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PART

1

FUNDAMENTALS OF FINANCIAL DECISIONS

Engineering Economic Decisions

Uber: “We Ignite Opportunity by Setting the World in Motion”¹ Uber Technologies is a ride-sharing company which transformed an industry by using technology to enable individuals to provide transportation for others using their own vehicles. Uber was at the forefront of what’s been called the gig economy when it burst on the scene in 2009. Ever since, its services have expanded to include food delivery, package delivery, couriers, even freight transportation.

How was Uber born²? Travis Kalanick, the founder of Uber, was born in Los Angeles, California, in 1976; he learned to code at an early age and went on to study computer engineering at UCLA but left with a few months to go before graduation. After a couple of start-ups, he had the financial means and time to create Uber. The story goes that on a snowy night in Paris, Kalanick and his cofounder (Garret Camp) struggled to find a taxi and the idea for a “car-on-demand” app was born out of their frustration³. Uber Garage was set up in April 2012 and was described as “a workshop where the company will experiment with new ideas for urban transportation.”

On launching, Uber entered into direct competition with the traditional taxi industry, which was highly fragmented globally. Licenses to operate taxis were generally tightly controlled by local authorities and regulatory bodies; new or additional licenses were not readily granted, and no consideration was given to evolving population figures. Existing operators were therefore heavily protected, allowing fares to climb in the absence of free competition. It was ripe for Uber’s entry because everybody hates it⁴.

Uber’s overriding service aim was to get cars to customers as fast as possible and at the lowest possible price. To do so, it developed a proprietary

¹ Uber.com

² Max Chafkin, “What Makes Uber Run,” *Fast Company*, September 8, 2015.

³ Uber.com/our-story

⁴ IMD, “Uber: An Empire in the Making?” International Institute for Management Development, Lausanne,

system and mechanism for managing the volume and flow of vehicles. Essentially, the algorithm tries to predict urban traffic flows based on the existing data and therefore be as accurate as possible in determining where and when customers would need a car. Uber itself extracted a flat 20% commission before paying the driver.

The company's growth exploded; by the end of 2019, it was available in 69 countries, providing 7 billion trips per year. In the United States, it had a 65% share of the ride-hailing market. Ten years after the company was launched, Uber went public on May 9, 2019, with an offering of 180 million shares trading at a price of \$45 per share.

The initial public offering (IPO) raked in \$8.1 billion, putting the company's valuation at around \$75 billion. It was the biggest IPO of the year on the New York Stock Exchange (NYSE) and one of the 10 largest ever. At the end of year 2021, Uber has further grown to:

- nearly 10,000 cities across approximately 72 countries
- \$58 billion in all gross bookings in 2020
- \$142 billion paid to drivers and delivery people (cumulative as of December 31, 2020)



- 18 million trips per day for the quarter ended on December 31, 2020
- 93 million active platform consumers for the quarter ended on December 31, 2020

Uber's been on a wild ride since, plunging to a low around \$20.29 per share on March 15, 2020, and peaking above \$58 per share on February 18, 2021. Since then, it continues to decline, closing at \$30.94 on April 26, 2022.

The story of how the Uber founders got motivated to develop a series of transportation and delivery service products and eventually transformed their invention to a multibillion-dollar business is a typical one. Companies such as Google, Facebook, and Microsoft all produce computer-related products and have market values of over a trillion dollars. These companies were all started by highly motivated young college students. One thing that is also common to all these successful businesses is that they have capable and imaginative engineers who constantly generate good ideas for capital investment, execute them well, and obtain good results. You might wonder what kind of role these engineers play in making such business decisions. In other words, what specific tasks are assigned to these engineers, and what tools and techniques are available to them for making such capital investment decisions? We answer these questions and explore related issues throughout this text.

CHAPTER LEARNING OBJECTIVES

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

- The role of engineers in business.
- Types of business organization.
- The nature and types of engineering economic decisions.
- What makes the engineering economic decisions difficult.
- How a typical engineering project idea evolves in business.
- Fundamental principles of engineering economics.

1.1 Role of Engineers in Business

Facebook, Google, and Microsoft produce computer products and have a market value of over a trillion dollars each, as stated earlier. These companies were all started by young college students with technical backgrounds. When they went into the computer business, these students initially organized their companies as proprietorships. As the businesses grew, they became partnerships and were eventually converted to corporations. This chapter begins by introducing the three primary forms of business organization and briefly discusses the role of engineers in business.

I.1.1 Types of Business Organization

As an engineer, you should understand the nature of the business organization with which you are associated. This section will present some basic information about the type of organization you should choose should you decide to go into business for yourself. The three legal forms of business, each having certain advantages and disadvantages, are proprietorships, partnerships, and corporations.

Proprietorships

A **proprietorship** is a business owned by one individual. This person is responsible for the firm's policies, owns all its assets, and is personally liable for its debts. A proprietorship has two major advantages. First, it can be formed easily and inexpensively. No legal and organizational requirements are associated with setting up a proprietorship, and organizational costs are therefore virtually nil. Second, the earnings of a proprietorship are taxed at the owner's personal tax rate, which may be lower than the rate at which corporate income is taxed. Apart from personal liability considerations, the major disadvantage of a proprietorship is that it cannot issue stocks and bonds, making it difficult to raise capital for any business expansion.

Partnerships

A **partnership** is similar to a proprietorship, except that it has more than one owner. Most partnerships are established by a written contract between the partners. The contract normally specifies salaries, contributions to capital, and the distribution of profits and losses. A partnership has many advantages, among which are its low cost and ease of formation. Because more than one person makes contributions, a partnership typically has a larger amount of capital available for business use. Since the personal assets of all the partners stand behind the business, a partnership can borrow money more easily from a bank. Each partner pays only personal income tax on his or her share of a partnership's taxable income.

On the negative side, under partnership law, each partner is liable for a business's debts. This means that the partners must risk all their personal assets—even those not invested in the business. And while each partner is responsible for his or her portion of the debts in the event of bankruptcy, if any partners cannot meet their pro rata claims, the remaining partners must take over the unresolved claims. Finally, a partnership has a limited life, insofar as it must be dissolved and reorganized if one of the partners quits.

Corporations

A **corporation** is a legal entity created under provincial or federal law. It is separate from its owners and managers. This separation gives the corporation four major advantages:

1. It can raise capital from a large number of investors by issuing stocks and bonds.
2. It permits easy transfer of ownership interest by trading shares of stock.
3. It allows limited liability—personal liability is limited to the amount of the individual's investment in the business.
4. It is taxed differently than proprietorships and partnerships, and under certain conditions, the tax laws favor corporations.

On the negative side, it is expensive to establish a corporation. Furthermore, a corporation is subject to numerous governmental requirements and regulations.

As a firm grows, it may need to change its legal form, because the form of a business affects the extent to which it has control of its own operations and its ability to acquire funds. The legal form of an organization also affects the risk borne by its owners in case of bankruptcy and the manner in which the firm is taxed. Apple Computer, for example, started out as a two-person garage operation. As the business grew, the owners felt constricted by this form of organization: It was difficult to raise capital for business expansion; they felt that the risk of bankruptcy was too high to bear; and as their business income grew, their tax burden grew as well. Eventually, they found it necessary to convert the partnership into a corporation. With a market value of close to \$2.78 trillion in March 2022, it is the largest corporation in terms of market value in the United States.

In the United States, the overwhelming majority of business firms are proprietorships, followed by corporations and partnerships. However, in terms of total business volume (dollars of sales), the quantity of business transacted by proprietorships and partnerships is several times less than that of corporations. Since most business is conducted by corporations, this text will generally address economic decisions encountered in that form of ownership.

1.1.2 Engineering Economic Decisions

What role do engineers play within a firm? What specific tasks are assigned to the engineering staff, and what tools and techniques are available to it to improve a firm's profits? Engineers are called upon to participate in a variety of decisions, ranging from manufacturing, through marketing, to financing decisions. We will restrict our focus, however, to various economic decisions related to engineering projects. We refer to these decisions as **engineering economic decisions**.

In manufacturing, engineering is involved in every detail of a product's production, from conceptual design to shipping. In fact, engineering decisions account for the majority (some say 85%) of product costs. Engineers must consider the effective use of capital assets such as buildings and machinery. One of the engineer's primary tasks is to plan for the acquisition of equipment (**capital expenditure**) that will enable the firm to design and produce products economically.

With the purchase of any fixed asset—equipment, for instance—we need to estimate the profits (more precisely, cash flows) that the asset will generate during its period of service. In other words, we have to make capital expenditure decisions based on predictions about the future. Suppose, for example, you are considering the purchase of a deburring machine to meet the anticipated demand for hubs and sleeves used in the production of gear couplings. You expect the machine to last 10 years. This decision thus involves an implicit 10-year sales forecast for the gear couplings, which means that a long waiting period will be required before you will know whether the purchase was justified.

An inaccurate estimate of the need for assets can have serious consequences. If you invest too much in assets, you incur unnecessarily heavy expenses. Spending too little on fixed assets, however, is also harmful, for then the firm's equipment may be too obsolete to produce products competitively, and without an adequate capacity, you may lose a portion of your market share to rival firms. Regaining lost customers involves heavy marketing expenses and may even require price reductions or significant product improvements, both of which are costly.

1.1.3 Personal Economic Decisions

In the same way that an engineer can play a role in the effective utilization of corporate financial assets, each of us is responsible for managing our personal financial affairs. After we have paid for nondiscretionary or essential needs, such as housing, food, clothing, and transportation, any remaining money is available for discretionary expenditures on items such as entertainment, travel, and investment. For money we choose to invest, we want to maximize the economic benefit at some acceptable risk. The investment choices are virtually unlimited and include savings accounts, guaranteed investment certificates, stocks, bonds, mutual funds, registered retirement savings plans, rental properties, land, business ownership, and more.

How do you choose? The analysis of one's personal investment opportunities utilizes the same techniques that are used for engineering economic decisions. Again, the challenge is predicting the performance of an investment into the future. Choosing wisely can be very rewarding, while choosing poorly can be disastrous. Some investors in the energy stock Enron who sold prior to the fraud investigation became millionaires. Others, who did not sell, lost everything. (Enron's bankruptcy on December 2, 2001, was the largest in U.S. history at the time.) A wise investment strategy is a strategy that manages risk by diversifying investments. With such an approach, you have a number of different investments ranging from very low to very high risk and are in a variety of business sectors. Since you do not have all your money in one place, the risk of losing everything is significantly reduced. (We discuss some of these important issues in Chapters 12 and 13.)

In this text, we will consider many types of investments—personal investments as well as business investments. The focus, however, will be on evaluating engineering projects on the basis of their economic desirability and on dealing with investment situations that a typical firm or a public institution faces.

1.1.4 Economic Decisions Versus Design Decisions

Economic decisions differ in a fundamental way from the types of decisions typically encountered in engineering design. In a design situation, the engineer utilizes known physical properties, the principles of chemistry and physics, engineering design correlations, and engineering judgment to arrive at a workable and optimal design. If the judgment is sound, the calculations are done correctly, and we ignore technological advances, the design is time invariant. In other words, if the engineering design to meet a particular need is done today, next year, or in five years' time, the final design would not change significantly.

In considering economic decisions, the measurement of investment attractiveness, which is the subject of this text, is relatively straightforward. However, the information required in such evaluations always involves predicting or forecasting product sales, product selling prices, and various costs over some future time frame—five years, 10 years, 25 years, etc.

All such forecasts have two things in common. First, they are never completely accurate compared with the actual values realized at future times. Second, a prediction or forecast made today is likely to be different from one made at some point in the future. It is this ever-changing view of the future that can make it necessary to revisit and even change previous economic decisions. Thus, unlike engineering design, the conclusions reached through economic evaluation are not necessarily time invariant. Economic decisions have to be based on the best information available at the time of the decision and a thorough understanding of the uncertainties in the forecasted data.

1.2 What Makes the Engineering Economic Decision Difficult?

The economic decisions that engineers make in business differ very little from the financial decisions made by individuals, except for the scale of the concern. The U.S. transportation sector, which includes cars, trucks, planes, trains, ships, and freight, produces nearly 30% of all U.S. global warming emissions, more than any other sectors. Among these, long-haul diesel trucks produce a disproportionate share of greenhouse gases and other pollutants in the air, as they spend so much time on the road. There is a considerable debate over how to make the trucking industry free of emissions, and which technology to adopt to solve the emission problems. Many industrialized countries including the United States, want to figure out how to reduce the emissions from these trucks.

Germany is at the forefront in experimenting the eHighway⁵ concept to fire up electric motors in big vehicles. Basically, the eHighway system is an electrified highway that feeds electricity to trucks as they drive, using wires strung above the roadway and a pantograph mounted on the cab as shown in Figure 1.1. This is just like a tram (a light rail vehicle) found in a larger city's mass transit system. The system is energy efficient as it delivers power directly from the electrical grid to the motors. The technology saves weight and money because batteries tend to be heavy and expensive, and a truck using overhead wires needs only a big enough battery to get from the off-ramp to its destination. The eHighway could eliminate the need for charging stops, important in the trucking industry where time is money. The cables also charge the battery, which stores enough power to drive short distances emission-free in urban traffic. That is another advantage of the catenary system. Trucking companies that use the routes would save money on fuel, their biggest cost, and easily justify the investment in trucks with rooftop pantographs. But the onus would be on the German government to build the overhead cables, which cost an estimated 2.5 million euros per kilometer, or about \$5 million per mile.

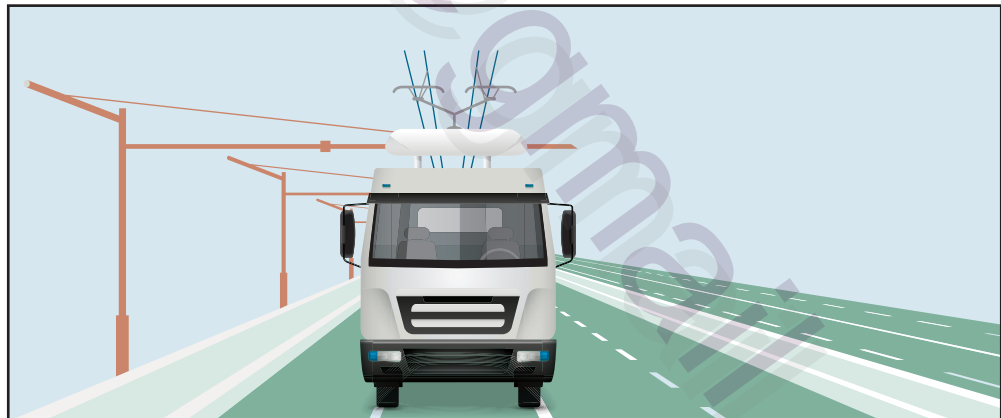


Figure 1.1 The eHighway concept of electrified road freight transport under development in Germany.

⁵ “What If Highways Were Electric? Germany Is Testing the Idea,” by Jack Ewing, *The New York Times*, August 3, 2021.

As a competing technology, either hydrogen fuel cells or improved batteries is also on the table.

- Truckmakers are betting on hydrogen fuel cells for long-haul rigs. They argue that the heavy batteries needed to provide acceptable range are impractical for trucks because they subtract too much capacity from payload.
- Another industry group argues that hydrogen is too expensive and inefficient, because of the energy needed to produce it. This group is betting on ever-improving batteries.

Even though numerous studies have indicated that the eHighway systems, despite the high infrastructure costs, are the most cost-effective option, the German government is being cautious as batteries are getting cheaper and better all the time, and charging times are dropping. Furthermore, the risk is so great that taxpayers would pay for electrified highways only for the technology to be shunned by the trucking industry or rendered obsolete by something else. Another overriding issue is how to build on a larger scale. Who's going to pay for thousands of miles of high-voltage electrical cable above the major highways? Eventually, the total cost of infrastructure, vehicles, and energy will decide what technology or combination of technologies prevails.

Obviously, this level of engineering decision is far more complex and more significant than a business decision about when to introduce a new product. Projects of this nature involve large sums of money over long periods of time, and it is difficult to estimate the magnitude of economic benefits in any precise manner. Even if we decide to build the eHighway systems, should we build in incremental steps, so that we can easily switch to a different system if more efficient technology becomes available over the years? Even if we can justify the project on economic reasoning, how to finance the project is another issue. Any engineering economic decision pertaining to this type of a large-scale project will be extremely difficult to make.

I.3 Large-Scale Engineering Projects

In the development of any product, a company's engineers are called upon to translate an idea into reality. A firm's growth and development depend largely upon a constant flow of ideas for new products, and for the firm to remain competitive, it has to make existing products better or produce them at a lower cost. We will present an example of how a large-scale engineering project evolves and what types of financial decisions have to be considered in the process of executing such a project.

I.3.1 Alcoa Makes a Big Bet on 3D Printing⁶

Aluminum mega company Alcoa has been utilizing 3D printing technology to build tools and prototypes for the past 20 years. With big plans in shaping metal with 3D printers, the company has invested \$60 million to expand its research and development (R&D) center located near Pittsburgh, Pennsylvania, for advanced 3D printing techniques and materials since 2017. The company believes that this investment strengthens Alcoa's leadership position in meeting fast-growing demand for

⁶ "Alcoa Makes a Big Bet on 3D Printing," by Jonathan Vanian, *Fortune*, September 3, 2015.

Alcoa's Ampliforge Process

Alcoa's proprietary Ampliforge technique that combines 3D printing with forging manufacturing processes to increase toughness, fatigue, and strength of 3D printed parts.

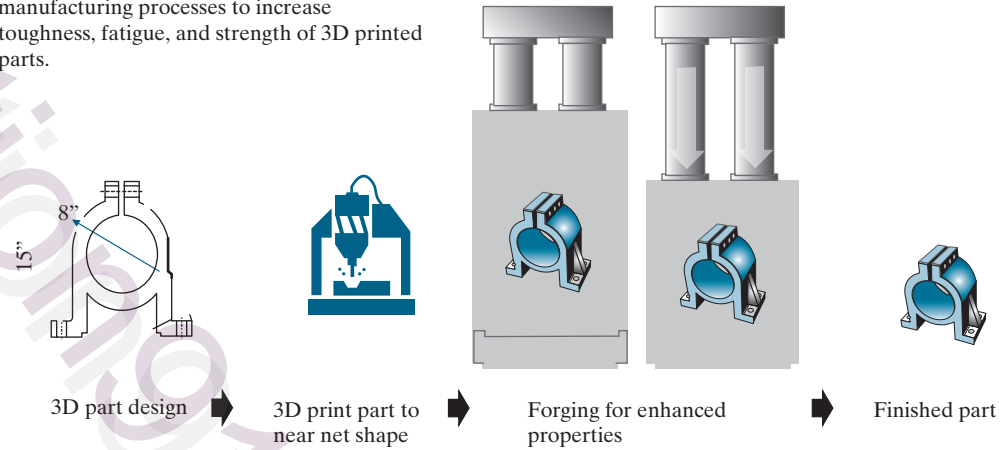


Figure 1.2 Alcoa's vision of additive manufacturing.

aerospace components made using additive technologies. As illustrated in Figure 1.2, the innovative Ampliforge™ process developed by Alcoa takes a part designed and produced using 3D printing and completes it using a more standard process, i.e., forging. According to Alcoa, the process enhances the properties of 3D-printed parts such as hardness and strength, compared to additive manufactured parts without further treatment⁷. The biggest question remaining about the expansion concerned its ability to develop a specialized manufacturing technique in time that combines 3D printing technology with traditional processes, as there is always a significant risk associated with this scale of investment.

Despite Alcoa management's decision to expand its R&D center, the financial analysts were still uncertain whether there would be enough demand to recover the investment made in the 3D printing technology. The financial risk would be further compounded if the company couldn't come up with cheaper metal materials that can be used to craft 3D printed objects rather than current materials used, which are extremely expensive. If either scenario proves to be true, the investment in the R&D center will never be fully recovered.

1.3.2 Impact of Engineering Projects on Financial Statements

Engineers must understand the business environment in which a company's major business decisions are made. It is important for an engineering project to generate profits, but it also must strengthen the firm's overall financial position. How do we measure Alcoa's success in the 3D Printing expansion project? Will enough business be generated, for example, by expanding the 3D printing capabilities as Alcoa's major source of securing

⁷ "Alcoa Details Research, Process Strategy to Maximize 3DP," by Robert Brooks, *Forging*, September 3, 2015.

aerospace business? While the advanced 3D printing system would provide revolutionary additive manufacturing technologies for the company's customers, the bottom line is its financial performance over the long run.

Regardless of a business' form, each company has to produce basic financial statements at the end of each operating cycle (typically a year). These financial statements provide the basis for future investment analysis. In practice, we seldom make investment decisions solely on the basis of an estimate of a project's profitability, because we must also consider the overall impact of the investment on the financial strength and position of the company.

Suppose that you were the president of the Alcoa Corporation. Suppose further that you even hold some shares in the company, making you one of the company's many owners. What objectives would you set for the company? While all firms are in business in hopes of making a profit, what determines the market value of a company are not profits per se, but cash flow. It is, after all, available cash that determines the future investments and growth of the firm. Therefore, one of your objectives should be to increase the company's value to its owners (including yourself) as much as possible. To some extent, the market price of your company's stock represents the value of your company.

Many factors affect your company's market value: present and expected future earnings, the timing and duration of those earnings, and the risks associated with them. Certainly, any successful investment decision will increase a company's market value. Stock price can be a good indicator of your company's financial health, and may also reflect the market's attitude about how well your company is managed for the benefit of its owners.

Any successful investment decision on the Alcoa's investment scale will tend to increase a firm's stock prices in the marketplace and promote long-term success. Thus, in making a large-scale engineering project decision, we must consider its possible effect on the firm's market value. (In Chapter 2, we discuss the financial statements in detail and show how to use them in our investment decision making.)

I.4 Common Types of Strategic Engineering Economic Decisions

The story of how the Alcoa Corporation successfully introduced a new product and became the market leader in the advanced 3D printing market is typical: Someone had a good idea, executed it well, and obtained good results. Project ideas such as the 3D printing technologies for aerospace components can originate from many different levels in an organization. Since some ideas will be good, while others will not, we need to establish procedures for screening projects.

Many large companies have a specialized project analysis division that actively searches for new ideas, projects, and ventures. Once project ideas are identified, they are typically classified as (1) equipment or process selection, (2) equipment replacement, (3) new product or product expansion, (4) cost reduction, or (5) improvement in service or quality. This classification scheme allows management to address key questions: Can the existing plant, for example, be used to attain the new production levels? Does the firm have the knowledge and skill to undertake the new investment? Does the new proposal warrant the recruitment of new technical personnel? The answers to these questions help firms screen out proposals that are not feasible, given a company's resources.

The 3D printing project represents a fairly complex engineering decision that required the approval of top executives and the board of directors. Virtually all big businesses face investment decisions of this magnitude at some time. In general, the larger the investment, the more detailed is the analysis required to support the expenditure. For example, expenditures aimed at increasing the output of existing products or at manufacturing a new product would invariably require a very detailed economic justification. Final decisions on new products, as well as marketing decisions, are generally made at a high level within the company. By contrast, a decision to repair damaged equipment can be made at a lower level. The five classifications of project ideas are further detailed as follows.

1.4.1 Equipment or Process Selection

This class of engineering decision problems involves selecting the best course of action out of several that meet a project's requirements. For example, which of several proposed items of equipment shall we purchase for a given purpose? The choice often hinges on which item is expected to generate the largest savings (or the largest return on the investment). For example, the choice of material will dictate the manufacturing process for the body panels in the automobile. Many factors will affect the ultimate choice of the material, and engineers should consider all major cost elements, such as the cost of machinery and equipment, tooling, labor, and material. Other factors may include press and assembly, production and engineered scrap, the number of dies and tools, and the cycle times for various processes.

1.4.2 Equipment Replacement

This category of investment decisions involves considering the expenditure necessary to replace worn-out or obsolete equipment. For example, a company may purchase 10 large presses, expecting them to produce stamped metal parts for 10 years. After five years, however, it may become necessary to produce the parts in plastic, which would require retiring the presses early and purchasing plastic molding machines. Similarly, a company may find that, for competitive reasons, larger and more accurate parts are required, making the purchased machines become obsolete earlier than expected.

Suppose, for example, that a firm is using a lathe that was purchased 12 years ago to produce pump shafts. As the production engineer in charge of this product, you expect demand to continue into the foreseeable future. However, the lathe has begun to show its age: It has broken frequently during the last two years and has finally stopped operating altogether. Now you have to decide whether to replace or repair it. If you expect a more efficient lathe to be available in the next one or two years, you might repair the old lathe instead of replacing it. The major issue is whether you should make the considerable investment in a new lathe now or later. As an added complication, if demand for your product begins to decline, you may have to conduct an economic analysis to determine whether declining profits from the project offset the cost of a new lathe.

1.4.3 New Product or Product Expansion

Investments in this category increase company revenues if output is increased. One common type of expansion decision includes decisions about expenditures aimed at increasing the output of existing production or distribution facilities. In these situations, we are basically asking, "Shall we build or otherwise acquire a new facility?"

The expected future cash inflows in this investment category are the profits from the goods and services produced in the new facility. A second type of expenditure decision includes considering expenditures necessary to produce a new product or to expand into a new geographic area. These projects normally require large sums of money over long periods.

I.4.4 Cost Reduction

A cost-reduction project is a project that attempts to lower a firm's operating costs. Typically, we need to consider whether a company should buy equipment to perform an operation currently done manually or spend money now in order to save more money later. The expected future cash inflows on this investment are savings resulting from lower operating costs.

I.4.5 Improvement in Service or Quality

Most of the examples in the previous sections were related to economic decisions in the manufacturing sector. The decision techniques we develop in this book are also applicable to various economic decisions related to improving services or quality of product. Start-ups are using technology to take a robotic approach to manicures, offering a simple way to provide foolproof nail polish⁸. Nimble, one of the start-ups with \$10 million in seed funding from venture capital, has incorporated so-called computer vision to work with artificial intelligence and a robotic arm to offer simple, 10-minute manicures in a device about the size of a toaster. Nimble's product is geared for home use, and the company plans to sell directly to consumers and in retail outlets with an intended price of \$399. Is this the right price to recover the investment made in the development of the product? We will provide several economic decision problems from the service sector throughout the text.

I.5 Fundamental Principles of Engineering Economics

This book is focused on the principles and procedures engineers use to make sound economic decisions. To the first-time student of engineering economics, anything related to money matters may seem quite strange when compared to other engineering subjects. However, the decision logic involved in solving problems in this domain is quite similar to that employed in any other engineering subject. There are fundamental principles to follow in engineering economics that unite the concepts and techniques presented in this text, thereby allowing us to focus on the logic underlying the practice of engineering economics.

- **Principle 1: A dollar earned today is worth more than a dollar earned in the future.** A fundamental concept in engineering economics is that money has a time value associated with it (Figure 1.3). Because we can earn interest on money received today, it is better to receive money earlier than later. This concept will be the basic foundation for all engineering project evaluation.

⁸ "The Simple Way to Get a Foolproof Manicure? Let a Robot Do Your Nails," *The New York Times*, June 21, 2021, page B5.

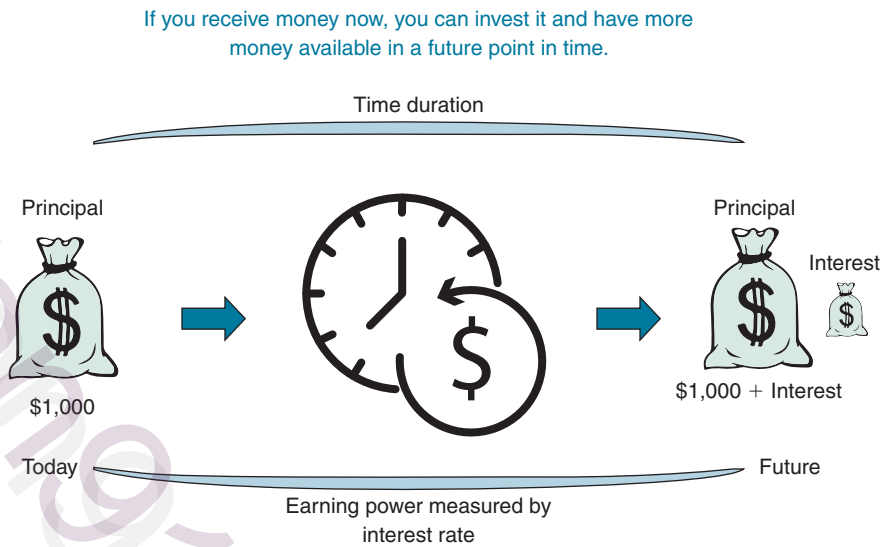


Figure 1.3 Time value of money.

- Principle 2: All that counts are the differences among alternatives.** An economic decision should be based on the *differences* among the alternatives considered (Figure 1.4). All that is common is irrelevant to the decision. Certainly, any economic decision is no better than the alternatives being considered. Thus, an economic decision should be based on the objective of making the best use of limited resources. Whenever a choice is made, something is given up. The opportunity cost of a choice is the value of the best alternative given up.

Comparing Buy versus Lease

Whatever you decide, you need to spend the same amount of money on fuel and maintenance

Option	Monthly Fuel Cost	Monthly Maintenance	Cash Outlay at Signing	Monthly Payment	Salvage Value at End of Year 3
Buy	\$960	\$550	\$6,500	\$350	\$9,000
Lease	\$960	\$550	\$2,400	\$550	0

Irrelevant items in decision making

Figure 1.4 Differential analysis.

- Principle 3: Marginal revenue must exceed marginal cost.** Effective decision making requires comparing the additional costs of alternatives with the additional benefits (Figure 1.5). Each decision alternative must be justified on its own economic merits before being compared with other alternatives. Any increased economic activity must be justified on the basis of the fundamental economic principle that marginal revenue must exceed marginal cost. Here, *marginal revenue* means the additional revenue made possible by increasing the activity by one unit (or small unit). *Marginal cost* has an analogous definition. Productive resources—the natural

resources, human resources, and capital goods available to make goods and services—are limited. Therefore, people cannot have all the goods and services they want; as a result, they must choose some things and give up others.

To justify your action, marginal revenue must exceed marginal cost

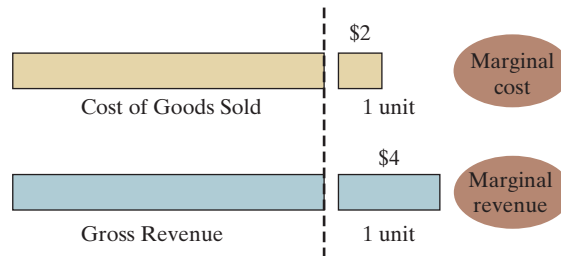


Figure 1.5 Marginal analysis.

- Principle 4: Additional risk is not taken without the expected additional return.** For delaying consumption, investors demand a minimum return that must be greater than the anticipated rate of inflation or any perceived risk (Figure 1.6). If they didn't receive enough to compensate for anticipated inflation and the perceived investment risk, investors would purchase whatever goods they desired ahead of time or invest in assets that would provide a sufficient return to compensate for any loss from inflation or potential risk. The preceding four principles are as much statements of common sense as they are theoretical precepts. These principles provide the logic behind what is to follow. We build on them and attempt to draw out their implications for decision-making. As we continue, keep in mind that, while the topics being treated may change from chapter to chapter, the logic driving our treatment of them is constant and rooted in the four fundamental principles.

Expected returns from bonds and stocks are normally higher than the expected return from a savings account

Investment Class	Potential Risk	Expected Return
Savings account (cash)	Low/None	1.5%
Bond (debt)	Moderate	4.8%
Stock (equity)	High	11.5%

Figure 1.6 Risk and return trade off.

SUMMARY

■ This chapter has given us an overview of a variety of engineering economic problems that commonly are found in the business world. We examined the role and the increasing importance of engineers in the firm, as evidenced by the

development of innovative 3D printing technologies by Alcoa. Commonly, engineers are called upon to participate in a variety of strategic business decisions ranging from product design to marketing.

- The term **engineering economic decision** refers to any investment decision related to an engineering project. The facet of an economic decision that is of most interest from an engineer's point of view is the evaluation of costs and benefits associated with making a capital investment.
- The five main types of engineering economic decisions are (1) equipment or process selection, (2) equipment replacement, (3) new product or product expansion, (4) cost reduction, and (5) improvement in service or quality.
- The factors of **time** and **uncertainty** are the defining aspects of any investment project.
- The four fundamental principles that must be applied in all engineering economic decisions are (1) the time value of money, (2) differential (incremental) cost and revenue, (3) marginal cost and revenue, and (4) the trade-off between risk and reward.

SELF-TEST QUESTIONS

- 1s.1** Which of the following statements is incorrect?
- (a) Economic decisions are time invariant.
 - (b) Time and risk are the most important factors in any investment evaluation.
 - (c) For a large-scale engineering project, engineers must consider the impact of the project on the company's financial statements.
 - (d) One of the primary roles of engineers is to make capital expenditure decisions.
- 1s.2** When evaluating a large-scale engineering project, which of the following items is important?
- (a) Expected profitability
 - (b) Timing of cash flows
 - (c) Degree of financial risk
 - (d) All of the above
- 1s.3** Which of the following statements defines the discipline of engineering economics most closely?
- (a) Economic decisions made by engineers.
 - (b) Economic decisions related to financial assets.
 - (c) Economic decisions primarily for real assets and services from engineering projects.
 - (d) Any economic decision related to the time value of money.
- 1s.4** Which of the following statements is not one of the four fundamental principles of engineering economics?
- (a) Receiving a dollar today is worth more than a dollar received in the future.
 - (b) To expect a higher return on investment, you need to take a higher risk.
 - (c) Marginal revenue must exceed marginal cost to justify any production.
 - (d) When you are comparing different alternatives, you must not focus only on differences in alternatives.

PROBLEMS

- 1.1** You find a townhouse that meets your living accommodations. You could lease the townhouse or buy it. If you have no financial constraints in taking either option, list all the expenses that should be considered in comparing the options.
- 1.2** Suppose you have \$1,000 to invest. You don't need this money for the next two years. Consider the following two options:
- (1) Loan the entire \$1,000 for two years to a friend (A) who promises you to pay back \$1,150.
 - (2) Loan \$500 to another friend (B) who will pay back \$600 a year later. In terms of trustworthiness, friend B is more reliable. Any unused funds can be deposited in a savings account that earns 3% interest per year. How do you approach this decision problem based on the four fundamental principles discussed in Section 1.5?

Short Case Studies with Excel

ST1.1 Review the contents of *The Wall Street Journal* for the past three months. Then, identify and categorize the types of investment decisions appearing in the journal according to the types of strategic economics decisions discussed in the text.

ST1.2 Work in small groups and brainstorm ideas about how a common appliance, device, or tool could be redesigned to improve it in some way. Identify the steps involved and the economic factors that you would need to consider prior to making a decision to manufacture the redesigned product. A detailed design and actual cost estimates are not required.

Some items which could be considered for this redesign exercise are a shopping cart, telephone, can opener, screwdriver, etc.

ST1.3 Many oil price forecasts during the pandemic in 2020 indicated that the price of oil in the year 2021 would not exceed \$50 per barrel. What is the price of oil today? Why are these prices so difficult to predict? Imagine what the consequences would be if you used these optimistic estimates in your economic analysis in your early project undertaking. What would be some practical ways to consider this type of variation in economic analysis?

Accounting Information for Engineering Economic Decisions

Broadcom in Talks to Buy Software Firm SAS Institute¹ *The Wall Street Journal* reported that Broadcom is in talks to buy SAS Institute for \$15 billion to \$20 billion. The deal could close in the coming weeks, assuming talks don't fall apart. Based in Irvine, CA, Broadcom (BRCM) is engaged in designing and marketing semiconductor components of network voice, video, and data traffic for various applications. On the other hand, North Carolina-based SAS provides data and analytics solutions to customers in 147 countries spread across several industries, including banking, healthcare, retail, and manufacturing.

Broadcom has been looking to expand their market penetration as a world leading global supplier of state-of-the-art digital and analog components to companies like Cisco, Apple, Extreme Networks, and Hewlett Packard. Broadcom's acquisition of SAS would be consistent with the company's move to diversify from semiconductors into enterprise software. The move should help Broadcom command a larger slice of the market and become more competitive. Why would a component industry giant purchase part of a software business that is experiencing market and performance challenges? It appears to be all about opportunity, competition, and assessing value.

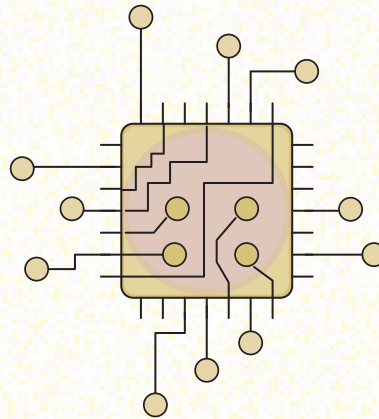
Suppose you are a chief engineer who oversees a new product development by integrating the soon-to-be acquired SAS software with the various BRCM's chip products. How would you determine the financial

¹ "Broadcom in Talks to Buy Software Firm SAS Institute," Technology, *The Wall Street Journal*, July 12, 2021. The Broadcom stock is traded under the symbol of "AVGO" in Nasdaq. Eventually, the deal didn't go through as Broadcom decided to buy VMware in \$61 billion on May 26, 2022.

success of your project? Or, as an investor, if you want to explore investing in BRCM stock, what information would you go by? You would certainly prefer that BRCM have a record of accomplishment of profitable operations, earning a profit (net income) year after year. The company would need a steady stream of cash coming in and a manageable level of debt. How would you determine whether the company met these criteria? Investors commonly use the financial statements contained in the annual report as a starting point in forming expectations about future levels of earnings and about the firm's riskiness.

Berkshire Hathaway founder and CEO, Warren Buffett², made an immense fortune by analyzing the numbers and seizing the moment by investing in companies restructuring or conducting sizeable corporate mergers and acquisitions. The Buffett model of analysis and investment decision making can be used to explain the economics of this potential acquisition³.

Buffett's philosophy on business investing is a modification of the value investing approach of his mentor Benjamin Graham⁴. Graham bought companies because they were inexpensive compared to their intrinsic value. He was of the belief that if the market undervalued them relative to their intrinsic value, he was making a solid investment. Buffett reasoned that



² "The World's Billionaires 2021," www.forbes.com/billionaires/list.

³ Mary Buffett and David Clark, "The New Buffettology," *Scribner*, September 24, 2002.

⁴ Benjamin Graham, Jason Zweig, and Warren E. Buffett, *The Intelligent Investor: The Definitive Book on Value Investing* (Harper Business Essentials, 2003).

the market will eventually realize it has undervalued the company and will correct its course regardless of what type of business the company was in. In addition, he believed that the business must have solid economics behind it. To determine whether an investment is viable, he considered the following factors:

- Is the company a world leader in the business they are in, are they innovative, and do they maintain a solid, quality reputation in their industry?
- Are company financials currently trending upward (i.e., increased earnings, above average gross margins, and appreciable return on investments).
- Does the company have a healthy balance sheet that shows operational costs well under control and properly balanced capital investments aligned with profitable returns?
- Is the company in a financial state where it can readily repay its debt and maintain low debt-to-equity and high earnings-to-debt ratios?
- Does the company have good cash position and a dedicated customer base that it can weather market changes and be able to adjust pricing during periods of inflation?
- Is there market momentum, product portfolio, and management structure in place to predict and expect good future growth?

Where would Buffett collect all these pieces of information for a company to purchase? And what do all these pieces of information have to do with the topic of engineering economics?

Before making any investment decision, it is good to understand an elementary aspect of your financial situation—one that you'll also need for retirement planning, estate planning, and, more generally, to get an answer to the question, "How am I doing?" It is called your **net worth**. If you want to invest \$10,000 in BRCM stocks, how would that affect your net worth? You may need this information for your own financial planning, but it is routinely required whenever you have to borrow a large sum of money from a financial institution. For example, when you are buying a home, you need to apply for a mortgage. Invariably, the bank will ask you to submit your net-worth statement as a part of loan processing. Your net-worth statement is a snapshot of where you stand financially at a given point in time. You do that by adding your assets—such as cash, investments, and pension plans—in one column and your liabilities—or debts—in the other. Then subtract your liabilities from your assets to find your net worth. In other words, your net worth is what you would be left with if you sold everything and paid off all you owe. The bank will determine how creditworthy you are by examining your net worth. In a similar way, a corporation prepares the same kind of information for its financial planning or to report its financial health to stockholders or investors. The reporting document is known as the financial statements.

CHAPTER LEARNING OBJECTIVES

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

- The role of accounting in economic decisions.
- Four types of financial statements prepared for investors and regulators.
- How to read the balance sheet statement.
- How to use the income statement to manage a business.
- The sources and uses of cash in business operation.
- How to conduct the ratio analysis and what the numbers really mean.

2.1 Accounting: The Basis of Decision Making

We need financial information to make business decisions. Virtually all businesses and most individuals keep accounting records to aid them in making decisions. As illustrated in Figure 2.1, accounting is the information system that measures business activities, processes that information into reports, and communicates the results to decision makers. For this reason, we call accounting “the language of business.” The better you understand this language, the better you can manage your financial well-being and make financial decisions.

Personal financial planning, education expenses, loans, car payments, income taxes, and investments are all determined on the basis of the information system we call accounting. The use of accounting information is diverse and varied:

- Business managers use accounting information to set goals for their organizations, to evaluate progress toward those goals, and to take corrective actions if necessary. Decisions based on accounting information may include which building or equipment to purchase, how much merchandise inventory to keep on hand, and how much cash to borrow.
- Investors and creditors provide the money a business needs to begin operations. To decide whether to help start a new venture, potential investors evaluate what income they can expect on their investment. This means analyzing the financial statements of the business. Before making a loan, banks determine the borrower’s ability to meet scheduled payments. This evaluation includes a projection of future operations and revenue, which is based on accounting information.

An essential product of accounting is a series of financial statements that allow people to make informed decisions. For business use, these statements are the documents that report financial information about a business entity to decision makers. They tell us how a business is performing and where it stands financially. These financial statements include the balance sheet, income statement, and statement of cash flows.

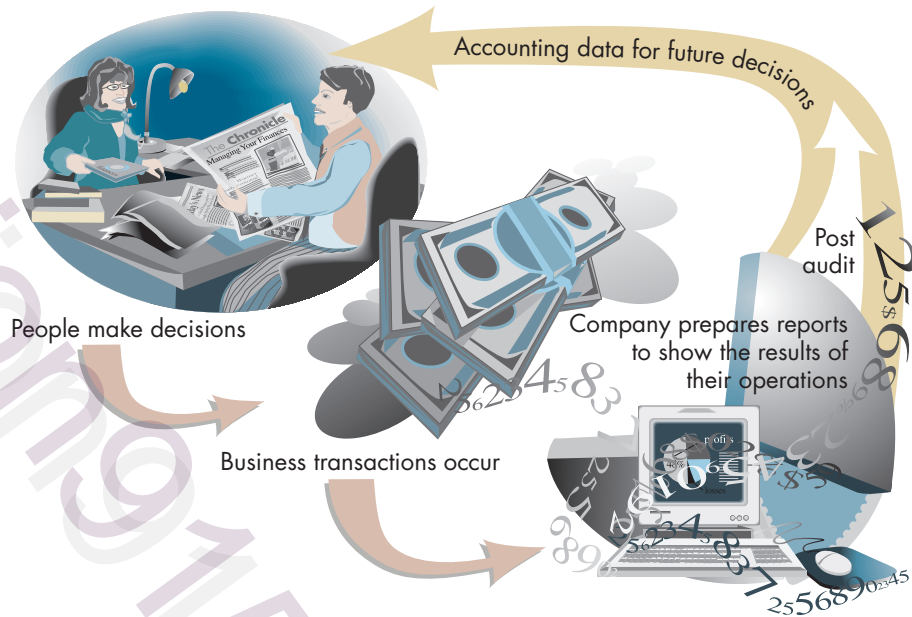


Figure 2.1 The accounting system, which illustrates the flow of information.

2.2 Financial Status for Businesses

All businesses must record and report on their financial status. Of the various reports corporations issue to their stockholders, the annual report is by far the most important. The annual report contains basic financial statements as well as management's opinion of the past year's operations and the firm's future prospects. What would managers and investors want to know about a company at the end of the fiscal year (or another fiscal period, such as a quarter)? Managers or investors are likely to ask the following four basic questions:

- What is the company's financial position at the end of the fiscal period?
- How much profit did the company make during the fiscal period?
- How did the company decide to use its profits?
- How much cash did the company generate and spend during the period?

As illustrated in Figure 2.2, the answer to each question is provided by one of the financial statements. The fiscal year (or operating cycle) can be any 12-month term but is usually January 1 through December 31 of a calendar year.

As mentioned in Section 1.1.2, one of the primary business responsibilities for engineers is to plan for the acquisition of equipment (capital expenditure) that will enable the firm to design and produce products economically. This task requires estimation of savings and costs associated with the equipment acquisition and the degree of risk associated with project execution. These amounts affect the business's bottom

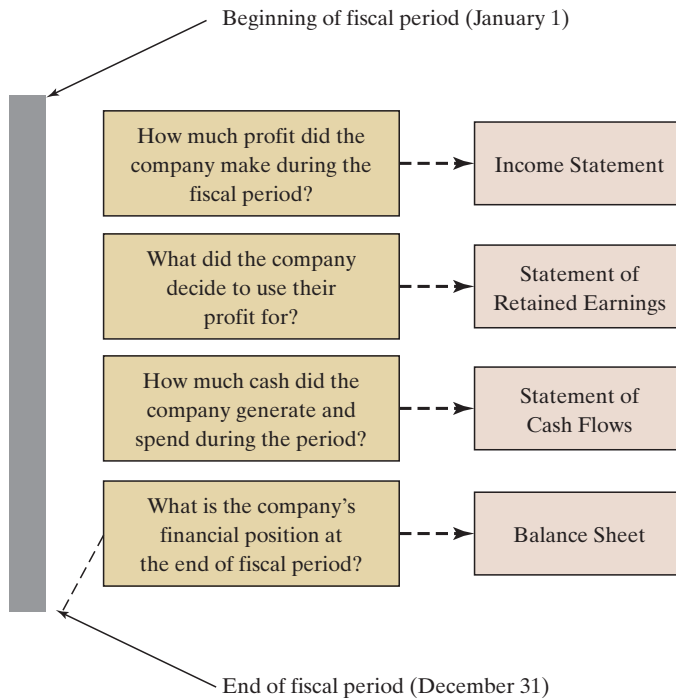


Figure 2.2 Information reported on a company's financial statements.

line (profitability), which eventually affects the firm's stock price in the marketplace as illustrated in Figure 2.3. Therefore, engineers should understand the meanings of various financial statements in order to communicate with upper management about the nature of a project's profitability.

For illustration purposes, we consider the financial statements of J&M Company, a medium-sized power equipment manufacturer whose major product lines include gas pressure washers and water pumps. Some of the key financial highlights in the 2021 annual report are as follows:

- Revenue topped \$300 million, an increase of 22.45% year-over-year.
- Closing total net cash balance reached \$2.4 million.
- Gross margins exceeded 37.33% of revenue.
- Operating margins were 11.09%.
- Net income rose to \$22.8 million, an increase of 57% year-over-year.
- Closing stock price was \$31.5 per share on December 29, 2021.

As you will see, investors use the information contained in an annual report to form expectations about future earnings and dividends. Therefore, the annual report is certainly of great interest to investors.

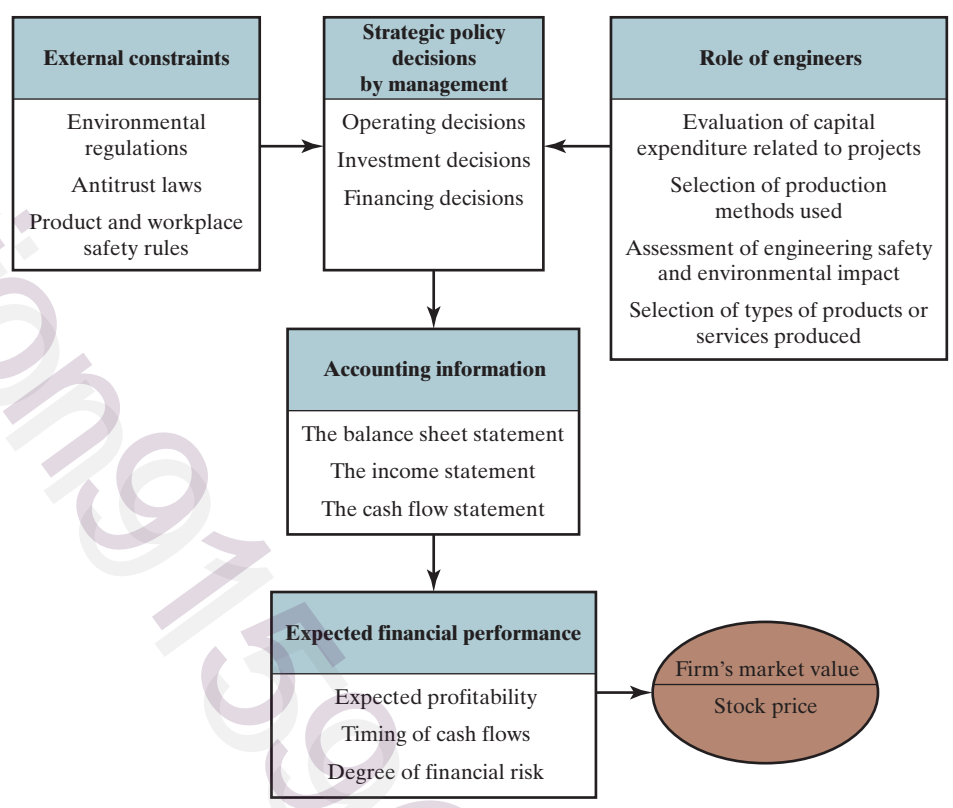


Figure 2.3 Summary of major factors affecting stock price.

2.2.1 The Balance Sheet

What is a company's financial position at the end of a reporting period? A company's **balance sheet statement** will provide the answer. A balance sheet, sometimes called a **statement of financial position**, reports three main categories of items: assets, liabilities, and stockholders' equity. Figure 2.4 illustrates the relationship between assets and liabilities, including equity, and how these items appear in the balance sheet. The financial statements are based on the most basic tool of accounting, the **accounting**

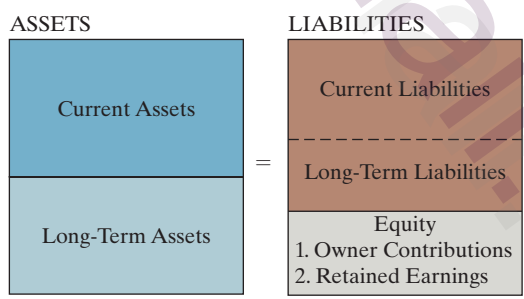


Figure 2.4 The four quadrants of the balance sheet.

equation. The accounting equation shows the relationship among assets, liabilities, and owners' equity:

$$\text{Assets} = \text{Liabilities} + \text{Stockholder's Equity.}$$

Every business transaction, no matter how simple or complex, can be expressed in terms of its effect on the accounting equation. Regardless of whether a business grows or contracts, this equality between its assets and the claims against those assets is always maintained. In other words, any change in the amount of total assets is necessarily accompanied by an equal change on the other side of the equation—that is, by an increase or decrease in either the liabilities or the owners' equity.

As shown in Table 2.1, the first half of J&M's year-end 2021 and 2020 balance sheets lists the firm's assets while the remaining portion shows the liabilities and equity, or claims against these assets.

Assets

The dollar amounts shown under the Assets column in Table 2.1 represent how much the company owns at the time of reporting. We list the asset items in the order of their "liquidity," or the length of time it takes to convert them to cash, according to the following three categories:

- **Current assets** can be converted to cash or its equivalent in less than one year. This type of asset generally includes four major accounts:
 1. The first account is *cash and cash equivalents*. A firm typically has a cash account at a bank to provide for the funds needed to conduct day-to-day business. Although we state all the assets in terms of dollars, only items labeled as cash represent actual money. Cash-equivalent items include marketable securities such as stocks and bonds.
 2. The second account includes *short-term investments* such as savings accounts, money market funds, certificates of deposit, and U.S. Treasury securities.
 3. The third account is *accounts receivable*, which is money that is owed to the firm but has not yet been received. For example, when J&M receives an order from a manufacturer, it will send an invoice along with the shipment to the manufacturer. Then the unpaid bill immediately falls into the accounts-receivable category. When this bill is paid, it is deducted from the accounts-receivable category and placed into the cash category. Normally, a typical firm will have 30- to 45-day accounts receivable, depending on the frequency of its bills and the payment terms for customers. We can treat sales on credit cards in a similar category.
 4. The fourth account is *inventories*, which show the dollars the company has invested in raw materials, work-in-process, and finished goods available for sale.
- **Fixed assets** are relatively permanent and take time to convert into cash. Fixed assets reflect the amount of money a company has paid for its plant and equipment acquired at some time in the past. The most common fixed assets include the physical investment in the business, such as land, buildings, factory machinery, office equipment, and automobiles. With the exception of land, most fixed assets have a limited useful life. For example, buildings and equipment are expended over a period of years. Each year, a portion of the usefulness of these assets expires, and a portion of their

TABLE 2.1 Consolidated Statement of Financial Position

J&M CORPORATION
CONSOLIDATED BALANCE SHEETS
 (in thousands, except per share data)

PERIOD ENDING	31-Dec-21	31-Dec-20	CHANGES
ASSETS			
Current Assets:			
Cash and Cash Equivalents	\$8,500	\$6,100	\$2,400
Short-Term Investments	\$3,000	\$5,000	\$(2,000)
Accounts Receivables	\$23,700	\$19,500	\$4,200
Inventories	\$37,700	\$39,800	\$(2,100)
Prepaid Expenses	\$2,000	\$1,500	\$500
Deferred Charges	\$2,500	\$3,000	\$(500)
Total Current Assets	\$77,400	\$74,900	\$2,500
Long-Term Assets			
Property Plant and Equipment	\$154,000	\$145,000	\$9,000
Less Accumulated Depreciation	\$(70,000)	\$(50,000)	\$(20,000)
Total Assets	\$161,400	\$169,900	\$(8,500)
LIABILITIES AND STOCKHOLDERS' EQUITY			
Current Liabilities:			
Accounts Payable	\$10,000	\$26,000	\$(16,000)
Wages Payable	\$16,000	\$15,000	\$1,000
Accrued Taxes	\$2,000	\$3,500	\$(1,500)
Total Current Liabilities	\$28,000	\$44,500	\$(16,500)
Long-Term Liabilities			
Long-Term Debt	\$30,000	\$32,000	\$(2,000)
Total Liabilities	\$58,000	\$76,500	\$(18,500)
Stockholders' Equity:			
Preferred Stock (100,000 shares at par value of \$100)	\$10,000	\$10,000	–
Common Stock (10,000,000 shares at par value of \$4)	\$40,000	\$40,000	–
Treasury Stock	–	–	–
Paid-In Capital (Capital Surplus)	\$11,000	\$11,000	–
Retained Earnings	\$42,400	\$32,400	\$10,000
Total Stockholder Equity	\$103,400	\$93,400	\$10,000
Total Liabilities and Stockholders' Equity	\$161,400	\$169,900	\$(8,500)

total cost should thus be recognized as a depreciation expense. As stated previously in this book, the term *depreciation* refers to the accounting process for this gradual conversion of fixed assets into expenses. Thus the item, *accumulated depreciation*, means that a portion of the original cost of the buildings and equipment has already been allocated as a cost of doing business. Sometimes, these two items are combined and listed as a single item, “property, plant, and equipment, net.” It simply represents the current book value of these assets after such depreciation expenses have been deducted.

- **Other assets** are listed at the end of this category. Typical assets in this category include investments made in other companies and intangible assets such as goodwill, copyrights, franchises, and so forth. Goodwill appears on the balance sheet only when an operating business is purchased in its entirety. This item indicates any additional amount paid for the business above the fair market value of the business. (Here, the fair market value is defined as the price that a buyer is willing to pay when the business is offered for sale.)

Liabilities and Stockholders’ Equity (Owners’ Net Worth)

The claims against assets are of two types: liabilities and stockholders’ equity. Liabilities refer to money the company owes. Stockholders’ equity indicates the portion of the assets of a company that is provided by the investors (owners). Therefore, stockholders’ equity is also the liability of a company to its owners. (Recall Figure 2.4, which illustrates the relationship between assets and liabilities, including equity.) The different categories of liabilities and stockholders’ equity are described as follows:

- **Current liabilities** are what a company currently owes to its suppliers and creditors. Major current liabilities include accounts and notes payable within a year as well as accrued expenses (wages, salaries, interest, rent, taxes, etc., owed but not yet due for payment) and advance payments and deposits from customers. Accrued expenses are bills that the company has incurred that it has not yet paid. In other words, accrued expenses are the opposite of prepaid expenses.
 - **Other liabilities** include *long-term liabilities* such as bonds, mortgages, and long-term notes, which are due and payable more than one year in the future. Another example is *Income Tax Payable*, which is the income tax a company accrues over the years that it does not have to pay yet according to various federal, state, and local tax schedules.
 - **Stockholders’ equity** represents the amount that is available to the stockholders (owners) after all other debts have been paid. It generally consists of preferred and common stock, treasury stock, capital surplus, and retained earnings.
1. **Preferred stock** is a hybrid between common stock and debt. Such stock promises a fixed dividend (much like a bond’s interest payment) but often limited voting rights. In the case of bankruptcy, preferred stockholders receive money after debt holders and before common stockholders are paid. Many firms do not use any preferred stock. The common stockholders’ equity, or **net worth**, is a residual and is calculated as follows:

$$\text{Assets} - \text{Liabilities} - \text{Preferred stock} = \text{Common stockholders' equity.}$$

2. **Common stock** is the aggregate par value of the company's issued stock. Companies rarely issue stocks at a discount (i.e., at an amount below the stated par). Corporations normally set the par value low enough so that, in practice, stock is usually sold at a premium.
3. **Treasury stock:** If the corporation buys back part of its own issued stock, the value of the repurchase is listed as *treasury stock* on the balance sheet. Companies buy back their shares for a variety of reasons. In most cases, it is a sign that management believes the stock is undervalued. Depending upon its objectives, a company can either retire the shares it purchases or hold them with the intention of reselling them to raise cash when the stock price rises.
4. **Paid-in capital** (capital surplus) is the amount of money received from the sale of stock over the par value. Outstanding stock is the number of shares issued that actually is held by the public.
5. **Retained earnings** represent the cumulative net income of the firm since its beginning, less the total dividends that have been paid to stockholders. In other words, retained earnings indicate the amount of assets that the company has financed by plowing profits back into the business. Therefore, these retained earnings belong to the stockholders.

What to Read from J&M's Balance Sheet

Recall that all financial data related to the annual report is shown in thousands of dollars, except share value. J&M generated revenue of \$300,000 (this number means \$300 million) for fiscal year 2021. The \$161,400 of total assets shown in Table 2.1 were necessary to support the sales of \$300,000.

- **Acquisition of Fixed Assets:** One way we can determine the amount of new fixed assets added during FY 2021 is to observe the change in the Property Plant and Equipment account, which shows a net increase in the amount of \$9,000.
- **Debt:** J&M had a total long-term debt of \$30,000 that consisted of the several bonds issued in previous years. The interest payments associated with these long-term debts were about \$5,200.
- **Equity:** J&M had 100,000 shares of preferred stock and 10,000,000 shares of common stock outstanding. Investors initially provided the company with a total capital of \$61,000 (= \$10,000 + \$40,000 + \$11,000). However, J&M has retained the current, as well as previous earnings of \$42,400, since it was incorporated. These earnings belong to J&M's common stockholders. At the end of 2021, the combined net stockholder's equity was \$103,400. (This net equity figure typically includes treasury stock if any.)
- **Share value:** Stockholders on average have a total investment of \$10.34 per share ($\$103,400,000 / 10,000,000$ shares) in the company; this investment is known as the stock's book value. In December 2021, the stock was traded in the general range of \$28 to \$32 per share. Note that this market price is quite different from the stock's book value. Many factors affect the market price—most importantly, how investors expect the company to do in the future. Certainly, the company's unique etch products have had a major influence on the market value of its stock.

2.2.2 The Income Statement

The second financial report is the **income statement**, which indicates whether the company is making or losing money during a stated *period*. Most businesses prepare quarterly and monthly income statements in addition to annual ones. For J&M's income statement, the accounting period begins on January 1, 2021 and ends on December 31, 2021. Table 2.2 gives the 2021 and 2020 income statements for J&M.

Net Income

Typical elements that are itemized in the income statement are as follows:

- The **total revenue** (or **net sales**) \$300,000 figure represents the gross sales less any sales return and allowances.
- The expenses and costs of doing business are listed on the next several lines as deductions from the revenues. The largest expense for a typical manufacturing firm is its production expense for making a product (such as labor, materials, and overhead) called the **cost of goods sold** (or **cost of revenue**).

TABLE 2.2 The Income Statement for J&M Corporation

J&M CORPORATION		
INCOME STATEMENT		
(in thousands, except per share data)		
PERIOD ENDING	31-Dec-21	31-Dec-20
Total Revenue	\$300,000	\$245,000
Cost of Goods Sold	\$188,000	\$153,000
Gross Profit (Margin)	\$112,000	\$92,000
Selling General and Administrative	\$44,720	\$38,000
Depreciation	\$20,000	\$18,000
Lease Payment	\$14,000	\$14,000
Operating Income or Loss	\$33,280	\$22,000
Interest Expense, Net	\$(2,400)	\$(2,560)
Income Before Tax	\$30,880	\$19,440
Income Tax Expense	\$8,080	\$4,920
Net Income	\$22,800	\$14,520
Cash Dividends		
Preferred Stock	\$600	\$600
Common Stock	\$12,200	\$8,200
Total Cash Dividends	\$12,800	\$8,800
Retained Earnings	\$10,000	\$5,720
Number of Shares Outstanding		
Preferred Stock	100,000	100,000
Common Stock	10,000,000	10,000,000

- Total revenue less the cost of goods sold indicates the **gross profit (margin)**.
- Next, we subtract any other **operating expenses** from operating income. These other operating expenses are items such as interest, lease, selling, research and development (R&D), and administration expenses. This operation results in the operating income period.
- If the company generated **other income** from investments or any nonoperating activities, this item will be a part of income subject to income taxes as well.
- Finally, we determine the **net income** (or net profit) by subtracting the income taxes from the taxable income. This net income is also commonly known as the *accounting income*.

Earnings per Share

Another important piece of financial information provided in the income statement is the **earnings per share** (EPS) figure. In simple situations, we compute this amount by dividing the available earnings to common stockholders by the number of shares of common stock outstanding. Stockholders and potential investors want to know what their relative share of profits is, not just the total dollar amount. Presentation of profits on a per-share basis allows stockholders to relate earnings to what they paid for a share of stock. Naturally, companies want to report a higher EPS to their investors as a means of summarizing how well they managed their businesses for the benefit of their owners.

Dividends and Retained Earnings

As a supplement to the income statement, corporations also report their retained earnings during the accounting period. When a corporation makes some profits, it has to decide what to do with these profits. The corporation may decide to pay out some of the profits as dividends to its stockholders. Alternatively, it may retain the remaining profits in the business in order to finance expansion or support other business activities.

When the corporation declares dividends, preferred stock has priority over common stock in regard to the receipt of dividends. Preferred stock pays a stated dividend much like the interest payment on bonds. The dividend is not a legal liability until the board of directors has declared it. However, many corporations view the dividend payments to preferred stockholders as a liability. Therefore, the term “available earnings for common stockholders” reflects the net earnings of the corporation less the preferred-stock dividends. When preferred- and common-stock dividends are subtracted from net income, the remainder is retained earnings (profits) for the year. As mentioned previously, these retained earnings are reinvested in the business.

What to Read from J&M’s Income Statement

(All numbers in thousands except per share data.) Net sales were \$300,000 in 2021, compared with \$245,000 in 2020, a whopping gain of 22.45%. Profits from operations (operating income) rose to \$33,280, and net income was up to a profit of \$22,800 from \$14,520 a year ago. We can infer the following:

1. **Dividends:** J&M issued 100,000 shares of preferred stock, so there is required cash dividend in the amount of \$600. In fact, J&M also declared cash dividends of \$12,200 to its common stockholders during this reporting period.