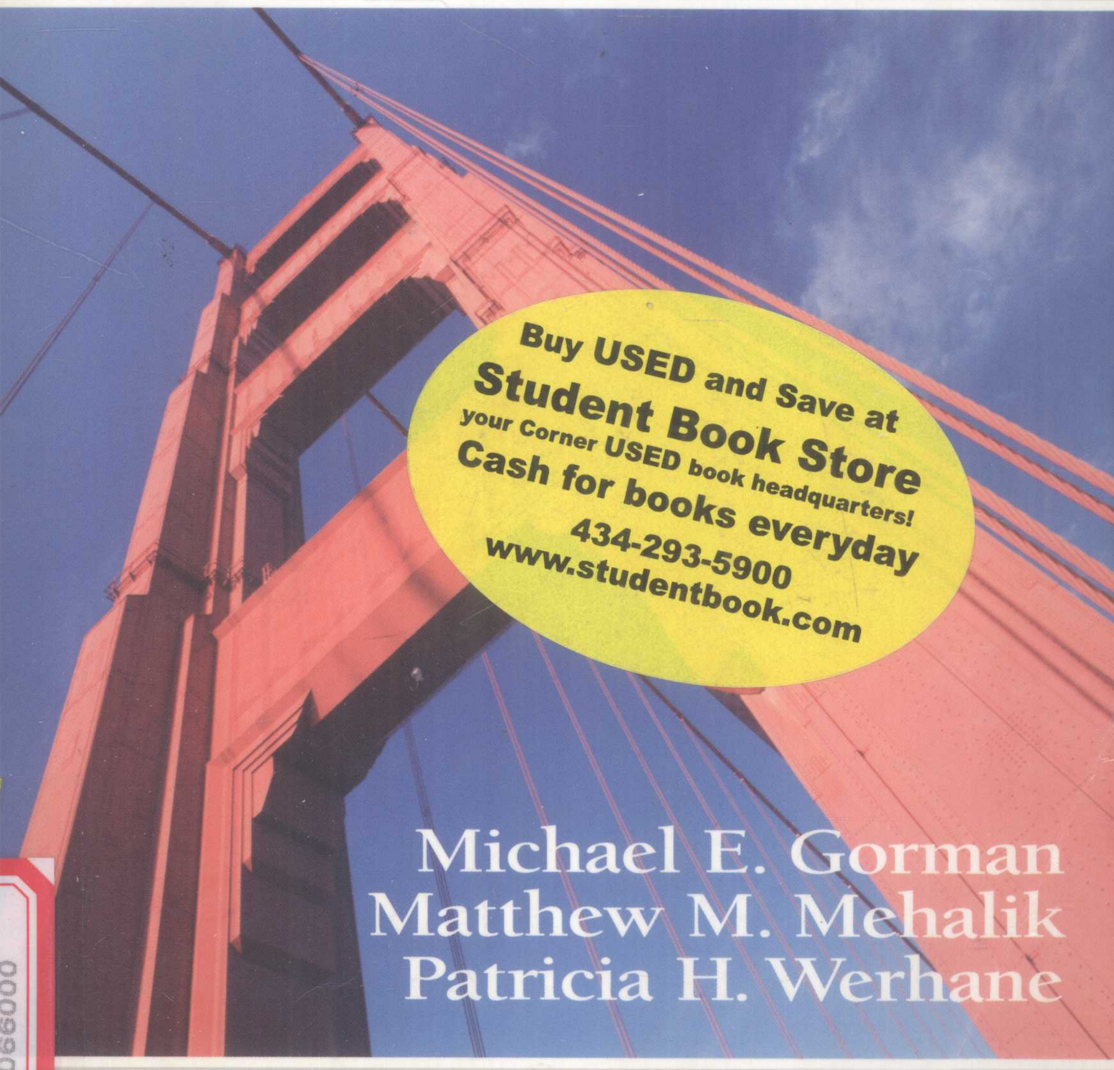
Ethical and Environmental Challenges to Engineering



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PREFACE

This is a casebook for engineers, managers, and students interested in design and managerial dilemmas in a variety of settings. The book grew out of our growing conviction that case method teaching is the best pedagogy to teach design, environmental engineering, managerial, and engineering ethics. The cases we include are real-life events, not hypothetical situations, that mirror situations that students will actually face. Our approach involves extended, fine-grained case studies with multiple dilemmas that encourage students to engage in moral imagination. Many of the cases present a cultural dimension that is especially important as global diversity becomes an essential part of design, management, and engineering.

All the cases in this collection have been taught at least once, some of them several times, to undergraduates or graduate students in engineering and management programs. They have been taught in courses in business ethics, engineering ethics, managerial ethics, engineering management, design, and environmental ethics. The Unilever cases have also been used in entrepreneurship and corporate venturing courses.

This book can be used as a main text or it can compliment other texts as a casebook to accompany any engineering ethics, environmental ethics, applied ethics, social studies of science, entrepreneurship, sustainable business, or business ethics course.

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INTRODUCTION

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This book presents a series of full-length case studies accompanied by background readings that illustrate how one can integrate ethical and environmental challenges into engineering decisions, especially ones early in the design process. These cases will be useful for engineers in a variety of disciplines, including systems engineering, and they should also be useful to those who manage engineers and to those who wish to know more about how technology can address global problems.

We begin with the thesis that the best pedagogical method to teach design, environmental engineering, and engineering ethics is through the case study approach. This approach is used widely in law, medicine, and business (Lynch, 1997; Self & Ellison, 1998). Case studies are also being used increasingly to teach engineering design (Richards et al., 1994). There is growing evidence that experts acquire much of their knowledge through cases and examples (Kolodner, 1993; Kolodner, 1991).

James Rest's extensive research (Rest, 1988) concludes that moral reasoning skills (and by analogy, engineering and environmental considerations) can be taught to adults. Such skills are best taught, Rest and his colleagues argue, through the case method. Students are exposed to real-life situations that illustrate some particular set of issues. Students then are asked to develop criteria for reasoning through these dilemmas that take into account ethical and environmental concerns. In this book we focus on real-life cases, typically with more than one decision point. Hypothetical cases have a place in engineering education, but in our experience, students need to see multiple examples of how ethical dilemmas are handled in the real world. They also need to see the kind of detailed information available to actual decision makers. Real-life events pose multiple dilemmas for which there is no one simple right answer. These cases are useful not only as illustrations but also as ways to encourage the imagination of engineering students to think more creatively about their work. The idea is to challenge readers to think broadly about ethical issues, environmental issues, and the practicality of their creative inventions. Accompanying these cases are a set of short theoretical articles that serve as background foundational considerations to which readers can appeal to justify their case analyses.

A case study approach to engineering ethics produces at least three positive outcomes:

1. Through practice, students internalize these reasoning processes so that such processes become habitual ways of dealing with new engineering dilemmas. Lecturing about ethics and testing students on ethical theories and principles is useful, but it is hard for students to translate this kind of knowledge into practice. Cases constitute a kind of virtual apprenticeship, in which students can apply ethical principles to actual situations and discuss the outcomes with each other and with a faculty mentor.
2. By exposing engineering students to a variety of situations where the design criteria, environmental issues, and thus resolutions of the cases, are not simple, students are encouraged to think imaginatively about design. This thinking is amplified by considering issues such as the impact of technological systems on the environment and on those groups traditionally underserved by technology. Moral imagination involves recognizing the role, scheme, or mental model that one is adopting, disengaging from it, and evaluating alternative perspectives and courses of action. Engineers need to engage in moral imagination in the earliest stages of the design process—this allows them to see how an apparent technological improvement looks from other perspectives. This kind of imagination is similar to thinking about the needs of a user when designing a product (Norman, 1993) but has an additional ethical component. For example, even if the product fits a user's mental model and needs, will it harm the environment or have a negative impact on a particular group or culture?
3. Case studies can encourage engineers to think about how they will assume leadership roles. Most graduates from schools of engineering at universities will eventually find themselves in managerial positions; those who do not will still end up serving as team leaders. In the cases we develop students are placed in managerial as well as engineering decision roles. This dimension of these cases further stimulates students to think about design from a number of differing perspectives.

With these outcomes in mind, the cases in this book:

1. Give illustrations of designs that are environmentally friendly and economically viable.
2. Demonstrate that design always involves ethical considerations.
3. Help to develop the moral imagination of engineering students in order to face ethical challenges in their professions.
4. Increase student skills in making ethical design decisions via a case-based approach, involving multiple dilemmas that stem from a detailed description of a real-world problem.
5. Present stories that will inspire engineering students. Along with the inspirational tales, there are some cases of engineering heroes who try to make a better world. Accompanying these success stories are examples of what to avoid; for instance,
   a. Designs that fail because they do not meet standards of commonsense morality or the challenges of preserving the environment.

b. Designs that are created with good ethical motives but fail either because they are impossible to produce or because the inventor cannot create a market for them.
c. Designs that are created with sound engineering, ethical, and/or environmental criteria but run into difficulties because of unforeseen background social, cultural, religious, or emotional conditions.

As you read and analyze the cases, consider the following:

1. Evaluate the decision at issue, based on the evidence at the time, using moral reasoning skills.
2. Evaluate and challenge the assumptions and framework of the decision from perspectives that appear to introduce points of view that seem irrelevant to the issues at hand but that will turn out to be central to the outcome of the case.
3. For cases dealing with design: Consider the importance of a product, its viability, its marketability, and its substitutability from a managerial as well as from an engineering perspective. Ask questions such as: Is this product essential? Is designing, manufacturing, or marketing this product this way the only option? What are the environmental side effects of this product? What are its ethical side effects? What are its social side effects? Is there another viable approach to this design and this product that would better take into account a wider variety of perspectives or points of view?
4. For cases dealing with engineering disasters: Evaluate the design, the process, and the social and cultural context in which the events preceding the disaster are embedded. What are the elements that made this event possible? Could it have been prevented? What is the role of moral imagination in preempting such occurrences or preventing them from reoccurring?
5. For cases that involve engineering and environmental challenges in less developed countries, consider the cultural, social, and economic setting of the case. Given those conditions, how might your approach to this case be different than, say, if this challenge were situated in the United States or in another industrial country? How can one create a win-win situation that respects cultural and indigenous differences, that enhances the well-being of the particular population, and that respects concerns for protecting and preserving the environment, all concerns facing the world today?

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Moral Reasoning, Mental Models, and Moral Imagination

The study of ethics and the analysis of moral decision making are ancient traditions in the history of human life. Procedures for ethical decision making and reasonable standards for behavior are part of every society, and the description of values, moral beliefs, and mores is part of the way we define and describe people, institutions, cultures, and nations. Still, the task of justifying moral beliefs and integrating them into all parts of our daily lives, and the process of applying moral standards to all aspects of decision making is incomplete. In practice, these processes are difficult, because social, technological, and economic goals and demands of one's profession often appear to override moral considerations.

These difficulties are most obvious in engineering. Gusterson (1996) discusses the way in which nuclear weapons designers thought about ethical issues in private but thought it inappropriate to carry on much public discussion about them. Typical participants in weapons laboratories and in defense-related work are trained to compartmentalize; they cannot even talk about their work to others who do not have their security clearance. Engineers working on confidential projects for companies also have to compartmentalize. Some of this compartmentalization is necessary, but with it can come a similar bracketing of moral concerns and can lead to an unthinking compliance with the demands of a role.

This phenomenon, of compartmentalizing one's decision making, is illustrated by the famous obedience studies conducted by Stanley Milgram. Milgram wanted an empirical answer to a question raised by the Nazi holocaust: Could that kind of mass obedience happen here, in the United States? He was particularly disturbed by Nazis such as

Adolph Eichmann who contended that their behavior was excusable because they were "just following orders."

Milgram asked for volunteers to be paid participants in a study of the effects of punishment on learning. Each of these participants was assigned the role of a teacher, who had to administer an electric shock to a learner every time the learner got a wrong answer. The learner also appeared to be a volunteer participant, but in fact he was a confederate of Milgram's. Voltage of the shocks increased with each error, and the confederate's protests became more and more vehement, until he refused to participate in the experiment any further.

In the initial version of the experiment, the teacher heard the learner's protests through a wall: Milgram had tape-recorded them. The experimenter, in a white lab coat, responded to teachers' concerns by reminding them that the experiment required them to continue to administer shocks. To Milgram's surprise and dismay, a majority of participants continued to the highest level of shock, 450 volts (Milgram, 1974). In a later version of the experiment, Milgram arranged for the teacher to see the confederate as he shouted in pain, protested, and finally slumped over. When obedience remained high, Milgram added a permutation in which the teacher had to force the learner's hand onto the shock plate. Even in this condition, over one-third of the participants went to the highest level of shock, and many others went to high levels before quitting.

One possible explanation for this result is that participants bracketed or compartmentalized their ordinary responses in assuming a role subservient to the experimenter. Milgram demonstrated this with a clever permutation of the experiment, in which the experimenter was forced to volunteer to receive shocks while the confederate who would have been the victim ordered the participant to continue them. As soon as the experimenter, now strapped in the chair, objected, participants overruled the confederate and released him (Milgram, 1974).

Philip Zimbardo did a similar study in which he assigned volunteers at random to be prisoners or guards in a prison simulation. After six days, he had to cancel it because everyone had fallen too deeply into their roles . Zimbardo himself recalled preparing for a prison break by moving all the prisoners to another site, then sitting in the empty prison and listening with annoyance while a colleague asked him intellectual questions about the experiment. Zimbardo later wondered why he didn't treat the potential prison break as an opportunity to study rumor transmission. Instead, he fell victim to the rumor himself. Zimbardo became so absorbed in his role as prison director that he forgot his primary goal was to study the environment he had created. In the same way, engineers and managers can become so absorbed in their roles that they are unable to step out of them and see what they are doing from another perspective (Zimbardo, 1972).

We see, then, that integrating moral standards into practical decision making is not easy nor without risk. Yet, not to take into account normative considerations in practical affairs such as engineering and management decision making itself is a normative decision that ignores some elementary facts.

1. Most decisions, even those of science and technology, are choices. Sometimes there is a limited range of alternatives, even, sometimes, one acceptable choice. Still, not every engineer makes the acceptable decision in every instance.

2. Such decisions affect people, and an alternate decision (or inaction) would affect them differently.
3. Every decision or set of decisions is embedded in a belief system and culture that presupposes some basic values. For example, Union Carbide's decision to join the Indian government in building the Bhopal pesticide plant illustrates how what appeared to be technological and economic decisions have had enormous moral consequences for the company and for Bhopal residents living near the plant.

The term *ethics* or *ethical* is often used to refer to good behavior, and the term *morals* sometimes refers to the mores or norms of a particular community. In what follows we shall use these terms interchangeably. What is ethics? *Ethics* will be used as a generic word referring to the analysis, processes, and normative elements of decision making, including what is right or wrong, good or bad, how we should or should not act, and standards for judging conduct. An ethical judgment includes evaluating bad as well as good decisions, actions, motives, and behavior. Philosophical ethics is the study of moral discourse, the analysis of the nature of moral principles, and the study of the nature and justification of moral terms. In applied and professional ethics, including engineering ethics, part of its task is the study of the appropriateness of moral discourse in practice, for example, in the practice of engineering. Ethics is also more explicitly normative, and ethicians study, develop, and critique moral standards, moral rules, and procedures for ethical decision making. In engineering ethics the viability of these standards and procedures makes sense only when there is a possibility of their practical application in particular contexts. Ethics is also empirical or descriptive. The collection of information on professions, professional codes, or the belief structure of a particular institution or culture, or descriptive data analysis of actual decision-making habits of researchers, engineers, or managers are all part of such empirical work (Werhane, 1999). The development of the Dow Corning breast implant illustrates such an empirical study, and one cannot understand Dow Corning's recent predicament surrounding the breast implant controversy unless one carefully examines the development of the product.

The distinction between normative and descriptive ethics, although not clear-cut, allows us to distinguish what, in fact, is an accepted practice in a particular situation, and what someone or some culture deems to be acceptable or valuable as a standard for judging practices. The Eskom cases illustrates this distinction. In rural South Africa today many inhabitants of small villages tap into electric power without paying for it. This practice was developed during the apartheid era as a protest against the white Afrikaans government. Today this habit persists, and it is still an accepted practice in some of these communities to tap into the power lines. The task for a company such as Eskom, the South African national power company, is to change this behavior to what, under Mandela's leadership, is a more acceptable practice—paying for the use of electricity.

What is accepted practice, of course, is not always immoral, and this distinction leads to another: that between what is legal and what is ethical. What is enacted into law is often, but not always, grounded on moral principles; for example, on the basis of human rights or principles of justice. But no legal system covers all ethical considerations, and we often appeal to moral principles to judge laws or even legal systems. The Neemix cases exemplify these difficulties. Under Indian law it is permissible to patent products such as pesticides made from the neem tree. But the neem tree has been part of ancient religious and healing traditions in India for several thousand years. Do Indian patent laws defy ancient customs or indigenous property claims? What is acceptable in this circumstance?

SOME TRADITIONAL THEORIES OF MORAL REASONING

Let us turn to a brief discussion of some important components of a few prominent ethical theories. This discussion, although not inclusive or complete, will help us to develop a framework for moral reasoning and decision making that takes into account these theories and will have practical applications in engineering decision making as well.

Utilitarianism

When faced with an ethical issue in practice, one of the first questions concerns harms or costs versus benefits or gains. For example, as the large multinational company, Unilever, faces decisions concerning the design and development of environmentally sustainable processes and products, costs and benefits are part of its decision equation. Although this approach appears to be primarily economic, it is buttressed by a well-known ethical theory: utilitarianism. Utilitarianism traces its roots to two British thinkers, Jeremy Bentham and John Stuart Mill. Linking what is universally desired with what is desirable, a utilitarian argues, in brief, that what is most important and universally valued by almost everyone is the satisfaction of desires or interests, human pleasure or happiness, or the reduction of pain or suffering. According to utilitarians, whatever one's motives or intentions are, we tend to judge human action in terms of its outcomes, not merely on what an action was meant to achieve. A utilitarian measures harms and benefits in terms of their qualitative and quantitative merit, long-term versus short-term satisfaction, and also in terms of human interests, for example, freedom, health, autonomy, as well as well-being. The best sort of decision, the most useful, is one that maximizes human interests, best satisfies desires or pleasures, or minimizes costs or harms. According to Bentham, the principle of utility should be applied impartially over the range of persons affected by the decision or its outcomes, weighing each person and his or her interests equally. The best outcome is that which maximizes the interests or contributes to the well-being of the greatest number, or, minimally, costs least or reduces the most harms, all things considered (Bentham, 1789; 1948).

Utilitarianism raises some important considerations that should be factored into any decision-making process. These include:

- Any decision should be impartial, taking into account the broadest range of interests, treating each person equally, but only as an equal partner.
- An ideal decision is one that maximizes interests, pleasures, or well-being for the greatest number of people.
- Ordinarily, a decision is not acceptable if it results in a net increase of harms of any sort, even to a small number of people. However,
- In measuring utility it may be justifiable, in some cases, to sacrifice the well-being of a very few in order to prevent harms to or increase the well-being of a far greater number of people.