

PART I

THE SCOPE OF ENGINEERING ETHICS

Whether or not it draws on new scientific research, technology is a branch of moral philosophy, not of science. It aims at prudent goods for the commonweal and to provide efficient means for these goods. . . . As a moral philosopher, a technician should be able to criticize the programs given him [or her] to implement.

Paul Goodman

Philosophy, though unable to tell us with certainty what is the true answer to the doubts which it raises, is able to suggest many possibilities which enlarge our thoughts and free them from the tyranny of custom.

Bertrand Russell

Morality . . . provides one possibility of settling conflict, a way of encompassing conflict which allows the continuance of personal relationships against the hard and apparently inevitable fact of misunderstanding, mutually incompatible wishes, commitments, loyalties, interests and needs. . . . We do not have to agree with one another in order to live in the same moral world, but we do have to know and respect one another's differences.

Stanley Cavell

INTRODUCTION

Engineers create products and processes to satisfy basic needs for food and shelter—and in addition enhance the convenience, power, and beauty of our everyday lives. They even make possible spectacular human triumphs once only dreamed of in myth and science fiction. A century ago in *From the Earth to the Moon*, Jules Verne imagined American space travelers being launched from Florida, circling the moon, and returning to splash down in the Pacific Ocean. In December of 1968, three astronauts aboard an Apollo spacecraft did exactly that. Seven months later, on July 20, 1969, Neil Armstrong took the first human steps on the moon. This extraordinary event was shared with millions of earthbound people who watched the live broadcast on television. Engineering had transformed our sense of connection with the cosmos and even fostered dreams of routine space travel for ordinary citizens.

Those dreams were widely shared on the morning of January 28, 1986, when schoolteacher Christa McAuliffe joined 6 astronauts for a voyage aboard space shuttle *Challenger*. But two small events that took place during the launch doomed *Challenger* and its crew. A few milliseconds after ignition, a simple seal joining two segments of a booster rocket failed to contain hot gases from the burning fuel. Soon after, vibration from the launch jarred a backup seal from its proper position, allowing flames to spew out near the enormous fuel tank. Less than a minute and a half into its flight, *Challenger* burst in a fiery explosion watched by horrified children who were following the telecast in classrooms and auditoriums.

Public shock and grief over the tragedy were quickly compounded by anger. It was learned that the night before the launch fourteen engineers at

Morton Thiokol, the manufacturer of the booster rocket, had unanimously and vigorously voiced opposition to the launch. They warned that temperatures at the launch site were well below the tested safety range. Low temperature could lessen the pliability of the rubber seals, causing them to fail. Moreover, the engineers were well aware of a history of concern over the gaskets, which had shown alarming erosion in previous launches. They were already redesigning the seals between segments of the booster rockets. Yet on the eve of the launch, their concerns were overridden by top managers at Thiokol who together with executives at NASA failed to convey the engineers' concerns to the NASA administrators responsible for making the decision to launch.

Later we will enter into the details about *Challenger*. We will also explore other tragedies in which it should have been known in advance that safety was being compromised beyond the level of acceptable risk: the accidents at the nuclear plants at Chernobyl and Three Mile Island and the chemical plant at Bhopal, the chemical dumping at Love Canal, exploding Pinto gas tanks, deadly all-terrain vehicles, and indiscriminate uses of asbestos in manufacturing and construction, to name just a few examples. But it is already clear that the work of engineers has moral dimensions which should be of interest to us all. These implications should also be the highest priority for engineers and other professionals involved in technology.

It is equally clear, however, that the moral aspects of engineering are complex. Most engineering takes place within profit-making corporations which in turn are embedded in an intricate structure of society and government regulation. This will have to be taken into account in understanding what can and cannot be morally required of engineers.

Hence we should not expect a quick and simple answer to the question of who was responsible for the *Challenger* disaster or to the question of how similar events can be prevented. Before we rush to blame the fourteen engineers for not trying to prevent the disaster by blowing the whistle, we need to appreciate our own possible failure as citizens to see to it that whistle-blowing engineers are not routinely fired and persecuted by their employers. We need to ask how corporations can be better structured to allow responsible engineers to act on their moral convictions and professional judgments. And we need an enriched understanding of what engineers can and cannot do to improve their own working conditions. We need, in short, to engage in the study of engineering ethics.

WHAT IS ENGINEERING ETHICS?

Engineering ethics is (1) the study of the moral issues and decisions confronting individuals and organizations involved in engineering and (2) the study of related questions about moral conduct, character, ideals, and relationships of people and organizations involved in technological development. Perhaps it is inevitable that moral

problems, especially the perplexing moral dilemmas, will preoccupy us. After all, it is usually the response to specific problems that prods us to make the world better. Yet we should bear in mind that character, general ideals, and moral relationships are equally important foci in approaching engineering ethics.

While the emphasis of this book will be upon engineers, the ethics of engineering is wider in scope than the ethics of engineers. It applies also to the decisions made by others engaged in the technological enterprise, including scientists, managers, production workers and their supervisors, technicians, technical writers, government officials, lawyers, and the general public.

Historical Note

Ethical concern among engineers began as early as the profession of engineering. In the late nineteenth century, newly emerging professional societies for engineers formally expressed this concern by writing codes of ethics. Nevertheless, engineering ethics has traditionally been too narrowly conceived. Too often it has been regarded as encompassing little more than the drafting and promulgating by professional societies of official prescriptions in the forms of codes, guidelines, and opinions. These activities are vitally important. But they are only one aspect of engineering ethics, not its full substance.

As a discipline or area of extensive inquiry, engineering ethics is still young, certainly younger than medical ethics and legal ethics. Only since the late 1970s has systematic attention been devoted to it by engineers and members of several other scholarly disciplines. Earlier books by Harding and Canfield (1936), Mantell (1964), and Alger et al. (1965), as well as journals such as the *Professional Engineer*, covered the traditional aspects of engineering ethics very well, but they did not examine its wider implications. In the middle years of the 1970s changes could be noticed in several engineering periodicals, such as *Issues in Engineering*, published by the American Society of Civil Engineers, and the *Newsletter of the Committee on Social Implications of Technology* (now *Technology and Society Magazine*), published by the Institute of Electrical and Electronics Engineers. Today it is increasingly common to find articles on ethics in journals published by these and other professional societies, such as the American Society of Chemical Engineers and the American Society of Mechanical Engineers.

The conception of engineering ethics as an "interdisciplinary discipline" involving philosophy, social science, law, and business theory, in addition to engineering theory, became more clearly defined with the National Project on Philosophy and Engineering Ethics carried out under the direction of Robert Baum from 1978 to 1980. The first interdisciplinary conference took place in 1980 at Rensselaer Polytechnic Institute, and there have been several others since then. The first scholarly bibliography on engineering ethics was

also published in 1980 at the Illinois Institute of Technology (Ladenson, 1980). The first interdisciplinary journal to emphasize articles on engineering ethics, the *Business and Professional Ethics Journal*, was created in 1981.

This late development of the discipline is ironic. Engineering is the largest profession numerically and affects all of us in most areas of our lives. The skill of a surgeon's hand affects one patient at a time; the judgment of a design engineer can influence hundreds of lives at once. Medicine manifests itself in the yearly checkup, the miraculous cure, and the contents of the household medicine chest; but the products of engineering confront us virtually everywhere we turn our eyes and every time we do something.

Why has the general significance of engineering ethics, with its focus on personal decision making and responsibility, only recently become appreciated? In spite of the dramatic impact of engineering on our safety and well-being, we have tended to stereotype it as a tool of vast impersonal organizations. Individuals involved in it have frequently been viewed as cogs in machines rather than as responsible decision makers. Emphasis has usually been upon products and their effects on society rather than upon the human drama behind their production. Yet engineering products derive from personal creative activity in which responsible conduct can make the difference between large-scale benefit or large-scale harm, up to and including life and death. Engineering ethics is the discipline which examines the moral import of that creative activity. It explores the moral dimensions of technology "from the inside."

Variety of Moral Issues

There are two contrasting approaches to engineering ethics, one of which emphasizes small everyday problems and the other larger social problems. Those of us who tend to view the world from the microcosm of our immediate surroundings may become preoccupied with the frequently petty, but nevertheless persistent and nagging, moral problems of everyday life and work. What we must do is to reach beyond those problems to seek an understanding of their root causes.

Others among us are more inclined toward a macroscopic view involving reflections on the moral condition of society. What we need is the discipline to reconcile the broad view with specific circumstances as they present themselves in different everyday settings.

Which approach is better? Neither by itself. What is required is ongoing interaction between the two. In this vein we will approach our topic, taking as examples some cases involving a wide social impact and others of a narrower or more routine nature.

An engineered product or project goes through various stages of design, manufacture or construction, testing, sales, and service. Engineers carry out or supervise the appropriate activities at whatever stage of this process a convenient division of labor has assigned them. The nature of the activity or

project will generally dictate whether the engineers involved are by training civil, electrical, mechanical, or chemical engineers, to name only the major fields, but every field involves moral problems.

For example, as engineers carry out their tasks, there will be times when their activities will ultimately lead to a product which is less than useful or safe. This may happen intentionally, or under pressure, or in ignorance. A product may be intentionally designed for early obsolescence; an inferior material may be substituted under pressure of time or lack of money; or a product's eventual harmful effects may not be foreseen. Then too, because of the size of a project, or because of the large numbers of a product sold on the mass market, many people may be affected. And these problems arise quite apart from the temptations of bribes and other forms of outright corruption.

The following four specific examples (some of which led to regulatory changes) hint at a few of the areas covered by engineering ethics:

1 An inspector discovered faulty construction equipment and applied a violation tag preventing its continued use. The inspector's superior, viewing as minor the infraction of a relatively insignificant regulation, ordered the tag removed so the project would not be delayed. The inspector objected and was threatened with disciplinary action.

2 An electric utility company applied for a permit to operate a nuclear power plant. The licensing agency was interested in knowing what emergency measures had been established for human safety in case of reactor malfunction. The utility engineers described the alarm system and arrangements with local hospitals for treatment. They did not emphasize that these measures applied to plant personnel only and that they had no plans for the surrounding population. "That is someone else's responsibility," they claimed upon being questioned about this omission.

3 A chemical plant dumped wastes in a landfill. Hazardous substances found their way into the underground water table. The plant's engineers were aware of the situation but did not change the disposal method because their competitors did it the same cheap way, no law explicitly forbade the practice, and local government was not alert to the danger.

4 Electronics company ABC geared up for production of its own version of a popular new item. The product was not yet ready for sale, but even so, pictures and impressive specifications appeared in advertisements. Prospective customers were led to believe that it was available off the shelf and were drawn away from competing lines.

These examples show how ethical problems arise most often when there are differences of judgment or expectations as to what constitutes the true state of affairs or a proper course of action. The engineer may be faced with contrary opinions from within the firm, from the client, from other firms within the industry, or from government. And not to be left out, as indicated in Fig. 1-1, are still other possible positions that can be taken by the profession of engineering itself, usually embodied by or represented in the form of

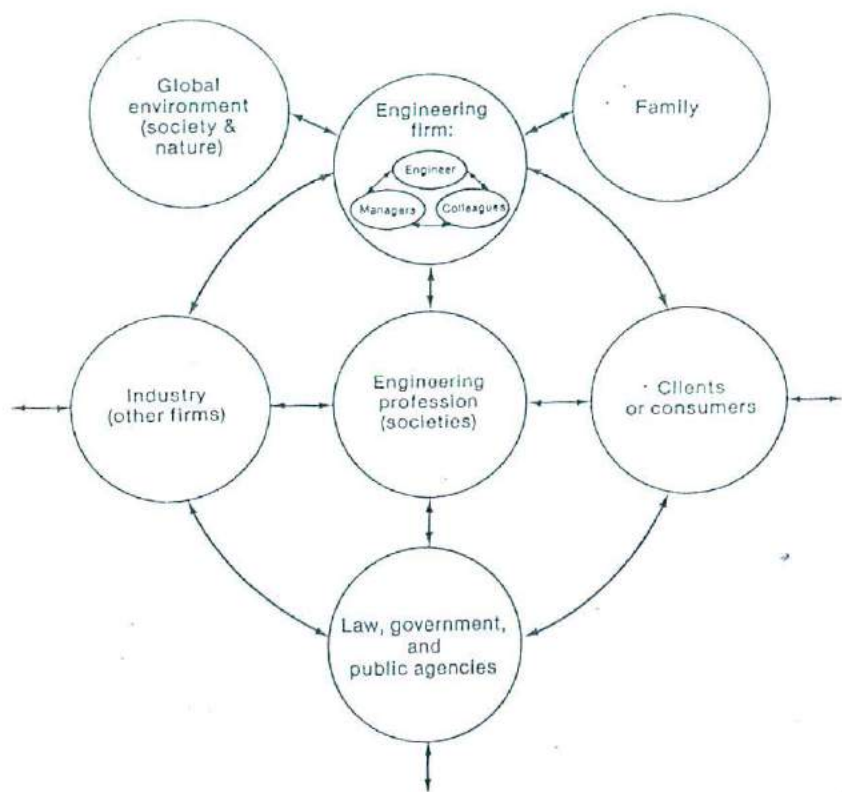


FIGURE 1-1
Contexts of potential professional disagreements engineers may encounter.

a professional society. We will have more to say about the relationships between engineers and their colleagues, their managers, and their clients later, particularly in connection with professional freedoms, rights, and obligations.

The four cases have already raised a number of pertinent moral questions. To what extent should an employer's or supervisor's directives be the authoritative guide to an engineer's conduct? What does one do when there are differences of judgment? Is it fair to be expected to put one's job on the line? Should one always follow the law to the letter? Is an engineer to do no more than what the specifications say, even if there are problems more serious than those initially anticipated? How far does an engineer's responsibility extend into the realm of anticipating and influencing the social impact of the projects he or she participates in?

The case of the inspector told to ignore rules has numerous variations: in the testing of prototypes or finished products in a factory, in the handling of

financial audits, or in the response to unsolicited reports of dangerous situations, to name but a few.

The nuclear power plant situation demonstrates several ways in which a product's ultimate use and possible failures may be overlooked by its designers. Lack of coordination in planning for its effects on everyone connected with it can lead to catastrophic results; limiting one's attention only to the narrow specifications can result in the delivery of a product that satisfies the contract but does not serve the needs of the customer or the public in the long run.

The questionable conduct of the chemical plant and, to a greater degree, the ABC company falls into the category of "ethics cases" which traditionally have occupied the ethics review boards of professional societies. Prescriptive codes of conduct can be established for such infractions of common decency, and for that reason those instances constitute the majority of cases in which action has been taken. This has encouraged the identification of engineering ethics with a finite set of specific maxims and regulations designed to assure moral conduct. Yet as we shall see, the moral problems arising in this field are not always manageable in this straightforward manner.

Normative, Conceptual, and Descriptive Inquiries

The study of the moral questions in engineering can be viewed as involving three distinct kinds of inquiry: *normative*, *conceptual*, and *descriptive*.

First, and most centrally, engineering ethics involves normative inquiries. "Normative" refers to the moral norms or standards which are desirable for actions, attitudes, policies, organizational structures, and individual character traits. The primary aim of engineering ethics is to identify and justify the moral obligations, rights, and ideals of individuals and organizations engaged in engineering. It seeks to establish which prescriptions of basic duty and higher ideal ought to be endorsed on moral grounds, and attempts to apply those results to specific situations in a manner that yields practical guidance.

For example, it asks the following: How far does the obligation of engineers to protect public safety extend in given situations? What are the bases of engineers' obligations to their employers, their clients, and the general public? When, if ever, should engineers be expected to blow the whistle on dangerous practices of the employers for whom they work? Is whistleblowing a minimal moral duty or more a matter of heroism that goes beyond the requirements of an engineer's basic duty? Whose values ought to be primary in making judgments about acceptable risks in a design for a public transport system: those of management, senior engineers, government, voters, or some combination of these? Which particular laws and organizational procedures affecting engineering practice are morally warranted? What moral rights should engineers be recognized as having in order to help them fulfill their professional obligations?

Dealing effectively with normative issues, however, requires two further types of inquiry. One of these is *conceptual*, directed toward clarifying the ba-

sic concepts or ideas, principles, problems, and types of arguments used in discussing moral issues in engineering. One example of a conceptual inquiry is seeking to define "safety" and its relationship to such ideas as "risk." A related conceptual inquiry attempts to sharpen understanding of entries in codes of ethics such as the following: Engineers should "protect the safety, health, and welfare of the public," while they should also "act as faithful agents or trustees for their employers or clients."

The third type of inquiry seeks to uncover factual information bearing upon conceptual and normative issues. Since it is concerned with specifying and gathering relevant facts, it is called a *descriptive inquiry*. Where possible, researchers attempt to conduct descriptive inquiries using proven scientific techniques. Topics of special interest in the context of our discussion are the business realities of contemporary engineering practice, the history of the engineering profession, the effectiveness of professional societies in fostering moral conduct, the procedures used in making risk assessments, and psychological profiles of engineers. Determining the facts in these areas provides an understanding of the background conditions which generate moral problems. It also enables us to deal realistically with alternative ways of resolving those problems.

Interrelatedness of the Three Inquiries

To summarize, engineering ethics involves three distinct types of inquiry:

- 1 Normative, whose practical aim is to provide reasoned evaluations of the conduct and character of individuals, the functioning of organizations, and the alternative responses available to solve concrete problems. Interwoven with this is the more theoretical aim of justifying the major moral principles which ought to be affirmed by individuals and organizations involved in engineering.

- 2 Conceptual, concerned with clarifying basic ideas, principles, issues, and types of argument concerning the moral problems in engineering.

- 3 Descriptive, which seeks to provide factual information needed for understanding and dealing with both conceptual and normative issues.

These three types of study are complementary and usually closely interrelated, as the following example illustrates. Consider a young engineer who becomes convinced that the level of pollutants her company is pouring into a stream is dangerously high, given that children are using the river downstream for swimming. She expresses her view to her immediate supervisor, who says her fears are unfounded because the pollution has caused no complaints in the past. Is she required to do more?

Obviously this question poses a practical normative issue. But we will also want to know additional facts about the case, such as the nature of the pollutants in this instance. Then we should want to know about the costs of con-

trolling them, and whether the engineer's conviction that they are dangerous is well founded. Hence a descriptive inquiry is called for.

Perhaps enough has already been said, however, to suggest that the engineer definitely should take further action, since her professional judgment has been overruled without a compelling reason. But should she merely request of the supervisor a more detailed response? Should she go above the supervisor to higher management? Should she write to the local mayor, or would going outside the normal organizational channels constitute disloyalty to the company? And what is the basis for holding that she even has the right to a cogently reasoned response from her supervisor?

These are further normative questions since they call for making moral evaluations of her responsibilities and rights. Answering them will require an understanding of the general moral obligations of engineers. And if this understanding is to be more than an undefended opinion or intuition, it will have to be grounded upon reasons as to why various specific moral principles ought to be affirmed. Providing these reasons is the task of a more theoretical inquiry, primarily normative in nature. But this inquiry will also involve clarification of ideas about safety, loyalty to companies, and professional freedom and autonomy. Hence it will involve conceptual inquiries.

Descriptive inquiries, moreover, enter the case yet again when we attempt to discover the realistic options open to the engineer, as well as to provide some estimate of their likely consequences. Those inquiries will help us understand the business, social, and political realities in which the company operates. Only with this knowledge can we make a sound recommendation about what the engineer should do.

Senses of "Engineering Ethics"

The word "ethics" (like the word "morals") has several distinct although related meanings. Corresponding to them are various senses of the expression "engineering ethics."

First, in the main sense used so far and in what follows, ethics is a discipline or area of study dealing with moral problems. Engineering ethics, accordingly, is the discipline or study of the moral issues arising in and surrounding engineering. As we have just seen, it involves normative (evaluative) inquiries, conceptual (meaning) inquiries, and descriptive (factual) inquiries into these moral issues. As understood here, the normative inquiries are central, with the conceptual and factual inquiries entering where relevant to support the normative inquiries.

Second, when we speak of ethical problems, issues, and controversies, we mean to distinguish them from nonethical or nonmoral problems. Here the word "ethical" marks a contrast between moral questions and questions of a political, legal, and artistic nature. Engineering ethics in this sense would refer to the set of specifically moral problems and issues related to engineering.

Third, sometimes the word "ethics" is used to refer to the particular set of

beliefs, attitudes, and habits which a person or group displays in the area of morality. Thus we say that Mussolini's ethics were different from those of Dwight Eisenhower, and both differed from those of Karl Marx. We also speak of the Romans' ethics, the Victorian ethic, the Protestant work ethic, and socialist ethics. In doing so we are referring to people's actual outlooks on moral issues. This sense is linked directly to the original sense of the Greek word *ethos*, which meant customs (as did *mores*, the Latin root of "morals"). As such, engineering ethics would be the currently accepted standards endorsed by various groups of engineers and engineering societies. The discipline of engineering ethics has the task of examining these accepted conventions to see if they are clear, justified, and sufficiently comprehensive.

This third sense of "engineering ethics" is purely descriptive because it concerns merely the facts about what engineers and others believe as regards moral problems in engineering. It is a usage in which social scientists especially might be interested, since they seek to describe and explain beliefs and actions related to morality. We will avoid it, however, because our main interest is in normative questions about correct beliefs.

Fourth, the word "ethics" and its grammatical variants can be used as synonyms for "morally correct." For example, people's actions and principles of conduct can be spoken of as either ethical (right, good, or permissible) or unethical (immoral), and individuals can be evaluated as ethical (decent, having moral integrity) or unethical (unscrupulous). In this usage, engineering ethics would amount to the set of justified moral principles of obligation, rights, and ideals which ought to be endorsed by those engaged in engineering. Discovering such principles and applying them to concrete situations is the central goal of the discipline of engineering ethics.

In order to simplify matters and avoid confusion, we shall restrict the expression "engineering ethics" to the sense in which it names a discipline. Nevertheless, we shall occasionally use the word "ethical" in its other senses when we speak of ethical problems, an individual's or group's ethics, and ethical conduct. The context will make it clear which of these is meant.

Engineering Ethics and Philosophy

Much of engineering ethics can be viewed as part of applied philosophical ethics. Like medical, legal, and business ethics,* it is focused upon practical moral problems but seeks where possible to apply methods and theories derived from more general philosophical principles.

Thus, applied ethics necessarily makes contact in many places with ethical

*We might note here that the closest cousin of engineering ethics is business ethics, which is also now undergoing rapid development. Since most engineers are salaried employees, and since engineering decisions are usually tied to business decisions, it is not surprising that moral problems in engineering and business often overlap. The question, for example, of what is wrong with offering and accepting more than nominal gifts when negotiating contracts for engineering services is at once an issue in engineering ethics and business ethics.

theory. This is because applied ethics is concerned with uncovering cogent moral reasons for beliefs and actions, as opposed to accepting uncritically whatever beliefs or actions might happen to strike one's fancy as being correct at a given moment. And the general moral principles to which such reasons make reference either explicitly or implicitly are directly linked to ethical theory.

We say, for example, that a given action is wrong because it amounts to accepting a bribe in the context of negotiating a contract, and bribes are wrong because they unfairly influence judgment and decisions. This claim is based on a general principle that contract negotiations ought to be impartially centered on the merits of the contract alone. And that general principle, in turn, will be justified by appealing to a higher-order principle to the effect that we ought to be fair and impartial in certain situations. Such higher-order principles, when developed and integrated within theories of justice, constitute the broad philosophical perspectives on conduct that ethical theory can provide.

An analogy might help clarify the relationship between applied and general philosophical ethics. Engineering is itself an applied science which draws upon principles from general physics and mathematics. It is "applied" in the sense that it is aimed at finding practical solutions to concrete problems by applying either theoretical knowledge or the more intuitive understanding of a field gained after years of working within it. "Pure" science and mathematics, by contrast, are directed toward obtaining new knowledge, usually of a general sort. Practical engineering solutions are often obtainable without having to await final proofs of theoretical principles. On occasion particular engineering solutions will have a wide importance, however, and will provide insights that can be fed back into the more theoretical levels of science. Thus there arises a dynamic interplay between applied and so-called "pure" science.

Much the same can be said of the relationship between applied and general ethics, remembering that here the concern is with moral instead of scientific issues. General ethics tends to emphasize theoretical knowledge and examines practical cases only in order to illustrate and test theories. Applied ethics, by contrast, focuses upon concrete problems for their own sake, and invokes general theory where helpful in dealing with those problems. It is not the task of applied ethics per se to resolve long-standing philosophical disputes over the validity of general moral perspectives.

On occasion, however, applied ethics may well yield insights having a more theoretical importance. Future developments in engineering ethics seem likely to provide fruitful directions for thinking about enduring philosophical questions concerning the nature of collective responsibility, legitimate authority, justice within economic systems, and moral rights within complex institutions.

Philosophy for its part plays a major role in supplying the basic concepts and theories needed to clarify the nature of ethical problems and issues in

engineering. Sometimes it can yield a heightened perception of those problems by placing them in perspective as aspects or instances of broader problems. For example, we shall see later how some appeals to codes of engineering ethics when trying to answer moral questions are problematic because the appeals presuppose a narrow kind of conventionalism in ethics. At other times philosophy can clarify general concepts which arise when thinking about any moral issue. An example of this to be dealt with in Chap. 2 is the concept of ethical dilemmas.

Study Questions

- 1 Cite examples of ethical problems which can arise in the production of a new type of motor bicycle as it passes through the stages of design, manufacture, testing, sales, and service. Use your imagination in developing the details of at least one problem at each stage.
- 2 The following three illustrations are based upon actual cases. With respect to each, first state what you see as the normative, or evaluative, issues involved. Then identify any descriptive inquiries which you think might be needed in making a reliable judgment about the case. Finally, are there any ideas or concepts involved in dealing with the moral issues that it would be useful to clarify?
 - a A County Engineer in Virginia demanded a 25 percent kickback in secret payments for highway work contracts he issued. In 1967 he made such an offer to Allan Kammerer, a 32-year-old civil engineer who was vice president of a young and struggling consulting firm greatly in need of the work. Kammerer discussed the offer with others in the firm, who told him it was his decision to make. Finally Kammerer agreed to the deal, citing as a main reason his concern for getting sufficient work to retain his current employees (Fairweather, 54-55).
 - b In 1970 Carl Houston was assigned as a welding superintendent to a nuclear power plant under construction. According to Houston, even his preliminary observations revealed numerous poor welds resulting from the use of poor procedures and improper materials. He considered this to be the result of improper training given to the welders and told his manager that if the situation was not corrected he would write to the main headquarters. Houston then described the situation to some of the subcontractors of the project, an act which led to his being fired for insubordination (Houston, 1975, 25-30).
 - c The principal project finance officer for a large firm learned that an engineer had been charging his personal long-distance phone calls to a client for several months. The officer informed the engineer's supervisor about this. The charges were around \$50 a month. It was extremely unlikely that the client would learn of them since the contract involved several million dollars, and if he did it would be easy to explain the situation as a bookkeeping error. The engineer was one of the firm's most valued employees, someone the supervisor regarded as the key to much of the hoped-for success of the firm during the next 2 years. The supervisor decided to ignore the situation. (From an unpublished case study written up by William Little.)
- 3 In response to a request by the *Monthly Newsletter* of The National Project on Philosophy and Engineering Ethics for brief definitions of engineering ethics, the following three suggestions were submitted and printed in the May-June 1979 issue. Which, if any, of the four senses distinguished above does each author seem to have in mind?

- a "Moral principles accepted by the profession relative to the practice of engineering." (Don Wilson, Engineer at Michael Baker, Jr., Inc.)
- b "The rights and responsibilities of those persons who practice the profession of engineering." (Albert Flores, Department of Philosophy, California State University, Fullerton.)
- c "If the task of *defining* engineering ethics is supposed to result in the articulation of a set of ethical principles which are individually necessary and jointly sufficient to distinguish engineering ethics from, say, business ethics, then there seems little hope that such a result is possible. For there will be an *engineering* ethics in this sense, that is, an ethics with principles which are engineering-specific, if and only if there are ethical aspects of engineering practice which are *unique* to the profession. . . . The ethical issues which bother the reflective engineer today revolve around questions of truth-telling, confidentiality, and obligations to employer/client vs. obligations to the public. But these ethical issues have been addressed by physicians for hundreds of years. . . ." (Thomas A. Long, Department of Philosophy, University of Cincinnati, used with permission.)
- 4 A full definition of engineering ethics will be linked with a definition of engineering. One broad definition of engineering says it is the application of science in the use of natural resources for the benefit of society or humanity. Such a notion would be preposterous if it implied that engineers are the only ones who participate in engineering as so defined (Ramo, 12). But if this implication is avoided, the definition has the advantage of emphasizing how all of us—citizens, engineers, management, scientists, technicians, government regulators—are participants in engineering and as such should be concerned with the field of engineering ethics. Consult a dictionary, an encyclopedia, and an introductory engineering textbook to see how they define engineering. Then carefully state the definition you prefer in connection with thinking about engineering ethics.
- 5 The terms "moral," "virtue," and "character" have acquired meanings in colloquial use which make them awkward to use at times. Find their etymological roots and describe how today's use often departs from their original or former meanings.

AIMS IN STUDYING ENGINEERING ETHICS

What is the point in studying engineering ethics? And what can be gained from taking a course or a segment of a course devoted to it?

As suggested above, studying engineering ethics should increase the ability of engineers, managers, citizens, and others to confront the urgent moral questions raised by technological activity. Yet more needs to be said about how this is to be achieved through college courses, continuing education, or individual study.

Should the study of engineering ethics aim at inculcating particular moral beliefs? We do not think so. Instead, the aim should be to empower individuals to reason more effectively concerning moral questions. The aim should be to strengthen moral autonomy.

Moral Autonomy

Of course there are many possible topics, and each of us will have special interests in probing different issues. Yet we believe that a shared practical

goal in studying ethics should be to think clearly and critically about moral issues. To invoke a term widely used in ethics, the unifying goal should be to increase one's *moral autonomy* in developing, expressing, and acting on reasoned moral views.

"Autonomy" literally means "self-ruling" or "independent." But not just any kind of independent reflection about ethics amounts to moral autonomy. Moral autonomy can be viewed as the ability to think, and the habit of thinking, rationally about ethical issues on the basis of moral concern. This foundation of moral concern, or general responsiveness to moral values, derives primarily from the training we receive as children in sensitivity to and consideration of the needs and rights of others. Where such training is absent, as it often is with abused or neglected children, the tragic result can be an adult sociopath capable of murdering without compunction. Sociopaths, who by definition lack a sense of moral concern and guilt, are never morally autonomous—no matter how "independent" their intellectual reasoning about ethics may be.

Adult moral concern, of course, can be evoked (or numbed) on specific occasions by any number of influences: friends, ministers, social events, novels, movies, and inspiring teachers of whatever subjects. It would be surprising if the topics dealt with in ethics courses did not call forth moral concern. Nevertheless, the main point of taking a course on applied ethics should be to improve the ability to reflect critically on moral issues.

This can be accomplished by improving various practical skills that will help produce effective independent thought about moral issues. As related to engineering ethics these skills include the following:

- 1 Proficiency in recognizing moral problems and issues in engineering. This involves being able to distinguish them from, as well as relate them to, problems in law, economics, religious doctrine, or the descriptions of physical systems.
- 2 Skill in comprehending, clarifying, and critically assessing arguments on opposing sides of moral issues.
- 3 The ability to form consistent and comprehensive viewpoints based upon consideration of relevant facts.
- 4 Imaginative awareness of alternative responses to the issues and creative solutions for practical difficulties.
- 5 Sensitivity to genuine difficulties and subtleties. This includes a willingness to undergo and tolerate some uncertainty in making troublesome moral judgments or decisions.
- 6 Increased precision in the use of a common ethical language, which is necessary in order to be able to express and defend one's moral views adequately to others.
- 7 Enriched appreciation of both the possibilities of using rational dialogue in resolving moral conflicts and of the need for tolerance of differences of perspective among morally reasonable people.

8 An awakened sense of the importance of integrating one's professional life and personal convictions—that is, the importance of maintaining one's moral integrity.

Most of us value moral autonomy for its own sake. Its exercise is central to what we think of as the possession of a mature moral outlook, that is, one which is something more than secondhand and passively adopted. Yet we also value it because we believe that it tends to lead to morally responsible conduct or is an integral part of being a responsible person. Certainly some faith in the ability of people to reflect on moral issues as morally autonomous individuals is presupposed in any attempt to engage in serious dialogue about ethics. And an affirmation of the individual's right to develop and exercise reasoned moral perspectives presupposes that most people have a large capacity for acting responsibly out of humane values. It is in this spirit that we, as authors, wish to enter into the discussion of engineering ethics.

Kohlberg's Theory of Moral Development

These comments on moral autonomy can be related to recent work in the psychology of moral development. In particular, they pertain to the psychological theories of moral development set forth by Lawrence Kohlberg and Carol Gilligan.

Building on the pioneering work of Jean Piaget, Lawrence Kohlberg suggested there are three main levels of moral development (Kohlberg, 1971). They are distinguished by the degree of moral cognitive development, that is, by the kinds of reasoning and motivation an individual adopts in response to moral questions.

Most primitive is the *Preconventional Level*, in which right conduct is regarded as whatever directly benefits oneself. Individuals are motivated primarily by the desire to avoid punishment, by unquestioning deference to power, or by a desire to satisfy their own needs. This is the level of development of all young children and a few adults who never manage to go beyond it.

Next is the *Conventional Level*, in which the norms of one's family, group, or society are accepted as the final standard of morality. These norms or conventions are adopted uncritically as being correct because they represent authority. Individuals at this level are motivated by the desire to please others and to meet the expectations of the social unit, regardless of immediate effects on their self-interest. Loyalty and close identification with others have overriding importance. Kohlberg's studies reveal that most adults never mature much beyond this stage.

Finally, the *Postconventional Level* is attained when an individual comes to regard the standard of right and wrong as a set of principles having to do with rights and the general good that are not reducible to self-interest or to social conventions. Kohlberg calls these individuals *autonomous* because they think for themselves and do not assume that customs are always right. They

also seek to reason and live by general principles, such as the Golden Rule ("Do unto others as you would have them do unto you"), which apply universally to all people in all cultures. Their motivation is to do what is morally reasonable for its own sake (rather than solely from ulterior motives), together with a desire to maintain their moral integrity, self-respect, and the respect of other autonomous individuals.

Kohlberg's schema of moral development has an obvious connection with what we said about the goals of studying ethics in college. To be morally responsible, one must be able and willing to exercise moral reasoning, and this in turn requires overcoming passive acceptance of the dominant conventions in one's society or "in group." Yet moral responsibility emerges from a foundation of early moral training by one's parents and culture. This early training, which involves submitting to the power of one's parents, makes possible later growth beyond complete self-centeredness (at the Preconventional Level) and uncritical acceptance of customs (at the Conventional Level) toward respect for the rights of other people (at the Postconventional Level).

But how does Kohlberg know that these are the correct stages specifying moral development or growth? How does he know that his "higher" levels represent more advanced stages of moral maturity? He contends that advanced stages constitute a "better cognitive organization" that embodies more distinctions and represents a more universalized perspective. But why does that amount to moral progress, and not merely to increased intellectual sophistication?

The answer to these questions is not found by a mere appeal to facts about the numbers of people who reach each level. As we noted, Kohlberg thinks that relatively few people reach the Postconventional Level, and hence his schema does not record the path of moral development that the majority of people follow. Instead, Kohlberg seems to base his schema on the fundamental assumption that movement toward autonomy is morally desirable. This is consistent with the view expressed earlier that moral autonomy is an inherently valuable general character trait essential for exercising moral responsibility. But it deserves emphasis that this is a normative claim, not a purely descriptive or psychological claim.

Could it be that Kohlberg bases his work on other moral assumptions that are somewhat more controversial? In particular, what should be said about his emphasis on abstract universal rules and rights?

Gilligan's Theory of Moral Development

One of Kohlberg's former students and colleagues has challenged his work on precisely this point and done so in a manner relevant to contemporary debates over male and female approaches to morality. In her book, *In a Different Voice*, Carol Gilligan charges that Kohlberg's studies are distorted by a male bias. Not only did he conduct his studies primarily with male subjects,

but according to Gilligan he approached his studies with a typically male preoccupation with general rules and rights.

Gilligan's own studies suggest that there is some tendency for men to be more interested in trying to solve moral problems by applying abstract moral principles. Males tend to resolve moral dilemmas by determining which moral rule is most important and should override other moral rules relevant to the dilemma. Women, by contrast, try harder to preserve personal relationships with all people involved in a situation. In order to do so, they focus greater attention on the details of the context in which the dilemma arises, rather than invoking and trying to rank general rules. Gilligan refers to this context-oriented emphasis on maintaining personal relationships as the *ethics of care*, and contrasts it with an *ethics of rules and rights*.

Both males and females sometimes use both kinds of ethics. Gilligan wishes to draw attention only to a difference in emphasis, not a strict difference based on gender. Moreover, she does not attempt to answer the question of whether this difference in emphasis is due to biology (genetic determination) or to social conditioning.

In order to make Gilligan's criticism of Kohlberg clearer, consider the most famous example that Kohlberg used in his questionnaires and interviews. This example, called "Heinz's Dilemma," involves a woman living in Europe who will die from cancer unless she obtains an expensive drug which the doctors think will help her. Her husband, Heinz, cannot afford to purchase the drug. The local pharmacist is charging 10 times the cost of making the drug. He also invented the drug and remains the sole source for obtaining it. The husband goes to everyone he knows seeking to borrow money, but he manages to raise only half the money needed to purchase the drug. When he asks the pharmacist to sell the drug at a cheaper price or to let him pay for it later, the pharmacist refuses. In desperation, Heinz breaks into the pharmacy and steals the drug. Was the theft morally right or wrong?

Applying his schema of moral development, Kohlberg ranked experimental subjects according to the kinds of reasoning they used about the dilemma (and not depending on their specific answers or conclusions). For example, the subjects who said that Heinz did wrong because he broke the law are reasoning at the Conventional Level, in which right conduct is regarded as simply obeying the law. Also at this level are subjects who said the husband did right because according to their religious beliefs God commanded that human life is sacred and God should be obeyed. By contrast, subjects who said that the right to life of the wife is inherently more important than the property right of the pharmacist are reasoning at the Postconventional Level.

Women, interestingly enough, tended to cluster more frequently than men at Kohlberg's Conventional Level. This was because they showed greater hesitancy about stealing the drug and searched for alternative solutions in terms of the context. For example, they recommended further attempts to reason with the pharmacist and to find creative ways to raise the

necessary money. Kohlberg inferred that the women were overly preoccupied with conventional rules against stealing and that they were also wishy-washy in applying general principles about the right to live.

Gilligan, however, drew a very different conclusion from this data. She contended that it reveals a greater sensitivity to people and personal relationships, including the relationship with the pharmacist and the wife (who would not be helped if the husband ended up in jail for stealing the drug). She also saw value in the context-oriented reasoning used by women who did not locate the solution of the dilemma in abstract general rules ranked in order of importance.

Drawing on such reinterpretations of Kohlberg's experimental data, and combining them with her own studies of women, Gilligan offered a strikingly different schema of moral development. She recast Kohlberg's three levels of moral development as stages of growth toward an ethic of caring. Gilligan's recasting looked something like this:

The Preconventional Level This is roughly the same as Kohlberg's first level in that the person is preoccupied with self-centered reasoning. Right conduct is viewed in a selfish manner as solely what is good for oneself.

The Conventional Level Here there is the opposite preoccupation with not hurting others and with a willingness to sacrifice one's own interests in order to help or nurture others. Women are especially prone to fall prey to the cultural stereotypes that pressure them always to be willing to give up their personal interests in order to serve the needs of others.

The Postconventional Level The individual becomes able to strike a reasoned balance between caring about other people and pursuing one's own self-interest while exercising one's rights. The aim is to balance one's own needs with the needs of others, while maintaining relationships based on mutual caring. This is achieved through context-oriented reasoning, rather than by applying abstract rules ranked in a hierarchy of importance.

How does Gilligan's theory of moral development relate to our emphasis on moral autonomy as a goal of studying ethics at the college level? Like Kohlberg's theory, it is entirely compatible. Note that we did not define autonomy as separateness from other people. On the contrary, we said that autonomy requires independent reasoning on the basis of moral concern. That concern is often best understood in terms of caring for others and trying to maintain personal relationships with them. Moral autonomy may well have as much to do with caring for other people within a community based on personal relationships (as Gilligan says) as it does with being sensitive to general principles and human rights (as Kohlberg says). And it surely has to do with sensitivity to the subtleties of special situations (consistent with Gilligan's emphasis on context-oriented reasoning), just as it does with appreciation of general moral principles and rights (consistent with Kohlberg).

Consensus and Controversy

When individuals exercise moral autonomy, there is no assurance that they will arrive at either the truth or the same verdicts as other people exercising *their* moral autonomy. Indeed, there seem to be some basic moral differences which are not reducible to disagreements over facts or errors in logical inference. Perhaps this is inevitable with a subject like morality which is not as precise and clear-cut as arithmetic (Aristotle, 936). Tolerance requires us to allow room for disagreement among autonomous, reasonable, and responsible persons.

This suggests that the aim of teaching engineering ethics should not be to produce a unanimous conformity of outlook, even if such conformity could be achieved by resorting to indoctrination, authoritarian and dogmatic teaching, hypnotism, or other autonomy-destroying techniques. Indeed, just as one major goal of investigators in the field of engineering ethics should be to uncover ways of promoting tolerance in the exercise of moral autonomy by engineers, the same goal should be sought in courses on engineering ethics.

This similarity between the goals of courses on engineering ethics and the goals of responsible engineering can be extended. In both the classroom and the workplace there is a need for authority: teachers having authority over students, and managers having authority over engineers. Both situations presuppose the need for some consensus concerning the role of authority. Is such a consensus undermined by stressing the moral autonomy of individuals to develop and express their own moral views?

Part III of this book responds to this question in detail. Indeed, the question is tacitly considered throughout the book as we discuss specific issues and examples. Here we wish to note two general points about the relationship between autonomy and authority, illustrating them by reference to the classroom.

The first point is that moral autonomy and respect for authority are not inherently incompatible. Moral autonomy, by definition, is exercised on the basis of moral concern for other people and recognition of good moral reasons. In addition, valuing moral autonomy presupposes faith in most people's capacity for moral reasonableness. Now, there is a very good reason for accepting authority in the classroom. Authority provides the framework in which learning can take place. This reason, and not sheer coercion, underlies the acceptance of authority by most students and professors. Without this rough consensus among autonomous members of the academic community, classes could not be conducted in orderly ways, cheating would be encouraged, and trust and respect between faculty and students would be eroded. Considered in this way, the constraints inherent in respecting authority of professors are not much different from those imposed by a conductor on the musicians in an orchestra.

Nevertheless, and this is the second point, sometimes a tension does arise between the need for autonomy of individuals and the need for consensus about authority. For one thing, authority and the rules it generates are not

always clear-cut. There may arise good-faith differences among students and faculty as to what is consistent with rules of a given class, differences that need to be discussed openly whenever possible.

Cheating, for example, is clearly forbidden. But is it always clear what cheating is? It is easy to give a general definition: *cheating* is dishonesty in trying to gain something underserved or in falsely representing one's work. But is it dishonest to work in groups on an assignment? Is it dishonest to look at a previous exam that is widely circulated among students? Does it matter that only a few students may have access to a previous exam if it is known that the professor rarely repeats exams?

Most of us know from our own experience that there are gray areas concerning course requirements and that autonomous reflection does not always result in everyone seeing eye to eye about them. Additional conflicts between autonomy and authority arise when authority is abused, or seems to be abused. In small classes it is usually assumed that students should be allowed to express their own views, and that authority is abused when discussion is discouraged by a professor's intimidating approach. Yet there may be reasonable differences concerning how much time should be allowed for discussion and also concerning what is an intimidating approach.

Study Questions

- 1 Most of us agree that the dogmatic teaching of ethics can threaten the exercise of moral autonomy. Does this mean that college teachers should withhold expression of their own views on moral issues?
- 2 Describe a clear-cut example of a situation in which one person tries to indoctrinate another into holding a particular belief or value. Does the attempt center more on what is said (for example, false views, one-sided views, etc.) or on how the view is presented (for example, with intimidation, intolerance, the suppression of criticism, etc.)?
- 3 Respond to the following argument: "The primary goal of a course on engineering ethics ought to be to have students meet the standards of professional conduct specified in the major engineering codes of ethics. This is because the codes are formulated by the engineering societies which officially speak for the engineering professional on moral issues. Encouraging engineers to think autonomously threatens to produce chaos within organizations."
- 4 Present and defend your view about Heinz's Dilemma: Should Heinz have stolen the drug in order to help his wife? Also, using the dilemma as a focus, explain whether you find Kohlberg's or Gilligan's theory more illuminating as an account of morally mature reasoning about the dilemma.
- 5 In 1959, C. P. Snow, an English scientist turned novelist, delivered a famous lecture entitled "The Two Cultures" (Snow). In it he warned of an increasing gap in communication and mutual appreciation between people educated primarily in science and those educated in the humanities. If you have experienced such a gap, what harm do you see it causing? How can education contribute to bridging the gap, and in particular how might the study of engineering ethics serve as one bridge between the "two cultures"? Do you see a different gap between the practice-oriented

disciplines, which include engineering and applied ethics, and the more theory-oriented disciplines, such as pure mathematics and more esoteric branches of philosophy?

SUMMARY

Various things may be meant by the expression "engineering ethics." In this book *engineering ethics* will mean the examination of the moral issues in engineering and the field of study which results from that examination. It centers on a *normative*, or evaluative, inquiry into how people and organizations involved in engineering ought to be and to act, and what laws, codes of ethics, and institutional norms morally ought to be in effect. But it also involves *conceptual* inquiries aimed at clarifying the meanings of key ideas and issues and *descriptive* inquiries designed to provide relevant factual information.

The issues in engineering ethics are wider in scope than the moral problems confronted specifically by engineers, for they include the moral problems bearing on engineering faced by many other people, including consumers, managers, scientists, technical writers, lawyers, and government officials. Even though the emphasis in this book will be on those problems as they relate to engineers, it will become clear in the course of our discussion that the responsibilities of engineers must be understood in conjunction with the rights and obligations of these other people, especially consumers and managers.

Engineering ethics is intimately tied to philosophical ethics, and it can be viewed as a branch of applied philosophical ethics. This is especially true wherever general ethical theories and distinctions are applied in order to (1) enrich our understanding of the nature of the moral problems and issues in engineering, (2) provide reasoned responses to those problems, and (3) clarify the meanings of key concepts and distinctions.

The practical aim in studying and teaching engineering ethics is to help foster moral autonomy. *Moral autonomy* is the ability to arrive at reasoned moral views based on the responsiveness to humane values most of us were taught as children. This does not require that a person always reach the "correct" moral view. But it involves displaying competencies and sensitivities such as the following: the abilities to discern moral problems and to clarify them, to work out reasoned and sometimes creative responses to them while taking account of opposing viewpoints, and to exercise the verbal and communicative skills relevant to discussing one's views with others.

Moral autonomy is an achievement made possible in part by a foundation of early moral training that helps instill moral concern. Psychologists Lawrence Kohlberg and Carol Gilligan trace the development of autonomy in three major stages: the Preconventional Level of self-centeredness, the Conventional Level of respect for conventional rules and authority, and the Postconventional Level of autonomy. Kohlberg gives greater emphasis to recognizing rights and abstract universal rules, whereas Gilligan stresses the importance of maintaining personal relationships based on mutual caring.

MORAL REASONING

On October 10, 1973, Spiro T. Agnew resigned as Vice President of the United States amidst charges of bribery and tax evasion related to his previous service as County Executive of Baltimore County. A civil engineer and lawyer, he had risen to influential positions in local government. As County Executive during 1962 to 1966 he had the authority to award contracts for public works projects to engineering firms. In exercising that authority he functioned at the top of a lucrative kickback scheme (Cohen 1974).

Lester Matz and John Childs were two of the many engineers who participated in that scheme. Their consulting firm was given special consideration in receiving contracts for public-works projects so long as they made secret payments to Agnew of 5 percent of fees from clients. Even though their firm was doing reasonably well, they entered into the arrangement in order to expand their business. They felt that in the past they had been denied contracts from the county because of their lack of political connections.

Moral Problems and Dilemmas

If we say that Matz and Childs confronted a moral problem, we might mean several things. We could be calling attention to the fact that they were in a situation calling for a decision involving moral considerations about fair practices, honesty, and avoiding deception. Or we could mean they were tempted to ignore these moral considerations and violate moral rules like "Do not cheat." But we would probably not intend to imply there was any

serious doubt or difficulty in determining what they were morally required to do—that was clear-cut. The only uncertainty was whether they would decide to do what was morally proper.

Usually, however, when we speak of moral problems we have in mind situations where what ought to be done is not so straightforward and obvious. Those situations may involve two sorts of murkiness or complexity which set them in sharp contrast to the case of Agnew, Matz, and Childs.

First, it may be unclear to the individuals involved which, if any, moral considerations or principles apply to their situation. An engineer starting a new job, for example, may have doubts about whether it is morally permissible to accept an expensive desk set as a gift from a salesperson with whom her company does business. Would this be accepting a bribe? Would it create a conflict of interest? Perhaps a conversation with a colleague will answer these questions. But there will always be troublesome cases where there is considerable vagueness about whether the "gift" is an innocent amenity or an unacceptable bribe.

Second, it may be perfectly clear which moral principles apply to one's situation. The difficulty instead might be that two different moral principles, both of which apply to one's situation, come into conflict or that one principle seems to point simultaneously in two different directions. These kinds of moral problems are called *moral dilemmas*.

Stated more fully, *moral dilemmas* are situations in which two or more moral obligations, duties, rights, goods, or ideals come into conflict with one another, and at least on the surface it appears that not all of them can be fulfilled or respected. It is also possible for one moral principle to have two or more incompatible applications in a given situation.

Moral dilemmas occur frequently, although usually there is only moderate difficulty in seeing what should be done. We make a promise to a friend, thereby creating an obligation to do what we have promised. Our parents become ill and staying home to help them prevents us from keeping the promise. The dilemma, which consists of a conflict between the duty to keep promises and an obligation to one's parents, can usually be resolved by an apologetic phone call to the friend. Or again, we make one promise to our employer and another to a colleague, and it turns out that we cannot keep both. Here the general duty to keep promises has two incompatible applications. Once again, an apology to the offended party will often settle the matter.

Yet dilemmas are not always so easily dealt with. Resolving some of them can require searching, even agonizing, reflection. Contemporary engineering practice makes it virtually inevitable that nearly all engineers will be confronted with some moral dilemmas during their careers. Indeed, this is true of all professionals, including physicians, lawyers, and teachers.

In the next section we will introduce four ethical theories that can be useful in confronting moral dilemmas. But first it will be helpful to sharpen our understanding of what morality is.

WHAT IS MORALITY?

We defined engineering ethics as the study of moral problems in engineering and the study of related questions about character, moral ideals, and moral relationships. But what is the meaning of the word "moral" in this definition?

One suggestion frequently given in dictionaries is that *morality* concerns what *ought* or *ought not* to be done in a given situation, what is *right* or *wrong* about the handling of it, or what is *good* or *bad* about the actions of the people involved in it. But this definition is inadequate for two reasons. On the one hand, morality concerns not just actions, but also good and bad character (what people ought to *be*, not just *do*), relationships (that ought to be sustained), and ideals (to which we ought to aspire).

On the other hand, mere reference to words like "ought," "right," and "good" does not suffice to define even the dimension of morality concerned with conduct. For there are many nonmoral usages of these words and ideas. Thus, in order to start a car a person *ought* to put the key in the ignition—that is the *right* thing to do. People *ought* to brush their teeth before leaving for school or work, and it is *good* to avoid drinking so much coffee that one becomes jittery. To increase profits a company *ought* to try to cut unnecessary costs while increasing efficiency. None of these judgments would typically be counted as moral ones. Moral judgments are about what *morally* ought or ought not to be done, what is *morally* right or wrong, and what is *morally* good or bad. Since the word "morally" is but the adverbial form of the adjective we are trying to define, we are caught in a circle if we cannot move beyond these general evaluative notions.

Some progress can be made if we characterize moral judgments in terms of the particular sorts of reasons used to justify them (Frankena, 1973, 110). This is because such reasons will typically differ significantly from the grounds we give in justifying other types of value judgments. If we ask why persons ought to brush their teeth, the answer will be in terms of health and social etiquette. If we ask why a certain painting is judged to be a good one, the answer will be in terms of its striking lines, color, unity, symbolism, and so on. Giving these reasons in support of judgments makes it explicit that the judgments are nonmoral ones. Thus, too, if an engineering design is said to be a good one simply because it is simple, elegant, or cost-effective, we know that technical and business values are at issue rather than specifically moral reasons.

What, then, are *moral* reasons and ideals? If this question calls for a comprehensive characterization, there is no easy answer. Morality is complex and not easily encapsulated. The theories about right action presented in the next section can be viewed as attempts to offer precise characterizations of morality, but as we shall see, even they are controversial.

If the question, by contrast, calls for examples of moral reasons and ideals, those are easy enough to provide. We are all familiar with a variety of such examples. They concern, for instance, respecting persons by being fair and

just with them, respecting their rights, keeping our promises, avoiding unnecessary offense and pain to them, avoiding cheating and dishonesty (of the sort Matz, Childs, and Agnew engaged in). They also concern caring for others by being sometimes willing to help them (especially when they are in distress), to show gratitude for favors, to be compassionate in response to their suffering. There are also high ideals that inspire us to go beyond the minimal requirements of moral duty, such as the ideals of selfless devotion to causes like ending world hunger, promoting world peace, and helping to advance disadvantaged groups. Such ideals may involve a highly personal dimension of morality that is desirable, though optional, for people to pursue. But there are also professional ideals, as we shall see, that should be fostered among practicing engineers.

Moral reasons and ideals, we have said, form a distinct category of value, different from other categories of values. Let us make this clearer by relating and contrasting moral values to three other types of values: self-interest (one's personal good), law, and religion. In each case, we will consider attempts to reduce morality to these other types of value. Following this discussion we turn to theories of right action.

Self-Interest and Ethical Egoism

It seemed easy to recognize that Matz and Childs should not have participated in the kickback scheme supervised by Spiro Agnew. That was because they were pursuing their own private good in a situation where they should have had regard to the requirements of fairness and honesty in business.

But suppose this judgment were challenged as follows: If Matz and Childs did wrong, it was because they adopted an overly narrow view of their own self-interest. Self-interest is what is good for oneself *in the long run*. Matz and Childs took foolish risks, which in the long run resulted in their being caught and probably harmed more than if they had not paid the kickback money. In general, people should always and only pursue their self-interest, but in doing so they should be careful to assess that interest rationally in light of the facts.

This view is called *Ethical Egoism*: "ethical" because it is a theory about morality, and "egoism" because it says that the sole duty of each of us is to maximize our own good. According to its proponents, moral values are reduced to concern for oneself (prudence), but always a "rational" concern requiring consideration of one's long-term interests (Rand, 1964).

Defenders of Ethical Egoism draw a distinction between narrower and wider forms of self-interest. To be selfishly preoccupied with one's own private good to the point of indifference and disregard for the good of others will generally cut one off from rewarding friendships and love. Thus the "paradox of happiness": To seek happiness by blinding oneself to other people's happiness leads to one's own unhappiness. Personal well-being generally requires taking some wider interest in others, although the rational ego-

ist insists that the only reason for showing an interest in others is for the sake of oneself.

There is a problem with this last claim, however. Friendship and love seem to require—by definition—caring for other people at least in part for themselves, not from ulterior motives of self-concern. They require valuing other people for their sakes, and not solely because they serve one's personal ends.

Ethical egoists also try to defend their position by contending that an ironic consequence of everyone rationally pursuing their self-interest is that everyone benefits. For example, the classical economist Adam Smith and his contemporary defender Milton Friedman believe that society benefits most when (1) individuals pursue their private good, and (2) corporations (as expressions of many individual wills) pursue maximum profits in a competitive free market (Smith; Friedman, 1962). The idea is that this will make the economy prosper, thereby benefiting everyone, because each individual and corporation is in the best position to know what is good for them and how best to pursue that good.

We will return to the views of Smith and Friedman in Chap. 6. Here we express our strong doubt that private pursuit of self-interest, whether at the individual or the corporate level, always works out to everyone's advantage. To be sure, often it does, and often the requirements of morality and prudence point in the same direction. For example, the prudent employee and the morally conscientious engineer for the most part look alike in their conduct—but only for the most part. Morality requires a willingness on the part of both individuals and corporations to place some restraints on the pursuit of private interests. Acceptance of some such constraints is presupposed in what is meant by moral concern. Engineering ethics has as one task uncovering the moral limits on the pursuit of self-interest in the profession of engineering.

Of course, these remarks do not constitute a refutation of Ethical Egoism; and we shall not attempt a further refutation beyond making the following suggestion. At the very least, morality requires that we value and are concerned for the good of other people. (It also requires not being cruel to animals.) This means that Ethical Egoism is not really a plausible theory about what morality is, but instead a skeptical rejection of morality. It amounts to claiming that what are ordinarily viewed as moral reasons (for example, respecting other people's rights or caring about their well-being for their sake) should be disregarded except where they happen to coincide with looking out for one's own neck. "Number 1" is all that counts. Such a view denies the validity of moral reasons.

Laws and Ethical Conventionalism

A different challenge to the distinctiveness of moral values is the idea that morality reduces to law or to the customs and conventions of a society. Ac-

According to this view, which is called *Ethical Conventionalism*, an act is morally right when it is approved by law or convention; it is wrong when it violates laws or customs.

Why would anyone believe this view? One reason is that laws seem so tangible and clear-cut. They provide a public way of cutting through seemingly endless disputes about right and wrong that at times seem little more than assertions of prejudice. Laws seem to be an "objective" way to approach values.

Ironically, a second rationale for this legalistic approach to morality points in the opposite direction. Ethical Conventionalism seems attractive to some people because it treats values as subjective at the cultural level. They insist that moral standards vary dramatically from culture to culture. The only kind of objectivity possible is limited to and "relative to" a given set of laws in a given society. Acknowledging this relativity of morality, they think, encourages tolerance of differences among societies.

Both of these arguments for Ethical Conventionalism are flawed in a manner that allows them to be turned on their heads. The first argument underestimates the extent to which moral reasons are objective so as to make them transcend individual prejudice and bias. Moral reasons, in fact, allow objective criticisms of given laws as immoral or morally inadequate. For example, moral reasons are used in criticizing the apartheid laws of South Africa, which flagrantly violate the human rights of the majority of black citizens. These human rights are not given legal protection, but they ought to be—*morally* ought to be. Apartheid laws represent precisely the harmful kind of subjectivity that morality helps us to overcome by calling for respect for all people, independent of race.

The second argument embodies two confusions. On the one hand it suggests that because laws, customs, and beliefs about morality differ from society to society it follows in effect that all of them are right and none of them are wrong. But there is nothing self-certifying about laws and beliefs. To use an extreme illustration, Ethical Conventionalism would allow that Hitler and his followers acted correctly when they murdered 6 million Jews, for their laws, customs, and beliefs were based on antisemitism.

This same illustration shows why Ethical Conventionalism is anything but the tolerant doctrine it claims to be. There is nothing tolerant—in any admirable sense—in refusing to criticize Nazi beliefs about morality. Sanctioning intolerant antisemitic beliefs is not an act of tolerance. It is true, as we shall emphasize in Chap. 8, that judgments about other cultures have to be based on understanding of and sensitivity to special cultural circumstances. But that is because those circumstances are objectively relevant to morality, and not because whatever a culture adopts as its laws or customs is automatically justified.

Defenders of Ethical Conventionalism generally add that an action is right "for cultures" that believe it is right—it is right "for them," though not "for us." Or moral beliefs are "true for" those cultures who hold them, though

not true "for us." But these are needless shuffles. If the expressions "right for them" and "true for them" mean merely that those cultures believed something was right and that this belief played a key role in their lives (such as when we say of the ancients that the earth was "flat for them"), then this shaky view reduces to the truism that they believed what they believed. If, by contrast, it means their beliefs justified their actions, then we are left with the false claim that believing something to be right makes it right. Beliefs, however customary or widely shared, are not self-certifying. Nor, we might add, are attitudes concerning morality.

Religion and Divine Command Ethics

Moral reasons are not reducible to matters of self-interest, nor to law and custom. But how about religion? *Divine Command Ethics* is the view that to say an act is right means it is commanded by God, and to say it is wrong means it is forbidden by God. Accordingly, if there were no God to issue commands, then there would be no morality.

One difficulty raised by this view, of course, is how to know precisely what God's commands are. Another difficulty is knowing whether God exists. In fact, there are religions which do not emphasize belief in God, unlike the theistic (God-centered) religions like Judaism, Christianity, and Islam. Buddhism, Taoism, and Confucianism, for example, call for faith in a *right path* from which is derived a code of ethics. In Buddhism, for instance, the right path incorporates eight steps: right understanding, right intention, right speech, right action, right livelihood, right effort, right mindfulness, and right concentration. Part of the right path for many nontheistic religions is the need for contemplation and a feeling of oneness with nature in place of communion with a deity.

Questions about belief in God, however, are not the main difficulty with Divine Command Ethics. In fact, most theologians (such as St. Thomas Aquinas) reject the view for a different reason. This reason pertains to a question asked long ago by Socrates (Plato). Socrates asked, in effect: *Why does God make certain commands and not others? Are the commands made on the basis of whim? Surely not, for God is supposed to be morally good and hence would neither approve of nor command such acts as wanton killing, rape, torture—and other immoralities.*

Stated in another way, suppose that a man claimed that God commanded him to kill people randomly. (The "Son-of-Sam" murderer who randomly shot people on the streets of New York claimed this.) Without having to make any kind of religious inquiry, we would know the man was mistaken. Wanton killing is a clear-cut example of immorality and we know that a morally good deity would not command that kind of act (by definition of a "morally good deity").

It follows that Divine Command Ethics has things backwards. A morally good deity commands on the basis of moral reasons that determine the

wrongness of certain kinds of actions and the rightness of others. Instead of the commands creating moral reasons, moral reasons are presupposed as the foundation for making certain commands rather than others.

Nothing in this argument against Divine Command Ethics should be viewed as a threat to religion. On the contrary, religious belief can be regarded as supporting morality by providing further motivation for being moral. We are not referring to self-interested motives like the fear of damnation or other types of punishment. Religious faith, or at least religious hope, implies trust: trust that we can receive insight into what should govern right action and that we can be sustained in that action. Hence it brings an added inspiration to be moral, even though many people are moral without having religious beliefs.

Consider in this connection the definition of religion given by C. J. Ducasse:

A religion... is any set of articles of faith—together with the observances, attitudes, obligations, and feelings tied up therewith—which, in so far as it is influential in a person, tends to perform two functions, one social and the other personal. The social function is to provide motivation for the individual to conduct himself altruistically on occasions when his individual interest conflicts with that of society and when neither his spontaneous altruistic impulses, nor the sanctions of the laws or of public opinion, are potent enough by themselves or together to motivate such conduct. The personal function, on the other hand, is to give the individual in some measure the serene assurance out of which flows courage on occasions of fear, endurance in adversity, strength in moments of weakness, dignity in defeat, humility in success, conscientiousness and moderation in the exercise of power (Ducasse, 1953, 115).

Ducasse points out that the main social function of religion is to motivate right action, which involves the notion of ethics per se. Likewise the personal function of religion is very important. It has sustained many people in trying to follow their convictions, and it can promote tolerance and moral concern for others when those motivated by it are confronted with the wide variety of beliefs and individual needs to be found in the world. Many engineers are certainly among those so motivated, which is why these paragraphs on religion are an appropriate part of our larger topic, engineering ethics.

Minimal Conception of Morality

The discussion in this section has moved us toward what might be called a *minimal conception of morality* (Rachels, 1986). The conception is minimal in that it does not presuppose any one of the theories about right action to be discussed in the next section. Instead, it is the starting point for developing an ethical theory. That is, any sound ethical theory should presuppose it and in part be about it.

According to the minimal conception as it pertains to actions, morality concerns *reasons* for the desirability of certain kinds of actions and the

undesirability of others. To say that an act is right is not to express a mere feeling or bias, but instead to assert that the best moral reasons support doing it.

What is a moral reason? It is a reason which requires us to respect other people, to care for their good as well as our own. In addition, moral reasons are such that they set limits to the legitimate pursuit of self-interest. They can be used to evaluate laws, to praise some and criticize others. They are not reducible to religious matters, although religious belief may provide an additional motivation for responding to them.

Study Questions

1. What is the moral dilemma involved in each of the following situations? Identify the moral obligations which come into conflict. How do you think the dilemma should be resolved? Would an ethical egoist and an ethical conventionalist agree with you about how to resolve the dilemma?

a "Bill, a process engineer, learns from a former classmate who is now an OSHA regional compliance officer that there will be an unannounced inspection of Bill's plant. Bill believes that unsafe practices are often tolerated in the plant, especially in the handling of toxic chemicals. Although there have been small spills, no serious accidents have occurred in the plant during the past few years. What should Bill do?" (Matley, Greene, McCauley, 1987, 115)

b "On a midnight shift, a botched solution of sodium cyanide, a reactant in an organic synthesis, is temporarily stored in drums for reprocessing. Two weeks later, the day shift foreperson cannot find the drums. Roy, the plant manager, finds out that the batch has been illegally dumped into the sanitary sewer. He severely disciplines the night shift foreperson. Upon making discreet inquiries, he finds out that no apparent harm has resulted from the dumping" (Matley, Greene, McCauley, 1987, 117). Should Roy inform government authorities, as is required by law in this kind of situation?

2. Interview someone involved in engineering, preferably an engineer. Ask them to describe one or more moral problems they have confronted. Is the problem they describe a moral dilemma? If so, explain which competing moral obligations, ideals, or principles are involved and how you would have resolved it.

3. Locate and read a complete work of fiction in which the subject matter is related to engineering and in which the plot involves a moral dilemma. Then write an essay in which you (a) discuss the origin and nature of the dilemma, and (b) explain whether or not you agree with how the person involved resolved the dilemma, giving reasons for your opinion.

You might consider the following works: Pierre Boulle, *The Bridge over the River Kwai*; Eugene Burdick and Harvey Wheeler, *Fail-Safe*; William Golding, *The Spire*; Henrik Ibsen, *The Master Builder*; John D. MacDonald, *Condominium*; Louis V. McIntyre and Marion B. McIntyre, *Scientists and Engineers: The Professionals Who Are Not*; Nevil Shute, *No Highway*; Kurt Vonnegut, Jr., *Player Piano*; Burton Wohl, *The China Syndrome*. Additional possibilities are given in Samuel C. Florman's *The Existential Pleasures of Engineering*.

THEORIES ABOUT MORALITY

Moral conduct is based on concern for other people; it is not reducible to self-interest, law, or religion. But more precisely, what makes some actions morally right and others wrong? What are the most basic reasons why we morally ought or ought not to do certain things?

Four Types of Moral Theories

More than two millenia of philosophical reflection since Socrates have not led to a consensus about how to answer these questions. Nevertheless, there is widespread agreement that there are four main types of theories about morality. These theories differ according to what they treat as the most fundamental moral concept: good consequences for all, duties, human rights, or virtue.

As an illustration to help introduce these theories, return to the kickback scheme described at the beginning of this chapter. We assumed it was clear that the actions of the participants were unethical. But what reasons can be given to support this assumption? *Why* was it wrong for the engineers to make secret payments to Spiro Agnew in return for being given preference in the awarding of contracts for public projects?

One answer is that more bad than good resulted. Other engineering firms were harmed by not having a chance to obtain the contracts they may have been best qualified to receive. The system also removed the potential benefits of healthy competition among a wider range of firms, benefits such as lower costs and better products for the public. Equally significant, discovery of the scheme led to a loss of trust in public officials, a trust important for the well-functioning of government. And the perpetrators themselves eventually suffered greatly.

Let us define *utility* as the overall balance of good over bad consequences. *High utility* will usually mean much good and little bad (although it can also mean the lesser of two evils). *Utilitarianism* holds that we ought always to produce the most utility, taking into equal account everyone affected by our actions. Good and bad consequences are the only relevant moral considerations, and hence all moral principles reduce to one: "We ought to maximize utility."

A different answer to what was wrong with engaging in the kickback scheme would have us focus directly on the actions involved, rather than their consequences. The actions were intended to keep outsiders deceived about what was going on. They were also inherently unfair to other people who were denied equality of opportunity to bid for the contracts. Hence the actions, irrespective of their actual or probable consequences, violated at least two basic principles of duty: "Avoid deceiving others" and "Be fair." *Duty ethics* asserts there are duties like these which ought to be performed even though doing so may not always produce the most good.

Yet another answer to why it was wrong to participate in the kickback

scheme is that it violated the rights of other people. A shared understanding exists that there will be equality of opportunity in seeking public contracts and that elected officials will grant contracts based on merit, not bribes. Against this background, qualified persons or firms acquire a right to unbiased consideration of their contract proposals, and these rights were violated by the kickback scheme. It might also be argued that the public's rights to the benefits of fair competition were violated as well.

Rights ethics views actions as wrong when they violate moral rights. Like duty ethics, it denies that good consequences are the only moral consideration. But rights ethics says we have duties to other people *because* people have rights that ought to be respected, whereas duty ethics says rights are created by duties.

A very different answer to why it was wrong to enter into the kickback scheme makes reference to virtues and vices, that is, to good and bad traits of character. Agnew displayed unfairness, dishonesty, and greed—that is the kind of person he showed himself to be. Matz and Childs displayed moral weakness, deceptiveness, dishonesty, and perhaps cowardice in the face of temptation. Morally better people would have manifested virtues such as courage, honesty, fairness, and conscientiousness.

Virtue ethics regards actions as wrong insofar as they manifest bad character traits (vices) and right insofar as they display or support good character traits (virtues). Here the fundamental concept is a morally good person, rather than right actions. Virtue ethicists are primarily interested in what kind of people we ought to be, to emulate, and to inspire others to become. Right actions are simply those which express, build, or reinforce virtues.

The following table lists the four main types of theories about morality. In the remainder of this section we will discuss one classical and one contemporary defender of each of the first three types introduced: utilitarianism, duty ethics, and rights ethics. In a later section virtue ethics will be discussed in more detail.

Theory about morality	Basic concepts
Utilitarianism	Most good for the most people
Duty ethics	Duties
Rights ethics	Human rights
Virtue ethics	Virtues and vices

Mill: Act-Utilitarianism and Happiness

Utilitarianism is the view that we ought to produce the most good for the most people, giving equal consideration to everyone affected. The standard of right conduct is maximization of goodness. At first glance, this seems simple enough. But what is the goodness that is to be maximized? And how is the "production" of goodness related to everyday moral rules? Depending

on how these questions are answered, utilitarianism can be developed in different directions.

Act-utilitarianism says we should focus on individual actions, rather than general rules. An act is right if it is likely to produce the most good for the most people involved in the particular situation. Everyday maxims like "Keep your promises," "Don't deceive," and "Don't bribe" are only rough guidelines. According to John Stuart Mill (1806-1873), these maxims are useful rules of thumb that summarize past human experience about the types of actions which usually maximize utility (Mill). But the rules should be broken whenever doing so will produce the most good in a specific situation.

If the standard of right action is maximizing goodness, what is goodness? Mill believed that happiness is the only *intrinsic good*, that is, something good in-and-of-itself or desirable for its own sake. All other good things are *instrumental goods* in that they provide means ("instruments") for happiness. A trip to the dentist, for example, is an instrumental good that promotes happiness by avoiding or removing the pain of toothache.

In Mill's view, a happy life is comprised of many pleasures in great variety, mixed with some inevitable brief pains. The happiest life is also rich in *higher pleasures*. Higher pleasures are preferable in quality or *in kind* to other pleasures. For example, Mill contended that the pleasures derived through intellectual inquiry, creative accomplishment, appreciation of beauty, and friendship and love are inherently better than the bodily pleasures derived from eating, sex, and exercise.

How did Mill know these are the "higher" pleasures? He offered the following test: One kind of pleasure is preferable to another if the majority of people who have experienced both kinds favor it. Using this test, it is no surprise that he and his contemporaries living in the Victorian Age should rank pleasures of the mind and of personal relationships over those of the body. Contemporary utilitarians often reject this aspect of Mill's thought as biased.

Brandt: Rule-Utilitarianism and Rational Desires

Rule-utilitarianism, which is the second main version of utilitarianism, regards moral rules as primary. According to it, we ought always to act on those rules which if generally followed would produce the most good for the most people. Individual actions are right when they conform to such rules. Thus, we ought to keep promises and avoid bribes, even when those acts do not have the best consequences in a particular situation, because the general practices of promising and not bribing produce the most overall good (compared to other practices).

Richard Brandt is an influential contemporary rule-utilitarian. Brandt believes that rules should be considered in sets which he calls *moral codes* (Brandt). A moral code is justified when it is the *optimal code* which (if adopted and followed) would maximize the public good more than alterna-

tive codes would. The codes may be society-wide standards or special codes for a profession like engineering.

There are debates over precisely how much act- and rule-utilitarianism differ from each other. Yet they do seem to lead to different conclusions in some situations. Rule-utilitarianism, for example, gives a more straightforward condemnation of participation in kickback schemes. Matz and Childs acted on a rule something like "Engage in secret payoffs when necessary for profitable business ventures." If this rule were generally followed, it would cause a breakdown of trust between business people and their clients. Again, general adherence to Agnew's principle of action, which was something like "Break the law when you can personally profit from doing so," would produce a mentality that would have devastating consequences.

Act-utilitarianism, by contrast, leaves it open whether participation in some kickback schemes may produce overall good. It all depends on the particular context: who is hurt and how much, and what are the chances of being caught? Because act-utilitarianism seems to open "loopholes" licensing unfair exceptions, many utilitarians have abandoned it in favor of rule-utilitarianism.

Many contemporary utilitarians also disagree with Mill's view that happiness is the only intrinsically good thing. They often regard friendship, love, understanding, and appreciation of beauty as intrinsically good, even when they do not lead to happiness.

Brandt, however, believes that such things are good because they satisfy rational desires. *Rational desires* are those we would have and approve of if we scrutinized our desires in light of all relevant information about the world and our own psychology. Some self-destructive desires, such as the desire to use dangerous drugs, are not rational since if we saw their full implications we would not approve of them.

Still other utilitarians, especially economists, are concerned with difficulties about how to identify and measure desires and the pleasures they yield. They seek an objective way to determine the good. Economists base their cost-benefit analyses on the preferences that people express through their buying habits. In this version, utilitarianism becomes that view that right actions are those producing the greatest satisfaction of the preferences of people affected.

Kant: Duties and Respect for Persons

Immanuel Kant (1724-1804) is the most famous of the ethicists who regard duties, rather than good consequences, as fundamental. In his view, right actions are those required by a list of duties such as: be honest, keep your promises, don't inflict suffering on other people, be fair, make reparation when you have been unfair, show gratitude for kindness extended by others.

There are also duties to ourselves: seek to improve one's own intelligence and character, develop one's talents, don't commit suicide.

Why are these our duties? According to Kant, it is because they meet three conditions: each expresses respect for persons, each expresses an unqualified command for autonomous moral agents, and each is a universal principle. We will now examine Kant's three conditions in more detail.

First, in contrast to Mill, who said happiness is the only intrinsic good, Kant valued the *good will*: the intention to do one's duty. Thus, Kant greatly valued the honest and conscientious effort to fulfill duties. Moreover, people also have inherent worth as rational beings insofar as they have the capacity for a good will. This capacity makes people worthy of respect. To respect people is to seek to fulfill our duties to them, and to respect oneself is to seek to fulfill our duties to ourselves.

This sounds rather abstract until we look at examples of what happens when duties are disregarded. Consider the deceiving, bribing, and coercing involved in the Agnew case. These activities are various forms of manipulation. They constitute treating people as means to one's own ends, rather than as rational beings who have purposes of their own (or who are "ends-in-themselves," to use Kant's expression). Violent acts such as murder, rape, and torture are even more flagrant ways of treating people as mere objects serving our own purposes.

Second, duties prescribe certain actions categorically, without qualifications or conditions attached. Duties are *categorical imperatives*. These commands are best understood by contrasting them with nonmoral commands which Kant called *hypothetical imperatives*. Hypothetical imperatives command on the basis of some condition or "hypothesis." For example, "If you desire to become healthier, then stop overeating" and "If you want to be happy, you ought to enrich your life by developing friendships." Another example is the mugger with a gun who commands, "Your money or your life." Here there is an implicit condition: "If you want to avoid being killed, then hand over your money."

Moral imperatives are different in that they have no such conditions attached. They require us to do certain things whether we want to or not. Thus, we ought to avoid cheating and other forms of dishonesty simply because we ought to—period! It is our duty, independently of whether it will make us happy. Stated another way, duty should be followed because of our autonomous commitment to morality itself, rather than because of ulterior motives.

Third, categorical imperatives are binding on us only if they are also applicable to everyone. That is, moral reasons and principles are those which we are willing to have everyone act upon and which we can conceive of all people heeding. In this sense they must be *universalizable*.

Most everyday moral rules pass this test. For example, we can imagine and favor having everyone obey the command "Keep promises." By contrast, we cannot imagine all people obeying the command "Keep promises

except when you don't feel like it." If everyone did that, promises would no longer be possible. Whenever someone attempted to give their solemn word to us by uttering the words "I promise," we would merely laugh. Serious promises are understood as not being subject to the whims of those who seek to gain advantages for themselves. Thus we are not *willing* to encourage people to break promises whenever they find it convenient, and we become caught in a *contradiction* when we try to imagine a situation in which everyone acted that way.

The kickback scheme provides a second illustration. Consider the principle "Engage in secret kickback schemes whenever you can profit and get away with it." If everyone followed this principle, people would no longer be able to make legal business contracts at all. Contracts are possible because of an underlying basis of trust among at least most participants. Whereas utilitarians objected to kickbacks because of their actual or probable consequences, Kant says they are wrong because they cannot be willed to be universal principles applying to all rational beings.

Prima Facie Duties

One difficulty with Kant's view is that he thought principles of duty were *absolute* in the sense of never having justifiable exceptions. He failed to be sensitive to how principles of duty can conflict with each other, thereby creating moral dilemmas. Contemporary duty ethicists recognize that some moral dilemmas are resolvable only by making exceptions to simple principles of duty. Thus, "Do not deceive" is a duty, but it has exceptions when it conflicts with the moral principle "Protect innocent life." One ought to deceive a kidnapper if that is the only way to keep a hostage alive until the police can intervene. Principles of duty that have exceptions are called *prima facie duties* (W. D. Ross, 1946). Most duties are in fact *prima facie* ones.

How do we tell which duties should override others when they come into conflict? Some recent duty ethicists emphasize the importance of careful reflection on each situation, weighing all relevant duties in light of all the facts, and trying to arrive at a sound judgment or intuition. They also stress that some principles, such as "Do not kill" and "Protect innocent life," clearly involve more pressing kinds of respect for persons than other principles, such as "Keep promises." Other duty ethicists, like John Rawls, have tried to formulate general principles that can be ranked in order of importance without having to rely on intuitive judgments.

Duty Ethics: Rawls's Two Principles

John Rawls is a leading contemporary ethicist who has developed Kant's ideas in fresh directions. According to Rawls, valid principles of duty are

those which would be voluntarily agreed upon by all rational persons in an imaginary "contracting" situation.

The persons in this hypothetical situation are characterized by several features:

1 They lack all specific knowledge about themselves—for example, about their particular desires, intelligence, and achievements. This ensures they will not be biased by self-interest in their deliberations.

2 They do have general knowledge about human psychology, the economics and politics of society, and science.

3 They have a rational concern for promoting their long-term interests.

4 They seek to agree with each other about the principles they will voluntarily and autonomously follow as a group. That is, they form a moral agreement or contract to abide by principles to which they all subscribe.

Rawls believes that placing ourselves (in imagination) in this hypothetical contracting situation helps us to reason more easily and honestly about moral principles. It enables us to check our intuitions and to set aside our biases. His view is Kantian in that it emphasizes the autonomy each person exercises in forming hypothetical agreements with other rational people.

All rational people, Rawls argues, will agree in this hypothetical situation to abide by two basic moral principles applicable to societies and social institutions like professions: (1) Each person is entitled to the most extensive amount of liberty compatible with an equal amount for others. (2) Differences in social power and economic benefits are justified only when they are likely to benefit everyone, including members of the most disadvantaged groups (Rawls, 1971, 60).

The first principle is most important and should be satisfied first. Without basic liberties no other economic or social benefits can be sustained in the long run. The second principle is also very important, however. It insists that allowing some people great wealth and power is justified only when all other groups benefit. Thus, it might be argued that allowing differences of this sort within the free enterprise system is permissible insofar as it provides the capital needed for businesses to prosper, thereby providing job opportunities and taxes to fund a welfare system to help the poor.

Locke: Liberty Rights

The third type of ethical theory, *human rights ethics*, is familiar and can be introduced more briefly. Human rights ethicists assert that duties arise because people have rights, not vice versa. For example, individuals do not have rights to life because others have duties not to kill them. Instead, possessing the right to life is the reason why others ought not to kill them.

John Locke (1632–1704) argued that to be a person entails having rights—human rights—to life, liberty, and the property generated by one's labor. His

views had an enormous impact at the time of the French and American revolutions. The words in the Declaration of Independence are not far from his own: "We hold these truths to be self-evident; that all men are created equal; that they are endowed by their creator with inherent and inalienable rights; that among these are life, liberty, and the pursuit of happiness."

Locke's own version of a human rights ethics was highly individualistic. He viewed rights primarily as entitlements that prevent other people from meddling in one's life. These are referred to as *liberty rights* or *negative rights* that place duties on other people *not* to interfere with one's life.

This aspect of Locke's thought is reflected on the contemporary political scene in the libertarian ideology, with its emphasis on protection of private property and the condemnation of welfare systems (Nozick, 1974). Libertarians take a harsh view of taxes and government involvement beyond the bare minimum necessary for national defense and preservation of free enterprise. This perspective contrasts sharply with Rawls's concern for the disadvantaged members of society. It also contrasts with a second version of human rights ethics.

Melden: Welfare Rights

This second version of rights ethics conceives of human rights as intimately related to communities of people. A contemporary philosopher, A. I. Melden, has argued that having moral rights presupposes the capacity to show concern for others and to be accountable within a moral community (Melden, 1977). The extent of rights, in his view, always has to be determined in terms of interrelationships among persons. Melden's account allows for more "positive" *welfare rights*, which he defined as rights to community benefits needed for living a minimally decent human life. Thus it lays the groundwork for recognizing a social welfare system such as the United States currently has.

Not all moral rights are human rights. Some arise from special relationships and roles which people might have. A promise, for example, gives rise to the special right to have the promise kept. But rights ethicists seek to justify special rights by reference to human rights. Thus, according to Melden, promises create special rights because people have human rights to liberty, and because breaking a promise is a way of interfering with the liberty of the person to whom one has committed one's help by making a promise.

Many of the rights we will examine later arise within institutions and professions, such as the right of engineers to warn the public about unsafe technological products. And there are rights of all participants in competitive situations to be treated fairly, rights which were violated in the Agnew kickback scheme. Later we shall see how basic human rights can be used as a basis for some of these special rights.

Testing Ethical Theories

Our intent is not to evaluate which of these theories is best. In fact, we believe that each of them has insights to offer, and we are more impressed by how they complement each other than by how they differ. For example, Kant and Locke disagree sharply over whether duties or rights are most fundamental. But we are more interested in how for every duty there is a corresponding right, and vice versa. Thus, if you have a right to life, then I have a duty not to kill you; and if I have a duty to respect your freedom, then you have a right not to be interfered with. It follows that for practical purposes it matters little whether we adopt duties or rights as the starting point for moral reflection.

Again, rights ethics, duty ethics, and rule-utilitarianism for the most part all agree about the general principles we ought to follow (even though they give different justifications of those principles). As authors, we have reservations about act-utilitarianism as a sound moral theory. But we are confident that rule-utilitarianism, duty ethics, rights ethics, and virtue ethics all capture essential elements of sound moral reflection, and that for the purposes of engineering ethics all of them converge toward similar conclusions.

We have already seen this illustrated as we looked at the the Agnew kick-back scheme. With the possible exception of act-utilitarianism (which left some loopholes for engaging in some such schemes), all the main ethical theories gave compelling and interrelated reasons for not participating in the scheme.

Perhaps someday an even more comprehensive moral theory will be developed that will reveal how all the theories are connected and have elements of truth. Yet even if there are ultimate moral disagreements that make such a unified theory impossible, there remain enough broad similarities between the existing theories to warrant invoking all of them as aids to practical moral reflection.

In what follows, therefore, we will draw freely on the language of duties, rights, utility, and virtue, wherever it aids practical reflections on moral dilemmas in engineering. Yet it is worth mentioning five widely used tests for evaluating ethical theories.

First, the theory must be clear and formulated with concepts that are coherent and applicable.

Second, it must be internally consistent in that none of its tenets contradicts any other.

Third, neither the theory nor its defense can rely upon false information.

Fourth, it must be sufficiently comprehensive to provide guidance in specific situations of interest to us.

Fifth, and perhaps most important, it must be compatible with our most carefully considered moral convictions (judgments, intuitions) about concrete situations. If an abstract ethical theory said it was all right to torture

mentally handicapped children to make other people happy, that would be enough to show the theory was false.

Good theories, of course, may lead us upon reflection to modify some of our previously held views—one of their main uses is to correct mistaken judgments. In this way theories and concrete intuitions mutually interact, each serving as a test for the other. Ethical theories are developed to illuminate, unify, and correct commonsense judgments; and refined commonsense judgments about specific situations are used to test ethical theories (Rawls, 1971, 46–53).

Study Questions

- 1 Apply utilitarianism, duty ethics, and rights ethics in resolving the following moral problems. Be sure to consider alternative versions of each theory, such as act-utilitarianism and rule-utilitarianism. Do the theories lead to the same or different answers to the problems?
 - a A train is approaching a switch, and it is traveling too fast to stop before a tragedy occurs. Tied to one fork of the track are the leaders of three important nations (who are vital to current efforts to achieve world peace and prosperity). Tied to the other fork are four people who are your closest friends and relatives, but who have no international or even national social importance. If you were in control of the switch, which fork in the track ought you to select?
 - b A doctor can save the lives of three important national leaders by making transplants of the kidneys and heart of a local convicted mass murderer who is serving a life sentence. The operations would be done in secret and would involve the full cooperation of the local police officials, who would claim the murderer was killed while trying to escape from prison. Is it morally permissible (i.e., all right) to make the transplants?
 - c George had a bad reaction to an illegal drug he accepted from friends at a party. He calls in sick the day after, and when he returns to work the following day he looks ill. His supervisor asks him why he is not feeling well. Is it morally permissible for George to lie by telling his supervisor that he had a bad reaction to some medicine his doctor prescribed for him?
 - d Jillian was aware of a recent company memo reminding employees that office supplies were for use at work only. Yet she knew that most of the other engineers in her division thought nothing about occasionally taking home notepads, pens, computer discs, and other office "incidentals." Her 8-year-old daughter had asked her for a company-inscribed ledger like the one she saw her carrying. The ledger costs less than \$20, and Jillian recalls that she has probably used that much from her personal stationery supplies during the past year for work purposes. Is it all right for her to take home a ledger for her daughter without asking her supervisor for permission?
 - e Robert is a third-year engineering student who has been placed on probation for a low grade-point average, even though he knows he is doing the best work he can. A friend offers to help him by sitting next to him and "sharing" his answers during the next exam. Robert has never cheated on an exam before, but this time he is desperate. Should he accept his friend's offer?

- f Because he had been mugged before, Bernard Goetz (who happened to be an engineer) illegally carried a concealed revolver when he rode the New York subway. When several young men confronted him in a threatening way, asking for money, he drew the revolver and fired several shots that resulted in permanent injuries. Did his right to life and his right to defend himself justify his acts of (i) carrying the revolver and (ii) using it as he did?
- 2 Find, in a current newspaper or magazine, an article which raises a moral issue in engineering. State the issue in your own words, making clear why you view it as a moral one. Explain how the problem might be approached and resolved by drawing on utilitarianism, duty ethics, and rights ethics.
 - 3 Consult the writings of a major ethicist and summarize the main ideas of the theories involved. For suggested sources see the bibliographical entries on Aristotle, Brandt, Kant, Melden, Mill, Oldenquist (1979), Rawls, and MacIntyre. For helpful secondary sources, see Frankena (1973), Rachels, and Taylor.

ETHICAL THEORY AND SAFETY OBLIGATIONS

Ethical theories have two main applications to engineering ethics. First, they help us to deal with practical moral problems, especially moral dilemmas. Second, they can be used to justify the general obligations of engineers and others involved in technological development. Using safety-related problems and obligations as examples, we will illustrate the applications of utilitarianism, rights ethics, and duty ethics, postponing virtue ethics to the next section of this chapter (see under "Responsibility and Virtue Ethics").

The DC-10 Case

In 1974 the first crash of a fully loaded DC-10 jumbo jet occurred over the suburbs of Paris; 346 people were killed, a record for a single-plane crash. It was known in advance that the crash was bound to occur because of the jet's defective design (Eddy, 1976; Godson, 1975).

The fuselage of the plane was developed by Convair, a subcontractor for McDonnell-Douglas. Two years earlier Convair's senior engineer directing the project, Dan Applegate, had written a memo to the vice president of the company itemizing the dangers that could result from the design. He accurately detailed several ways the cargo doors could burst open during flight, depressurize the cargo space, and thereby collapse the floor of the passenger cabin above. Since control lines ran along the cabin floor, this would mean a loss of control of the plane. Applegate recommended redesigning the doors and strengthening the cabin floor. Without such changes, he stated, it was inevitable that some DC-10 cargo doors would open in midair, resulting in crashes.

In responding to this memo, top management at Convair disputed neither the technical facts cited by Applegate nor his predictions. Company officers maintained, however, that the possible financial liabilities Convair might incur prohibited them from passing on this information to McDonnell-

Douglas. These liabilities could be severe since the cost of grounding the planes to make safety improvements would be very high and come at a time when McDonnell-Douglas would be placed at a competitive disadvantage (Newhouse, 1982).

It might be argued that as a loyal employee Applegate had an obligation to follow company directives, at least reasonable ones. Perhaps he also had family obligations which made it important for him not to jeopardize his job. Yet as an engineer he was obligated to protect the safety of those who would use or be affected by the products he designed. Thus the dilemma he confronted involved a clash between at least two general professional obligations—one to his employer and one to the public—and possibly a clash between professional and personal obligations as well.

While this is an extreme case, it nevertheless illustrates a common class of moral dilemmas in engineering. Given that the vast majority of engineers are salaried employees, it is very likely that duties to employers will on occasion conflict with duties to the public. For this reason we will take all of Chap. 5 to examine the relations between these kinds of obligations. Later we shall also comment on some of the managerial and regulatory voids revealed after the crash over Paris.

Steps in Confronting Moral Dilemmas

In approaching dilemmas like the one Dan Applegate had to face, several steps are important. The steps are distinct, even though they are interrelated and can often be taken in tandem.

- 1 Identify the relevant moral factors and reasons. What are the clashing duties, competing rights, alternative goods and bads, and virtues and vices involved?
- 2 Gather all available facts that are pertinent to the moral factors involved.
- 3 If possible, rank the moral considerations in order of importance as they apply to the situation.
- 4 Consider alternative courses of action as ways of resolving the dilemma, tracing the full implications of each.
- 5 Talk with colleagues (or friends or other students), seeking their suggestions and alternative perspectives on the dilemma.
- 6 Arrive at a carefully reasoned judgment by weighing all the relevant moral factors and reasons in light of the facts.

Ethical theories cannot be expected to provide simple resolutions of complex dilemmas. They are not moral algorithms that can be mechanically applied to remove perplexity. But they can help by providing frameworks for understanding and reflecting upon dilemmas. In fact, they can be useful at each of the above steps.

1 Ethical theories aid in identifying the moral considerations or reasons which constitute the dilemma. Thus, utilitarianism construes the Applegate

dilemma in terms of competing goods: the safety of the public versus the economic benefits to Convair and the personal benefits to Applegate. Duty ethics indicates that he had competing duties to protect the public affected by his work and to respect his employer's legitimate authority to make management-level decisions about expenditures. And rights ethics emphasizes the rights of the public to be protected (or at least warned of dangers) and the rights of management to have their decisions respected.

2 Ethical theories provide a more precise sense of what kinds of information are relevant. All the theories, for example, agree that facts about the potential harm to the public are directly and urgently relevant. It would be improper to consider only the benefits to Convair and to Applegate in reaching a decision about the dilemma.

3 Sometimes the theories offer ways to rank the relevant moral considerations in order of importance. We shall argue in a moment that the theories suggest a priority of the obligation to protect the public, given (i) the special importance of rights to life and to informed consent concerning risks to one's life, (ii) the importance of duties to protect the vulnerable public, and (iii) the degree of badness involved in death and risk of death compared to economic benefits to corporations.

4 The theories help us identify the full moral ramifications of alternative courses of action, urging a wide perspective on the moral implications of the options, and providing a systematic framework for comparing the alternatives.

5 The theories augment the precision with which we use moral terms, and they provide frameworks for moral reasoning when discussing moral issues with colleagues.

6 By providing frameworks for development of moral arguments, the theories strengthen our ability to reach balanced and insightful judgments.

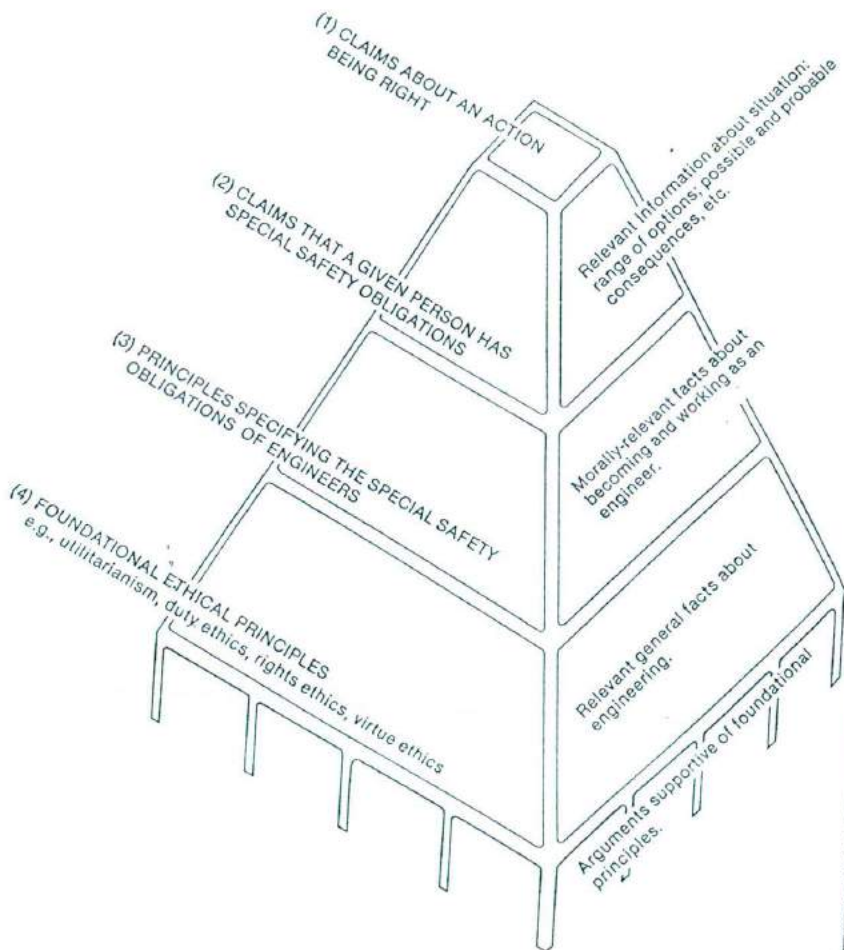
Foundations of Professional Obligations: Safety

The second use of ethical theories is in justifying the general obligations of engineers and others involved in technological development. We will illustrate this by asking, "Why do engineers have obligations to protect the safety of the public affected by their products and projects?" What reasons or justification can be given for our earlier claims that engineers have these obligations?

This question has wide relevance to engineering ethics, beyond its connection with the DC-10 example. In one way or another, safety is involved in most of the thorny issues in engineering ethics. Certainly it is the most pressing consideration in most situations involving whistle-blowing, confidentiality, and the exercise of professional autonomy. In fact, it is perhaps only a slight exaggeration to say that engineering ethics takes as its primary focus the promotion of safety while bringing useful technological products to the public, whereas medical ethics centers on the professional's role in promoting health within the bounds of patient autonomy, and legal ethics centers on the advocacy of clients' rights within the bounds set by law.

An architectural metaphor may help orient the reader to the idea of justifying the safety obligations of engineers. In the tower shown in Fig. 2-1, each of the four main stages or girders represents a type of moral claim. Girder 4 at the top represents claims about particular actions being right or obligatory.

FIGURE 2-1
Justifying moral claims about safety in engineering.



The next beam down symbolizes claims that specific engineers have special moral obligations concerning safety. Girder 2 represents the special safety principles themselves. Candidates for inclusion here would be items appearing in engineering codes of ethics, such as "Engineers shall hold paramount the safety, health and welfare of the public in the performance of their duties" and "Should the Engineers' professional judgment be overruled under circumstances where the safety, health, and welfare of the public are endangered, the Engineers shall inform their clients or employers of the possible consequences and notify other proper authority of the situation, as may be appropriate." (These are only "candidates," since they must be established as justified in order to be included.) The lowest stage, girder 1, is concerned with the most general and basic foundational or philosophical principles.

The columns connecting the girders represents the morally relevant information needed to move from one type of normative claim to another. For example, consider the move from level 3 to level 4. Suppose we agree that an engineer has an obligation to inform the proper authority of serious dangers to the public. In order to know how this obligation should be carried out correctly, then, we need to know who in the particular situation constitutes the proper authority and how that authority should be notified—by an anonymous phone call or by a formal memo delivered via certified mail?

The move from level 1 to level 2 consists in deriving the special obligations of engineers concerning safety from general ethical theory and the relevant facts about engineers' work.

Under *act-utilitarianism*, the special safety obligations of engineers would ultimately reduce to one general obligation: to act in each situation so as to maximize the good consequences for everyone affected by engineering projects and products. *Rule-utilitarianism*, on the other hand, would have engineers act according to those rules which if widely followed would produce the best consequences for everyone affected. *Duty ethics* would ground the obligations of engineers in one or more basic principles of duty. And *rights ethics* would emphasize how engineers' safety obligations are based on the requirement that professionals respect the moral rights of those affected by their work.

Rather than elaborating on each of these approaches, we will select the rights theory for further comment because of its special relevance to the perspective on engineers' responsibilities developed in Part II of this text.

A rights theory begins with the assumption that every person has an inherent right as a human being to pursue his or her legitimate interests, i.e., interests not harming others (Melden, 1977).

Does this imply an unqualified right not to be harmed by technological products? No. If people purchase hanggliders and then kill themselves by flying them carelessly or under unfortunate weather conditions, their rights have not been violated—so long as advertisements about the joys of hanggliding did not contain misleading information. But the basic right does

imply a right not to be poisoned, maimed, or killed by technological products whose dangers are not obvious or are deliberately hidden. This in turn implies a right to informed consent when purchasing or using products or services that might be dangerous (e.g., buying an airplane ticket). We might think of this as a right to make an "informed purchase."

These rights place on those creating products, or engaging in projects, correlative obligations to acquire and transfer relevant safety information to consumers and others affected by the products or projects. The nature of such obligations, in general outline, will be shaped by the rights. Thus there is a direct link between basic human rights and the safety obligations of engineers, both in regard to what those obligations are and how they are acquired. And laws, professional codes, and employment agreements are important to that linkage insofar as they help ensure that the safety obligations are fulfilled. These issues will arise again for discussion in later chapters.

Professional Ethics and Ordinary Morality

As the above illustration suggests, the special obligations concerning safety that engineers acquire as a consequence of their work are intimately connected with ordinary or everyday morality. The same ethical theories that are useful in expressing everyday moral experience are also useful in justifying the obligations of professionals.

To underscore this fact, consider four other views concerning the origin and justification of the safety (and other) obligations of engineers.

1 The first view is that engineers acquire moral obligations concerning safety by being subject to laws or enforced codes that require them to be so obligated. This constitutes a legalistic approach to morality, that is, an attempt to model morality on the law or reduce it to legal and paralegal considerations. When generalized to all morality, it is a version of what we referred to earlier as Ethical Conventionalism: the doctrine that morality is nothing more than the dominant conventions, mores, or laws operating within a given society. And we reject this view, just as we rejected Ethical Conventionalism.

2 The second view is that engineers acquire special obligations by joining a professional society and thereby agreeing to live by that society's code of ethics.

This view differs greatly from the first by emphasizing the voluntary act of agreeing to abide by a code rather than passively being subject to enforced laws and codes. Like the next two views to be discussed, it places the origin of engineers' obligations to safety in a personal commitment to act according to principles implying ethical obligation. Thus it ties directly into our ordinary understanding of how promises and other self-committing acts generate obligations. Yet it is also doubly insufficient. What of the many engineers who choose not to join professional societies? Surely they are not released

from the responsibility to meet obligations to ensure safety. But if the failure to join a society does not remove such obligations, then the act of joining cannot be the sole or main way they are acquired. Moreover, there is always the question of whether what is promised is ethical or not. Thus, if the code of a professional society happened to contain morally harmful entries—such as one restricting responsible criticism of other engineers' safety judgments—the promise to obey that code would either be nullified or overridden by other moral considerations.

3 The third view is that engineers acquire safety obligations through the contractual agreements by which they are hired by their companies or employers. Here we may agree immediately that *some* special safety obligations are acquired in this way. An engineer who is hired as a safety inspector surely does acquire special work responsibilities related to safety. And those responsibilities cannot be reduced merely to prudential concerns, i.e., reduced to the attitude that not meeting them would lead to the loss of one's job or a promotion. Rather they entail specific commitments to fulfill such job-related duties, and this means *moral* obligations have been generated.

Yet even explicit obligations to employers cannot be the sole basis for the safety obligations of engineers. For no engineer is obligated by her or his employee status to sacrifice safety by following an unscrupulous employer's directives to lie, cheat, forge, or directly risk innocent lives by producing or approving shoddy designs and constructions. It is not empty rhetoric, or at least it should not be, to insist that general safety obligations to the public can override obligations to employers. Rather it reflects the point made earlier that specific promises and voluntary commitments sometimes must give way to wider obligations.

4 A fourth view is that engineers, upon entering their careers, made a broad, tacit promise to the public to protect and safeguard it in the course of performing their tasks. In return the public has largely underwritten their education through financial support for schools and implicitly granted the profession as a whole certain privileges. For example, it allows professional societies to accredit schools of engineering, and to participate in setting standards for the title of "professional engineer," as well as establishing technical standards. In principle it could also grant individual engineers the right to zealously pursue public safety, backed by the support of professional societies. An analogy to this would be how the public has granted doctors and lawyers the special privilege of keeping patient and client information confidential so as to increase the trust needed for successful medical therapy and legal defense (Freedman, 1978, 13). Because of these privileges as well as the public's expectations, it is claimed it would be unfair of professionals not to reciprocate by committing themselves to promoting those aspects of the public good that fall within their sphere of activity—in the case of engineers, to promoting public safety.

This amounts to the appealing view that engineers have tacitly signed a kind of mutual contract with the public although the shared understanding

needed to make sense of such a contract is currently rather limited. Nevertheless, if this idea of a contract is to be more than just a metaphor, it remains to be seen how such contracts are justified. That is, are such mutual agreements morally permissible or even obligatory? Answering this question takes us beyond the mere idea of agreements and reciprocal commitments to the issue of *justification*, i.e., to the question of whether those commitments ought to be made in the first place. That issue can only be resolved by reference to the kinds of general ethical theories that we have invoked. Hence each of these four views proves to be inadequate by itself, without reference to ethical theory.

In conclusion, we might distinguish between two different senses in which it is sometimes claimed that engineers have *special* safety obligations in regard to their work. If "special obligations" refers to obligations not grounded in the general human rights which play a central role in ordinary morality by placing obligations on *all* people, then the only special obligations of engineers are those arising out of special employment agreements or agreements with professional societies. But the main safety obligations of engineers do *not* arise from some special membership in a professional society, or from some special law, tradition, or employment condition inapplicable to nonengineers.

If, however, the word "special" is applied to obligations to give special care and attention to safety matters concerning the projects they engage in, then all engineers do have special safety obligations. They have them in virtue of how their particular expertise and functions are directly related to the rights of persons affected by their work. In this sense we can say that an examination of the special professional obligations of engineers in regard to safety meshes straightforwardly with an examination of human rights and other basic moral considerations, and this establishes a link between engineering and moral philosophy.

Study Questions

- 1 Sketch a rule-utilitarian justification of the special safety obligations of engineers listed in the National Society of Professional Engineers code (see Appendix). Then sketch a duty-based justification for those obligations. What would act-utilitarianism have to say about them?
- 2 According to Kenneth Kipnis, a professor of philosophy, the design engineers share the blame for the death of the passengers in the DC-10 crash described above. Kipnis contends that the engineers' overriding obligation was to obey the following principle: "Engineers shall not participate in projects that degrade ambient levels of public safety unless information concerning those degradations is made generally available" (Kipnis, 1981, 82). Do you agree or disagree with Kipnis, and why?
- 3 An engineer visits a construction site where a structure designed by him is being erected. He has not been hired to supervise the construction. Noticing some unsafe conditions (poor scaffolding and the like), he wonders whether or not to report

them. He remembers that on a previous job a colleague had early on reported some safety violations; then, when on later visits to the site she had not noticed additional safety violations which subsequently caused injuries to workers, she had been sued for carelessness. Her first reports had placed her in jeopardy! What should he do?

RESPONSIBILITY AND VIRTUE ETHICS

The ability to effectively confront problems and dilemmas related to right conduct is a vital part of professional ethics. Yet preoccupation with it should not lead us to neglect the heart and spirit of true professionalism. That has to do with the moral ideals to which a profession is dedicated and the moral character of its practitioners. Moral character, as defined by virtues and vices, has as much to do with motives, attitudes, aspirations, and ideals as it does with right and wrong conduct.

It will be useful, therefore, to turn from utilitarianism, duty ethics, and rights ethics to a fuller discussion of virtue ethics. After briefly discussing one classical and one contemporary virtue ethicist, we will consider in more detail the general virtue of being morally responsible and two specific virtues, trustworthiness and benevolence. This will lay a foundation for the conception of responsible engineering set forth in the next chapter.

Aristotle: Virtue and The Golden Mean

Aristotle (384–322 B.C.) defined virtues as acquired habits that enable us to engage effectively in rational activities—activities which define us as human beings. For example, foresight, efficiency, mental discipline, perseverance, and creativity are necessary for successful rational activities that range from engineering to philosophical inquiry. Aristotle called these particular qualities *intellectual virtues* to distinguish them from specifically *moral virtues*.

Moral virtues are tendencies, acquired through habit formation, to reach a proper balance between extremes in conduct, emotion, desire, and attitude. To use the phrase inspired by his theory, virtues are tendencies to find *The Golden Mean* between the extremes of too much (excess) and too little (deficiency).

For example, courage is the appropriate middle ground between foolhardiness (the excess of rashness) and cowardice (the deficiency of self-control and clear thought in the face of danger). Truthfulness is the mean between revealing just everything in violation of tact and confidentiality (excess) and being secretive or lacking in candor (deficiency). Generosity is the virtue lying between wasting one's resources (excess) and being miserly (deficiency). Friendliness is being agreeable and considerate without being annoyingly effusive (excess) or sulky and surly (deficiencies).

Moral virtues enable us to pursue a variety of social goods within a com-

munity—a concept that was especially important for citizens of ancient Greek city-states, since the city-state's survival depended on close cooperation of its citizens. Taken together, the moral virtues also enable us to fulfill ourselves as human beings. They enable us to attain *happiness*, by which Aristotle meant an active life in accordance with our reason (rather than a life of pleasure).

MacIntyre: Virtues and Practices

Virtue ethics has recently been revived and enriched by Alasdair MacIntyre, among others, and applied to professional ethics (MacIntyre, 1984). MacIntyre begins with the idea of *practices*—cooperative activities aimed toward achieving social goods that could not otherwise be achieved. These goods are *internal* to the practices in that they define what the practices are all about. Hence they differ from *external goods* like fame and prestige which can be achieved through many different kinds of activities and do not define any specific practice. For example, the primary internal goods of medicine are good health and respect for patients' autonomy; the primary internal good of law is social justice.

The primary internal good of engineering is the creation of useful and safe products while respecting the autonomy of clients and the public. The virtues and ideals especially for engineers are defined by reference to these end products. Only the conscientious, safety conscious, and imaginative engineer is likely to achieve the good outcomes expected of engineering. These virtues also make possible *integrity*, or moral unity, between the engineer's personal and professional life. Before developing these ideas in the next chapter, let us gain a richer understanding of moral responsibility.

Moral Responsibility

The notion of moral responsibility cuts across judgments about both right actions and people. In every case where moral responsibility is ascribed to someone, a moral judgment is being made; judgments may be of various types (Hart, 1973, 211–230). The interest may be in assessing (1) obligations to perform right actions, (2) general moral capacities of people, (3) the virtue of a person, or (4) liabilities and accountability for actions.

1 We speak of persons as *having* moral responsibilities. In this sense, responsibilities are simply obligations and duties to perform morally right acts. Some of those are shared by us all: for example, the responsibilities to be truthful, to be fair, and to promote justice. Others relate only to people performing within certain social roles or professions: For example parents have specific responsibilities to care for their children, a safety engineer might have responsibilities for making regular inspections at a building site, or an

operations engineer might have special responsibilities for identifying potential benefits and risks of one system as compared to another.

2 Sometimes when we ascribe responsibility to a person viewed as a whole rather than in respect to a specific area of his or her conduct, we have in mind an active *capacity* for knowing how to act in morally appropriate ways. In this sense young children are not yet morally responsible. They gradually become so as they mature and learn how to be responsive to the needs and interests of others. Adult sociopaths who lack any sense of guilt for wrongdoing never become responsible in this sense.

3 At other times when we say someone is responsible, we mean to ascribe a general moral *virtue* to the person. We mean that he or she is regularly concerned to do the right thing, is conscientious and diligent in meeting obligations, and is someone who can be counted on to carry out duties or be considerate of others. In a moment we shall return to this sense.

4 Finally, "responsible" often means accountable, answerable, or liable for meeting obligations. In this sense, to say individuals are responsible for actions means they can be "held to account" for them: that is, they can be called upon to explain why they acted as they did; to provide excuses or justification if appropriate; and to be open to commendation or censure, praise or blame, or demands for compensation. We also hold ourselves accountable for our own actions, responding to them with emotions of self-esteem or shame, self-respect or guilt. This notion of responsibility will also be developed more fully in Chap. 3.

Accountability and Voluntary Action Usually when we hold a person accountable for an action we imply that the action was not completely involuntary. But it is not easy to know precisely what this requirement amounts to.

Aristotle suggested that involuntary acts are of two main kinds (Aristotle, 964-967). First, they include acts done in ignorance. If, unknowingly, we loan a car to a distraught friend who crashes it, we have not voluntarily contributed to the friend's death. The problem here is that we also hold people accountable when they *should have known* what they were doing and what the likely consequences of their action would be. Ignorance then, is not always an excuse. On the other hand, it is often difficult to judge fairly what people should have known, especially in the types of complicated situations that can arise in professions like engineering.

Second, Aristotle said acts are involuntary when performed under compulsion. He interpreted compulsion as an external force which determines our actions. Aristotle also noted that the mere existence of obstacles does not entirely negate voluntariness. Rather their presence limits the range of choices open to us. When those choices become sufficiently limited, we have to think in terms of degrees of voluntariness, and hence degrees of liability for harm done. An example would be the limitations placed on our decisions

in response to a kidnapper who demands a ransom for not killing someone dear to us.

To make things even more complicated, many psychologists today would make a major addition to Aristotle's views: Acts may be involuntary when they are generated by uncontrollable inner compulsions, such as those motivating psychotics or pathological liars. Yet it is extremely difficult to make accurate assessments of other people at this level.

Causal and Legal Responsibility There are two other concepts of responsibility (Hart, 1973, 214–215). These should not be confused with moral responsibility in any of its four preceding senses. First, *causal responsibility* consists simply in being a cause of some event. In this sense we speak of lightning as being responsible for a house catching fire.

People can be causally responsible for an event without necessarily being morally responsible for it. For example, a 2-year-old child may cause a fire while playing with matches, but it is the parents who left the matches within the child's reach who are morally responsible for the fire.

Second, *legal responsibility* should also be distinguished from moral responsibility. An engineer or engineering firm can be held legally responsible for harm which was so unlikely and unforeseeable that little or no moral responsibility is involved.

One famous court case involved a farmer who lost an eye when a metal chip flew off the hammer he was using (Vaughn, 1977, 41–47). He had used the hammer without problems for 11 months before the accident. It was constructed from metals satisfying all the relevant safety regulations, and no specific defect was found in it. The manufacturer was held legally responsible and required to pay damages. The basis for the ruling was the doctrine of *strict legal liability*, which does not require proof of defect or negligence in design. Yet surely the manufacturer was not morally culpable or blameworthy for the harm done. If we say the manufacturer was morally responsible, we mean at most that the company has an obligation (based on the special relationship between it and the farmer created by the accident) to help remedy the problem caused by the defective hammer.

Conversely, it is also possible to be morally responsible for something one cannot be held legally responsible for. For example, because of the fine wording of a contract an engineer may be free from any legal liability for failing to report an observed danger at a construction site. Yet it may have been his or her professional and moral obligation to report that danger.

Motives and Professional Ethics

Let us now focus on responsibility as a virtue. Calling professionals responsible in this sense ascribes to them conscientious concern for the moral ideals and aims of their profession. A responsible physician is motivated (in part) by a concern for the health and autonomy of patients. A responsible engineer

is motivated (in part) by respect for the safety and autonomy of the public and clients.

Of course, none of us is motivated by entirely simple motives. Very frequently we pursue a line of conduct from a combination of motives, some pertaining to morality and some not. A student's motives for attending college, for example, might include the desire to obtain a well-paying job, to gain social recognition, to please parents, and to prepare for a socially useful career. The last of these motives is often grounded in the morally admirable motive of altruism—the desire to contribute to the good of other people. Similarly, the desire to obtain a well-paying job so as not to be a burden on others or so as to be able to support a family is a morally admirable motive. Even the desire to find challenging work is related to the moral ideal of self-fulfillment.

Professionals are similarly motivated in their careers by a mixture of motives. This mixed motivation is not lamentable; instead it is desirable. Moral ideals are easier to achieve when moral motives are reinforced by self-interest. ("Self-interest" means concern for one's own good. It does not mean "selfishness"—that is, excessive concern for one's own good at the expense of other people.)

In addition to motives of moral concern and self-interest, there is another important category of professional motives: concern for achieving excellence in the technical aspects of one's work. The excitement of engineering, combined with a strong desire to see it done well, constitutes a potent stimulus for professional conduct.

In fact, the technical challenge of work is sometimes enough by itself to inspire right conduct throughout much of a career, even though some moral motivation seems essential to most careers. An interesting illustration of this is presented by Graham Greene in his novel *A Burnt-Out Case*.

Greene describes an architect who has reached the top of his profession without caring very much about the good of the public which has benefited from his work. The architect, world renowned, abandons a career in which he has made numerous brilliant contributions without any wrongdoing. He travels to Africa and meets a doctor who is practicing medicine on the basis of a concern for his patients. In one scene the architect explains to the doctor that his interest had always been in the "space and light and the proportion" of buildings, not in the people who might use them (Greene, 1977, 44). Jokingly, the doctor remarks that he would not have trusted the plumbing in the structure designed by the architect. But the architect presses his point. He confesses that of course he had to consider human needs, but only in the same way he had to consider the brick, glass, and other building materials. His sole motivation, however, was the creation of beautiful structures.

As this incident suggests, it is possible for a person to act on professional obligations from primarily nonmoral motives, such as a sheer pleasure in the beauty of the emerging product and excitement over the technical aspects of the work. The doctor's facetious remark about plumbing reminds us that ar-

chitects and engineers must be concerned professionally to satisfy the needs of people they serve, but that concern may not be moral in origin. Accordingly, much of professional ethics focuses on the level of care the architect says he showed in his work—attention to the safety, well-being, and needs of those affected by the professional activities involved—no matter what the ultimate wellspring of that attention may be.

The story also illustrates, however, that long-term involvement in a career (avoiding early “burnout”) may require moral concern. Moreover, things easily go amiss when preoccupation with the technical aspects of work leads to a disregard of moral obligations. An illustration of this point is found in William Golding’s novel *The Spire*.

The Spire is a rich allegory about fidelity, creativity, and the way in which self-deception can warp concern for safety within engineering. Set in England during the Middle Ages, the plot revolves around the construction of a 400-foot spire atop an aging cathedral. Success in the project would mean developing technology well beyond its then current state, and this provides the motivation for the master builder commissioned to undertake the project.

Yet as the master builder assesses the weaknesses of the foundations supporting the church, he is led to suspect that the stone and glass spire cannot be supported properly. Thereafter his suspicions are repeatedly confirmed to the point where his best professional judgment—what he humbly calls his “guesses”—indicate the task is both futile and dangerous. Nevertheless, the priest who is his client desperately clings to a vision of the spire as a “prayer in stone” and urges the craftsman on.

The master builder gradually becomes biased as he allows his excitement over the project and the personal influence of the priest to lead him to disregard safety. As the story ends, the entire structure is slowly crumbling.

Personal Integrity and Virtues

There is a further reason why moral conduct is essential for professionals. This reason has to do with the maintenance of personal and moral integrity. Morality requires that our lives be unified where fundamental values are at stake, not compartmentalized. There must not be a cleavage between the working life and the public self of the sort Charles Reich described when he wrote, “It is this split that sometimes infuriates his children when they become of college age, for they see it as hypocrisy. The individual has two roles, two lives, two masks, two sets of values. . . . Neither the man at work nor the man at home is the whole man; it is impossible to know, talk to, or confront the whole man, for that wholeness is precisely what does not exist” (Reich, 1970, 78).

Virtues provide a bridge between private and professional life. Virtues are general patterns of action, emotion, and attitude that permeate all areas of life. They involve habits that constitute fundamental ways of relating to the

world, not just to selected situations. Moral integrity (inner unity on the basis of moral commitments) is maintained when virtues are manifested across the line between personal and professional life.

This explains what is often wrong when an employee says, "Don't blame me; I was just doing my job." The implication is that the employee is a mere cog in the machinery of the workplace, or a mere tool to be used by an employer, rather than a responsible person whose life has moral coherence. Again, when people try to justify wrongdoing by saying, "If I don't do it, someone else will," they are failing to take responsibility for their actions (regardless of what other people do).

Trustworthiness and Benevolence

Taking responsibility for one's actions is a very general virtue. Trustworthiness and benevolence are two of the specific virtues it encompasses—virtues especially important in professions like engineering.

Trustworthiness is a fundamental virtue for those who engage in the relationships between engineers and their employers and clients. These relationships are based on trust—trust that engineers will effectively perform the services for which they are hired. Here is a list of even more specific virtues that trustworthiness involves (Bayles, 1981, 70–86).

Honesty in Acts: For example, not stealing, not padding expense sheets, not engaging in bribes and kickbacks

Honesty in Speech: Not deceiving; being candid by revealing all pertinent information

Competence: Being well prepared for the jobs one undertakes

Diligence: Zeal and careful attention to detail in performing tasks (by, for example, avoiding the defect of laziness and the excesses of the workaholic)

Loyalty: Acting faithfully on behalf of the interests of the employer or client (avoiding the defect of allowing self-interest to distort one's service and avoiding the excess of disregarding other important duties such as those to the public)

Discretion: Sensitivity to the legitimate areas of privacy of the employer or client, especially with regard to confidential information

Benevolence is also pertinent to the relationship between employers and clients, but it is especially important in thinking about obligations to third parties affected by one's work, in particular the public. *Benevolence* is the desire to promote the good of others based on an attitude of concern for their well-being. Hence much of the discussion of concern for others presented in this section applies to benevolence.

The following specific virtues are all aspects of benevolence.

Nonmaleficence: Not harming others

Beneficence: Doing good and preventing or removing harms to others

Generosity: Going beyond the minimal degrees of helping others

While each of these aspects of benevolence is important, the first is the most basic. It lies behind the oldest professional dictum, one embedded in the Hippocratic Oath taken by physicians: "Above all, do no harm." As we shall see, heeding that charge is a complicated task in engineering.

Study Questions

Kermit Vandivier had worked at B. F. Goodrich for 5 years, first in instrumentation and later as a data analyst and technical writer. In 1968 he was assigned to write a report on the performance of the Goodrich wheels and brakes commissioned by the Air Force for its new A7D light attack aircraft. According to his account, he became aware of the design's limitations and of serious irregularities in the qualification tests. The brake failed to meet Air Force specifications. Upon pointing out these problems, however, he was given a direct order to stop complaining and write a report which would show the brake qualified. He was led to believe that several layers of management were behind this demand and would accept whatever distortions might be needed because their engineering judgment assured them the brake was acceptable.

Vandivier then drafted a 200-page report with dozens of falsifications and misrepresentations. But he refused to sign it. Later he gave as excuses for his complicity the facts that he was 42 years old with a wife and six children. He had recently bought a home and felt financially unable to change jobs. He felt certain that he would have been fired if he had refused to participate in writing the report (Vandivier, 20-24).

- 1 Present and defend your view as to whether Vandivier was justified in writing the report or not. In doing so, draw upon one of the theories of right action discussed in the second section of this chapter.
- 2 Was Vandivier guilty or blameworthy? That is, even if his actions were wrong, is it appropriate to excuse him from blame because of circumstances beyond his control?
- 3 Is Vandivier responsible for what he did? In answering this question, distinguish between the various senses of "responsible" discussed in this section.
- 4 Which virtues did Vandivier not display, and what might those virtues have required of him in his situation?
- 5 Truthfulness and truth telling are key virtues for engineers as they interact with other participants in the technological enterprise (illustrated in Fig. 1-1, Chap. 1). Their meanings come into sharper focus when their antonyms are examined. These include lying, deception, and withholding information. (The latter two are often grouped as "disinformation" in government parlance.) Give examples from engineering, business, or other professions to illustrate these concepts.

SUMMARY

Moral problems, in the widest sense, are those that arise in any situation calling for decisions based upon moral reasons. Sometimes what ought to be done is a straightforward matter, and the only difficulty is in avoiding temptations to violate moral obligations. At other times it may be unclear whether

a moral principle applies, as when deciding whether accepting some gifts from salespeople violates the rule "Do not accept bribes." *Moral dilemmas* are those moral problems in which two or more moral obligations, duties, rights, ideals, or applications of a single principle come into conflict in a situation in which not all of them can be respected or fulfilled. Duties which sometimes allow exceptions in such situations are called *prima facie duties*.

Moral values require that we be concerned about the good and the rights of other people. Hence morality is not reducible to matters of self-interest, law, or religion. For this reason we rejected *Ethical Egoism* (the view that right action consists in producing one's own good), *Ethical Conventionalism* (the view that right action is merely what the law and customs of one's society require), and *Divine Command Ethics* (the view that right action is defined by the commands of God, such that without a God there could be no moral values).

There are four main types of ethical theories which provide helpful frameworks for identifying the factors involved in moral dilemmas and for offering guidance.

Acts are morally right when:

• They produce the most good for the most people.	Act-utilitarianism: Mill	} Utilitarianism
• They fall under a rule which if widely followed would produce the most good for the most people. *	Rule-utilitarianism: Brandt	
• They fall under principles of duty which respect the autonomy and rationality of persons, and which can be willed universally to apply to all people.	Kant	} Duty Theories
• They fall under principles which would be agreed upon by all rational agents in a hypothetical contracting situation that assures impartiality.	Rawls	
• They are the best way to respect the human rights of everyone affected.	Locke and Melden	} Rights Theories
• They most fully manifest or support relevant virtues, where virtues are traits of character making possible the achievement of social goods.	Aristotle and MacIntyre	} Virtue Theories

These ethical theories give help in approaching moral dilemmas by providing frameworks for assessing the relevant moral factors involved and by offering guidance. They can also be applied to identify and justify the general obligations of engineers and other professionals.

Finally, if *actions* can be judged right or wrong, *people* can be judged as good or bad, virtuous or vicious, responsible or irresponsible. Underlying

such assessments are moral virtues: good traits of character which involve habits and patterns of action, emotion, attitude, and desire. The most general professional virtue is moral responsibility, which differs from mere causal and legal responsibility. In addition to this "virtue" sense of responsibility, the concept of moral responsibility also refers sometimes to obligations, the general capacity to act in morally concerned ways, and accountability for actions. Two of the more specific virtues related to being responsible as a professional are trustworthiness (honesty in action and speech, competence, diligence, loyalty, and discretion) and benevolence (nonmaleficence, beneficence, and generosity).