CHAPTER

3 Understanding Ethical Problems

Objectives

After reading this chapter, you will be able to

- Discuss several ethical theories
- See how these theories can be applied to engineering situations.

In late 1984, a pressure-relief valve on a tank used to store methyl isocyanate (MIC) at a Union Carbide plant in Bhopal, India, accidentally opened. MIC is a poisonous compound used in the manufacture of pesticides. When the valve opened, MIC was released from the tank, and a cloud of toxic gas formed over the area surrounding the plant. Unfortunately, this neighborhood was very densely populated. Some two thousand people were killed, and thousands more were injured as a result of the accident. Many of the injured have remained permanently disabled.

The causes of the accident are not completely clear, but there appear to have been many contributing factors. Pipes in the plant were misconnected, and essential safety systems were either broken or had been taken off-line for maintenance. The effects of the leak were intensified by the presence of so many people living in close proximity to the plant.

Among the many important issues this case brings up are questions of balancing risk to the local community with the economic benefits to the larger community of the state or nation. Undoubtedly, the presence of this chemical plant brought significant local economic benefit. However, the accident at the plant also brought disaster to the local community at an enormous cost in human lives and suffering. How can we decide if on balance the economic benefit brought by this plant outweighed the potential safety hazards?

In order to answer this question and analyze other engineering ethics cases, we need a framework for analyzing ethical problems. Codes of ethics can be used as an aid in analyzing ethical issues. In this chapter, we will examine moral theories and see how they can also be used as a means for analyzing ethical cases such as the Bhopal disaster.

3.1 INTRODUCTION

In this chapter, we will develop moral theories that can be applied to the ethical problems confronted by engineers. Unfortunately, a thorough and in-depth discussion of all possible ethical theories is beyond the scope of this text. Rather, some important theories will be developed in sufficient detail for use in analyzing cases.

Our approach to ethical problem solving will be similar to problem-solving strategies in other engineering classes. To learn how to build a bridge, you must first learn the basics of physics and then apply this knowledge to engineering statics and dynamics. Only when the basic understanding of these topics has been acquired can problems in structures be solved and bridges built. Similarly, in ethical problem solving, we will need some knowledge of ethical theory to provide a framework for understanding and reaching solutions in ethical problems. In this chapter, we will develop this theoretical framework and apply it to an engineering case. We will begin by looking at the origins of Western ethical thinking.

3.2 A BRIEF HISTORY OF ETHICAL THOUGHT

It is impossible in this text to give a complete history of ethical thinking. Numerous books, some of them quite lengthy, have already been written on this subject. However, it is instructive to give a brief outline of the origins and development of the ethical principles that will be applied to engineering practice.

The moral and ethical theories that we will be applying in engineering ethics are derived from a Western cultural tradition. In other words, these ideas originated in the Middle East and Europe. Western moral thought has not come down to us from just a single source. Rather, it is derived both from the thinking of the ancient Greeks and from ancient religious thinking and writing, starting with Judaism and its foundations.

Although it is easy to think of these two sources as separate, there was a great deal of influence on ancient religious thought by the Greek philosophers. The written sources of the Jewish moral traditions are the Torah and the Old Testament of the Bible and their enumeration of moral laws, including the Ten Commandments. Greek ethical thought originated with the famous Greek philosophers that are commonly studied in freshman philosophy classes, principally Socrates and Aristotle, who discussed ethics at great length in his *Nichomachean Ethics*. Greek philosophic ideas were melded together with early Christian and Jewish thought and were spread throughout Europe and the Middle East during the height of the Roman Empire.

Ethical ideas were continually refined during the course of history. Many great thinkers have turned their attention to ethics and morals and have tried to provide insight into these issues through their writings. For example, philosophers such as Locke, Kant, and Mill wrote about moral and ethical issues. The thinking of these philosophers is especially important for our study of engineering ethics, since they did not rely on religion to underpin their moral thinking. Rather, they acknowledged that moral principles are universal, regardless of their origin, and are applicable even in secular settings.

Many of the moral principles that we will discuss have also been codified and handed down through the law. So, in discussing engineering ethics, there is a large body of thinking—philosophical, legal, and religious—to draw from. However, even though there are religious and legal origins of many of the moral principles that we will encounter in our study of engineering ethics, it is important to acknowledge that ethical conduct is fundamentally grounded in a concern for other people. It is not just about law or religion.

3.3 ETHICAL THEORIES

In order to develop workable ethical problem-solving techniques, we must first look at several theories of ethics in order to have a framework for decision making. Ethical problem solving is not as cut and dried as problem solving in engineering classes. In most engineering classes, there is generally just one theory to consider when tackling a problem. In studying engineering ethics, there are several theories that will be considered. The relatively large number of theories doesn't indicate a weakness in theoretical understanding of ethics or a "fuzziness" of ethical thinking. Rather, it reflects the complexity of ethical problems and the diversity of approaches to ethical problem solving that have been developed over the centuries.

Having multiple theories to apply actually enriches the problem-solving process, allowing problems to be looked at from different angles, since each theory stresses different aspects of a problem. Even though we will use multiple theories to examine ethical problems, each theory applied to a problem will not necessarily lead to a different solution. Frequently, different theories yield the same solution. Our basic ethical problem-solving technique will utilize different theories and approaches to analyze the problem and then try to determine the best solution.

3.3.1 What Is a Moral Theory?

Before looking more closely at individual moral theories, we should start with a definition of what a moral theory is and how it functions. A moral theory defines terms in uniform ways and links ideas and problems together in consistent ways [Harris, Pritchard, and Rabins, 2000]. This is exactly how the scientific theories used in other engineering classes function. Scientific theories also organize ideas, define terms, and facilitate problem solving. So, we will use moral theories in exactly the same way that engineering theories are used in other classes.

There are four ethical theories that will be considered here, each differing according to what is held to be the most important moral concept. *Utilitarianism* seeks to produce the most utility, defined as a balance between good and bad consequences of an action, taking into account the consequences for everyone affected. A different approach is provided by *duty ethics*. Duty ethics contends that there are duties that should be performed (for example, the duty to treat others fairly or the duty not to injure others) regardless of whether these acts lead to the most good. *Rights ethics* emphasizes that we all have moral rights, and any action that violates these rights is ethically unacceptable. Like duty ethics, the ultimate overall good of the actions is not taken into account. Finally, *virtue ethics* regards actions as right that manifest good character traits (virtues) and regards actions as bad that display bad character traits (vices); this ethical theory focuses on the type of person we should strive to be.

3.3.2 Utilitarianism

The first of the moral theories that will be considered is utilitarianism. Utilitarianism holds that those actions are good that serve to maximize human well-being. The emphasis in utilitarianism is not on maximizing the well-being of the individual, but rather on maximizing the well-being of society as a whole, and as such it is somewhat of a collectivist approach. An example of this theory that has been played out in this country many times over the past century is the building of dams. Dams often lead to great benefit to society by providing stable supplies of drinking water, flood control, and recreational opportunities. However, these benefits often come at the expense of people who live in areas that will be flooded by the dam and are required to find new homes, or lose the use of their land. Utilitarianism tries to balance the needs of society with the needs of the individual, with an emphasis on what will provide the most benefit to the most people.

Utilitarianism is fundamental to many types of engineering analysis, including risk–benefit analysis and cost–benefit analysis, which we will discuss later. However, as good as the utilitarian principle sounds, there are some problems with it. First, as seen in the example of the building of a dam, sometimes what is best for everyone may be bad for a particular individual or a group of individuals. An example of this problem is the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico. WIPP is designed to be a permanent repository for nuclear waste generated in the United States. It consists of a system of tunnels bored into underground salt formations. These salt beds are considered by geologists to be extremely stable, especially to incursion of water which could lead to seepage of the nuclear wastes into groundwater. However, there are many who oppose this facility, principally on the grounds that transportation of the wastes across highways has the potential for accidents that might cause health problems for people living near these routes.

An analysis of WIPP using utilitarianism might indicate that the disposal of nuclear wastes is a major problem hindering the implementation of many useful technologies, including medicinal uses of radioisotopes and nuclear generation of electricity. Solution of this waste disposal problem will benefit society by providing improved health care and more plentiful electricity. The slight potential for adverse health effects for individuals living near the transportation routes is far outweighed by the overall benefits to society. So, WIPP should be allowed to open. As this example demonstrates, the utilitarian approach can seem to ignore the needs of individuals, especially if these needs seem relatively insignificant.

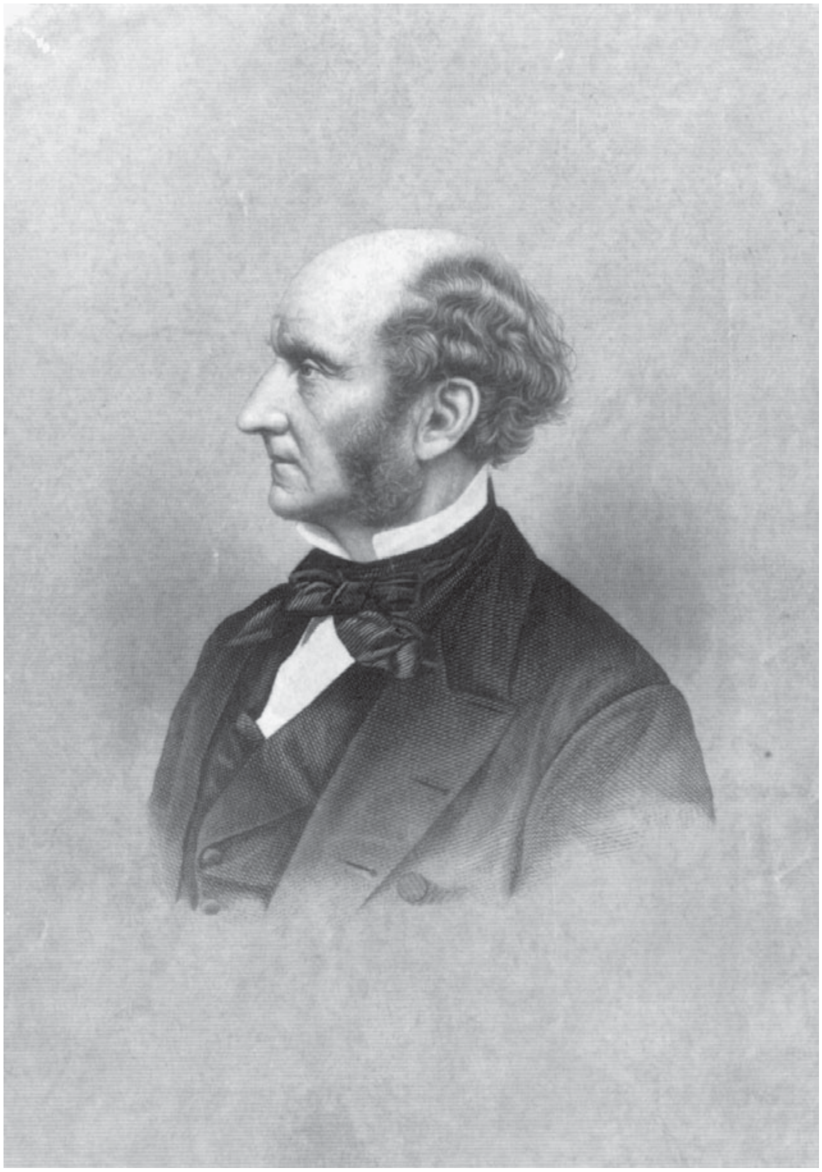
Another objection to utilitarianism is that its implementation depends greatly on knowing what will lead to the most good. Frequently, it is impossible to know exactly what the consequences of an action are. It is often impossible to do a complete set of experiments to determine all of the potential outcomes, especially when humans are involved as subjects of the experiments. So, maximizing the benefit to society involves guesswork and the risk that the best guess might be wrong. Despite these objections, utilitarianism is a valuable tool for ethical problem solving, providing one way of looking at engineering ethics cases.

Before ending our discussion of utilitarianism, it should be noted that there are many flavors of the basic tenets of utilitarianism. Two of these are act utilitarianism and rule utilitarianism. Act utilitarianism focuses on individual actions rather than on rules. The best known proponent of act utilitarianism was John Stuart Mill (1806–1873), who felt that most of the common rules of morality (e.g., don't steal, be honest, don't harm others) are good guidelines derived from centuries of human experience. However, Mill felt that individual actions should be judged based on whether the most good was produced in a given situation, and rules should be broken if doing so will lead to the most good.

Rule utilitarianism differs from act utilitarianism in holding that moral rules are most important. As mentioned previously, these rules include "do not harm others" and "do not steal." Rule utilitarians hold that although adhering to these rules might not always maximize good in a particular situation, overall, adhering to moral rules will ultimately lead to the most good. Although these two different types of utilitarianism can lead to slightly different results when applied in specific situations, in this text, we will consider these ideas together and not worry about the distinctions between the two.

3.3.3 Cost–Benefit Analysis

One tool often used in engineering analysis, especially when trying to determine whether a project makes sense, is cost–benefit analysis. Fundamentally, this type of analysis is just an application of utilitarianism. In cost–benefit analysis, the costs of a



John Stuart Mill, a leading philosopher of utilitarianism. Courtesy of the Library of Congress.

project are assessed, as are the benefits. Only those projects with the highest ratio of benefits to costs will be implemented. This principle is similar to the utilitarian goal of maximizing the overall good.

As with utilitarianism, there are pitfalls in the use of cost–benefit analysis. While it is often easy to predict the costs for most projects, the benefits that are derived from them are often harder to predict and to assign a dollar value to. Once dollar amounts for the costs and benefits are determined, calculating a mathematical ratio may seem very objective and therefore may appear to be the best way to make a decision. However, this ratio can't take into account many of the more subjective aspects of a decision. For example, from a pure cost–benefit discussion, it might seem that the building of a dam is an excellent idea. But this analysis won't include other issues such as whether the benefits outweigh the loss of a scenic wilderness area or the loss of an endangered species with no current economic value. Finally, it is also important to determine whether those who stand to reap the benefits are also those who will pay the costs. It is unfair to place all of the costs on one group while another reaps the benefits.

It should be noted that although cost–benefit analysis shares many similarities with utilitarianism, cost–benefit analysis isn't really an ethical analysis tool. The goal of an ethical analysis is to determine what the ethical path is. The goal of a cost–benefit analysis is to determine the feasibility of a project based on costs. When looking at an ethical problem, the first step should be to determine what the right course of action is and then factor in the financial costs in choosing between ethical alternatives.

3.3.4 Duty Ethics and Rights Ethics

Two other ethical theories—duty ethics and rights ethics—are similar to each other and will be considered together. These theories hold that those actions are good that respect the rights of the individual. Here, good consequences for society as a whole are not the only moral consideration.

A major proponent of duty ethics was Immanuel Kant (1724–1804), who held that moral duties are fundamental. Ethical actions are those actions that could be written down on a list of duties: be honest, don't cause suffering to other people, be fair to others, etc. These actions are our duties because they express respect for persons, express an unqualified regard for autonomous moral agents, and are universal principles [Schinzinger and Martin, 2000]. Once one's duties are recognized, the ethically correct moral actions are obvious. In this formulation, ethical acts are a result of proper performance of one's duties.

Rights ethics was largely formulated by John Locke (1632–1704), whose statement that humans have the right to life, liberty, and property was paraphrased in the Declaration of Independence of the soon-to-be United States of America in 1776. Rights ethics holds that people have fundamental rights that other people have a duty to respect.

Duty ethics and rights ethics are really just two different sides of the same coin. Both of these theories achieve the same end: Individual persons must be respected, and actions are ethical that maintain this respect for the individual. In duty ethics, people have duties, an important one of which is to protect the rights of others. And in rights ethics, people have fundamental rights that others have duties to protect.

As with utilitarianism, there are problems with the duty and rights ethics theories that must be considered. First the basic rights of one person (or group) may conflict with the basic rights of another group. How do we decide whose rights have priority? Using our previous example of the building of a dam, people have the right to use their property. If their land happens to be in the way of a proposed dam, then rights ethics would hold that this property right is paramount and is sufficient to stop the dam project. A single property holder's objection would require that the project be terminated. However, there is a need for others living in nearby communities to have a reliable water supply and to be safe from continual flooding. Whose rights are paramount here? Rights and duty ethics don't resolve this conflict very well; hence, the utilitarian approach of trying to determine the most good is more useful in this case.

The second problem with duty and rights ethics is that these theories don't always account for the overall good of society very well. Since the emphasis is on the individual, the good of a single individual can be paramount compared to what is

Immanuel Kant, a German philosopher whose work included early formulations of duty ethics. Courtesy of the Library of Congress.

good for society as a whole. The WIPP case discussed before illustrates this problem. Certainly, people who live along the route where the radioactive wastes will be transported have the right to live without fear of harm due to accidental spills of hazardous waste. But the nation as a whole will benefit from the safe disposal of these wastes. Rights ethics would come down clearly on the side of the individuals living along the route despite the overall advantage to society.

Already it is clear why we will be considering more than one ethical theory in our discussion of engineering cases. The theories already presented clearly represent different ways of looking at ethical problems and can frequently arrive at different solutions. Thus, any complete analysis of an ethical problem must incorporate multiple theories if valid conclusions are to be drawn.

3.3.5 Virtue Ethics

Another important ethical theory that we will consider is virtue ethics. Fundamentally, virtue ethics is interested in determining what kind of people we should be. Virtue is often defined as moral distinction and goodness. A virtuous person exhibits good and beneficial qualities. In virtue ethics, actions are considered right if they support good character traits (virtues) and wrong if they support bad character traits (vices) [Schinzinger and Martin, 2000]. Virtue ethics focuses on words such as responsibility, honesty, competence, and loyalty, which are virtues. Other virtues might include trustworthiness, fairness, caring, citizenship, and respect. Vices could include dishonesty, disloyalty, irresponsibility, or incompetence. As you can see, virtue ethics is closely tied to personal character. We do good things because we are virtuous people and seek to enhance these character traits in ourselves and in others.

In many ways, this theory may seem to be mostly personal ethics and not particularly applicable to engineering or professional ethics. However, personal morality cannot, or at any rate should not, be separated from professional morality. If a behavior is virtuous in the individual's personal life, the behavior is virtuous in his or her professional life as well.

How can virtue ethics be applied to business and engineering situations? This type of ethical theory is somewhat trickier to apply to the types of problems that we will consider, perhaps because virtue ethics seems less concrete and less susceptible to rigorous analysis and because it is harder to describe nonhuman entities such as a corporation or government in terms of virtue. However, we can use virtue ethics in our engineering career by answering questions such as: Is this action honest? Will this action demonstrate loyalty to my community and/or my employer? Have I acted in a responsible fashion? Often, the answer to these questions makes the proper course of action obvious. To use virtue ethics in an analysis of an ethical problem, you should first identify the virtues or vices that are applicable to the situation. Then, determine what course of action each of these suggests.

As with any ethical theory, it is important to be careful in applying virtue ethics. Problems can arise with words that on the face seem to be virtues, but can actually lead to vices. For example, the concept of "honor" has been around for centuries and is often viewed positively. One sense of the word "honor" is a code of dignity, integrity, and pride. Honor may seem like a very positive thing, especially the aspects related to integrity. But the aspects related to pride can often have negative consequences. There are numerous examples in history of wars that have been fought and atrocities committed in order to preserve the honor of an individual or a nation. Individuals have often committed crimes as a way of preserving their honor. In using virtue ethics, it is important to ensure that the traits you identify as virtues are indeed virtuous and will not lead to negative consequences.

3.3.6 Personal vs. Corporate Morality

This is an appropriate place to discuss a tricky issue in engineering ethics: Is there a distinction between the ethics practiced by an individual and the ethics practiced by a corporation? Put another way, can a corporation be a moral agent as an individual can? This is a question that is central to many discussions of business and engineering ethics. If a corporation has no moral agency, then it cannot be held accountable for its actions, although sometimes individuals within a company can be held accountable. The law is not always clear on the answer to this question and can't be relied upon to resolve the issue.

This dilemma comes most sharply into focus in a discussion of virtue ethics. Can a company truly be expected to display honesty or loyalty? These are strictly human traits and cannot be ascribed to a corporation. In the strictest definition of moral agency, a company cannot be a moral agent, and yet companies have many dealings with individuals or groups of people.

How, then, do we resolve this problem? In their capacity to deal with individuals, corporations should be considered pseudo-moral agents and should be held accountable in the same way that individuals are, even if the ability to do this within the legal system is limited. In other words, with regard to an ethical problem, responsibility for corporate wrongdoing shouldn't be hidden behind a corporate mask. Just because it isn't really a moral agent like a person doesn't mean that a corporation can do whatever it pleases. Instead, in its interactions with individuals or communities, a corporation must respect the rights of individuals and should exhibit the same virtues that we expect of individuals.

Some insight into how the legal system views the moral status of corporations came in the Supreme Court decision in *Citizens United v. Federal Election Commission*, handed down in 2010. This case was in response to a federal law that limited the ability of corporations to contribute money to the campaigns of political candidates. The Supreme Court held that corporations have a free-speech right to contribute to political campaigns just like individual citizens do, and that this right was being infringed upon by the federal law. Basically, the court said that corporations are like individuals and have some of the same rights.

3.3.7 Which Theory to Use?

Now that we have discussed four different ethical theories, the question arises: How do we decide which theory is applicable to a given problem? The good news is that in solving ethical problems, we don't have to choose from among these theories. Rather, we can use all of them to analyze a problem from different angles and see what result each of the theories gives us. This allows us to examine a problem from different perspectives to see what conclusion each one reaches. Frequently, the result will be the same even though the theories are very different.

Take, for example, a chemical plant near a small city that discharges a hazardous waste into the groundwater. If the city takes its water from wells, the water supply for the city will be compromised and significant health problems for the community may result. Rights ethics indicates that this pollution is unethical, since it causes harm to many of the residents. A utilitarian analysis would probably also come to the same conclusion, since the economic benefits of the plant would almost certainly be outweighed by the negative effects of the pollution and the costs required to ensure a safe municipal water supply. Virtue ethics would say that discharging wastes into groundwater is irresponsible and harmful to individuals and so shouldn't be done. In this case, all of the ethical theories lead to the same conclusion.

What happens when the different theories seem to give different answers? This scenario can be illustrated by the discussion of WIPP presented previously. Rights ethics indicated that transporting wastes through communities is not a good idea, whereas utilitarianism concluded that WIPP would be beneficial to society as a whole. This is a trickier situation, and the answers given by each of the theories must be examined in detail, compared with each other, and carefully weighed. Generally, rights and duty ethics should take precedence over utilitarian considerations. This is because the rights of individuals should receive relatively stronger weight than the needs of society as a whole. For example, an action that led to the death of even one person is generally viewed very negatively, regardless of the overall benefit to society. After thorough analysis using all of the theories, a balanced judgment can be formed.

3.4 NON-WESTERN ETHICAL THINKING

It is tempting to think that the ethical theories that have been described here are applicable only in business relations within cultures that share our Western ethical traditions: Europe and the Americas. Since the rest of the world has different foundations for its ethical systems, it might seem that what we learn here won't be applicable in our business dealings in, for example, Japan, India, Africa, or Saudi Arabia. However, this thinking is incorrect. Ethics is not geographic or cultural. Indeed, ethical thinking and standards have developed similarly around the world and is not dependent on a Western cultural or religious tradition. Since the engineering workforce in the United States is international, and since engineering itself is a global profession with engineers from differing cultural backgrounds working together all over the world, it is important that we understand the origins of ethical thinking from places outside the Western world.

A detailed understanding of ethical thinking from cultures around the world is well beyond the scope (or page limit!) of a book such as this. So we will look at the ethical thinking in a few representative cultural/religious traditions—Chinese, Indian, Islamic, and Buddhist—and will attempt to see how these ethical principles influence the ethics of engineering practice in these cultures. In trying to do this in a few paragraphs, we will of necessity oversimplify ethical traditions that have developed over centuries, and which are not monolithic, but rather have evolved rich and varied interpretations and meanings over the centuries as they have matured, and expanded into new cultural groups. Despite the diversity of origins of ethical philosophy, we will see that the ethical concepts governing engineering practice are similar regardless of where engineers practice.

For example, ethical principles in Arab countries are grounded in the traditions of their religion, Islam. Islam is one of the three major monotheistic religions, along with Christianity and Judaism. It is surprising to many Westerners that Islam, which developed in the Middle East just as Judaism and Christianity did, shares many prophets and religious concepts with the other two monotheistic religions. The foundations of ethical principles relating to engineering and business in Islamic countries are thus very similar to those in Western countries. Although cultural practices may vary when dealing with the many Islamic nations that stretch from Africa and the Middle East to Southeast Asia, the same ethical principles that apply in Western countries are applicable.

Similarly, ethical principles of Hindus, Buddhists, and practitioners of all the world's major religions are similar. Although the ethical principles in other cultures may be derived in different ways, the results are generally the same regardless of culture.

Personal ethics are not determined by geography. Personal and business behavior should be the same regardless of where you happen to be on a given day. For example, few would find the expression "When in Rome, do as the Romans do" applicable to personal morality. If you believe that being deceptive is wrong, certainly it is no less wrong when you are dealing with a (hypothetical) culture where this behavior is not considered to be bad. Thus, the ethics that we discuss in this book will be applicable regardless of where you are doing business.

3.4.1 Chinese Ethical Traditions

Chinese ethical philosophy originates with the writings of Kongzi, more commonly known in the West by his Latinized name, Confucius, who lived from 551 to 479 BCE in what is now the southern portion of Shandong province in China. Confucius' written works reflect a practical rather than a theoretical approach to moral problems, unlike Western philosophy after Plato that emphasizes more theoretical thinking. This way of thinking is often called "pre-theoretical." Confucian ethics emphasizes the role of ideal character traits. As such, it has much in common with the Western concept of virtue ethics.

Confucian ethics emphasizes the importance of balancing individual rights with the needs of the larger community, often expressed through a sense of mutual respect. In trying to balance individual and group rights, Confucianism emphasizes the fact that this is not an either/or proposition: either individual rights are paramount or the rights of society as a whole are paramount. Rather Confucianism emphasizes the interdependence of the group and the individual. In other words, the individual depends on the group and so must take group concerns into account, but also the group must recognize its dependence on individuals and must respect individual rights. In acknowledging this interdependence, Confucianism mirrors the tension inherent in trying to balance the Western concepts of utilitarianism and rights or duty ethics [Wong, 2008].

How might Confucian ethics inform our decision making as engineers? First, its emphasis on virtues and the importance of leading a virtuous life speaks very directly to the engineering profession especially in terms of integrity, honesty, and other core values of engineers. It also speaks toward ensuring that we do not harm others by our actions. In its sense of the interdependence of individual and group rights, Confucianism speaks to the need for engineers to balance respect for individuals with the needs of society in making design decisions.

3.4.2 Indian Ethics

The philosophical traditions of the Indian subcontinent are the oldest surviving written philosophical systems in human civilization. Discussing Indian philosophy and Indian ethics are made very difficult by the diversity and richness of the various cultures that make up the modern nation of India, each with its own literature and philosophical background. Indian philosophical and ethical thinking have their origins in the ancient texts known as the Vedas, further developed through the Upanishads, Jainism, Buddhism, and also expressed in the Bhagavad-Gita. These ancient traditions continue to inform current philosophical thinking in India, though more contemporary thinkers such as Tagore, Gandhi, and Nehru have adapted these traditions to the modern world [Sharma and Daugert, 1965].

Indian philosophy and ethics, like many other non-Western philosophies, focuses less on the theoretical and intellectual aspects of philosophy, and more on the practical and the spiritual. "Indian ethics, instead of analyzing the nature of good, lays down practical means of attaining a life of perfection..." [Sharma and

Daugert, 1965]. This practical orientation speaks directly to our interest in ethics; nothing could be more practical than the ethical concerns about human social behavior. In a very general way, like Chinese ethics, Indian ethical philosophy has much in common with virtue ethics discussed in Western ethical traditions. For example, "the Bhagavad-Gita mentions the virtues of non-violence, truth, freedom from anger, renunciation, tranquility, aversion to fault-finding, compassion to living beings, freedom from greed, gentleness, modesty, steadfastness, forgiveness, purity, freedom from malice; and excessive pride, anger, harshness, and ignorance" [Sharma and Daugert, 1965]. These virtues are similar to those discussed by Western philosophers, and in the same way can be thought of as leading to good or bad character traits.

How do Indian philosophical and ethical traditions speak to modern engineering practice? The emphasis on the practical everyday nature of philosophy directly speaks to modern engineers and engineering practice. In addition, the emphasis on reinforcing virtues and avoiding vices directly mirrors the language used in modern engineering codes of ethics. Indeed, codes of ethics of engineering professional societies in India are basically the same as those in Western countries. Of course, this is partly due to the international nature of the engineering profession, but certainly also reflects ancient Indian ethical thinking applied to the modern world. An example of a code of ethics from an Indian engineering society is shown in Appendix I.

3.4.3 Muslim Ethics

The early Muslim philosophers who formulated the foundations of Muslim ethical thinking were influenced by the early Greek philosophers, such as Aristotle, whose works had been translated into Arabic and were available throughout what is now known as the Middle East. So Muslim ethics can be considered a cousin to many Western ethical traditions.

Broadly speaking, Muslim ethics have much in common with what Western philosophers refer to as virtue ethics. For Muslim philosophers, ethics is derived from principles set forth in the Qur'an. Specific virtues mentioned in the Qur'an are humility, honesty, giving to the poor, kindness, and trustworthiness. Very clearly honesty and trustworthiness are important virtues for those practicing a profession such as engineering, and indeed are articulated in the codes of ethics of the engineering societies in the United States. It's also not much of a stretch to see how humility and kindness can be applied to professional practice. The Qur'an also mentions vices such as boasting, blasphemy, and slander [Donaldson, 1963]. While blasphemy is only applicable in a religious context, the other two vices do speak to engineering professional practice. For example, the engineering codes of ethics discuss making accurate and realistic claims based on available data and prohibit engineers from making false claims about other engineers.

Thus, it seems that although some of the roots of ethical thinking common in the Islamic world are different from those in the Western world, the way Islamic ethics impacts engineering professional practice is the same as that of Western ethics. Indeed, the codes of ethics of professional engineering societies in the Middle East are similar and frequently overlap those from the United States, as can be seen in Appendix A.

3.4.4 Buddhist Ethics

Buddhism had its origins between the 6th and 4th centuries BCE in India and is based on the teachings of Siddhartha Guatama also known as Buddha. Buddhist teachings come down to us through various ancient religious and philosophical writings in Sanskrit, and through subsequent interpretations and thought regarding these ancient works. Buddhism was very influential outside of India and is the dominant religious tradition in nations of the Far East such as Japan, China, Tibet, Korea, Vietnam, and Cambodia. In India, Buddhism is less widely practiced today than are other religious traditions such as Hinduism.

Like other formulations of ethical thinking in non-Western societies, Buddhist ethics can appear to be similar to the Western concept of virtue ethics. Buddhist's speak of five major vices: destruction of life, taking what is not given, licentiousness, lying, and taking intoxicants. Buddhism also speaks of virtues such as friendship, spiritual development, learning, mastery of skills, filial piety, generosity, diligence, patience, and a sense of proportion or limits [ref to Dharmasiri book]. Buddhist teachings also emphasize the basic equality of mankind, and the interdependence of people on each other as well as our dependence on nature. Clearly, these virtues and vices have much in common with the virtue ethics systems developed by Western thinkers [Dharmasiri, 1989].

Equally clear is how many of these virtues and vices speak to our roles in the engineering profession. For example, the desire to avoid destruction of life tells us that the safety of those who will use products and structures based on our engineering work is important and closely parallels the statements in codes of ethics that tell us to keep paramount the health and safety of the public. Likewise, the Buddhist teachings against the vices of theft and lying have parallels in the codes of ethics relating to honesty and integrity. We should also examine the role that the Buddhist virtues of learning, mastery of skills, and diligence have in relation to engineering practice. The engineering codes of ethics often discuss the importance of continuous development of an engineer's skills, and supporting others in developing their skills. It is interesting to note that many of those involved in the origins of the environmental movement beginning in the 1970s based their ideas on the Buddhist principals of the sense of limits and human's basic interdependence with nature. Thus, the ideas regarding protecting the environment and sustainable development that appear in the most recent versions of the codes of ethics of professional engineering societies are similar to ideas found in Buddhist teachings. As with other non-Western professional engineering societies, those based in predominantly Buddhist countries are very similar to those of Western countries as can be seen in the codes of ethics reproduced in Appendix A.

3.4.5 Engineering Codes of Ethics in non-Western Countries

Although ethical thinking throughout the world has originated in various ways and has diverse language and terminology, the results are similar across cultures. How then are the ethical principles of differing cultures expressed when applied to professional ethics in general, and codes of ethics specifically? It seems that the concept of a formal code of ethics is a Western creation designed to serve the needs of professional communities. However, engineers around the world have recognized the value of codes of ethics in expressing shared values and ideas on engineering practice. Indeed, many of the codes of ethics for engineering professional practice borrow heavily and sometimes even use the exact wording of the codes of ethics of the U.S. engineering societies. In addition, some of the engineering societies, such as the IEEE, already have an international reach and their code of ethics is widely recognized and adhered to by electrical engineers worldwide.

APPLICATION

CASES

The Disaster at Bhopal

On the night of December 2, 1984, a leak developed in a storage tank at a Union Carbide chemical plant in Bhopal, India. The tank contained 10,000 gallons of MIC, a highly toxic chemical used in the manufacture of pesticides, such as Sevin. The leak sent a toxic cloud of gas over the surrounding slums of Bhopal, resulting in the death of over 2,000 people, and injuries to over 200,000 more.

The leak was attributed to the accidental pouring of water into the tank. Water reacts very vigorously with MIC, causing heating of the liquid. In Bhopal, the mixing of water with MIC increased the temperature of the liquid in the tank to an estimated 400°F. The high temperature caused the MIC to vaporize, leading to a build-up of high pressure within the tank. When the internal pressure became high enough, a pressure-relief valve popped open, leaking MIC vapors into the air.

The water had probably been introduced into the tank accidentally. A utility station on the site contained two pipes side by side. One pipe carried nitrogen, which was used to pressurize the tank to allow the liquid MIC to be removed. The other pipe contained water. It appears that instead of connecting the nitrogen pipe, someone accidentally connected the water pipe to the MIC tank. The accident was precipitated when an estimated 240 gallons of water were injected into the MIC storage tank.

As with many of the disasters and accidents that we study in this book, there was not just one event that led to the disaster, but rather there were several factors that contributed to this accident. Any one of these factors alone probably wouldn't have led to the accident, but the combination of these factors made the accident almost inevitable and the consequences worse. A major factor in this accident was the curtailment of plant maintenance as part of a cost-cutting effort. The MIC storage tank had a refrigeration unit on it, which should have helped to keep the tank temperatures closer to normal, even with the water added, and might have prevented the vaporization of the liquid. However, this refrigeration unit had stopped working five months before the accident and hadn't yet been repaired.

The tank also was equipped with an alarm that should have alerted plant workers to the dangerous temperatures; this alarm was improperly set, so no warning was given. The plant was equipped with a flare tower. This is a device designed to burn vapors before they enter the atmosphere, and it would have been able to at least reduce, if not eliminate, the amount of MIC reaching the surrounding neighborhood. The flare tower was not functioning at the time of the accident. Finally, a scrubber that was used to neutralize toxic vapors was not activated until the vapor release was already in progress. Some investigators pointed out that the scrubber and flare systems were probably inadequate, even had they been functioning. However, had any of these systems been functioning at the time of the accident, the disaster could have at least been mitigated, if not completely averted. The fact that none of them were operating at the time ensured that once the water had been mistakenly added to the MIC tank, the ensuing reaction would proceed undetected until it was too late to prevent the accident.

It is unclear on whom the ultimate blame for this accident should be laid. The plant designers clearly did their job by anticipating problems that would occur and installing safety systems to prevent or mitigate potential accidents. The management of the plant seems obviously negligent. It is sometimes necessary for some safety features to be taken off-line for repair or maintenance. But to have all of the safety systems inoperative simultaneously is inexcusable. Union Carbide also seems negligent in not preparing a plan for notifying and evacuating the surrounding population in the event of an accident. Such plans are standard in the United States and are often required by local ordinance.

Union Carbide was unable to say that such an accident was unforeseeable. Leaky valves in the MIC system had been a problem at the Bhopal plant on at least six occasions before the accident. One of these gas leaks involved a fatality. Moreover, Union Carbide had a plant in Institute, West Virginia, that also produced MIC. The experience in West Virginia was similar to that in Bhopal before the accident. There had been a total of 28 leaks of MIC over the previous five years, none leading to any serious problems. An internal Union Carbide memo from three months before the Bhopal accident warned of the potential for a runaway reaction in MIC storage tanks in West Virginia and called into question the adequacy of emergency plans at the plants. The memo concluded that "a real potential for a serious incident exists" [*US News and World Report*, Feb. 4, 1985, p. 12]. Apparently, these warnings had not been transmitted to the plant in India.

Ultimately, some share of the blame must be borne by the Indian government. Unlike in most Western nations, there was very little in the way of safety standards under which U.S. corporations must operate. In fact, third-world countries have often viewed pollution control and safety regulation as too expensive, and attempts by the industrialized nations to enforce Western-style safety and environmental regulations worldwide are regarded as attempts to keep the economies of developing countries backward [*Atlantic Monthly*, March 1987, p. 30]. In addition, the local government had no policy or zoning forbidding squatters and others from living so close to a plant where hazardous compounds are stored and used. The bulk of the blame goes to Union Carbide for failure to adequately train and supervise its Indian employees in the maintenance and safety procedures that are taken for granted in similar plants in the United States.

In the aftermath of the accident, lawsuits totaling over $250 billion were filed on behalf of the victims of the accident. Union Carbide committed itself to ensuring that the victims of the accident were compensated in a timely fashion. Union Carbide also helped set up job training and relocation programs for the victims of the accident. Ultimately, it has been estimated that approximately 10,000 of those injured in the accident will suffer some form of permanent damage [*Atlantic Monthly*, March 1987, p. 30].

The Aberdeen Three

The Aberdeen Three is one of the classic cases often used in engineering ethics classes and texts to illustrate the importance of environmental protection and the safety of workers exposed to hazardous and toxic chemicals. The Aberdeen Proving Ground is a U.S. Army weapons development and test center located on a military base in Maryland with no access by civilian nonemployees. Since World War II, Aberdeen has been used to develop and test chemical weapons. Aberdeen has also been used for the storage and disposal of some of these chemicals.

This case involves three civilian managers at the Pilot Plant at the Proving Grounds: Carl Gepp, manager of the Pilot Plant; William Dee, who headed the chemical weapons development team; and Robert Lentz, who was in charge of developing manufacturing processes for the chemical weapons [Weisskopf, 1989]. Between 1983 and 1986, inspections at the Pilot Plant indicated that there were serious safety hazards. These hazards included carcinogenic and flammable substances left in open containers, chemicals that can become lethal when mixed together being stored in the same room, barrels of toxic chemicals that were leaking, and unlabeled containers of chemicals. There was also an external tank used to store sulfuric acid that had leaked 200 gallons of acid into a local river. This incident triggered state and federal safety investigations that revealed inadequate chemical retaining dikes and a system for containing and treating chemical hazards that was corroded and leaking.

In June of 1988, the three engineer/managers were indicted for violation of RCRA, the Resource Conservation and Recovery Act. RCRA had been passed by Congress in 1976 and was intended to provide incentives for the recovery of important resources from wastes, the conservation of resources, and the control of the disposal of hazardous wastes. RCRA banned the dumping of solid hazardous wastes and included criminal penalties for violations of hazardous-waste disposal guidelines. The three managers claimed that they were not aware that the plant's storage practices were illegal and that they did things according to accepted practices at the Pilot Plant. Interestingly, since this was a criminal prosecution, the Army could not help defray the costs of the manager's defense, and each of them incurred great costs defending themselves.

In 1989, the three engineer/managers were tried and convicted of illegally storing, treating, and disposing of hazardous wastes. There was no indication that these three were the ones who actually handled chemicals in an unsafe manner, but as managers of the plant, the three were ultimately responsible for how the chemicals were stored and for the maintenance of the safety equipment. The potential penalty for these crimes was up to 15 years in prison and a fine of up to $750,000. Gepp, Dee, and Lentz were each found guilty and sentenced to three years' probation and 1,000 hours of community service. The relative leniency of the sentences was based partly on the large court costs each had already incurred.

PROFESSIONAL SUCCESS

TEAMWORK

Ethical issues can arise when working on projects in groups or teams. Many of your engineering classes are designed so that labs or projects are performed in groups. Successful performance in a group setting is a skill that is best learned early in your academic career since most projects in industry involve working as part of a team.

In order for a project to be completed successfully, cooperation among team members is essential. Problems can arise when a team member doesn't do a good job on his part of the project, doesn't make a contribution at all, or doesn't complete his assignments on time. There can also be a problem when one team member tries to do everything. This shuts out teammates who want to contribute and learn. An analogy can be made here to team sports: clearly one individual on the team who is not performing his role can lead to a loss for the entire team. Equally true, individuals who try to do it all—"ballhogs"—can harm the team. Ethical teamwork includes performing the part of the work that you are assigned, keeping to schedules, sharing information with other team members, and helping to foster a cooperative and supportive team atmosphere so everyone can contribute.

KEY TERMS

Cost–benefit analysis
Duty ethics
Rights ethics
Utilitarianism
Virtue ethics

REFERENCES

CHARLES E. HARRIS, JR., MICHAEL S. PRITCHARD, AND MICHAEL J. RABINS, *Engineering Ethics: Concepts and Cases*, Wadsworth Publishing Company, Belmont, CA, 2000.

ROLAND SCHINZINGER AND MIKE W. MARTIN, *Introduction to Engineering Ethics*, McGraw-Hill, New York, 2000.

Non-Western Ethical Traditions

WONG, DAVID, "Chinese Ethics," *The Stanford Encyclopedia of Philosophy (Fall 2008 Edition)*, Edward N. Zalta (ed.); available at: http://plato.stanford.edu/archives/fall2008/entries/ethics-chinese/.

GUNAPALA DHARMASIRI, *Fundamentals of Buddhist Ethics,* Golden Leaves, Antioch, CA, 1989.

DWIGHT DONALDSON, *Studies in Muslim Ethics,* S.P.C.K., London, 1963.

I.C. SHARMA AND STANLEY DAUGERT, *Ethical Philosophies of India,* George Allen & Unwin Ltd., London, 1965.

Bhopal

PHILIP ELMER-DEWITT, "What Happened at Bhopal?" *Time,* April 1, 1985, p. 71.

"Bhopal Disaster—New Clues Emerge," *US News and World Report,* February 4, 1985, p. 12.

PETER STOLER, "Frightening Findings at Bhopal," *Time,* February 18, 1985, p. 78.

FERGUS M. BORDEWICH, "The Lessons of Bhopal," *Atlantic Monthly,* March 1987, p. 30.

Aberdeen Three

STEVEN WEISSKOPF, "The Aberdeen Mess," *The Washington Post,* January 15, 1989, p. 55.

PROBLEMS

3.1 Find information on the space shuttle *Challenger* accident in 1986 and analyze it, using the ethical theories developed in this chapter. What does utilitarianism tell us about this case? In your analysis, be sure to include issues regarding benefits to the United States and mankind that might result from the space shuttle program. You might also include benefits to Morton Thiokol and the communities where it operates if the program is successful.

3.2 What do duty and rights ethics tell us about the *Challenger* case? How do your answers to this question and to the previous question influence your ideas on whether the *Challenger* should have been launched?

3.3 Use contemporary newspaper accounts to find information on problems with Intel's Pentium computer chip (1995) and with runway concrete at the Denver

International Airport (1994). Analyze these cases, using virtue ethics. Start by deciding what virtues are important for people in these businesses (e.g., honesty, fairness, etc.). Then see if these virtues were exhibited by the engineers working for these companies.

NON-WESTERN ETHICAL TRADITIONS

3.4 Develop a list of values that you think are important to being a successful engineer. This list will probably include things such as engineering knowledge and technical skills that are not ethical in nature. For the values that are ethical, think about where these values come from and how you came to hold them.

3.5 Discuss with a fellow student or faculty member who grew up in a different culture what their ethical values are and how those values are transmitted and discussed in their country. Develop a list of values that are common between your culture and their culture.

BHOPAL

3.6 Use the ethical theories discussed in this chapter to analyze the Bhopal case. Topics to be considered should include the placing of a hazardous plant in a populated area, decisions to defer maintenance on essential safety systems, etc. Important theories to consider when doing your analysis are rights and duty ethics and utilitarianism.

3.7 Find a copy of the code of ethics of the American Institute of Chemical Engineers and use it to analyze what a process engineer working at this plant should have done. What does the code say about the responsibilities of the engineers who designed the plant and the engineers responsible for making maintenance decisions?

3.8 What responsibility does Union Carbide have for the actions of its subsidiaries? Union Carbide India was 50.9% owned by the parent company.

3.9 What duty did Union Carbide have to inform local officials in India of the potential dangers of manufacturing and storing MIC in India?

3.10 Some of Union Carbide's reports hinted strongly that part of the fault lay with the inadequate workforce available in a third-world country such as India. How valid is this statement? What are the ethical implications for Union Carbide if this statement is true?

3.11 What responsibility should the national and local government in Bhopal have for ensuring that the plant is operated safely?

3.12 What relative importance should be placed on keeping safety systems operating as compared to maintaining other operations? (Note: From the reports on this accident, there is no indication that Union Carbide skimped on safety to keep production going. Rather, this is a hypothetical question.)

3.13 In the absence of environmental or safety laws in the locality where it operates, what responsibility does a U.S. corporation have when operating overseas? Does the answer change if the locality does have laws, but they are less strict than ours? What about the ethics of a U.S. corporation selling products overseas that are banned in the United States, such as DDT?

THE ABERDEEN THREE

3.14 What does utilitarianism tell us about the behavior of the Aberdeen Three? What do duty and rights ethics tell us? In analyzing this, start by determining