharmacy director.

[1] "Know What It Costs to Own a Piece of Equipment: A Hospital Pharmacy Gets a Robotic Helper," Katherine Sather, *Seattle Times Eastside bureau,* Copyright © 2004 The Seattle Times Company.

"It's the future," he said. "Safety is the main benefit." Efficiency is another plus. The robot can prepare a 24-hour medication supply for in-house patients, about 1,500 doses, in a little more than an hour. The same task used to take three people about three hours to complete, Blanchard said.

Now, staff [members] only label the medications with bar codes. Ernie does the rest.

The machine looks like a mini space ship. A door opens into an octagon-shaped room, 12 feet long diagonally, stocked with more than 400 racks of medicine. Each dose is labeled with a bar code that tells Ernie what it is and where it should be stored. Affixed to the center of the room is a mechanical arm that scans the bar-coded medicine and places it on its designated rack.

When staff [members] give Ernie a computerized order, his arm buzzes to the correct row of medication, grabs it with suction cups and drops it into an envelope that is bar coded with the patient's profile.

"Research shows using it decreases certain predictable errors," Blanchard said. "We're very excited about it—we've really led the drive to move to automation."

At Evergreen, [the] pharmacy staff hope[s] for Ernie to eventually dispense 93 percent of the medication that is distributed to patients in the 244-bed hospital. Medication that needs care such as refrigeration is prepared by staff.

"The technology is such that it's been tested and it's reliable. Given the volume of patients we see, it makes sense," said Amy Gepner, a spokesperson for the hospital. "It's a safety initiative." Ernie is being purchased with a seven-year lease along with 23 automated medical cabinets placed throughout the hospital. But [the] staff [is] fonder of the robot.

Now ask yourself, How does the cost of this robot ($3 million) affect the financial position of the hospital? In the long run, the system promises to create greater cost savings for the hospital by enhancing productivity, improving safety, and cutting down lead time in filling orders. In the short run, however, the high initial cost of the robot will adversely affect the organization's "bottom line," because that cost is only gradually rewarded by the benefits the robot offers.

Another consideration should come to mind as well: This state-of-the-art robot must inevitably wear out over time, and even if its productive service extends over many years, the cost of maintaining its high level of functioning will increase as the individual pieces of hardware wear out and need to be replaced. Of even greater concern is the question of how long this robot will be the state of the art. When will the competitive advantage the hospital has just acquired become a competitive disadvantage through obsolescence?

One of the facts of life that organizations must deal with and account for is that fixed assets lose their value—even as they continue to function and contribute to the engineering projects that use them. This loss of value, called **depreciation**, can involve deterioration and obsolescence.

The main function of **depreciation accounting** is to account for the cost of fixed assets in a pattern that matches their decline in value over time. The cost of the robot we have just described, for example, will be allocated over several years in the hospital's financial statements, so that the pattern of the robot's costs roughly matches its pattern of service. In this way, as we shall see, depreciation accounting enables the firm to stabilize the statements about its financial position that it distributes to stockholders and the outside world.

On a project level, engineers must be able to assess how the practice of depreciating fixed assets influences the investment value of a given project. To do this, the engineers need to estimate the allocation of capital costs over the life of the project, which requires an understanding of the conventions and techniques that accountants use to depreciate assets. In this chapter, we will review the conventions and techniques of asset depreciation and income taxes.

We begin by discussing the nature and significance of depreciation, distinguishing its general economic definition from the related, but different, accounting view of depreciation. We then focus our attention almost exclusively on the rules and laws that govern asset depreciation and the methods that accountants use to allocate depreciation expenses. Knowledge of these rules will prepare you to apply them in assessing the depreciation of assets acquired in engineering projects. Then we turn our attention to the subject of depletion, which utilizes similar ideas, but specialized techniques, to allocate the cost of the depletion of natural-resource assets.

Once we understand the effect of depreciation at the project level, we need to address the effect of corporate taxes on project cash flows. There are many forms of government taxation, including sales taxes, property taxes, user taxes, and state and federal income taxes. In this chapter, we will focus on federal income taxes. When you are operating a business, any profits or losses you incur are subject to income tax consequences. Therefore, we cannot ignore the impact of income taxes in project evaluation. The chapter will give you a good idea of how the U.S. tax system operates and of how federal income taxes affect economic analysis. Although tax law is subject to frequent changes, the analytical procedures presented here provide a basis for tax analysis that can be adapted to reflect future changes in tax law. Thus, while we present many examples based on current tax rates, in a larger context we present a general approach to the analysis of *any* tax law.

CHAPTER LEARNING OBJECTIVES

After completing this chapter, you should understand the following concepts:

- How to account for the loss of value of an asset in business.
- The meaning and types of depreciation.
- The difference between book depreciation and tax depreciation.
- The effects of depreciation on net income calculation.
- The general scheme of U.S. corporate taxes.
- How to determine ordinary gains and capital gains.
- How to determine the appropriate tax rate to use in project analysis.
- The relationship between net income and net cash flow.

9.1 Asset Depreciation

Fixed assets, such as equipment and real estate, are economic resources that are acquired to provide future cash flows. Generally, **depreciation** can be defined as a gradual decrease in the utility of fixed assets with use and time. While this general definition does not capture the subtleties inherent in a more specific definition of depreciation, it does provide us with a starting point for examining the variety of underlying ideas and practices that are discussed in this chapter. Figure 9.1 will serve as a road map for understanding the different types of depreciation that we will explore here.

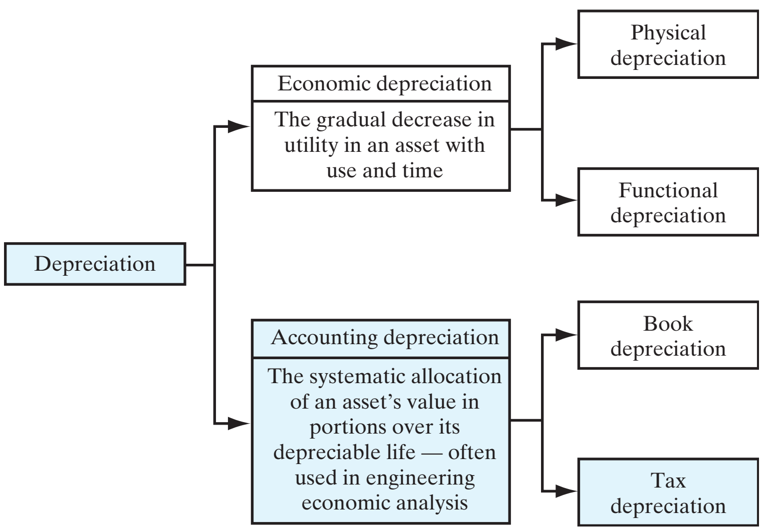

Figure 9.1 Classification of types of depreciation.

We can classify depreciation into the categories of physical or functional depreciation. **Physical depreciation** can be defined as a reduction in an asset's capacity to perform its intended service due to physical impairment. Physical depreciation can occur in any fixed asset in the form of (1) deterioration from interaction with the environment, including such agents as corrosion, rotting, and other chemical changes, and (2) wear and tear from use. Physical depreciation leads to a decline in performance and high maintenance costs.

Functional depreciation occurs as a result of changes in the organization or in technology that decrease or eliminate the need for an asset. Examples of functional depreciation include obsolescence attributable to advances in technology, a declining need for the services performed by an asset, and the inability to meet increased quantity or quality demands.

9.1.1 Economic Depreciation

This chapter is concerned primarily with accounting depreciation, which is the form of depreciation that provides an organization with the information it uses to assess its financial position. It would also be useful, however, to discuss briefly the economic ideas upon which accounting depreciation is based. In the course of the discussion, we will develop a precise definition of economic depreciation that will help us distinguish between various conceptions of depreciation.

If you have ever owned a car, you are probably familiar with the term *depreciation* as it is used to describe the decreasing value of your vehicle. Because a car's reliability and appearance usually decline with age, the vehicle is worth less with each passing year. You can calculate the economic depreciation accumulated for your car by subtracting the current market value, or "blue book" value, of the car from the price you originally paid for it. We can define **economic depreciation** as follows:

$$\text{Economic depreciation} = \text{Purchase price} - \text{market value}.$$

Physical and functional depreciation are categories of economic depreciation. The measurement of economic depreciation does not require that an asset be sold: The market value of the asset can be closely estimated without actually testing it in the marketplace. The need to have a precise scheme for recording the ongoing decline in the value of an asset as a part of the accounting process leads us to an exploration of how organizations account for depreciation.

9.1.2 Accounting Depreciation

The acquisition of fixed assets is an important activity for a business organization, whether the organization is starting up or acquiring new assets to remain competitive. Like other disbursements, the cost of these fixed assets must be recorded as expenses on a firm's balance sheet and income statement. However, unlike costs such as maintenance, material, and labor costs, the costs of fixed assets are not treated simply as expenses to be accounted for in the year that they are acquired. Rather, these assets are **capitalized**; that is, their costs are distributed by subtracting them as expenses from gross income, one part at a time over a number of periods. The systematic allocation of the initial cost of an asset in parts over a time, known as the asset's depreciable life, is what we mean by **accounting depreciation**. Because accounting depreciation is the standard of the business world, we sometimes refer to it more generally as **asset depreciation**.

Accounting depreciation: Amount allocated during the period to amortize the cost of acquiring long term assets over the useful life of the assets.

Accounting depreciation is based on the **matching concept**: A fraction of the cost of the asset is chargeable as an expense in each of the accounting periods in which the asset provides service to the firm, and each charge is meant to be a percentage of the whole cost that "matches" the percentage of the value utilized in the given period. The matching concept suggests that the accounting depreciation allowance generally reflects, at least to some extent, the actual economic depreciation of the asset. *In engineering economic analysis, we use the concept of accounting depreciation exclusively*. This is because accounting depreciation provides a basis for determining the income taxes associated with any project undertaken.

9.2 Factors Inherent in Asset Depreciation

The process of depreciating an asset requires that we make several preliminary determinations: (1) What is the cost of the asset? (2) What is the asset's value at the end of its useful life? (3) What is the depreciable life of the asset? and, finally, (4) What method of depreciation do we choose? In this section, we will examine each of these questions.

9.2.1 Depreciable Property

As a starting point, it is important to recognize what constitutes a **depreciable asset**—that is, a property for which a firm may take depreciation deductions against income. For the purposes of U.S. tax law, any depreciable property has the following characteristics:

1. It must be used in business or must be held for the production of income.
2. It must have a definite service life, and that life must be longer than 1 year.
3. It must be something that wears out, decays, gets used up, becomes obsolete, or loses value from natural causes.

Depreciable property includes buildings, machinery, equipment, and vehicles. Inventories are not depreciable property, because they are held primarily for sale to customers in the ordinary course of business. If an asset has no definite service life, the asset cannot be depreciated. For example, *you can never depreciate land*.[2]

As a side note, we mention the fact that, while we have been focusing on depreciation within firms, individuals may also depreciate assets, as long as they meet the conditions we have listed. For example, an individual may depreciate an automobile if the vehicle is used exclusively for business purposes.

[2] This also means that you cannot depreciate the cost of clearing, grading, planting, and landscaping. All four expenses are considered part of the cost of the land.

9.2.2 Cost Basis

The **cost basis** of an asset represents the total cost that is claimed as an expense over the asset's life (i.e., the sum of the annual depreciation expenses). The cost basis generally includes the actual cost of the asset and all other incidental expenses, such as freight, site preparation, and installation. This total cost, rather than the cost of the asset only, must be the depreciation basis charged as an expense over the asset's life.

Besides being used in figuring depreciation deductions, an asset's cost basis is used in calculating the gain or loss to the firm if the asset is ever sold or salvaged. (We will discuss these topics in Section 9.8.)

Cost basis: The cost of an asset used to determine the depreciation base.

Book value: The value of an asset as it appears on a balance sheet, equal to cost minus accumulated depreciation.

EXAMPLE 9.1 Cost Basis

Lanier Corporation purchased an automatic hole-punching machine priced at \$62,500. The vendor's invoice included a sales tax of \$3,263. Lanier also paid the inbound transportation charges of \$725 on the new machine, as well as the labor cost of \$2,150 to install the machine in the factory. In addition, Lanier had to prepare the site at a cost of \$3,500 before installation. Determine the cost basis for the new machine for depreciation purposes.

SOLUTION

Given: Invoice price = \$62,500, freight = \$725, installation cost = \$2,150, and site preparation = \$3,500.

Find: The cost basis.

The cost of machine that is applicable for depreciation is computed as follows:

Cost of new hole-punching machine	\$62,500
Freight	725
Installation labor	2,150
Site preparation	3,500
Cost of machine (cost basis)	\$68,875

COMMENTS: Why do we include all the incidental charges relating to the acquisition of a machine in its cost? Why not treat these incidental charges as expenses incurred during the period in which the machine is acquired? The matching of costs and revenue is the basic accounting principle. Consequently, the total costs of the machine should be viewed as an asset and allocated against the future revenue that the machine will generate. All costs incurred in acquiring the machine are costs of the services to be received from using the machine.

If the asset is purchased by trading in a similar asset, the difference between the book value (the cost basis minus the total accumulated depreciation) and the trade-in allowance must be considered in determining the cost basis for the new asset. If the trade-in allowance exceeds the book value, the difference (known as **unrecognized gain**) needs to be subtracted from the cost basis of the new asset. If the opposite is true (**unrecognized loss**), the difference should be added to the cost basis for the new asset.

EXAMPLE 9.2 Cost Basis with Trade-In Allowance

In Example 9.1, suppose Lanier purchased the hole-punching press by trading in a similar machine and paying cash for the remainder. The trade-in allowance is $5,000, and the book value of the hole-punching machine that was traded in is $4,000. Determine the cost basis for this hole-punching press.

SOLUTION

Given: Accounting data from Example 9.1; trade allowance = $5,000.

Find: The revised cost basis.

Old hole-punching machine (**book value**)	$ 4,000
Less: Trade-in allowance	5,000
Unrecognized gains	$ 1,000
Cost of new hole-punching machine	$62,500
Less: Unrecognized gains	(1,000)
Freight	725
Installation labor	2,150
Site preparation	3,500
Cost of machine (cost basis)	$67,875

9.2.3 Useful Life and Salvage Value

Over how many periods will an asset be useful to a company? What do published statutes allow you to choose as the life of an asset? These are the central questions to be answered in determining an asset's depreciable life (i.e., the number of years over which the asset is to be depreciated).

Historically, depreciation accounting included choosing a depreciable life that was based on the service life of an asset. Determining the service life of the asset, however, was often very difficult, and the uncertainty of these estimates often led to disputes between taxpayers and the Internal Revenue Service (IRS). To alleviate the problems, the IRS published guidelines on lives for categories of assets. The guidelines, known as **asset depreciation ranges**, or **ADRs**, specified a range of lives for classes of assets based on historical data, and taxpayers were free to choose a depreciable life within the specified range for a given asset. An example of ADRs for some assets is given in Table 9.1.

TABLE 9.1 Asset Depreciation: Some Selected Asset Guideline Classes

	Asset Depreciation Range (Years)		
Assets Used	Lower Limit	Midpoint Life	Upper Limit
Office furniture, fixtures, and equipment	8	10	12
Information systems (computers)	5	6	7
Airplanes	5	6	7
Automobiles, taxis	2.5	3	3.5
Buses	7	9	11
Light trucks	3	4	5
Heavy trucks (concrete ready-mixer)	5	6	7
Railroad cars and locomotives	12	15	18
Tractor units	5	6	7
Vessels, barges, tugs, and water transportation systems	14.5	18	21.5
Industrial steam and electrical generation and/or distribution systems	17.5	22	26.5
Manufacturer of electrical and nonelectrical machinery	8	10	12
Manufacturer of electronic components, products, and systems	5	6	7
Manufacturer of motor vehicles	9.5	12	14.5
Telephone distribution plant	28	35	42

Source: IRS Publication 534. *Depreciation*. Washington, DC: U.S. Government Printing Office, 1995.

The **salvage value** is an asset's estimated value at the end of its life—the amount eventually recovered through sale, trade-in, or salvage. The eventual salvage value of an asset must be estimated when the depreciation schedule for the asset is established. If this estimate subsequently proves to be inaccurate, then an adjustment must be made. We will discuss these specific issues in Section 9.6.

9.2.4 Depreciation Methods: Book and Tax Depreciation

Most firms calculate depreciation in two different ways, depending on whether the calculation is (1) intended for financial reports (the **book depreciation method**), such as for the balance sheet or income statement, or (2) for the Internal Revenue Service (IRS), for the purpose of determining taxes (the **tax depreciation method**). In the United States, this distinction is totally legitimate under IRS regulations, as it is in many other countries.

Calculating depreciation differently for financial reports and for tax purposes allows the following benefits:

- It enables firms to report depreciation to stockholders and other significant outsiders on the basis of the matching concept. Therefore, the actual loss in value of the assets is generally reflected.
- It allows firms to benefit from the tax advantages of depreciating assets more quickly than would be possible with the matching concept. In many cases, tax depreciation allows firms to defer paying income taxes. This does not mean that they pay less tax overall, because the total depreciation expense accounted for over time is the same in either case. However, because tax depreciation methods usually permit a higher depreciation in earlier years than do book depreciation methods, the tax benefit of depreciation is enjoyed earlier, and firms generally pay lower taxes in the initial years of an investment project. Typically, this leads to a better cash position in early years, and the added cash leads to greater future wealth because of the time value of the funds.

As we proceed through the chapter, we will make increasing use of the distinction between depreciation accounting for financial reporting and depreciation accounting for income tax calculation. Now that we have established the context for our interest in both tax and book depreciation, we can survey the different methods with an accurate perspective.

9.3 Book Depreciation Methods

Three different methods can be used to calculate the periodic depreciation allowances: (1) the straight-line method, (2) accelerated methods, and (3) the unit-of-production method. In engineering economic analysis, we are interested primarily in depreciation in the context of income tax computation. Nonetheless, a number of reasons make the study of book depreciation methods useful. First, tax depreciation methods are based largely on the same principles that are used in book depreciation methods. Second, firms continue to use book depreciation methods for financial reporting to stockholders and outside parties. Third, book depreciation methods are still used for state income tax purposes in many states and even for federal income tax purposes for assets that were put into service before 1981. Finally, our discussion of depletion in Section 9.5 is based largely on one of these three book depreciation methods.

9.3.1 Straight-Line Method

The **straight-line (SL) method** of depreciation interprets a fixed asset as an asset that offers its services in a uniform fashion. The asset provides an equal amount of service in each year of its useful life.

Straight-line depreciation: An equal dollar amount of depreciation in each accounting period.

The straight-line method charges, as an expense, an equal fraction of the net cost of the asset each year, as expressed by the relation

$$D_n = \frac{(I - S)}{N}, \tag{9.1}$$

where D_n = Depreciation charge during year n,

I = Cost of the asset, including installation expenses,

S = Salvage value at the end of the asset's useful life,

N = Useful life.

The book value of the asset at the end of n years is then defined as

Book value in a given year = Cost basis − total depreciation charges made to date

or

$$B_n = I - (D_1 + D_2 + D_3 + \cdots + D_n). \tag{9.2}$$

EXAMPLE 9.3 Straight-Line Depreciation

Consider the following data on an automobile:

$$\text{Cost basis of the asset, } I = \$10{,}000,$$
$$\text{Useful life, } N = 5 \text{ years},$$
$$\text{Estimated salvage value, } S = \$2{,}000.$$

Use the straight-line depreciation method to compute the annual depreciation allowances and the resulting book values.

SOLUTION

Given: $I = \$10{,}000$, $S = \$2{,}000$, and $N = 5$ years.
Find: D_n and B_n for $n = 1$ to 5.

The straight-line depreciation rate is $\frac{1}{5}$, or 20%. Therefore, the annual depreciation charge is

$$D_n = (0.20)(\$10{,}000 - \$2{,}000) = \$1{,}600.$$

The asset would then have the following book values during its useful life:

n	B_{n-1}	D_n	B_n
1	$10,000	$1,600	$8,400
2	8,400	1,600	6,800
3	6,800	1,600	5,200
4	5,200	1,600	3,600
5	3,600	1,600	2,000

Here, B_{n-1} represents the book value before the depreciation charge for year n. This situation is illustrated in Figure 9.2.

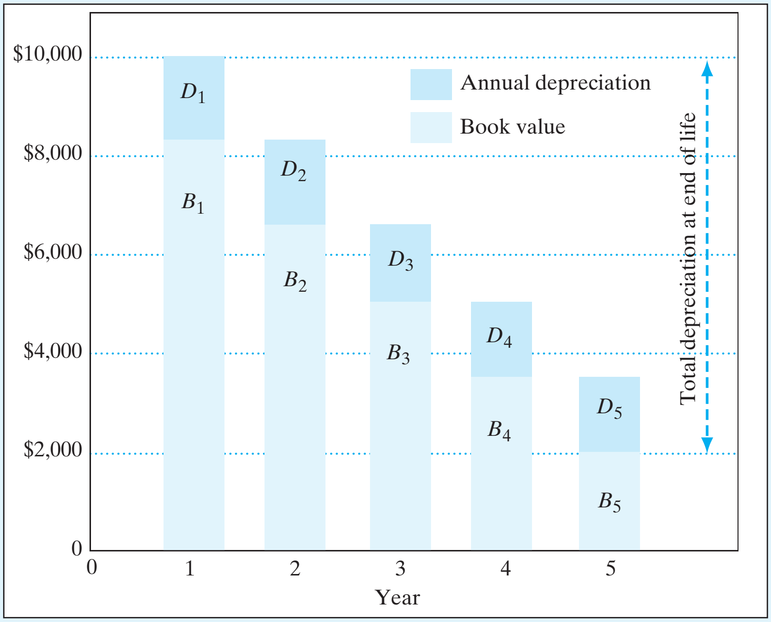

Figure 9.2 Straight-line depreciation methods (Example 9.3).

9.3.2 Accelerated Methods

The second concept of depreciation recognizes that the stream of services provided by a fixed asset may decrease over time; in other words, the stream may be greatest in the first year of an asset's service life and least in its last year. This pattern may occur because the mechanical efficiency of an asset tends to decline with age, because maintenance costs tend to increase with age, or because of the increasing likelihood that better equipment will become available and make the original asset obsolete. This kind of reasoning leads to a method that charges a larger fraction of the cost as an expense of the early years than of the later years. Any such method is called an **accelerated method**. The most widely used accelerated method is the **double-declining-balance method**.

Accelerated method: Any depreciation method that produces larger deductions for depreciation in the early years of a project's life.

Double-declining balance method: A depreciation method, in which double the straight-line depreciation amount is taken the first year, and then that same percentage is applied to the undepreciated amount in subsequent years.

Declining-Balance Method

The **declining-balance (DB) method** of calculating depreciation allocates a fixed fraction of the beginning book balance each year. The fraction, α, is obtained as follows:

$$\alpha = \left(\frac{1}{N}\right)(\text{multiplier}). \tag{9.3}$$

The most commonly used multipliers in the United States are 1.5 (called 150% DB) and 2.0 (called 200%, or double-declining balance, DDB). As N increases, α decreases, resulting in a situation in which depreciation is highest in the first year and then decreases over the asset's depreciable life.

The fractional factor can be utilized to determine depreciation charges for a given year, D_n, as follows:

$$D_1 = \alpha I,$$
$$D_2 = \alpha(I - D_1) = \alpha I(1 - \alpha),$$
$$D_3 = \alpha(I - D_1 - D_2) = \alpha I(1 - \alpha)^2,$$

Thus, for any year n, we have a depreciation charge

$$D_n = \alpha I(1 - \alpha)^{n-1}. \quad (9.4)$$

We can also compute the total DB depreciation (TDB) at the end of n years as follows:

$$\begin{aligned} \text{TDB} &= D_1 + D_2 + \cdots + D_n \\ &= \alpha I + \alpha I(1 - \alpha) + \alpha I(1 - \alpha)^2 + \cdots + \alpha I(1 - \alpha)^{n-1} \\ &= \alpha I[1 + (1 - \alpha) + (1 - \alpha)^2 + \cdots + (1 - \alpha)^{n-1}] \\ &= I[1 - (1 - \alpha)^n]. \end{aligned} \quad (9.5)$$

The book value B_n at the end of n years will be the cost I of the asset minus the total depreciation at the end of n years:

$$\begin{aligned} B_n &= I - \text{TDB} \\ &= I - I[1 - (1 - \alpha)^n] \\ B_n &= I(1 - \alpha)^n. \end{aligned} \quad (9.6)$$

EXAMPLE 9.4 Declining-Balance Depreciation

Consider the following accounting information for a computer system:

$$\text{Cost basis of the asset, } I = \$10{,}000,$$
$$\text{Useful life, } N = 5 \text{ years},$$
$$\text{Estimated salvage value, } S = \$778.$$

Use the double-declining-depreciation method to compute the annual depreciation allowances and the resulting book values (Figure 9.3).

SOLUTION

Given: $I = \$10{,}000$, $S = \$778$, $N = 5$ years

Find: D_n and B_n for $n = 1$ to 5

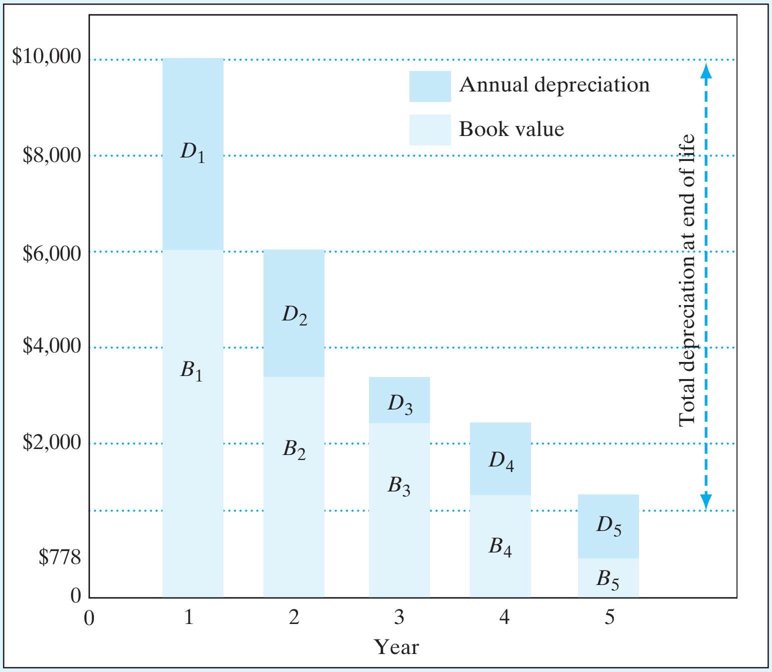

Figure 9.3 Double-declining-balance method (Example 9.4).

The book value at the beginning of the first year is \$10,000, and the declining-balance rate (α) is $\left(\frac{1}{5}\right)(2) = 40\%$. Then the depreciation deduction for the first year will be \$4,000 $(40\% \times \$10{,}000 = \$4{,}000)$. To figure the depreciation deduction in the second year, we must first adjust the book value for the amount of depreciation we deducted in the first year. The first year's depreciation from the beginning book value is subtracted $(\$10{,}000 - \$4{,}000 = \$6{,}000)$, and the resulting amount is multiplied by the rate of depreciation $(\$6{,}000 \times 40\% = \$2{,}400)$. By continuing the process, we obtain the following table:

n	B_n	D_n	B_n
1	10,000	4,000	6,000
2	6,000	2,400	3,600
3	3,600	1,440	2,160
4	2,160	864	1,296
5	1,296	518	778

The declining balance is illustrated in terms of the book value of time in Figure 9.3.

The salvage value (S) of the asset must be estimated at the outset of depreciation analysis. In Example 9.4, the final book value (B_N) conveniently equals the estimated salvage value of \$778, a coincidence that is rather unusual in the real world. When $B_N \neq S$, we would want to make adjustments in our depreciation methods.

- **Case 1: $B_N > S$**

  When $B_N > S$, we are faced with a situation in which we have not depreciated the entire cost of the asset and thus have not taken full advantage of depreciation's tax-deferring benefits. If you would prefer to reduce the book value of an asset to its salvage value as quickly as possible, it can be done by switching from DB to SL whenever SL depreciation results in larger depreciation charges and therefore a more rapid reduction in the book value of the asset. The switch from DB to SL depreciation can take place in any of the n years, the objective being to identify the optimal year to switch. The switching rule is as follows: If depreciation by DB in any year is less than (or equal to) what it would be by SL, we should switch to and remain with the SL method for the duration of the project's depreciable life. The straight-line depreciation in any year n is calculated by

$$D_n = \frac{\text{Book value at beginning of year } n - \text{salvage value}}{\text{Remaining useful life at beginning of year } n} \tag{9.7}$$

EXAMPLE 9.5 Declining Balance with Conversion to Straight-Line Depreciation ($B_N > S$)

Suppose the asset given in Example 9.4 has a zero salvage value instead of \$778; that is,

$$\begin{aligned} \text{Cost basis of the asset, } I &= \$10{,}000 \\ \text{Useful life, } N &= 5 \text{ years,} \\ \text{Salvage value, } S &= \$0, \\ a &= (1/5)(2) = 40\%. \end{aligned}$$

Determine the optimal time to switch from DB to SL depreciation and the resulting depreciation schedule.

SOLUTION

Given: $I = \$10{,}000$, $S = 0$, $N = 5$ years, and $\alpha = 40\%$.
Find: Optimal conversion time, D_n and B_n for $n = 1$ to 5.

We will first proceed by computing the DDB depreciation for each year, as before:

Year	D_n	B_n
1	\$4,000	\$6,000
2	2,400	3,600
3	1,440	2,160
4	864	1,296
5	518	778

Then, using Eq. (9.7), we compute the SL depreciation for each year. We compare SL with DDB depreciation for each year and use the aforementioned decision rule for when to change:

If Switch to SL at Beginning of Year	SL Depreciation	DDB Depreciation	Switching Decision
2	(\$6,000 − 0)/4 = \$1,500	< \$2,400	Do not switch
3	(3,600 − 0)/3 = 1,200	< 1,440	Do not switch
4	(2,160 − 0)/2 = 1,080	> 864	Switch to SL

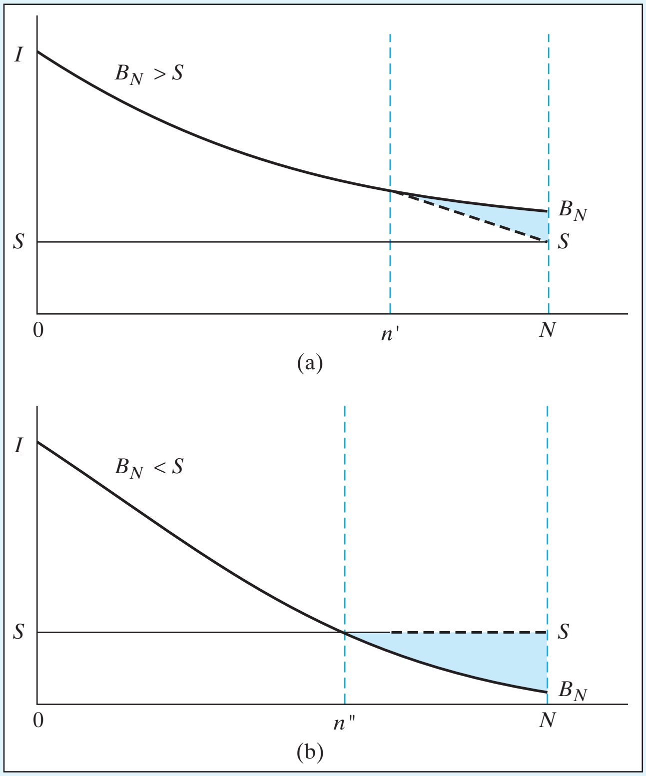

Figure 9.4 Adjustments to the declining-balance method: (a) Switch from declining balance to straight line after n'; (b) no further depreciation allowances are available after n'' (Examples 9.5 and 9.6).

The optimal time (year 4) in this situation corresponds to n' in Figure 9.4(a). The resulting depreciation schedule is

Year	DDB with Switch to SL	End-of-Year Book Value
1	\$ 4,000	\$6,000
2	2,400	3,600
3	1,440	2,160
4	1,080	1,080
5	1,080	0
	\$10,000	

- **Case 2: $B_N < S$**

  With a relatively high salvage value, it is possible that the book value of the asset could decline below the estimated salvage value. When $B_n < S$, we must readjust our analysis because tax law does not permit us to depreciate assets below their salvage value. To avoid deducting depreciation charges that would drop the book value below the salvage value, you simply stop depreciating the asset whenever you get down to $B_n = S$. In other words, if, at any period, the implied book value is lower than S, then the depreciation amounts are adjusted so that $B_n = S$.

EXAMPLE 9.6 Declining Balance, $B_N < S$

Compute the double-declining-balance (DDB) depreciation schedule for the data used in Example 9.5, this time with the asset having a salvage value of \$2,000. Then

$$\text{Cost basis of the asset, } I = \$10{,}000,$$
$$\text{Useful life, } N = 5 \text{ years},$$
$$\text{Salvage value, } S = \$2{,}000,$$
$$\alpha = \left(\tfrac{1}{5}\right)(2) = 40\%.$$

SOLUTION

Given: $I = \$10{,}000$, $S = \$2{,}000$, $N = 5$ years, and $\alpha = 40\%$.
Find: D_n and B_n for $n = 1$ to 5.

The given data result in the accompanying table.
Note that B_4 would be less than $S = \$2{,}000$ if the full deduction (\$864) had been taken. Therefore, we adjust D_4 to \$160, making $B_4 = \$2{,}000$. D_5 is zero and B_5 remains at \$2,000. Year 4 is equivalent to n'' in Figure 9.4(b).

End of Year	D_n	B_n
1	0.4($10,000) = $4,000	$10,000 − $4,000 = $6,000
2	0.4(6,000) = 2,400	6,000 − 2,400 = 3,600
3	0.4(3,600) = 1,440	3,600 − 1,440 = 2,160
4	0.4(2,160) = 864 > 160	2,160 − 160 = 2,000
5	0	2,000 − 0 = 2,000
	Total = $8,000	

9.3.3 Units-of-Production Method

Straight-line depreciation can be defended only if the machine is used for exactly the same amount of time each year. What happens when a punch press machine runs 1,670 hours one year and 780 the next or when some of its output is shifted to a new machining center? This leads us to a consideration of another depreciation method that views the asset as consisting of a bundle of service units; unlike the SL and accelerated methods, however, this one does not assume that the service units will be consumed in a time-phased pattern. Rather, the cost of each service unit is the net cost of the asset divided by the total number of such units. The depreciation charge for a period is then related to the number of service units consumed in that period. The result is the **units-of-production method**, according to which the depreciation in any year is given by

$$D_n = \frac{\text{Service units consumed during year } n}{\text{Total service units}}(I - S). \tag{9.8}$$

When the units-of-production method is used, depreciation charges are made proportional to the ratio of the actual output to the total expected output. Usually, this ratio is figured in machine hours. The advantages of using the units-of-production method include the fact that depreciation varies with production volume, so the method gives a more accurate picture of machine usage. A disadvantage of the method is that collecting data on machine usage is somewhat tedious, as are the accounting methods.

This method can be useful in depreciating equipment used to exploit natural resources if the resources will be depleted before the equipment wears out. It is not, however, considered a practical method for general use in depreciating industrial equipment.

EXAMPLE 9.7 Units-of-Production Depreciation

A truck for hauling coal has an estimated net cost of $55,000 and is expected to give service for 250,000 miles, resulting in a $5,000 salvage value. Compute the allowed depreciation amount for a truck usage of 30,000 miles.

SOLUTION

Given: $I = \$55{,}000$, $S = \$5{,}000$, total service units = 250,000 miles, and usage for this year = 30,000 miles.

Find: Depreciation amount in this year.

The depreciation expense in a year in which the truck traveled 30,000 miles would be

$$\frac{30{,}000 \text{ miles}}{250{,}000 \text{ miles}}(\$55{,}000 - \$5{,}000) = \left(\frac{3}{25}\right)(\$50{,}000)$$

$$= \$6{,}000.$$

9.4 Tax Depreciation Methods

Prior to the Economic Recovery Act of 1981, taxpayers could choose among several methods when depreciating assets for tax purposes. The most widely used methods were the straight-line method and the declining-balance method. The subsequent imposition of the Accelerated Cost Recovery System (ACRS) and the Modified Accelerated Cost Recovery System (MACRS) superseded these methods for use in tax purposes.

MACRS method allows taxpayers to deduct greater amounts during the first few years of an asset's life.

9.4.1 MACRS Depreciation

From 1954 to 1981, congressional changes in tax law evolved fairly consistently toward simpler, more rapid depreciation methods. Prior to 1954, the straight-line method was required for tax purposes, but that year accelerated methods such as double-declining balance and sum-of-years'-digits were permitted. In 1981, these conventional accelerated methods were replaced by the simpler ACRS. In 1986, Congress modified the ACRS and introduced the MACRS, sharply reducing depreciation allowances that were enacted in the Economic Recovery Tax Act of 1981. This section will present some of the primary features of MACRS tax depreciation.

MACRS Recovery Periods

Historically, for both tax and accounting purposes, an asset's depreciable life was determined by its estimated useful life; it was intended that the asset be fully depreciated at approximately the end of its useful life. The MACRS scheme, however, totally abandoned this practice, and simpler guidelines were established that created several classes of assets, each with a more or less arbitrary life called a **recovery period**. (Note: *Recovery periods do not necessarily bear any relationship to expected useful lives*.)

A major effect of the original ACRS method of 1981 was to shorten the depreciable lives of assets, thus giving businesses larger depreciation deductions that, in early years, resulted in lower taxes and increased cash flows available for reinvestment. As shown in Table 9.2, the MACRS method of 1986 reclassified certain assets on the basis of the

TABLE 9.2 MACRS Property Classifications

Recovery Period	ADR* Midpoint Class	Applicable Property
3 years	ADR $\leq$ 4	Special tools for the manufacture of plastic products, fabricated metal products, and motor vehicles
5 years	4 $<$ ADR $\leq$ 10	Automobiles,† light trucks, high-tech equipment, equipment used for research and development, computerized telephone switching systems
7 years	10 $<$ ADR $\leq$ 16	Manufacturing equipment, office furniture, fixtures
10 years	16 $<$ ADR $\leq$ 20	Vessels, barges, tugs, railroad cars
15 years	20 $<$ ADR $\leq$ 25	Wastewater plants, telephone-distribution plants, similar utility property
20 years	25 $<$ ADR	Municipal sewers, electrical power plant
$27\frac{1}{2}$ years		Residential rental property
39 years		Nonresidential real property, including elevators and escalators

* ADR = Asset depreciation range; guidelines are published by the IRS.
† Automobiles have a midpoint life of 3 years in the ADR guidelines, but are classified into a 5-year property class.

midpoint of their lives under the ADR system. The MACRS scheme includes eight categories of assets, with lives of 3, 5, 7, 10, 15, 20, 27.5, and 39 years:

MACRS: Depreciation methods applied to assets placed in service after 1986; less favorable than the earlier ACRS system.

- Investments in some short-lived assets are depreciated over 3 years by using 200% DB and then switching to SL depreciation.
- Computers, automobiles, and light trucks are written off over 5 years by using 200% DB and then switching to SL depreciation.
- Most types of manufacturing equipment are depreciated over 7 years, but some long-lived assets are written off over 10 years. Most equipment write-offs are calculated by the 200% DB method, followed by a switch to SL depreciation, which allows faster write-offs in the first few years after an investment is made.
- Sewage-treatment plants and telephone-distribution plants are written off over 15 years by using 150% DB and then switching to SL depreciation.
- Sewer pipes and certain other very long-lived equipment are written off over 20 years by using 150% DB and then switching to SL depreciation.
- Investments in residential rental property are written off in straight-line fashion over $27\frac{1}{2}$ years. Nonresidential real estate (commercial buildings), by contrast, is written off by the SL method over 39 years.

Under the MACRS, *the salvage value of property is always treated as zero*.

9.4.2 MACRS Depreciation Rules

Under earlier depreciation methods, the rate at which the value of an asset declined was estimated and was then used as the basis for tax depreciation. Thus, different assets were depreciated along different paths over time. The MACRS method, however, established prescribed depreciation rates, called **recovery allowance percentages**, for all assets within each class. These rates, as set forth in 1986 and 1993, are shown in Table 9.3. The yearly recovery, or depreciation expense, is determined by multiplying the asset's depreciation base by the applicable recovery allowance percentage.

Half-Year Convention

The MACRS recovery percentages shown in Table 9.3 use the **half-year convention**; that is, it is assumed that all assets are placed in service at midyear and that they will have *zero* salvage value. As a result, only a half year of depreciation is allowed for the first year that property is placed in service. With half of one year's depreciation being taken in the first

TABLE 9.3 MACRS Depreciation Schedules for Personal Properties with Half-Year Convention, Declining-Balance Method

	Class	3	5	7	10	15	20
Year	Depreciation Rate	200%	200%	200%	200%	150%	150%
1		33.33	20.00	14.29	10.00	5.00	3.750
2		44.45	32.00	24.49	18.00	9.50	7.219
3		14.81*	19.20	17.49	14.40	8.55	6.677
4		7.41	11.52*	12.49	11.52	7.70	6.177
5			11.52	8.93*	9.22	6.93	5.713
6			5.76	8.92	7.37	6.23	5.285
7				8.93	6.55*	5.90*	4.888
8				4.46	6.55	5.90	4.522
9					6.56	5.91	4.462*
10					6.55	5.90	4.461
11					3.28	5.91	4.462
12						5.90	4.461
13						5.91	4.462
14						5.90	4.461
15						5.91	4.462
16						2.95	4.461
17							4.462
18							4.461
19							4.462
20							4.461
21							2.231

* Year to switch from declining balance to straight line. (*Source*: IRS Publication 534. *Depreciation*. Washington, DC: U.S. Government Printing Office, December 2005.)

year, a full year's depreciation is allowed in each of the remaining years of the asset's recovery period, and the remaining half-year's depreciation is taken in the year following the end of the recovery period. A half year of depreciation is also allowed for the year in which property is disposed of, or is otherwise retired from service, anytime before the end of the recovery period.

Switching from DB to the Straight-Line Method

The MACRS asset is depreciated initially by the DB method and then by SL depreciation. Consequently, the MACRS adopts the switching convention illustrated in Example 9.5. To demonstrate how the MACRS depreciation percentages were calculated by the IRS with the use of the half-year convention, consider Example 9.8.

EXAMPLE 9.8 MACRS Depreciation: Personal Property

A taxpayer wants to place in service a $10,000 asset that is assigned to the five-year class. Compute the MACRS percentages and the depreciation amounts for the asset.

SOLUTION

Given: Five-year asset, half-year convention, $\alpha = 40\%$, and $S = 0$.
Find: MACRS depreciation percentages D_n for $10,000 asset.

For this problem, we use the following equations:

$$\text{Straight-line rate} = \tfrac{1}{5} = 0.20,$$
$$200\%\ \text{declining balance rate} = 2(0.20) = 40\%,$$
$$\text{Under MACRS, salvage } (S) = 0.$$

Then, beginning with the first taxable year and ending with the sixth year, MACRS deduction percentages are computed as follows:

Year	Calculation (%)	MACRS Percentage
1	$\frac{1}{2}$-year DDB depreciation $= 0.5(0.40)(100\%)$	$= \boxed{20\%}$
2	DDB depreciation $= (0.40)(100\% - 20\%)$	$= \boxed{32\%}$
	SL depreciation $= (1/4.5)(100\% - 20\%)$	$= 17.78\%$
3	DDB depreciation $= (0.40)(100\% - 52\%)$	$= \boxed{19.20\%}$
	SL depreciation $= (1/3.5)(100\% - 52\%)$	$= 13.71\%$
4	DDB depreciation $= (0.40)(100\% - 71.20\%)$	$= 11.52\%$
	SL depreciation $= (1/2.5)(100\% - 71.20\%)$	$= \boxed{11.52\%}$
5	SL depreciation $= (1/1.5)(100\% - 82.72\%)$	$= \boxed{11.52\%}$
6	$\frac{1}{2}$-year SL depreciation $= (0.5)(11.52\%)$	$= \boxed{5.76\%}$

In year 2, we check to see what the SL depreciation would be. Since 4.5 years are left to depreciate, SL depreciation $= (1/4.5)(100\% - 20\%) = 17.78\%$. The DDB depreciation is greater than the SL depreciation, so DDB still applies. Note that SL depreciation $\geq$ DDB depreciation in year 4, so we switch to SL then.

We can calculate the depreciation amounts from the percentages we just determined. In practice, the percentages are taken directly from Table 9.3, supplied by the IRS. The results are as follows and are also shown in Figure 9.5.

Year n	MACRS Percentage (%)		Depreciation Basis		Depreciation Amount (D_n)
1	20	×	\$10,000	=	\$2,000
2	32	×	10,000	=	3,200
3	19.20	×	10,000	=	1,920
4	11.52	×	10,000	=	1,152
5	11.52	×	10,000	=	1,152
6	5.76	×	10,000	=	576

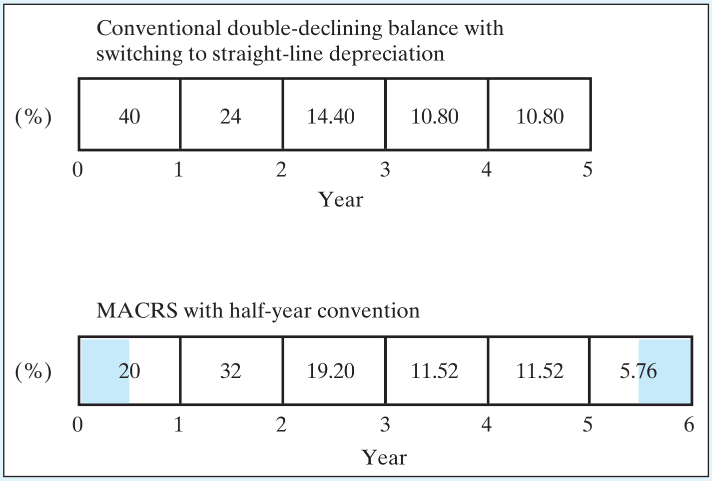

Figure 9.5 MACRS with a five-year recovery period (Example 9.8).

Note that when an asset is disposed of before the end of a recovery period, only half of the normal depreciation is allowed. If, for example, the \$10,000 asset were to be disposed of in year 2, the MACRS deduction for that year would be \$1,600.

Midmonth Convention for Real Property

Table 9.4 shows the useful lives and depreciation percentages for real property. In depreciating such property, the straight-line method and the midmonth convention are used. For example, a property placed in service in March would be allowed $9\frac{1}{2}$ months' depreciation for year 1. If it is disposed of before the end of the recovery period, the depreciation percentage must take into account the number of months the property was in service during the year of its disposal.

EXAMPLE 9.9 MACRS for Real Property

On May 1, Jack Costanza paid $100,000 for a residential rental property. This purchase price represents $80,000 for the cost of the building and $20,000 for the cost of the land. Three years and five months later, on October 1, he sold the property for $130,000. Compute the MACRS depreciation for each of the four calendar years during which Jack owned the property.

SOLUTION

Given: Residential real property, cost basis = $80,000; the building was put into service on May 1.

Find: The depreciation in each of four tax years the property was in service.

In this example, the midmonth convention assumes that the property is placed in service on May 15, which gives $7\frac{1}{2}$ months of depreciation in the first year. Remembering that only the building (not the land) may be depreciated, we use the SL method to compute the depreciation over a $27\frac{1}{2}$-year recovery period:

Year	Calculation		D_n	Recovery Percentages
1	$\left(\frac{7.5}{12}\right)\frac{80{,}000 - 0}{27.5}$	=	\$1,818	2.273%
2	$\frac{80{,}000 - 0}{27.5}$	=	\$2,909	3.636%
3	$\frac{80{,}000 - 0}{27.5}$	=	\$2,909	3.636%
4	$\left(\frac{9.5}{12}\right)\frac{80{,}000 - 0}{27.5}$	=	\$2,303	2.879%

Notice that the midmonth convention also applies to the year of disposal. Now compare the percentages with those in Table 9.4. As with personal property, calculations for real property generally use the precalculated percentages in the table.

TABLE 9.4 MACRS Percentages for Real Property

	Month Property Is Placed in Service											
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
(a) Residential Rental Property: Straight Line over $27\frac{1}{2}$ Years with Midmonth Convention												
1	3.485%	3.182%	2.879%	2.576%	2.273%	1.970%	1.667%	1.364%	1.061%	0.758%	0.455%	0.152%
2–9	3.636	3.636	3.636	3.636	3.636	3.636	3.636	3.636	3.636	3.636	3.636	3.636
10	3.637	3.637	3.637	3.637	3.637	3.637	3.636	3.636	3.636	3.636	3.636	3.636
11	3.636	3.636	3.636	3.636	3.636	3.636	3.637	3.637	3.637	3.637	3.637	3.637
12	3.637	3.637	3.637	3.637	3.637	3.637	3.636	3.636	3.636	3.636	3.636	3.636
13	3.636	3.636	3.636	3.636	3.636	3.636	3.637	3.637	3.637	3.637	3.637	3.637
14	3.637	3.637	3.637	3.637	3.637	3.637	3.636	3.636	3.636	3.636	3.636	3.636
15	3.636	3.636	3.636	3.636	3.636	3.636	3.637	3.637	3.637	3.637	3.637	3.637
16	3.637	3.637	3.637	3.637	3.637	3.637	3.636	3.636	3.636	3.636	3.636	3.636
17	3.636	3.636	3.636	3.636	3.636	3.636	3.637	3.637	3.637	3.637	3.637	3.637
18	3.637	3.637	3.637	3.637	3.637	3.637	3.636	3.636	3.636	3.636	3.636	3.636
19	3.636	3.636	3.636	3.636	3.636	3.636	3.637	3.637	3.637	3.637	3.637	3.637
20	3.637	3.637	3.637	3.637	3.637	3.637	3.636	3.636	3.636	3.636	3.636	3.636
21	3.636	3.636	3.636	3.636	3.636	3.636	3.637	3.637	3.637	3.637	3.637	3.637
22	3.637	3.637	3.637	3.637	3.637	3.637	3.636	3.636	3.636	3.636	3.636	3.636
23	3.636	3.636	3.636	3.636	3.6363	3.636	3.637	3.637	3.637	3.637	3.637	3.637
24	3.637	3.637	3.637	3.637	3.637	3.637	3.636	3.636	3.636	3.636	3.636	3.636
25	3.636	3.636	3.636	3.636	3.636	3.636	3.637	3.637	3.637	3.637	3.637	3.637
26	3.637	3.637	3.637	3.637	3.637	3.637	3.636	3.636	3.636	3.636	3.636	3.636
27	3.636	3.636	3.636	3.636	3.636	3.636	3.637	3.637	3.637	3.637	3.637	3.637
28	1.97	2.273	2.576	2.879	3.182	3.485	3.636	3.636	3.636	3.636	3.636	3.636
29							0.152	0.455	0.758	1.061	1.364	1.667
(b) Nonresidential Real Property: Straight Line over 39 Years with Midmonth Convention												
1	2.4573	2.2436	2.0299	1.8162	1.6026	1.3889	1.1752	0.9615	0.7479	0.5342	0.3205	0.1068
2–39	2.5641	2.5641	2.5641	2.5641	2.5641	2.5641	2.5641	2.5641	2.5641	2.5641	2.5641	2.5641
40	0.1068	0.3205	0.5342	0.7479	0.9615	1.1752	1.3889	1.6026	1.8162	2.0299	2.2436	2.4573

Source: IRS Publication No. 534. *Depreciation*. Washington, DC: U.S. Government Printing Office, 2000.

9.5 Depletion

Depletion: Unlike depreciation and amortization, which mainly describe the deduction of expenses due to the aging of equipment and property, depletion is the actual physical reduction of natural resources by companies.

If you own mineral property (distinguished from personal and real properties), such as oil, gas, a geothermal well, or standing timber, you may be able to claim a deduction as you deplete the resource. A capital investment in natural resources needs to be recovered as those resources are being removed and sold. The process of amortizing the cost of natural resources in the accounting periods is called depletion. The objective of depletion is the same as that of depreciation: to amortize the cost in a systematic manner over the asset's useful life.

There are two ways of figuring depletion: **cost depletion** and **percentage depletion**. These depletion methods are used for book as well as tax purposes. In most instances, depletion is calculated by both methods, and the larger value is taken as the depletion allowance for the year. For standing timber and for most oil and gas wells, only cost depletion is permissible.

9.5.1 Cost Depletion

The cost depletion method is based on the same concept as the units-of-production method. To determine the amount of cost depletion, the adjusted basis of the mineral property is divided by the total number of recoverable units in the deposit, and the resulting rate is multiplied by the number of units sold:

$$\text{Cost depletion} = \frac{(\text{Adjusted basis of mineral property})}{\text{Total number of recoverable units}} \times (\text{Number of units sold}). \tag{9.9}$$

The **adjusted basis** represents all the depletion allowed (or the allowable cost on the property). Estimating the number of recoverable units in a natural deposit is largely an engineering problem.

EXAMPLE 9.10 Cost Depletion for a Timber Tract

Suppose you bought a timber tract for $200,000 and the land was worth $80,000. The basis for the timber is therefore $120,000. The tract has an estimated 1.5 million board feet (1.5 MBF) of standing timber. If you cut 0.5 MBF of timber, determine your depletion allowance.

SOLUTION

Given: Basis = $120,000, total recoverable volume = 1.5 MBF, and amount sold this year = 0.5 MBF.

Find: The depletion allowance this year.

Timber depletion may be figured only by the cost method. Percentage depletion does not apply to timber, nor does your depletion basis include any part of the cost of the land. Because depletion takes place when standing timber is cut, you may figure your depletion deduction only after the timber is cut and the quantity is first accurately measured. We have

$$\begin{aligned}\text{Depletion allowance per MBF} &= \$120{,}000/1.5 \text{ MBF} \\ &= \$80{,}000/\text{MBF} \\ \text{Depletion allowance for the year} &= 0.5 \text{ MBF} \times \$80{,}000/\text{MBF} \\ &= \$40{,}000.\end{aligned}$$

9.5.2 Percentage Depletion

Percentage depletion is an alternative method of calculating the depletion allowance for certain mineral properties. For a given mineral property, the depletion allowance calculation is based on a prescribed percentage of the gross income from the property during the tax year. Notice the distinction between depreciation and depletion: **Depreciation** is the allocation of cost over a useful life, whereas **percentage depletion** is an annual allowance of a percentage of the gross income from the property.

Since percentage depletion is computed on the basis of the income from, rather than the cost of, the property, the total depletion on a property may exceed the cost of the property. To prevent this from happening, the annual allowance under the percentage method cannot be more than 50% of the taxable income from the property (figured without the deduction for depletion). Table 9.5 shows the allowed percentages for selected mining properties.

TABLE 9.5 Percentage Depletion Allowances for Mineral Properties

Deposits	Percentage Allowed
Oil and gas wells (only for certain domestic and gas production)	15
Sulfur and uranium and, if from deposits in the United States, asbestos, lead, zinc, nickel, mica, and certain other ores and minerals	22
Gold, silver, copper, iron ore, and oil shale, if from deposits in the United States	15
Coal, lignite, and sodium chloride	10
Clay and shale to be used in making sewer pipe or bricks	7.5
Clay (used for roofing tile), gravel, sand, and stone	5
Most other minerals; includes carbon dioxide produced from a well and metallic ores	14

EXAMPLE 9.11 Percentage Depletion versus Cost Depletion

A gold mine with an estimated deposit of 300,000 ounces of gold has a basis of $30 million (cost minus land value). The mine has a gross income of $16,425,000 for the year from selling 45,000 ounces of gold (at a unit price of $365 per ounce). Mining expenses before depletion equal $12,250,000. Compute the percentage depletion allowance. Would it be advantageous to apply cost depletion rather than percentage depletion?

SOLUTION

Given: Basis = $30 million, total recoverable volume = 300,000 ounces of gold, amount sold this year = 45,000 ounces, gross income = $16,425,000, and this year's expenses before depletion = $12,250,000.

Find: Maximum depletion allowance (cost or percentage).

Percentage depletion: Table 9.5 indicates that gold has a 15% depletion allowance. The percentage depletion allowance is computed from the gross income:

Gross income from sale of 45,000 ounces	$16,425,000
Depletion percentage	× 15%
Computed percentage depletion	$ 2,463,750

Next, we need to compute the taxable income. The percentage depletion allowance is limited to the computed percentage depletion or 50% of the taxable income, whichever is smaller:

Gross income from sale of 45,000 ounces	$16,425,000
Less mining expenses	12,250,000
Taxable income from mine	4,175,000
Deduction limitation	× 50%
Maximum depletion deduction	$ 2,088,000

Since the maximum depletion deduction ($2,088,000) is less than the computed percentage depletion ($2,463,750), the allowable percentage deduction is $2,088,000.

Cost depletion: It is worth computing the depletion allowance with the cost depletion method:

$$\text{Cost depletion} = \left(\frac{\$30{,}000{,}000}{300{,}000}\right)(45{,}000)$$
$$= \$4{,}500{,}000.$$

Note that percentage depletion is less than the cost depletion. Since the law allows the taxpayer to take whichever deduction is larger in any one year, in this situation it

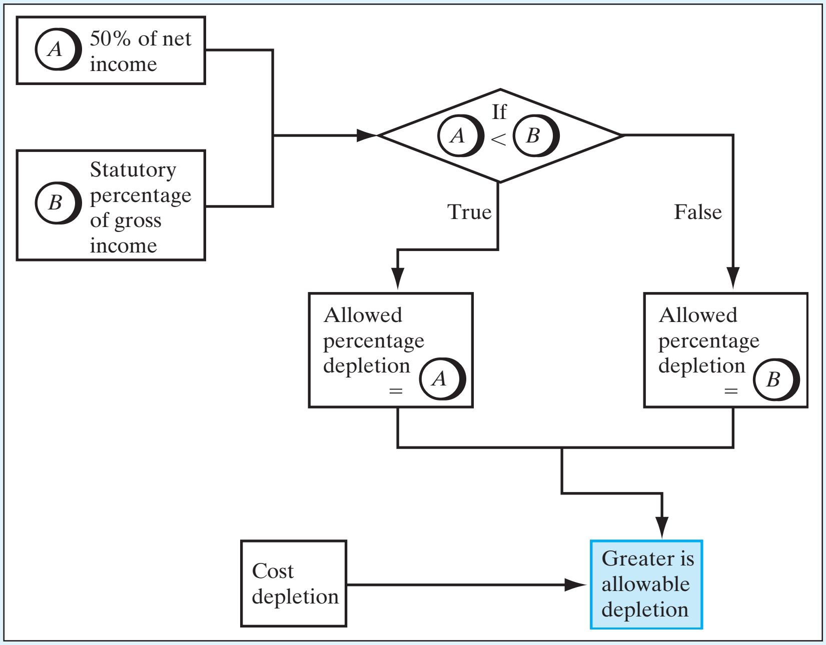

Figure 9.6 Calculating the allowable depletion deduction for federal tax purposes.

would be advantageous to apply the cost depletion method. Figure 9.6 illustrates the steps to be taken to apply that depletion method.

9.6 Repairs or Improvements Made to Depreciable Assets

If any major repairs (e.g., an engine overhaul) or improvements (say, an addition) are made during the life of the asset, we need to determine whether these actions will extend the life of the asset or will increase the originally estimated salvage value. When either of these situations arises, a revised estimate of the useful life of the asset should be made, and the periodic depreciation expense should be updated accordingly. We will examine how repairs or improvements affect both book and tax depreciations.

9.6.1 Revision of Book Depreciation

Recall that book depreciation rates are based on estimates of the useful lives of assets. Such estimates are seldom precise. Therefore, after a few years of use, you may find that the asset could last for a considerably longer or shorter period than was originally estimated. If this happens, the annual depreciation expense, based on the estimated useful life, may be either excessive or inadequate. (If repairs or improvements do not extend the life or increase the salvage value of the asset, these costs may be treated as maintenance expenses during the year in which they were incurred.) The procedure for correcting the book depreciation schedule is to revise the current book value and to allocate this cost over the remaining years of the asset's useful life.

9.6.2 Revision of Tax Depreciation

For tax depreciation purposes, repairs or improvements made to any property are treated as *separate* property items. The recovery period for a repair or improvement to the initial property normally begins on the date the repaired or improved property is placed in service. The recovery class of the repair or improvement is the recovery class that would apply to the property if it were placed in service at the same time as the repair or improvement. Example 9.12 illustrates the procedure for correcting the depreciation schedule for an asset that had repairs or improvements made to it during its depreciable life.

EXAMPLE 9.12 Depreciation Adjustment for an Overhauled Asset

In January 2001, Kendall Manufacturing Company purchased a new numerical control machine at a cost of $60,000. The machine had an expected life of 10 years at the time of purchase and a zero expected salvage value at the end of the 10 years.

- For book depreciation purposes, no major overhauls had been planned over the 10-year period, and the machine was being depreciated toward a zero salvage value, or $6,000 per year, with the straight-line method.
- For tax purposes, the machine was classified as a 7-year MACRS property.

In December 2003, however, the machine was thoroughly overhauled and rebuilt at a cost of $15,000. It was estimated that the overhaul would extend the machine's useful life by 5 years.

(a) Calculate the book depreciation for the year 2006 on a straight-line basis.

(b) Calculate the tax depreciation for the year 2006 for this machine.

SOLUTION

Given: $I = \$60{,}000$, $S = \$0$, $N = 10$ years, machine overhaul $= \$15{,}000$, and extended life $= 15$ years from the original purchase.

Find: D_6 for book depreciation and D_6 for tax depreciation.

(a) Since an improvement was made at the end of the year 2003, the book value of the asset at that time consisted of the original book value plus the cost added to the asset. First, the original book value at the end of 2003 is calculated:

$$B_3 \text{ (before improvement)} = \$60{,}000 - 3(\$6{,}000) = \$42{,}000.$$

After the improvement cost of $15,000 is added, the revised book value is

$$B_3 \text{ (after improvement)} = \$42{,}000 + \$15{,}000 = \$57{,}000.$$

To calculate the book depreciation in the year 2006, which is 3 years after the improvement, we need to calculate the annual straight-line depreciation amount with the extended useful life. The remaining useful life before the improvement was made was 7 years. Therefore, the revised remaining useful life should be 12 years. The revised annual depreciation is then $57,000/12 = $4,750. Using the straight-line depreciation method, we compute the depreciation amount for 2006 as follows:

$$D_6 = \$4{,}750.$$

(b) For tax depreciation purposes, the improvement made is viewed as a separate property with the same recovery period as that of the initial asset. Thus, we need to calculate both the tax depreciation under the original asset and that of the new asset. For the 7-year MACRS property, the 6th-year depreciation allowance is 8.92% of $60,000, or $5,352. The 3rd-year depreciation for the improved asset is 17.49% of $15,000, or $2,623. Therefore, the total tax depreciation in 2006 is

$$D_6 = \$5{,}352 + \$2{,}623 = \$7{,}975.$$

Figure 9.7 illustrates how additions or improvements are treated in revising depreciation amounts for book and tax purposes.

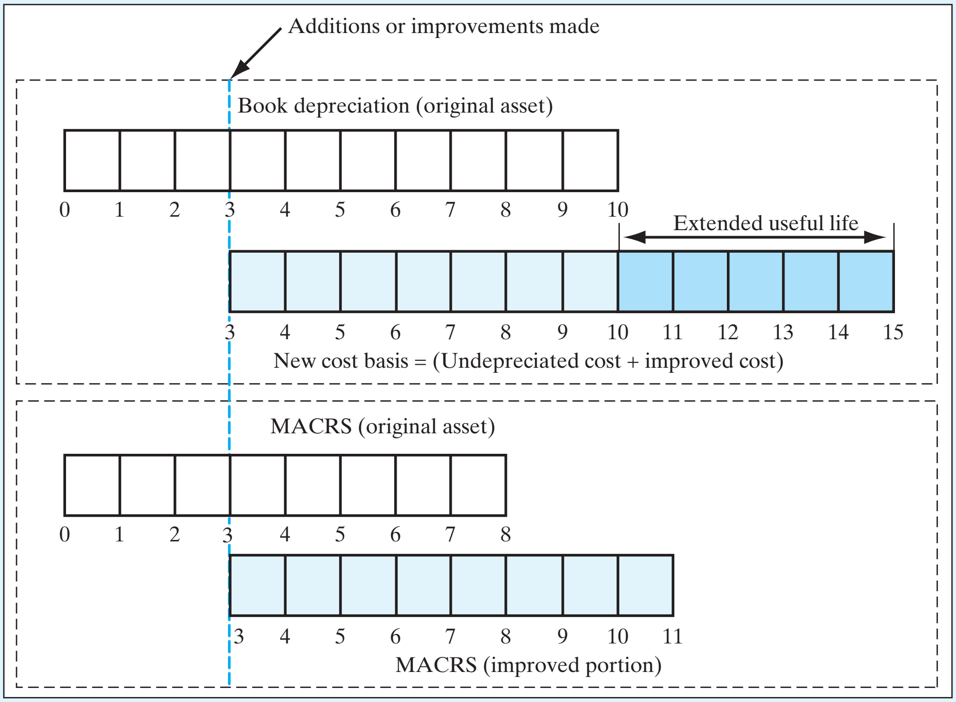

Figure 9.7 Revision of depreciation amount as additions or improvements are made as described in Example 9.12.

9.7 Corporate Taxes

Now that we have learned what elements constitute taxable income, we turn our attention to the process of computing income taxes. The corporate tax rate, is applied to the taxable income of a corporation. As we briefly discussed in Section 8.5, the allowable deductions include the cost of goods sold, salaries and wages, rent, interest, advertising, depreciation, amortization,[3] depletion, and various tax payments other than federal income tax. The following table is illustrative:

Item
Gross income
Expenses:
Cost of goods sold
Depreciation
Operating expenses
Taxable operating income
Income taxes
Net income

9.7.1 Income Taxes on Operating Income

The corporate tax rate structure for 2006 is relatively simple. As shown in Table 9.6, there are four basic rate brackets (15%, 25%, 34%, and 35%), plus two surtax rates (5% and 3%), based on taxable incomes. U.S. tax rates are progressive; that is, businesses with lower taxable incomes are taxed at lower rates than those with higher taxable incomes.

TABLE 9.6 Corporate Tax Schedule for 2006

Taxable Income (X)	Tax Rate	Tax Computation Formula
\$0–\$50,000	15%	$\$0 + 0.15X$
50,001–75,000	25%	$7{,}500 + 0.25(X - \$50{,}000)$
75,001–100,000	34%	$13{,}750 + 0.34(X - 75{,}000)$
100,001–335,000	34% + 5%	$22{,}250 + 0.39(X - 100{,}000)$
335,001–10,000,000	34%	$113{,}900 + 0.34(X - 335{,}000)$
10,000,001–15,000,000	35%	$3{,}400{,}000 + 0.35(X - 10{,}000{,}000)$
15,000,001–18,333,333	35% + 3%	$5{,}150{,}000 + 0.38(X - 15{,}000{,}000)$
18,333,334 and up	35%	$6{,}416{,}666 + 0.35(X - 18{,}333{,}333)$

[3] The **amortization expense** is a special form of depreciation for an intangible asset, such as patents, goodwill, and franchises. More precisely, the amortization expense is the systematic write-off to expenses of the cost of an intangible asset over the periods of its economic usefulness. Normally a straight-line method is used to calculate the amortization expense.

Marginal Tax Rate

Marginal tax rate: The amount of tax paid on an additional dollar of income.

The **marginal tax rate** is defined as the rate applied to the last dollar of income earned. Income of up to \$50,000 is taxed at a 15% rate (meaning that if your taxable income is less than \$50,000, your marginal tax rate is 15%); income between \$50,000 and \$75,000 is taxed at 25%; and income over \$75,000 is taxed at a 34% rate.

An additional 5% surtax (resulting in 39%) is imposed on a corporation's taxable income in excess of \$100,000, with the maximum additional tax limited to \$11,750 $(235{,}000 \times 0.05)$. This surtax provision phases out the benefit of graduated rates for corporations with taxable incomes between \$100,000 and \$335,000. Another 3% surtax is imposed on corporate taxable income in the range from \$15,000,001 to \$18,333,333.

Corporations with incomes in excess of \$18,333,333 in effect pay a flat tax of 35%. As shown in Table 9.6, the corporate tax is progressive up to \$18,333,333 in taxable income, but essentially is constant thereafter.

Effective (Average) Tax Rate

Effective (average) tax rate: The rate a taxpayer would be taxed at if taxing was done at a constant rate, instead of progressively.

Effective tax rates can be calculated from the data in Table 9.6. For example, if your corporation had a taxable income of \$16,000,000 in 2006, then the income tax owed by the corporation would be as follows:

Taxable Income	Tax Rate	Taxes	Cumulative Taxes
First \$50,000	15%	\$7,500	\$7,500
Next \$25,000	25%	6,250	13,750
Next \$25,000	34%	8,500	22,250
Next \$235,000	39%	91,650	113,900
Next \$9,665,000	34%	3,286,100	3,400,000
Next \$5,000,000	35%	1,750,000	5,150,000
Remaining \$1,000,000	38%	380,000	\$5,530,000

Alternatively, using the tax formulas in Table 9.6, we obtain

$$\$5{,}150{,}000 + 0.38(\$16{,}000{,}000 - \$15{,}000{,}000) = \$5{,}530{,}000.$$

The effective (average) tax rate would then be

$$\frac{\$5{,}530{,}000}{\$16{,}000{,}000} = 0.3456, \text{ or } 34.56,$$

as opposed to the marginal rate of 38%. In other words, on the average, the company paid 34.56 cents for each taxable dollar it generated during the accounting period.

EXAMPLE 9.13 Corporate Taxes

A mail-order computer company sells personal computers and peripherals. The company leased showroom space and a warehouse for $20,000 a year and installed $290,000 worth of inventory-checking and packaging equipment. The allowed depreciation expense for this capital expenditure ($290,000) amounted to $58,000 using the category of 5-year MACRS. The store was completed and operations began on January 1. The company had a gross income of $1,250,000 for the calendar year. Supplies and all operating expenses, other than the lease expense, were itemized as follows:

Merchandise sold in the year	$600,000
Employee salaries and benefits	150,000
Other supplies and expenses	90,000
	$840,000

Compute the taxable income for this company. How much will the company pay in federal income taxes for the year?

SOLUTION

Given: Income, preceding cost information and depreciation.
Find: Taxable income and federal income taxes.

First we compute the taxable income as follows:

Gross revenues	$1,250,000
Expenses	–840,000
Lease expense	–20,000
Depreciation	–58,000
Taxable income	$332,000

Note that capital expenditures are not deductible expenses. Since the company is in the 39% marginal tax bracket, its income tax can be calculated by using the formula given in Table 9.6, namely, $22{,}250 + 0.39\,(X - 100{,}000)$:

$$\begin{aligned}\text{Income tax} &= \$22{,}250 + 0.39(\$332{,}000 - \$100{,}000)\\ &= \$112{,}730.\end{aligned}$$

The firm's current marginal tax rate is 39%, but its average corporate tax rate is

$$\frac{\$112{,}730}{\$332{,}000} = 33.95\%.$$

COMMENTS: Instead of using the tax formula in Table 9.6, we can compute the federal income tax in the following fashion:

First \$50,000 at 15%	\$ 7,500
Next \$25,000 at 25%	6,250
Next \$25,000 at 34%	8,500
Next \$232,000 at 39%	90,480
Income tax	\$112,730

9.8 Tax Treatment of Gains or Losses on Depreciable Assets

As in the disposal of capital assets, gains or losses generally are associated with the sale (or exchange) of depreciable assets. To calculate a gain or loss, we first need to determine the book value of the depreciable asset at the time of its disposal.

9.8.1 Disposal of a MACRS Property

For a MACRS property, one important consideration at the time of disposal is whether the property is disposed of *during* or *before* its specified recovery period. Moreover, with the half-year convention, which is now mandated by all MACRS depreciation methods, the year of disposal is charged one-half of that year's annual depreciation amount, if it should occur during the recovery period.

EXAMPLE 9.14 Book Value in the Year of Disposal

Consider a five-year MACRS asset purchased for \$10,000. Note that property belonging to the five-year MACRS class is depreciated over six years due to the half-year convention. The applicable depreciation percentages, shown in Table 9.3, are 20%, 32%, 19.20%, 11.52%, 11.52%, and 5.76%. Compute the allowed depreciation amounts and the book value when the asset is disposed of (a) in year 3, (b) in year 5, and (c) in year 6.

SOLUTION

Given: Five-year MACRS asset, cost basis = \$10,000, and MACRS depreciation percentages as shown in Figure 9.8.

Find: Total depreciation and book value at disposal if the asset is sold in year 3, 5, or 6.

(a) If the asset is disposed of in year 3 (or at the end of year 3), the total accumulated depreciation amount and the book value would be

$$\begin{aligned}\text{Total depreciation} &= \$10{,}000(0.20 + 0.32 + 0.192/2)\\ &= \$6{,}160,\end{aligned}$$

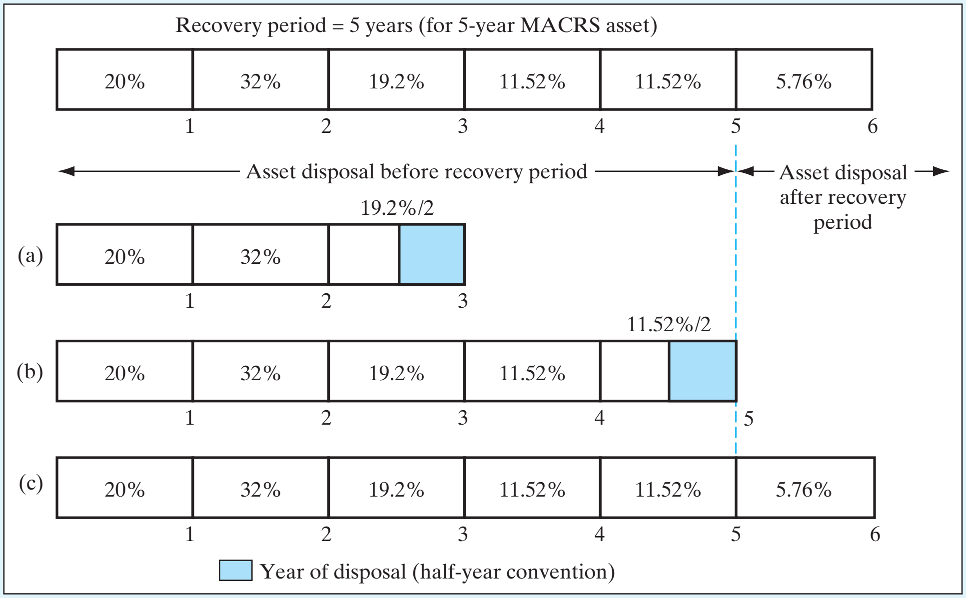

Figure 9.8 Disposal of a MACRS property and its effect on depreciation allowances (Example 9.14).

$$\text{Book value} = \$10{,}000 - \$6{,}160$$
$$= \$3{,}840.$$

(b) If the asset is disposed of during[4], year 5, the depreciation and book values will be

$$\text{Total depreciation} = \$10{,}000(0.20 + 0.32 + 0.192 + 0.1152 + 0.1152/2)$$
$$= \$8{,}848,$$
$$\text{Book value} = \$10{,}000 - \$8{,}848$$
$$= \$1{,}152.$$

(c) If the asset is disposed of after the recovery period, there will be no penalty due to early disposal. Since the asset is depreciated fully, we have

$$\text{Total depreciation} = \$10{,}000,$$
$$\text{Book value} = \$0.$$

[4] Note that even though you dispose of the asset at the *end* of the recovery period, the half-year convention still applies.

9.8.2 Calculations of Gains and Losses on MACRS Property

When a depreciable asset used in business is sold for an amount that differs from its book value, the gain or loss has an important effect on income taxes. The gain or loss is found as follows:

- **Case 1: Salvage value < Cost basis**

  If the salvage value of the asset is less than its cost basis, then

$$\text{Gains (losses)} = \text{Salvage value} - \text{book value},$$

  where the salvage value represents the proceeds from the sale (i.e., the selling price) less any selling expense or removal cost. These gains, commonly known as **depreciation recapture**, are taxed as ordinary income under current tax law.

- **Case 2: Salvage value > Cost basis**

  In the unlikely event that an asset is sold for an amount greater than its cost basis, the gains (salvage value − book value) are divided into two parts for tax purposes:

$$\begin{aligned}\text{Gains} &= \text{Salvage value} - \text{book value} \\ &= \underbrace{(\text{Salvage value} - \text{cost basis})}_{\text{Capital gains}} \\ &\quad + \underbrace{(\text{Cost basis} - \text{book value})}_{\text{Ordinary gains}}. \end{aligned} \tag{9.10}$$

  Recall from Section 9.2.2 that the cost basis is the cost of purchasing an asset, plus any incidental costs, such as freight and installation costs. As illustrated in Figure 9.9,

Capital gain: An increase in the value of a capital asset that gives it a higher worth than the purchase price, when the asset is sold.

$$\text{Capital gains} = \text{Salvage value} - \text{cost basis},$$

$$\text{Ordinary gains} = \text{Cost basis} - \text{book value}.$$

This distinction is necessary only when capital gains are taxed at the capital gains tax rate and ordinary gains (or depreciation recapture) at the ordinary income tax rate. Current tax

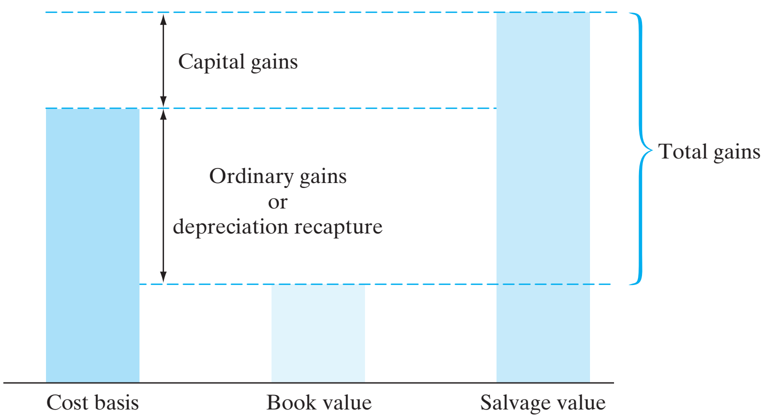

Figure 9.9 Capital gains and ordinary gains (or depreciation recapture) when the salvage value exceeds the cost basis.

law does not provide a special low rate of taxation for capital gains. Instead, capital gains are treated as ordinary income, but the maximum tax rate is set at the U.S. statutory rate of 35%. Nevertheless, the statutory structure for capital gains has been retained in the tax code. This provision could allow Congress to restore capital gains' preferential treatment at some future time.

EXAMPLE 9.15 Gains and Losses on Depreciable Assets

A company purchased a drill press costing $230,000 in year 0. The drill press, classified as seven-year recovery property, has been depreciated by the MACRS method. If it is sold at the end of three years, compute the gains (losses) for the following four salvage values: (a) $150,000, (b) $120,693, (c) $100,000, and (d) $250,000. Assume that both capital gains and ordinary income are taxed at 34%.

SOLUTION

Given: Seven-year MACRS asset, cost basis = $230,000, and the asset is sold three years after its purchase.

Find: Gains or losses, tax effects, and net proceeds from the sale if the asset is sold for $150,000, $120,693, $100,000, or $250,000.

In this example, we first compute the current book value of the machine. From the MACRS depreciation schedule in Table 9.3, the allowed annual depreciation percentages for the first three years of a seven-year MACRS property are 14.29%, 24.49%, and 17.49%. Since the asset is disposed of before the end of its recovery period, the depreciation amount in year 3 will be reduced by half. The total depreciation and the final book value will be

$$
\begin{aligned}
\text{Total allowed depreciation} &= \$230{,}000\left(0.1429 + 0.2449 + \frac{0.1749}{2}\right) \\
&= \$109{,}308, \\
\text{Book value} &= \$230{,}000 - \$109{,}308 \\
&= \$120{,}693.
\end{aligned}
$$

(a) Case 1: Book value < Salvage value < Cost basis

In this case, there are no capital gains to consider. All gains are ordinary gains. Thus, we have

$$
\begin{aligned}
\text{Ordinary gains} &= \text{Salvage value} - \text{book value} \\
&= \$150{,}000 - \$120{,}693 = \$29{,}308, \\
\text{Gains tax } (34\%) &= 0.34(\$29{,}308) = \$9{,}965, \\
\text{Net proceeds from sale} &= \text{Salvage value} - \text{gains tax} \\
&= \$150{,}000 - \$9{,}965 = \$140{,}035.
\end{aligned}
$$

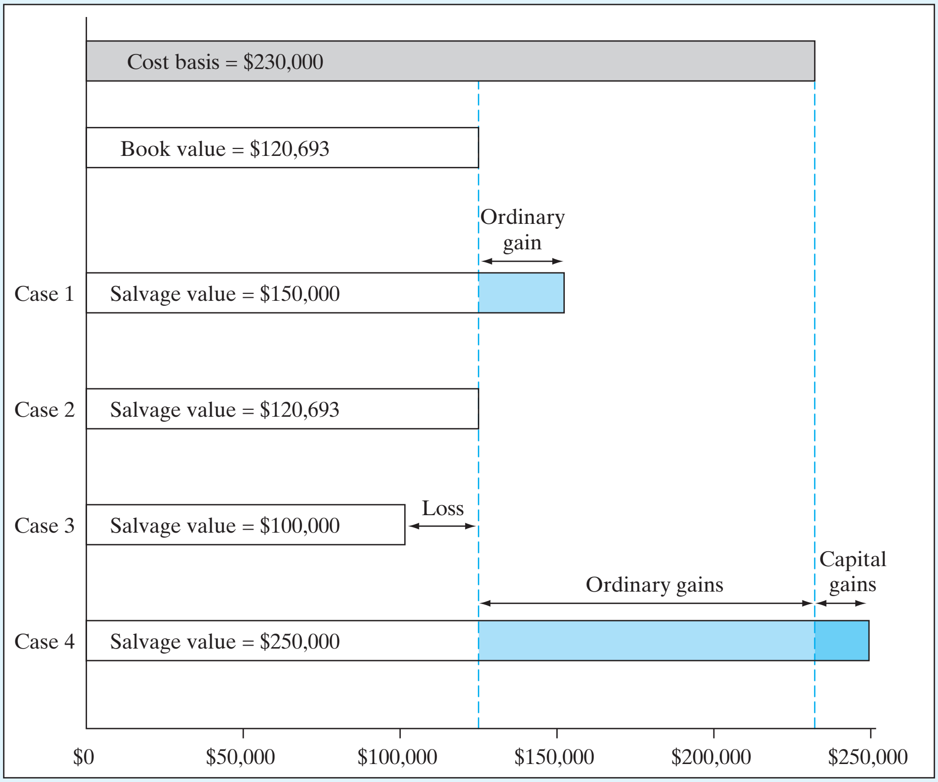

Figure 9.10 Calculations of gains or losses on MACRS property (Example 9.15).

This situation (in which the asset's salvage value exceeds its book value) is denoted as Case 1 in Figure 9.10.

(b) Case 2: Salvage value = Book value

In Case 2, the book value is again $120,693. Thus, if the drill press's salvage value equals $120,693—its book value—no taxes are levied on that salvage value. Therefore, the net proceeds equal the salvage value.

(c) Case 3: Salvage value < Book value

Case 3 illustrates a loss, when the salvage value (say, $100,000) is less than the book value. We compute the net salvage value after tax as follows:

$$\begin{aligned} \text{Gain (loss)} &= \text{Salvage value} - \text{book value} \\ &= \$100{,}000 - \$120{,}693 \\ &= (\$20{,}693), \\ \text{Tax savings} &= 0.34(\$20{,}693) \\ &= \$7{,}036, \end{aligned}$$

$$\text{Net proceeds from sale} = \$100{,}000 + \$7{,}036$$
$$= \$107{,}036.$$

(d) Case 4: Salvage value > Cost basis

This situation is not likely for most depreciable assets (except real property). But it is the only situation in which both capital gains and ordinary gains can be observed. Nevertheless, the tax treatment on this gain is as follows:

$$\text{Capital gains} = \text{Salvage value} - \text{cost basis}$$
$$= \$250{,}000 - \$230{,}000$$
$$= \$20{,}000,$$

$$\text{Capital gains tax} = \$20{,}000(0.34)$$
$$= \$6{,}800,$$

$$\text{Ordinary gains} = \$230{,}000 - \$120{,}693$$
$$= \$109{,}307,$$

$$\text{Gains tax} = \$109{,}307(0.34)$$
$$= \$37{,}164,$$

$$\text{Net proceeds from sale} = \$250{,}000 - (\$6{,}800 + \$37{,}164)$$
$$= \$206{,}036.$$

COMMENTS: Note that in (c) the reduction in tax, due to the loss, actually increases the net proceeds. This is realistic when the incremental tax rate (34% in this case) is positive, indicating the corporation is still paying tax, but less than if the asset had not been sold at a loss. The incremental tax rate will be discussed in Section 9.9.

9.9 Income Tax Rate to Be Used in Economic Analysis

As we have seen in earlier sections, average income tax rates for corporations vary with the level of taxable income from 0 to 35%. Suppose that a company now paying a tax rate of 25% on its current operating income is considering a profitable investment. What tax rate should be used in calculating the taxes on the investment's projected income?

9.9.1 Incremental Income Tax Rate

The choice of a corporation's rate depends on the incremental effect of an investment on the company's taxable income. In other words, the tax rate to use is the rate that applies to the additional taxable income projected in the economic analysis.

To illustrate, consider ABC Corporation, whose taxable income from operations is expected to be $70,000 for the current tax year. ABC management wishes to evaluate the incremental tax impact of undertaking a project during the same tax year. The revenues, expenses, and taxable incomes before and after the project are estimated as follows:

	Before	After	Incremental
Gross revenue	$200,000	$240,000	$40,000
Salaries	100,000	110,000	10,000
Wages	30,000	40,000	10,000
Taxable income	$ 70,000	$ 90,000	$20,000

Because the income tax rate is progressive, the tax effect of the project cannot be isolated from the company's overall tax obligations. The base operations of ABC without the project are expected to yield a taxable income of $70,000. With the new project, the taxable income increases to $90,000. From the tax computation formula in Table 9.6, the corporate income taxes with and without the project are as follows:

$$\begin{aligned}\text{Income tax without the project} &= \$7{,}500 + 0.25(\$70{,}000 - \$50{,}000)\\ &= \$12{,}500,\\ \text{Income tax with the project} &= \$13{,}750 + 0.34(\$90{,}000 - \$75{,}000)\\ &= \$18{,}850.\end{aligned}$$

The additional income tax is then $18,850 − $12,500 = $6,350. This amount, on the additional $20,000 of taxable income, is based on a rate of 31.75%, which is an incremental rate. This is the rate we should use in evaluating the project in isolation from the rest of ABC's operations. As shown in Figure 9.11, the 31.75% is not an arbitrary figure, but a weighted average of two distinct marginal rates. Because the new project pushes ABC into a higher tax bracket, the first $5,000 it generates is taxed at 25%; the remaining $15,000 it generates is taxed in the higher bracket, at 34%. Thus, we could have calculated the incremental tax rate with the formula

$$0.25\left(\frac{\$5{,}000}{\$20{,}000}\right) + 0.34\left(\frac{\$15{,}000}{\$20{,}000}\right) = 31.75\%.$$

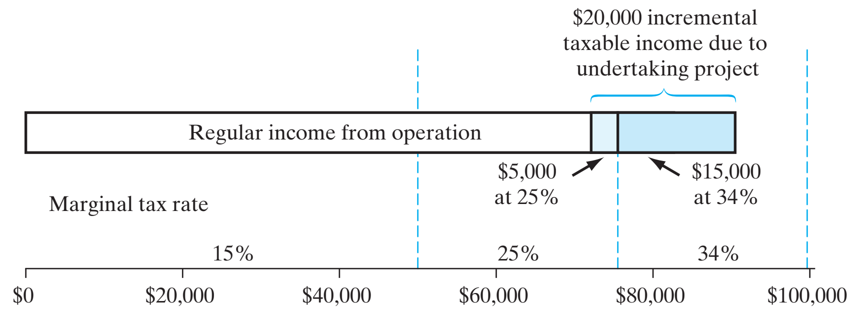

Figure 9.11 Illustration of incremental tax rate.

The average tax rates before and after the new project being considered is undertaken are as follows:

	Before	After	Incremental
Taxable income	\$70,000	\$90,000	\$20,000
Income taxes	12,500	18,850	6,350
Average tax rate	17.86%	20.94%	
Incremental tax rate			31.75%

Note that neither 17.86% nor 20.94% is a correct tax rate to use in evaluating the new project.

A corporation with continuing base operations that place it consistently in the highest tax bracket will have both marginal and average federal tax rates of 35%. For such firms, the tax rate on an additional investment project is, naturally, 35%. But for corporations in lower tax brackets, and for those which fluctuate between losses and profits, the marginal and average tax rates are likely to vary. For such corporations, estimating a prospective incremental tax rate for a new investment project may be difficult. The only solution may be to perform scenario analysis, in which we examine how much the income tax fluctuates due to undertaking the project. (In other words, we calculate the total taxes and the incremental taxes for each scenario.) A typical scenario is presented in Example 9.16.

EXAMPLE 9.16 Scenario Analysis for a Small Company

EverGreen Grass Company expects to have an annual taxable income of \$320,000 from its regular grass-sodding business over the next two years. EverGreen has just won a contract to sod grasses for a new golf complex for just those years. This two-year project requires a purchase of new equipment costing \$50,000. The equipment falls into the MACRS five-year class, with depreciation allowances of 20%, 32%, 19.2%, 11.52%, 11.52%, and 5.76% in each of the six years, respectively, during which the equipment will be depreciated. After the contract is terminated, the equipment will be retained for future use (instead of being sold), indicating no salvage cash flow, gain, or loss on this asset. The project will bring in an additional annual revenue of \$150,000, but it is expected to incur additional annual operating costs of \$90,000. Compute the incremental (marginal) tax rates applicable to the project's operating profits for years 1 and 2.

SOLUTION

Given: Base taxable income = \$320,000 per year, incremental income, expenses, and depreciation amounts as stated.

Find: Incremental tax rate for this new project in years 1 and 2.

First, we compute the additional taxable income from the golf course project over the next two years:

Year	1	2
Gross Revenue	$150,000	$150,000
Expenses	90,000	90,000
Depreciation	10,000	16,000
Taxable income	$ 50,000	$ 44,000

Next, we compute the income taxes. To do this, we need to determine the applicable marginal tax rate, but because of the progressive income tax rate on corporations, the project cannot be isolated from the other operations of EverGreen.

We can solve this problem much more efficiently by using the incremental tax rate concept discussed at the beginning of this section. Because the golf course project pushes EverGreen into the 34% tax bracket from the 39% bracket, we want to know what proportion of the incremental taxable income of $50,000 in year 1 is taxed at 39% and what proportion is taxable at 34%. Without the project, the firm's taxable income is $320,000 and its marginal tax rate is 39%. With the additional taxable income of $50,000, EverGreen's tax bracket reverts to 34%, as its combined taxable income changes from $320,000 to $370,000. Since the rate changes at $335,000, the first $15,000 of the $50,000 taxable income will still be in the 39% bracket, and the remaining $35,000 will be in the 34% bracket. In year 2, we can divide the additional taxable income of $44,000 in a similar fashion. Then we can calculate the incremental tax rates for the first two years as follows:

$$0.39\left(\frac{\$15{,}000}{\$50{,}000}\right) + 0.34\left(\frac{\$35{,}000}{\$50{,}000}\right) = 0.3550,$$

$$0.39\left(\frac{\$15{,}000}{\$44{,}000}\right) + 0.34\left(\frac{\$29{,}000}{\$44{,}000}\right) = 0.3570.$$

Note that these incremental tax rates vary slightly from year to year. Much larger changes could occur if a company's taxable income fluctuates drastically from its continuing base operation.

9.9.2 Consideration of State Income Taxes

For large corporations, the top federal marginal tax rate is 35%. In addition to federal income taxes, state income taxes are levied on corporations in most states. State income taxes are an allowable deduction in computing federal taxable income, and two ways are available to consider explicitly the effects of state income taxes in an economic analysis.

The first approach is to estimate explicitly the amount of state income taxes before calculating the federal taxable income. We then reduce the federal taxable income by the amount of the state taxes and apply the marginal tax rate to the resulting federal taxes. The total taxes would be the sum of the state taxes and the federal taxes.

The second approach is to calculate a single tax rate that reflects both state and federal income taxes. This single rate is then applied to the federal taxable income, without subtracting state income taxes. Taxes computed in this fashion represent total taxes. If state income taxes are considered, the combined state and federal marginal tax rate may be higher than 35%. Since state income taxes are deductible as expenses in determining federal taxes, the marginal rate for combined federal and state taxes can be calculated with the expression

$$t_m = t_f + t_s - (t_f)(t_s), \quad (9.11)$$

where

t_m = combined marginal tax rate,
t_f = federal marginal tax rate.
t_s = state marginal tax rate.

This second approach provides a more convenient and efficient way to handle taxes in an economic analysis in which the incremental tax rates are known. Therefore, incremental tax rates will be stated as combined marginal tax rates, unless indicated otherwise. (For large corporations, these would be about 40%, but they vary from state to state.)

EXAMPLE 9.17 Combined State and Federal Income Taxes

Consider a corporation whose revenues and expenses before income taxes are as follows:

Gross revenue	$1,000,000
All expenses	400,000

If the marginal federal tax rate is 35% and the marginal state rate is 7%, compute the combined state and federal taxes, using the two methods just described.

SOLUTION

Given: Gross income = $1,000,000, deductible expenses = $400,000, $t_f = 35\%$, and $t_s = 7\%$.

Find: Combined income taxes t_m.

(a) Explicit calculation of state income taxes:

Let's define FT as federal taxes and ST as state taxes. Then

$$\text{State taxable income} = \$1{,}000{,}000 - \$400{,}000$$

and

$$\begin{aligned} \text{ST} &= (0.07)(\$600{,}000) \\ &= \$42{,}000. \end{aligned}$$

Also,

$$\begin{aligned} \text{Federal taxable income} &= \$1{,}000{,}000 - \$400{,}000 - \text{ST} \\ &= (\$558{,}000), \end{aligned}$$

so that

$$FT = (0.35)(\$558{,}000) \\ = \$195{,}300.$$

Thus,

$$\text{Combined taxes} = FT + ST \\ = \$237{,}300.$$

(b) Tax calculation based on the combined tax rate:

Compute the combined tax rate directly from the formula:

$$\text{Combined tax rate } (t_m) = 0.35 + 0.07 - (0.35)(0.07) \\ = 39.55\%.$$

Hence,

$$\text{Combined taxes} = \$600{,}000(0.3955) \\ = \$237{,}300.$$

As expected, these two methods always produce exactly the same results.

9.10 The Need for Cash Flow in Engineering Economic Analysis

Traditional accounting stresses net income as a means of measuring a firm's profitability, but it is desirable to discuss why cash flows are relevant in project evaluation. As seen in Section 8.2, net income is an accounting measure based, in part, on the **matching concept**. Costs become expenses as they are matched against revenue. The actual timing of cash inflows and outflows is ignored.

9.10.1 Net Income versus Net Cash Flow

Over the life of a firm, net incomes and net cash inflows will usually be the same. However, the timing of incomes and cash inflows can differ substantially. Given the time value of money, it is better to receive cash now rather than later, because cash can be invested to earn more cash. (You cannot invest net income.) For example, consider two firms and their income and cash flow schedules over two years:

		Company A	Company B
Year 1	Net income	\$1,000,000	\$1,000,000
	Cash flow	1,000,000	0
Year 2	Net income	1,000,000	1,000,000
	Cash flow	1,000,000	2,000,000

Both companies have the same amount of net income and cash over two years, but Company A returns $1 million cash yearly, while Company B returns $2 million at the end of the second year. If you received $1 million at the end of the first year from Company A, you could, for example, invest it at 10%. While you would receive only $2 million in total from Company B at the end of the second year, you would receive $2.1 million in total from Company A.

9.10.2 Treatment of Noncash Expenses

Apart from the concept of the time value of money, certain expenses do not even require a cash outflow. Depreciation and amortization are the best examples of this type of expense. Even though depreciation (or amortization expense) is deducted from revenue on a daily basis, no cash is paid to anyone.

In Example 9.13, we learned that the annual depreciation allowance has an important impact on both taxable and net income. However, although depreciation has a direct impact on net income, it is *not* a cash outlay; hence, it is important to distinguish between annual income in the presence of depreciation and annual cash flow.

The situation described in Example 9.13 serves as a good vehicle to demonstrate the difference between depreciation costs as expenses and the cash flow generated by the purchase of a fixed asset. In that example, cash in the amount of $290,000 was expended in year 0, but the $58,000 depreciation charged against the income in year 1 was not a cash outlay. Figure 9.12 summarizes the difference.

Net income (**accounting profit**) is important for accounting purposes, but **cash flows** are more important for project evaluation purposes. However, as we will now demonstrate, net income can provide us with a starting point to estimate the cash flow of a project.

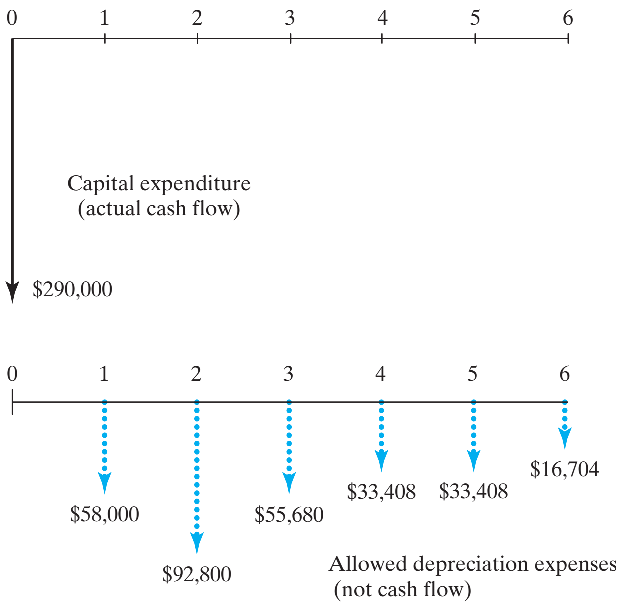

Figure 9.12 Cash flows versus depreciation expenses for an asset with a cost basis of $290,000, which was placed in service in year 0.

The procedure for calculating net cash flow (after tax) is identical to that used to obtain net income from operations, with the exception of depreciation, which is excluded from the net cash flow computation. (It is needed only for computing income taxes.) Assuming that revenues are received and expenses are paid in cash, we can obtain the net cash flow by adding the **noncash expense** (depreciation) to net income, which cancels the operation of subtracting it from revenues:

Item
Gross income
Expenses:
Cost of goods sold
Depreciation
Operating expenses
Taxable operating income
Income taxes
Net income
Net cash flow = Net income + Depreciation

Example 9.18 illustrates this relationship.

EXAMPLE 9.18 Cash Flow versus Net Income

A company buys a numerically controlled (NC) machine for $28,000 (year 0) and uses it for five years, after which it is scrapped. The allowed depreciation deduction during the first year is $4,000, as the equipment falls into the category of seven-year MACRS property. (The first-year depreciation rate is 14.29%.) The cost of the goods produced by this NC machine should include a charge for the depreciation of the machine. Suppose the company estimates the following revenues and expenses, including depreciation, for the first operating year:

$$\begin{aligned}\text{Gross income} &= \$50{,}000,\\ \text{Cost of goods sold} &= \$20{,}000,\\ \text{Depreciation on NC machine} &= \$4{,}000,\\ \text{Operating expenses} &= \$6{,}000.\end{aligned}$$

(a) If the company pays taxes at the rate of 40% on its taxable income, what is its net income from the project during the first year?

(b) Assume that (1) all sales are cash sales and (2) all expenses except depreciation were paid during year 1. How much cash would be generated from operations?

SOLUTION

Given: Net-income components.

Find: Cash flow.

We can generate a cash flow statement simply by examining each item in the income statement and determining which items actually represent receipts or disbursements (some of the assumptions listed in the statement of the problem make this process simpler):

Item	Income	Cash Flow
Gross income (revenues)	$50,000	$50,000
Expenses:		
Cost of goods sold	20,000	−20,000
Depreciation	4,000	
Operating expenses	6,000	−6,000
Taxable income	20,000	
Taxes (40%)	8,000	−8,000
Net income	$12,000	
Net cash flow		$16,000

Column 2 shows the income statement, while Column 3 shows the statement on a cash flow basis. The sales of $50,000 are all cash sales. Costs other than depreciation were $26,000; these were paid in cash, leaving $24,000. Depreciation is not a cash flow: The firm did not pay out $4,000 in depreciation expenses. Taxes, however, are paid in cash, so the $8,000 for taxes must be deducted from the $24,000, leaving a net cash flow from operations of $16,000. As shown in Figure 9.13, this $16,000 is exactly equal to net income plus depreciation: $\$12,000 + \$4,000 = \$16,000$.

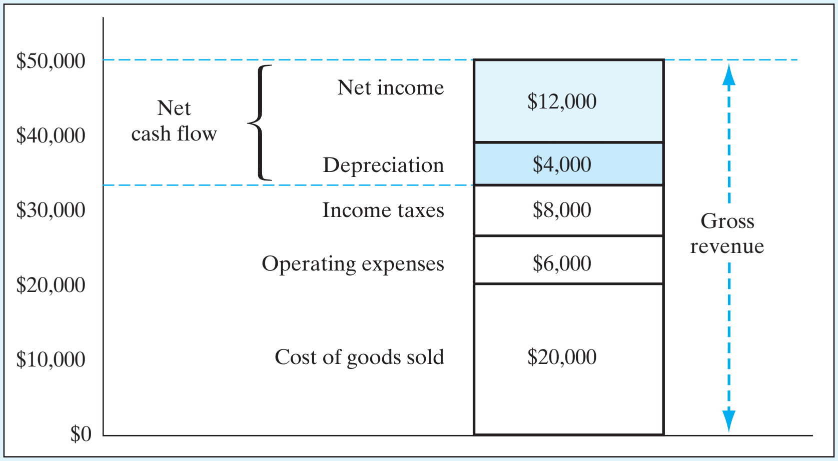

Figure 9.13 Net income versus net cash flow (Example 9.18). Cash flow versus depreciation expenses for an asset with a cost basis of $28,000, which was placed in service in year 0.

As we've just seen, depreciation has an important impact on annual cash flow in its role as an accounting expense that reduces taxable income and thus taxes. (Although depreciation expenses are not actual cash flows, depreciation has a positive impact on the after-tax cash flow of the firm.) Of course, during the year in which an asset is actually acquired, the cash disbursed to purchase it creates a significant negative cash flow, and during the depreciable life of the asset, the depreciation charges will affect the taxes paid and, therefore, cash flows.

As shown in Example 9.18, through its influence on taxes, depreciation plays a critical role in project cash flow analysis, which we will explore further in Chapter 10.

SUMMARY

- Machine tools and other manufacturing equipment, and even the factory buildings themselves, are subject to wear over time. However, it is not always obvious how to account for the cost of their replacement. Clearly, the choice of estimated service life for a machine, and the method used to calculate the cost of operating it, can have significant effects on an asset's management.
- The entire cost of replacing a machine cannot be properly charged to any one year's production; rather, the cost should be spread (or capitalized) over the years in which the machine is in service. The cost charged to operations during a particular year is called **depreciation**. Several different meanings and applications of depreciation have been presented in this chapter. From an engineering economics point of view, our primary concern is with **accounting depreciation**: the systematic allocation of an asset's value over its depreciable life.
- Accounting depreciation can be broken into two categories:
  1. **Book depreciation**—the method of depreciation used in financial reports and for pricing products;
  2. **Tax depreciation**—the method of depreciation used for calculating taxable income and income taxes; this method is governed by tax legislation.
- The four components of information required to calculate depreciation are as follows:
  1. The cost basis of the asset.
  2. The salvage value of the asset.
  3. The depreciable life of the asset.
  4. The method of its depreciation.

  Table 9.7 summarizes the differences in the way these components are treated for purposes of book and tax depreciation.
- Because it employs accelerated methods of depreciation and shorter-than-actual depreciable lives, the **Modified Accelerated Cost Recovery System (MACRS)** gives taxpayers a break, allowing them to take earlier and faster advantage of the tax-deferring benefits of depreciation.
- Many firms select straight-line depreciation for book depreciation because of its relative ease of calculation.

TABLE 9.7 Summary of Book versus Tax Depreciation

Component of Depreciation	Book Depreciation	Tax Depreciation (MACRS)
Cost basis	Based on the actual cost of the asset, plus all incidental costs, such as the cost of freight, site preparation, installation, etc.	Same as for book depreciation.
Salvage value	Estimated at the outset of depreciation analysis. If the final book value does not equal the estimated salvage value, we may need to make adjustments in our depreciation calculations.	Salvage value is zero for all depreciable assets.
Depreciable life	Firms may select their own estimated useful lives or follow government guidelines for asset depreciation ranges (ADRs).	Eight recovery periods—3, 5, 7, 10, 15, 20, 27.5, and 39 years—have been established; all depreciable assets fall into one of these eight categories.
Method of depreciation	Firms may select from the following: • straight line • accelerated methods (declining balance, double-declining balance, and sum-of-years'-digits) • units of production	Exact depreciation percentages are mandated by tax legislation, but are based largely on DDB and straight-line methods. The sum-of-years'-digits method is rarely used in the United States, except for some cost analysis in engineering valuation.

- Depletion is a cost allocation method used particularly for natural resources. **Cost depletion** is based on the units-of-production method of depreciation. **Percentage depletion** is based on a prescribed percentage of the gross income of a property during a tax year.
- Given the frequently changing nature of depreciation and tax law, we must use whatever percentages, depreciable lives, and salvage values are in effect *at the time an asset is acquired*.
- Explicit consideration of taxes is a necessary aspect of any complete economic study of an investment project.
- For corporations, the U.S. tax system has the following characteristics:
  1. Tax rates are progressive: The more you earn, the more you pay.
  2. Tax rates increase in stair-step fashion: four brackets for corporations and two additional surtax brackets, giving a total of six brackets.
  3. Allowable exemptions and deductions may reduce the overall tax assessment.

- Three distinct terms to describe taxes were used in this chapter: **marginal tax rate**, which is the rate applied to the last dollar of income earned; **effective (average) tax rate**, which is the ratio of income tax paid to net income; and **incremental tax rate**, which is the average rate applied to the incremental income generated by a new investment project.
- **Capital gains** are currently taxed as ordinary income, and the maximum rate is capped at 35%. **Capital losses** are deducted from capital gains; net remaining losses may be carried backward and forward for consideration in years other than the current tax year.
- Since we are interested primarily in the measurable financial aspects of depreciation, we consider its effects on two important measures of an organization's financial position: **net income** and **cash flow**. Once we understand that depreciation has a significant influence on the income and cash position of a firm, we will be able to appreciate fully the importance of utilizing depreciation as a means of maximizing the value both of engineering projects and of the organization as a whole.

PROBLEMS

Note: *Unless otherwise specified, use current tax rates for corporate taxes. Check the website (described in the preface) for the most current tax rates for corporations.*

Economic Depreciation

9.1 A machine now in use was purchased four years ago at a cost of $20,000. It has a book value of $6,246. It can be sold for $7,000, but could be used for three more years, at the end of which time it would have no salvage value. What is the current amount of economic depreciation for this asset?

Cost Basis

9.2 General Service Contractor Company paid $200,000 for a house and lot. The value of the land was appraised at $65,000 and the value of the house at $135,000. The house was then torn down at an additional cost of $5,000 so that a warehouse could be built on the lot at a cost of $250,000. What is the total value of the property with the warehouse? For depreciation purposes, what is the cost basis for the warehouse?

9.3 To automate one of its production processes, Milwaukee Corporation bought three flexible manufacturing cells at a price of $500,000 each. When they were delivered, Milwaukee paid freight charges of $25,000 and handling fees of $12,000. Site preparation for these cells cost $35,000. Six foremen, each earning $15 an hour, worked five 40-hour weeks to set up and test the manufacturing cells. Special wiring and other materials applicable to the new manufacturing cells cost $1,500. Determine the cost basis (amount to be capitalized) for these cells.

9.4 A new drill press was purchased for $126,000 by trading in a similar machine that had a book value of $39,000. Assuming that the trade-in allowance is $40,000 and that $86,000 cash is to be paid for the new asset, what is the cost basis of the new asset for depreciation purposes?

9.5 A lift truck priced at $35,000 is acquired by trading in a similar lift truck and paying cash for the remaining balance. Assuming that the trade-in allowance is $10,000 and the book value of the asset traded in is $6,000, what is the cost basis of the new asset for the computation of depreciation for tax purposes?

Book Depreciation Methods

9.6 Consider the following data on an asset:

Cost of the asset, I	\$132,000
Useful life, N	5 years
Salvage value, S	\$ 20,000

Compute the annual depreciation allowances and the resulting book values, using
(a) The straight-line depreciation method.
(b) The double-declining-balance method.

9.7 A firm is trying to decide whether to keep an item of construction equipment for another year. The firm is using DDB for book purposes, and this is the fourth year of ownership of the equipment, which cost \$150,000 new. What is the depreciation in year 3?

9.8 Consider the following data on an asset:

Cost of the asset, I	\$50,000
Useful life, N	7 years
Salvage value, S	\$0

Compute the annual depreciation allowances and the resulting book values, using the DDB and switching to SL.

9.9 The double-declining-balance method is to be used for an asset with a cost of \$68,000, an estimated salvage value of \$12,000, and an estimated useful life of six years.
(a) What is the depreciation for the first three fiscal years, assuming that the asset was placed in service at the beginning of the year?
(b) If switching to the straight-line method is allowed, when is the optimal time to switch?

9.10 Compute the double-declining-balance (DDB) depreciation schedule for the following asset:

Cost of the asset, I	\$76,000
Useful life, N	8 years
Salvage value, S	\$ 6,000

9.11 Compute the DDB depreciation schedule for the following asset:

Cost of the asset, I	\$46,000
Useful life, N	5 years
Salvage value, S	\$10,000

(a) What is the value of α?
(b) What is the amount of depreciation for the second full year of use of the asset?
(c) What is the book value of the asset at the end of the fourth year?

9.12 Upjohn Company purchased new packaging equipment with an estimated useful life of five years. The cost of the equipment was $35,000, and the salvage value was estimated to be $5,000 at the end of year 5. Compute the annual depreciation expenses over the five-year life of the equipment under each of the following methods of book depreciation:

(a) Straight-line method.

(b) Double-declining-balance method. (Limit the depreciation expense in the fifth year to an amount that will cause the book value of the equipment at year-end to equal the $5,000 estimated salvage value.)

(c) Sum-of-years'-digits method.

9.13 A secondhand bulldozer acquired at the beginning of the fiscal year at a cost of $68,000 has an estimated salvage value of $9,500 and an estimated useful life of 12 years. Determine

(a) The amount of annual depreciation by the straight-line method.

(b) The amount of depreciation for the third year, computed by the double-declining-balance method.

(c) The amount of depreciation for the second year, computed by the sum-of-years'-digits method.

Units-of-Production Method

9.14 If a truck for hauling coal has an estimated net cost of $100,000 and is expected to give service for 250,000 miles, resulting in a salvage value of $5,000, depreciation would be charged at a rate of 38 cents per mile. Compute the allowed depreciation amount for the same truck's usage amounting to 55,000 miles.

9.15 A diesel-powered generator with a cost of $65,000 is expected to have a useful operating life of 50,000 hours. The expected salvage value of this generator is $7,500. In its first operating year, the generator was operated for 5,000 hours. Determine the depreciation for the year.

Tax Depreciation

9.16 Zerex Paving Company purchased a hauling truck on January 1, 2005, at a cost of $32,000. The truck has a useful life of eight years with an estimated salvage value of $5,000. The straight-line method is used for book purposes. For tax purposes, the truck would be depreciated with the MACRS method over its five-year class life. Determine the annual depreciation amount to be taken over the useful life of the hauling truck for both book and tax purposes.

9.17 The Harris Foundry Company purchased new casting equipment in 2006 at a cost of $220,000. Harris also paid $35,000 to have the equipment delivered and installed. The casting machine has an estimated useful life of 12 years, but it will be depreciated with MACRS over its seven-year class life.

(a) What is the cost basis of the casting equipment?

(b) What will be the depreciation allowance in each year of the seven-year class life of the casting equipment?

9.18 A machine is classified as seven-year MACRS property. Compute the book value for tax purposes at the end of three years. The cost basis is $145,000.

9.19 A piece of machinery purchased at a cost of $86,000 has an estimated salvage value of $12,000 and an estimated useful life of five years. It was placed in service on May 1 of the current fiscal year, which ends on December 31. The asset falls into a seven-year MACRS property category. Determine the depreciation amounts over the useful life.

9.20 Suppose that a taxpayer places in service a $20,000 asset that is assigned to the six-year class (say, a new property class) with a half-year convention. Develop the MACRS deductions, assuming a 200% declining-balance rate followed by switching to straight line.

9.21 On April 1, Leo Smith paid $250,000 for a residential rental property. This purchase price represents $200,000 for the building and $50,000 for the land. Five years later, on November 1, he sold the property for $300,000. Compute the MACRS depreciation for each of the five calendar years during which he had the property.

9.22 In 2006, you purchased a spindle machine (seven-year MACRS property) for $26,000, which you placed in service in January. Use the calendar year as your tax year. Compute the depreciation allowances.

9.23 On October 1, you purchased a residential home in which to locate your professional office for $250,000. The appraisal is divided into $80,000 for the land and $170,000 for the building.

(a) In your first year of ownership, how much can you deduct for depreciation for tax purposes?

(b) Suppose that the property was sold at $325,000 at the end of fourth year of ownership. What is the book value of the property?

9.24 For each of four assets in the following table, determine the missing amounts (for asset type III, the annual usage is 15,000 miles):

Types of Asset	I	II	III	IV
Depreciating Methods	SL	DDB	UP	MACRS
End of year	7	4	3	4
Initial cost ($)	10,000	18,000	30,000	8,000
Salvage value ($)	2,000	2,000	0	1,000
Book value ($)	3,000	2,320		1,382
Depreciable life	8 yr	5 yr	90,000 mi	
Depreciable Amount ($)				
Accumulated Depreciable ($)		15,680		

9.25 Flint Metal Shop purchased a stamping machine for $147,000 on March 1, 2006. The machine is expected to have a useful life of 10 years, a salvage value of $27,000, a production of 250,000 units, and working hours of 30,000. During 2006, Flint used the stamping machine for 2,450 hours to produce 23,450 units. From the information given, compute the book depreciation expense for 2006 under each of the following methods:

(a) Straight line.

(b) Units-of-production method.

(c) Working hours.

(d) Double-declining balance (without conversion to straight line).

(e) Double-declining balance (with conversion to straight line).

Depletion

9.26 Early in 2006, Atlantic Mining Company began operation at its West Virginia mine. The mine had been acquired at a cost of $6,900,000 in 2004 and is expected to contain 3 million tons of silver and to have a residual value of $1,500,000 (once the silver is depleted). Before beginning mining operations, the company installed equipment at a cost of $2,700,000. This equipment will have no economic usefulness once the silver is depleted. Therefore, depreciation of the equipment is based upon the estimated number of tons of ore produced each year. Ore removed from the West Virginia mine amounted to 500,000 tons in 2006 and 682,000 tons in 2007.

(a) Compute the per ton depletion rate of the mine and the per ton depreciation rate of mining equipment.

(b) Determine the depletion expense for the mine and the depreciation expense for the mining equipment.

9.27 Suppose you bought a timber tract for $550,000, and the land was worth as much as $150,000. An estimated 4.8 million board feet (4.8 MBF) of standing timber was in the tract. If you cut 1.5 MBF of timber, determine your depletion allowance.

9.28 A gold mine with an estimated deposit of 500,000 ounces of gold is purchased for $40 million. The mine has a gross income of $22,623,000 for the year, obtained from selling 52,000 ounces of gold. Mining expenses before depletion equal $12,250,000. Compute the percentage depletion allowance. Would it be advantageous to apply cost depletion rather than percentage depletion?

9.29 Oklahoma Oil Company incurred acquisition, exploration, and development costs during 2006 as follows:

	Site		
Items*	**Parcel A**	**Parcel B**	**Total**
Acquisition costs	6	4	10
Exploration costs	13	9	22
Development costs	20	11	31
Recoverable oil (millions of barrels)	9	5	14

* *Units are in millions of dollars, except recoverable oil.*

The market price of oil during 2006 was $16 per barrel.

(a) Determine the cost basis for depletion on each parcel.

(b) During 2006, 1,200,000 barrels were extracted from parcel A at a production cost of $3,600,000. Determine the depletion charge allowed for parcel A.

(c) In (b), if Oklahoma Oil Company sold 1,000,000 of the 1,200,000 barrels extracted during 2006 at a price of $55 per barrel, the sales revenue would be $55,000,000. If it qualified for the use of percentage depletion (15%), what would be the allowed depletion amount for 2006?

(d) During 2006, 800,000 barrels were extracted from parcel B at a production cost of $3,000,000. Assume that during 2007 it is ascertained that the remaining proven reserves on parcel B total only 4,000,000 barrels, instead of the originally estimated 5,000,000. This revision in proven reserves is considered a change in an accounting estimate that must be corrected during the current and future years. (A correction of previous years' depletion amounts is not permitted.) If 1,000,000 barrels are extracted during 2007, what is the total depletion charge allowed, according to the unit cost method?

9.30 A coal mine expected to contain 6.5 million tons of coal was purchased at a cost of $30 million. One million tons of coal are produced this year. The gross income for this coal is $600,000, and operating costs (excluding depletion expenses) are $450,000. If you know that coal has a 10% depletion allowance, what will be the depletion allowance for

(a) Cost depletion?

(b) Percentage depletion?

Revision of Depreciation Rates

9.31 Perkins Construction Company bought a building for $800,000 to be used as a warehouse. A number of major structural repairs, completed at the beginning of the current year at a cost of $125,000, are expected to extend the life of the building 10 years beyond the original estimate. The building has been depreciated by the straight-line method for 25 years. The salvage value is expected to be negligible and has been ignored. The book value of the building before the structural repairs is $400,000.

(a) What has the amount of annual depreciation been in past years?

(b) What is the book value of the building after the repairs have been recorded?

(c) What is the amount of depreciation for the current year, according to the straight-line method? (Assume that the repairs were completed at the very beginning of the year.)

9.32 The Dow Ceramic Company purchased a glass-molding machine in 2001 for $140,000. The company has been depreciating the machine over an estimated useful life of 10 years, assuming no salvage value, by the straight-line method of depreciation. For tax purposes, the machine has been depreciated under 7-year MACRS property. At the beginning of 2004, Dow overhauled the machine at a cost of $25,000. As a result of the overhaul, Dow estimated that the useful life of the machine would extend 5 years beyond the original estimate.

(a) Calculate the book depreciation for year 2006.

(b) Calculate the tax depreciation for year 2006.

9.33 On January 2, 2004, Hines Food Processing Company purchased a machine that dispenses a premeasured amount of tomato juice into a can. The machine cost $75,000, and its useful life was estimated at 12 years, with a salvage value of $4,500. At the time it purchased the machine, Hines incurred the following additional expenses:

Freight-in	$800
Installation cost	2,500
Testing costs prior to regular operation	1,200

Book depreciation was calculated by the straight-line method, but for tax purposes, the machine was classified as a 7-year MACRS property. In January 2006, accessories costing $5,000 were added to the machine to reduce its operating costs. These accessories neither prolonged the machine's life nor provided any additional salvage value.

(a) Calculate the book depreciation expense for 2007.

(b) Calculate the tax depreciation expense for 2007.

Corporate Tax Systems

9.34 In tax year 1, an electronics-packaging firm had a gross income of $25,000,000, 5,000,000 in salaries, $4,000,000 in wages, $800,000 in depreciation expenses, a loan principal payment of $200,000, and a loan interest payment of $210,000. Determine the net income of the company in tax year 1.

9.35 A consumer electronics company was formed to develop cellphones that run on or are recharged by fuel cells. The company purchased a warehouse and converted it into a manufacturing plant for $6,000,000. It completed installation of assembly equipment worth $1,500,000 on December 31. The plant began operation on January 1. The company had a gross income of $8,500,000 for the calendar year. Manufacturing costs and all operating expenses, excluding the capital expenditures, were $2,280,000. The depreciation expenses for capital expenditures amounted to $456,000.

(a) Compute the taxable income of this company.

(b) How much will the company pay in federal income taxes for the year?

9.36 Huron Roofing Company had gross revenues of $1,200,000 from operations. Financial transactions as shown in Table P9.36 were posted during the year. The old equipment had a book value of $75,000 at the time of its sale.

(a) What is Huron's income tax liability?

(b) What is Huron's operating income?

Gains or Losses

9.37 Consider a five-year MACRS asset purchased at $60,000. (Note that a five-year MACRS property class is depreciated over six years, due to the half-year convention.

TABLE P9.36

Manufacturing expenses (including depreciation)	$450,000
Operating expenses (excluding interest expenses)	120,000
A new short-term loan from a bank	50,000
Interest expenses on borrowed funds (old and new)	40,000
Dividends paid to common stockholders	80,000
Old equipment sold	60,000

The applicable salvage values would be $20,000 in year 3, $10,000 in year 5, and $5,000 in year 6.) Compute the gain or loss amounts when the asset is disposed of

(a) In year 3.

(b) In year 5.

(c) In year 6.

9.38 In year 0, an electrical appliance company purchased an industrial robot costing $300,000. The robot, to be used for welding operations and classified as seven-year recovery property, has been depreciated by the MACRS method. If the robot is to be sold after five years, compute the amounts of gains (losses) for the following three salvage values (assume that both capital gains and ordinary incomes are taxed at 34%):

(a) $10,000.

(b) $125,460.

(c) $200,000.

9.39 AmSouth, Inc., bought a machine for $50,000 on January 2, 2004. Management expects to use the machine for 10 years, at the end of which time it will have a $1,000 salvage value. Consider the following questions independently:

(a) If AmSouth uses straight-line depreciation, what will be the book value of the machine on December 31, 2007?

(b) If AmSouth uses double-declining-balance depreciation, what will be the depreciation expense for 2007?

(c) If AmSouth uses double-declining-balance depreciation, followed by switching to straight-line depreciation, when will be the optimal time to switch?

(d) If Amsouth uses 7-year MACRS and sells the machine on April 1, 2007, at a price of $30,000, what will be the taxable gains?

Marginal Tax Rate in Project Evaluation

9.40 Boston Machine Shop expects to have an annual taxable income of $325,000 from its regular business over the next six years. The company is considering acquiring a new milling machine during year 0. The machine's price is $200,000, installed. The machine falls into the MACRS five-year class, and it will have an estimated salvage value of $30,000 at the end of six years. The machine is expected to generate additional before-tax revenue of $80,000 per year.

(a) What is the total amount of economic depreciation for the milling machine if the asset is sold at $30,000 at the end of six years?

(b) Determine the company's marginal tax rates over the next six years with the machine.

(c) Determine the company's average tax rates over the next six years with the machine.

9.41 Major Electrical Company expects to have an annual taxable income of $550,000 from its residential accounts over the next two years. The company is bidding on a two-year wiring service for a large apartment complex. This commercial service requires the purchase of a new truck equipped with wire-pulling tools at a cost of $50,000. The equipment falls into the MACRS five-year class and will be retained for future use (instead of being sold) after two years, indicating no gain or loss on the property. The project will bring in an additional annual revenue of $200,000, but it is expected to incur additional annual operating costs of $100,000. Compute the marginal tax rates applicable to the project's operating profits for the next two years.

9.42 Florida Citrus Corporation estimates its taxable income for next year at $2,000,000. The company is considering expanding its product line by introducing pineapple–orange juice for the next year. The market responses could be (1) good, (2) fair, or (3) poor. Depending on the market response, the expected additional taxable incomes are (1) $2,000,000 for a good response, (2) $500,000 for a fair response, and (3) a $100,000 loss for a poor response.

(a) Determine the marginal tax rate applicable to each situation.

(b) Determine the average tax rate that results from each situation.

9.43 Simon Machine Tools Company is considering purchasing a new set of machine tools to process special orders. The following financial information is available:

- Without the project, the company expects to have a taxable income of $300,000 each year from its regular business over the next three years.
- With the three-year project, the purchase of a new set of machine tools at a cost of $50,000 is required. The equipment falls into the MACRS three-year class. The tools will be sold for $10,000 at the end of project life. The project will be bringing in additional annual revenue of $80,000, but it is expected to incur additional annual operating costs of $20,000.

(a) What are the additional taxable incomes (due to undertaking the project) during each of years 1 through 3?

(b) What are the additional income taxes (due to undertaking the new orders) during each of years 1 through 3?

(c) Compute the gain taxes when the asset is disposed of at the end of year 3.

Combined Marginal Income Tax Rate

9.44 Consider a corporation whose taxable income without state income tax is as follows:

Gross revenue	$2,000,000
All expenses	1,200,000

If the marginal federal tax rate is 34% and the marginal state rate is 6%, compute the combined state and federal taxes using the two methods described in the text.

9.45 A corporation has the following financial information for a typical operating year:

Gross revenue	$4,500,000
Cost of goods sold	2,450,000
Operating costs	630,000
Federal taxes	352,000
State taxes	193,120

(a) On the basis of this financial information, determine both federal and state marginal tax rates.

(b) Determine the combined marginal tax rate for this corporation.

9.46 Van-Line Company, a small electronics repair firm, expects an annual income of $70,000 from its regular business. The company is considering expanding its repair business to include personal computers. The expansion would bring in an additional annual income of $30,000, but will require an additional expense of $10,000 each year over the next three years. Using applicable current tax rates, answer the following:

(a) What is the marginal tax rate in tax year 1?

(b) What is the average tax rate in tax year 1?

(c) Suppose that the new business expansion requires a capital investment of $20,000 (a three-year MACRS property). At $i = 10\%$, what is the PW of the total income taxes to be paid over the project life?

9.47 A company purchased a new forging machine to manufacture disks for airplane turbine engines. The new press cost $3,500,000, and it falls into a seven-year MACRS property class. The company has to pay property taxes to the local township for ownership of this forging machine at a rate of 1.2% on the beginning book value of each year.

(a) Determine the book value of the asset at the beginning of each tax year.

(b) Determine the amount of property taxes over the machine's depreciable life.

Short Case Studies

ST9.1 On January 2, 2000, Allen Flour Company purchased a new machine at a cost of $63,000. Installation costs for the machine were $2,000. The machine was expected to have a useful life of 10 years, with a salvage value of $4,000. The company uses straight-line depreciation for financial reporting. On January 3, 2003, the machine broke down, and an extraordinary repair had to be made to the machine at a cost of $6,000. The repair extended the machine's life to 13 years, but left the salvage value unchanged. On January 2, 2006, an improvement was made to the machine in the amount of $3,000 that increased the machine's productivity and increased the salvage value (to $6,000), but did not affect the remaining useful life. Determine depreciation expenses every December 31 for the years 2000, 2003, and 2006.

ST9.2 On March 17, 2003, Wildcat Oil Company began operations at its Louisiana oil field. The oil field had been acquired several years earlier at a cost of $11.6 million. The field is estimated to contain 4 million barrels of oil and to have a salvage value of $2 million both before and after all of the oil is pumped out. Equipment costing $480,000 was purchased for use at the oil field. The equipment will have no economic usefulness once the Louisiana field is depleted; therefore, it is depreciated on a units-of-production method. In addition, Wildcat Oil built a pipeline at a cost of $2,880,000 to serve the Louisiana field. Although this pipeline is physically capable of being used for many years, its economic usefulness is limited to the productive life of the Louisiana field; therefore, the pipeline has no salvage value. Depreciation of the pipeline is based on the estimated number of barrels of oil to be produced. Production at the Louisiana oil field amounted to 420,000 barrels in 2006 and 510,000 barrels in 2007.

(a) Compute the per barrel depletion rate of the oil field during the years 2006 and 2007.

(b) Compute the per barrel depreciation rates of the equipment and the pipeline during the years 2006 and 2007.

ST9.3 At the beginning of the fiscal year, Borland Company acquired new equipment at a cost of $65,000. The equipment has an estimated life of five years and an estimated salvage value of $5,000.

(a) Determine the annual depreciation (for financial reporting) for each of the five years of the estimated useful life of the equipment, the accumulated depreciation at the end of each year, and the book value of the equipment at the end of each year, all by (1) the straight-line method, and (2) the double-declining-balance method.

(b) Determine the annual depreciation for tax purposes, assuming that the equipment falls into a seven-year MACRS property class.

(c) Assume that the equipment was depreciated under seven-year MACRS. In the first month of the fourth year, the equipment was traded in for similar equipment priced at $82,000. The trade-in allowance on the old equipment was $10,000, and cash was paid for the balance. What is the cost basis of the new equipment for computing the amount of depreciation for income tax purposes?

ST9.4 Electronic Measurement and Control Company (EMCC) has developed a laser speed detector that emits infrared light, which is invisible to humans and radar detectors alike. For full-scale commercial marketing, EMCC needs to invest $5 million in new manufacturing facilities. The system is priced at $3,000 per unit. The company expects to sell 5,000 units annually over the next five years. The new manufacturing facilities will be depreciated according to a seven-year MACRS property class. The expected salvage value of the manufacturing facilities at the end of five years is $1.6 million. The manufacturing cost for the detector is $1,200 per unit, excluding depreciation expenses. The operating and maintenance costs are expected to run to $1.2 million per year. EMCC has a combined federal and state income tax rate of 35%, and undertaking this project will not change this current marginal tax rate.

(a) Determine, for the next five years, the incremental taxable income, income taxes, and net income due to undertaking this new product.

(b) Determine the gains or losses associated with the disposal of the manufacturing facilities at the end of five years.

ST9.5 Diamonid is a start-up diamond-coating company that is planning to manufacture a microwave plasma reactor which synthesizes diamonds. Diamonid anticipates that the industry demand for diamonds will skyrocket over the next decade, for use in industrial drills, high-performance microchips, and artificial human joints, among other things. Diamonid has decided to raise $50 million through issuing common stocks for investment in plant ($10 million) and equipment ($40 million). Each reactor can be sold at a price of $100,000 per unit. Diamonid can expect to sell 300 units per year during the next 8 years. The unit manufacturing cost is estimated at $30,000, excluding depreciation. The operating and maintenance cost for the plant is estimated at $12 million per year. Diamonid expects to phase out the operation at the end of 8 years, revamp the plant and equipment, and adopt a new diamond-manufacturing technology. At that time, Diamonid estimates that the salvage values for the plant and equipment will be about 60% and 10% of the original investments, respectively. The plant and equipment will be depreciated according to 39-year real property (placed in service in January) and 7-year MACRS, respectively. Diamonid pays 5% of state and local income taxes on its taxable income.

(a) If the 2006 corporate tax system continues over the project life, determine the combined state and federal income tax rate each year.

(b) Determine the gains or losses at the time the plant is revamped.

(c) Determine the net income each year over the plant life.