Philosophy of Engineering and Technology

Colleen Murphy
Paolo Gardoni
Hassan Bashir
Charles E. Harris, Jr.
Eyad Masad *Editors*

Engineering Ethics for a Globalized World

Springer

Philosophy of Engineering and Technology

Volume 22

The Philosophy of Engineering and Technology book series provides the multifaceted and rapidly growing discipline of philosophy of technology with a central overarching and integrative platform. Specifically it publishes edited volumes and monographs in: the phenomenology, anthropology and socio-politics of technology and engineering the emergent fields of the ontology and epistemology of artifacts, design, knowledge bases, and instrumentation engineering ethics and the ethics of specific technologies ranging from nuclear technologies to the converging nano-, bio-, information and cognitive technologies written from philosophical and practitioners perspectives and authored by philosophers and practitioners. The series also welcomes proposals that bring these fields together or advance philosophy of engineering and technology in other integrative ways. Proposals should include: A short synopsis of the work or the introduction chapter. The proposed Table of Contents The CV of the lead author(s). If available: one sample chapter. We aim to make a first decision within 1 month of submission. In case of a positive first decision the work will be provisionally contracted: the final decision about publication will depend upon the result of the anonymous peer review of the complete manuscript. We aim to have the complete work peer-reviewed within 3 months of submission. The series discourages the submission of manuscripts that contain reprints of previous published material and/or manuscripts that are below 150 pages / 75,000 words. For inquiries and submission of proposals authors can contact the editor-in-chief Pieter Vermaas via: p.e.vermaas@tudelft.nl, or contact one of the associate editors.

More information about this series at http://www.springer.com/series/8657

Colleen Murphy • Paolo Gardoni • Hassan Bashir
Charles E. Harris, Jr. • Eyad Masad
Editors

Engineering Ethics for a Globalized World

Springer

Editors
Colleen Murphy
University of Illinois at Urbana-Champaign
Urbana, IL, USA

Paolo Gardoni
University of Illinois at Urbana-Champaign
Urbana, IL, USA

Hassan Bashir
Texas A&M University at Qatar
Doha, Qatar

Charles E. Harris, Jr.
Texas A&M University
College Station, TX, USA

Eyad Masad
Texas A&M University at Qatar
Doha, Qatar

ISSN 1879-7202 ISSN 1879-7210 (electronic)
Philosophy of Engineering and Technology
ISBN 978-3-319-18259-9 ISBN 978-3-319-18260-5 (eBook)
DOI 10.1007/978-3-319-18260-5

Library of Congress Control Number: 2015941149

Springer Cham Heidelberg New York Dordrecht London

Printed on acid-free paper

Springer International Publishing AG Switzerland is part of Springer Science+Business Media (www.springer.com)

Contents

1 Introduction 1
Colleen Murphy, Paolo Gardoni, Hassan Bashir, Charles E. Harris, Jr., and Eyad Masad

Part I Ethical Issues in a Globalized World

2 Engineers, Firms and Nations: Ethical Dilemmas in the New Global Environment 15
Leonard Lynn and Hal Salzman

3 International Ethics and Failures: Case Studies 35
Norbert Delatte

4 US Engineering Ethics and Its Connections to International Activity 55
Rachelle D. Hollander

5 "Global Engineering Ethics": Re-inventing the Wheel? 69
Michael Davis

6 Engineering Decisions in a Global Context and Social Choice 79
Noreen M. Surgrue and Timothy G. McCarthy

7 Engineering Responsibility for Human Well-Being 91
Charles E. Harris, Jr.

8 Towards an Ethics of Technology and Human Development 109
Ilse Oosterlaken

9 Ethics, Economics and the Environment 127
Khalid Mir

10 Ethics for Construction Engineers and Managers in a Globalized Market 143
George C. Wang and John S. Buckeridge

Part II Implications for Engineering Ethics Education

11 Overcoming the Challenges of Teaching Engineering Ethics in an International Context: A U.S. Perspective 167
Brock E. Barry and Joseph R. Herkert

12 A Cross Cultural Comparison of Engineering Ethics Education: Chile and United States 189
Ruth I. Murrugarra and William A. Wallace

13 Responsible Conduct of Research Training for Engineers: Adopting Research Ethics Training for Engineering Graduate Students.. 213
Sara R. Jordan and Phillip W. Gray

14 Training Engineers in Moral Imagination for Global Contexts 229
William J. Frey

15 Sifting, Winnowing, and Scaffolding: Structured Exploration for Engineering in a Modern World 249
Sarah K.A. Pfatteicher

16 Toward a Global Engineering Curriculum 265
Eugene Moriarty

Index 281

About the Editors

Hassan Bashir is Associate Professor of Political Science at Texas A&M University at Qatar. His areas of research interest include political theory, non-Western political thought, and moral dimensions of globalization. His recent work focuses on intercultural political theory, history of political thought, Asian Politics, and non-state actors in international relations. Dr. Bashir is the author of *Europe and the Eastern Other: Comparative Perspectives on Politics, Religion and Culture before the Enlightenment* (Lexington Books, 2013). He is also the editor of *Co-existing in a Globalized World: Key Themes in Inter-professional Ethics* (Lexington Books, 2013) and *Global Citizenship and Multiculturalism: Political, Cultural and Ethical Perspectives* (Forthcoming, 2015). Dr. Bashir is the Founding Director of The Initiative in Professional Ethics at Texas A&M University, Qatar.

Paolo Gardoni is a Professor in the Department of Civil and Environmental Engineering at the University of Illinois at Urbana-Champaign. His research focuses on the development and use of probabilistic methods to model the impact of natural and human-made hazards on interdependent structural and infrastructural systems. He has been working on several multidisciplinary projects encompassing different areas including engineering, public policy, and ethics. Professor Gardoni is the Director of the Mid-America Earthquake (MAE) Center, established in 1997 by the National Science Foundation as one of three national earthquake engineering research centers. He is also the Associate Director of the Community Resilience Center of Excellence funded by the National Institute of Standards and Technology (NIST).

Charles E. (Ed) Harris, Jr. is a former Professor of Philosophy and former holder of the Sue and Harry Bovay Professorship in the History and Ethics of Professional Engineering at Texas A&M University. His specialty is applied and professional ethics. He and his co-authors have published a textbook in engineering ethics. He has also published a textbook in applied ethics and numerous articles in professional and applied ethics.

Eyad Masad is a Professor in the Zachry Department of Civil Engineering at Texas A&M University and the Mechanical Engineering Program at Texas A&M University at Qatar. He is a licensed professional engineer in the State of Texas. He teaches courses in engineering and ethics and has organized several workshops on professional ethics. He is also the Co-Founding Director of The Initiative in Professional Ethics at Texas A&M University at Qatar.

Colleen Murphy is an Associate Professor of Law and Philosophy and Director of the Women and Gender in Global Perspectives Program at the University of Illinois at Urbana-Champaign. Her research focuses on engineering ethics, the ethics of risk, and transitional justice in post-conflict societies. She is the author of *A Moral Theory of Political Reconciliation* (Cambridge University Press). Professor Murphy was a Laurance S. Rockefeller Visiting Faculty Fellow at the Princeton University Center for Human Values. Her research has received financial support from the National Science Foundation, the National Endowment for the Humanities, and the Qatar National Research Fund.

Chapter 1
Introduction

Colleen Murphy, Paolo Gardoni, Hassan Bashir, Charles E. Harris, Jr., and Eyad Masad

Abstract This volume considers the way(s) in which globalization complicates or alters discussions of engineering ethics and engineering ethics education. This introductory chapter lays out some of the key ethical questions that have emerged for engineers in their education, research, and practice due to the rise of a global economy and briefly summarizes each of the chapters in Parts I and II of this volume. The chapters in Part I provide an overview of particular dimensions of globalization and the criteria that an adequate engineering ethics framework must satisfy in a globalized world. The chapters in Part II consider pedagogical challenges and aims that arise in a globalized engineering ethics education curriculum.

Keywords Engineering ethics • Globalization • Engineering ethics education

1.1 Introduction

Engineering touches every facet of human life, from health and entertainment to food and the environment. Engineered products include the wheel, the pulley, and computers, as well as refrigerators, roads, and bridges. Engineers transform individual lives and the contours of communities, altering the form of all dimensions of our lives, including communication, transportation, and education through the artifacts and technology they produce. Frequently, lives change in ways unanticipated by engineers (Smith et al. 2013).

That engineering transforms lives through the artifacts and technology created is not surprising, since the aim of engineering is to respond to societal needs.

C. Murphy (✉) • P. Gardoni
University of Illinois at Urbana-Champaign, Urbana, IL, USA
e-mail: colleenm@illinois.edu; gardoni@illinois.edu

H. Bashir • E. Masad
Texas A&M University at Qatar, Doha, Qatar
e-mail: hassan.bashir@qatar.tamu.edu; eyad.masad@qatar.tamu.edu

C.E. Harris, Jr.
Texas A&M University, College Station, TX, USA
e-mail: e-harris@tamu.edu

C. Murphy et al. (eds.), *Engineering Ethics for a Globalized World*, Philosophy of Engineering and Technology 22, DOI 10.1007/978-3-319-18260-5_1

Engineering practice is designed to satisfy a particular goal or achieve a particular purpose: construct a bridge, design a new airbag, or retrofit a structure. An important standard of success for engineering products is functionality; that is, engineering products are successful insofar as they are useful for a given purpose. What is needed is a function of background circumstances, including economic conditions and the broader infrastructure. Consequently, the most technologically sophisticated artifact may not always be best suited to fulfill a particular need. A technologically less sophisticated artifact may be cheaper to produce and repair, and easier to use (Murphy et al. 2011).

Engineers contribute to the development of new technologies that influence and shape the way we live, in anticipated and unanticipated ways. For example, in 1935 when Wallace Carothers developed long, strong, and very elastic fibers, later called "nylons," he did not anticipate the widespread application of his work to consumer goods such as toothbrushes, fishing lines, and lingerie, or in special uses such as surgical thread, parachutes, or pipes. Nor did he anticipate the powerful effect nylons would have in launching a whole era of synthetics. More recently, in 1980 Tim Berners-Lee, a consultant at CERN (the European Laboratory for Particle Physics), wrote a program to link computers; he did not foresee that his program was the beginning of the World Wide Web, which in 2000 had more than sixteen billion Web user sessions (Nissenbaum 2001, 2004). The societal implications and impact of a given technology may be much greater than originally imagined and may vary across societies.

As this discussion highlights, a successful engineering solution cannot be simply technically sound, but also must account for cultural, social and religious constraints. Often the solution space is not well defined, making it harder to identify all possible solutions. Moreover, there is no single criterion that determines the best solution, and consequently it is frequently difficult to rank solutions. In practice multiple criteria, or external constraints, are used to evaluate possible engineering solutions. Cost effectiveness, ease of manufacture, safety, sustainability, and aesthetic appeal are just some of the more common criteria. Such constraints provide resources for delimiting possible solutions and guidelines for selecting among possible options, but because criteria are multiple, engineers must determine the relative weight that will be given to diverse kinds of considerations. Value judgments underpin both the criteria themselves and the relative weight assigned; using a given criterion, such as safety, to evaluate possible solutions reflects the judgment that safety is important. Placing greater priority on cost over aesthetic appeal reflects a judgment of the relative value of each kind of consideration.

Engineers are not only designers; academic engineers serve as advisors to graduate students. Academic and nonacademic engineers serve on professional engineering society committees and local agencies involved in developing and writing codes, designing guidelines, city standards, and specifications. Such codes, guidelines, standards, and specifications affect the entire society. Engineers also work for companies, and increasingly serve in managerial roles in this context.

Ethics is concerned with understanding what is good and of value in human life, and what constitutes the standards for right conduct for individuals and for justice in institutions. Engineering ethics considers these issues in the specific context of engineering. Questions considered include the standards for laboratory safety, fabrication, plagiarism, and authorship. Engineering ethics explores many issues in design and research. What standards determine when a system is safe enough to be used? When is the likelihood of a catastrophic event small enough to be ignored? At what point should an engineer be confident that all unforeseeable events and their implications are accounted for in the design? Engineering ethics also addresses issues of professional responsibility, professional advice, ethics support, and corporate ethics. Engineering ethics education is designed to help educate engineers to be cognizant of and take into account the social and ethical dimensions and implications of their work, instilling in students the importance and non-negotiability of recognizing certain ethical considerations inherent in engineering and of maintaining ethical standards. Successfully achieving these educational objectives is especially challenging in the context of the ongoing wave of globalization.

This volume considers the way(s) in which globalization complicates or alters discussions of engineering ethics and engineering ethics education. Globalization, which is essentially increased global interdependence, has fundamentally transformed the environment in which engineers learn and practice. There is an unprecedented demand today for engineers and other science and technology professionals with advanced degrees, due both to the offshoring of Western jobs and the rapid development of non-Western countries. In this new environment professionals in the high-tech fields are often required to work as part of international teams and devise solutions that are then implemented across national and cultural boundaries (Stukalina 2007). Motivated by the promise of mutual economic benefits, Western and non-Western countries are increasingly adopting strategies that encourage Western companies to establish foreign operations. In many cases, the costs of doing business in non-Western countries are low because of the compromises made regarding potentially harmful human and environmental effects. Not just the practice but also the teaching of engineering has gone international, and several Western universities and colleges have opened campuses in non-Western countries. As discussed later in this volume, the biggest challenge faced by these Western institutions is the diverse nature of the student body in terms of national origin, cultural orientation, and preparedness for entering higher education.

These changes have potentially far-reaching implications for engineering ethics. In the United States, professional engineering licensure is established as a standard measure of competency. However, most developing countries do not have a system for professional engineering licensing. This poses a challenge for international companies and local organizations in establishing a standard measure of competency for their engineers. Based on the experience in the State of Qatar and the surrounding region, some countries are requiring engineers to have professional licensing from the United States and/or European countries. Other countries are looking to establish their own professional exams and licensing. The interest in professional registration in engineering is becoming increasingly evident in various parts of the world, including Australia, Brazil, China, and Japan. In the United States, all Professional Engineer (PE) licensing is based on three requirements: education, experience, and examination. Education and experience standards are somewhat similar around the world, but examination requirements vary more widely. Western Europe also has a well-developed system for professional registration, usually based on a 5-year course of engineering education and an examination. Often delegations are sent to the United States, especially to the National Council of Examiners for Engineering and Surveying (NCEES), to which all state registration boards in the United States belong and which serves as a clearinghouse for information about registration in the United States.

With the increasing interest in mutual recognition of engineering licensure, an increasing interest in uniform standards can be expected to follow (Weil 1998; Love and Russon 2004). However, local traditions in custom and morality vary considerably. In some cultures, giving gifts is a way of cementing friendships. What looks like a bribe in a Western country might not be considered a bribe in other countries. Similarly, while nepotism is viewed negatively in most Western countries, in some parts of the world getting jobs for extended family members may be a very strong moral obligation. Thus in any attempt to formulate a model international code, universal requirements must be balanced against local traditions and cultural identities (Harris et al. 2009).

The current flow of technology and professionals is from the West to the rest of the world. Professional practices followed by Western (or Western-trained) engineers are, however, often based on presuppositions that can be in fundamental disagreement with the viewpoints of non-Westerners. Values and design constraints are varied, not only within individual communities but also across communities. If one does not take these educational and cultural differences into account, students may misunderstand the whole purpose of introducing students to ethical issues and moral decision-making. The lag between rapid technological advancement and the development of appropriate professional and ethical standards can lead to serious problems that may eventually nullify any gains from increased participation in the world economy for previously disadvantaged countries.

The chapters in this volume discuss some of the key ethical issues that have emerged for engineers in their education, research, and practice due to the rise of a global economy. Many of the chapters were originally presented at two conferences focusing on “Engineering Ethics for a Globalized World.” The first conference was hosted at Texas A&M University in Doha, Qatar, in October 2011. The second was held at the University of Illinois at Urbana-Champaign in Champaign, Illinois in October 2012. The National Science Foundation in the United States and the Qatar National Research Fund both provided support for these conferences.

The authors, scholars and practitioners from diverse national, disciplinary and professional backgrounds discuss the ethical issues emerging from the inherent symbiotic relationship between the engineering profession and globalization. Their discussions facilitate a deeper and more complete understanding of the precise ways in which globalization impacts the formulation and justification of ethical standards in engineering, as well as the curriculum and pedagogy of engineering ethics education. Part I provides an overview of particular dimensions of globalization and the criteria that an adequate engineering ethics framework must satisfy in a globalized world. Part II considers pedagogical challenges and aims that arise in a globalized engineering ethics education curriculum.

Understanding the implications of globalization for engineering ethics requires first understanding what is changing as a result of globalization. In the first chapter, "Firms, Nations and Engineers: Considering Ethics in the New Global Environment" Leonard Lynn and Hal Salzman concentrate on the globalization of technology and scientific knowledge and provide an overview of important changes in how multinational enterprises (MNEs) operate. Commercial engineering takes place primarily through MNEs. Lynn and Salzman highlight structural changes in technology development, which is no longer the sole domain of "advanced" economies but increasingly occurs in emerging economies. Such changes challenge the assumption that advanced economies possess an innovation advantage. The increasing percentage of international students in science and technology programs has altered U.S. MNEs. In particular, management positions are held by an increasing number of these graduates. Occupants of decision-making positions thus have "the experience, familiarity, and linkages to facilitate the location of science and technology work globally, particularly to their countries of origin." Finally, outsourcing has expanded to include "high value-added functions." One important implication of these changes is that it is no longer obvious, for a number of reasons that Lynn and Salzman discuss, that MNEs can or should strive to give precedence to the home country's national interests. Lynn and Salzman consider some of the public policy implications of removing the assumption that a home country's interests should dominate. In particular, they argue that it behooves advanced countries to adopt a "collaborative advantage" model that seeks to identify mutual-gain strategies. "The goal for U.S. policy makers would be to benefit U.S. citizens through giving them a smaller piece of a much bigger pie, much as free trade policies historically have been far more beneficial to most people than mercantilist policies."

Norb Delatte's chapter "International Ethics and Failures: Case Studies" provides a comparative survey of how five different countries in both advanced and emerging economies have dealt with engineering failures. These case studies are the Hyatt Regency Walkway Collapse (1981) in the United States, the Malpasset Dam (1959) in France, the Vaiont Dam Landslide (1963) in Italy, the Sampoong Superstore (1995) in the Republic of Korea, and the Rana Plaza Building (2013) in Bangladesh. The specific focus of Delatte's analysis is on how engineers were held responsible by the legal system or professional societies. Different forms of legal sanctions include imprisonment or penalties. These cases highlight the very different approaches taken toward public safety in different countries, and the views of the role of engineers in achieving this aim. Delatte's discussion also draws attention to the importance of considering the source of a risk, or how a risk is created, in the process of risk management (Murphy and Gardoni 2011; Gardoni and Murphy 2013).

The final piece of important background context is provided by Rachelle Hollander, who in "US Engineering Ethics and its Connections to International Activity" provides a historical overview of engineering ethics, with a particular emphasis on the questions motivating work in the field. Hollander highlights how increasing complexity in the structure of organizations within which engineers work, often as a result of globalization, complicates questions of individual and organizational responsibility. Hollander concludes with a helpful summary of on-going international efforts to set standards that affect engineering practice by the U.S. government, U.S. professional engineering societies, and the U.S. National Academies (NA), including NA efforts that involve similar bodies in other countries.

Hollander highlights a divide among scholars, who disagree about whether additional complexity requires new ethical concepts and/or new policies. Michael Davis directly addresses this issue, arguing in "'Global Engineering Ethics': Re-inventing the Wheel?" that it is a mistake to think that there are not already sufficient resources for dealing with the ethical dimensions of engineering in a global context. Davis argues that engineering is already global in the sense that engineers tend to share a common "culture," or distinctive terminology and technology. Specifically, Davis maintains that there already exist satisfactory global standards for engineering, including a global code of engineering ethics. Moreover, he claims, there is already an adequate global curriculum for engineering ethics. Finally, Davis cautions against the necessity and value of attempting to establish global registration or licensing requirements for engineering. Such efforts, he argues, would not contribute to the professionalism of engineers.

By contrast, subsequent chapters take as their point of departure the assumption that there are not sufficient ethical standards and education appropriate for engineers in the global context. In "Engineering Decisions in a Global Context and Social Choice," Noreen Sugrue and Tim McCarthy address the issue of how professionals should adjudicate among competing ethical standards in a global setting. Sugrue and McCarthy discuss three kinds of normative constraints that engineers must consider in their work—the values of the host country in which an engineer works, the values of the society from which engineers come, and the professional norms of engineering. They argue that adjudication among these constraints is best done by utilizing the Rawlsian original position construction, according to which an individual determines how the normative constraints would be balanced in a particular case by considering what an ideal rational agent would choose if he or she did not know his or her society or role. Sugrue and McCarthy illustrate the proposed methodology with three case studies.

A number of authors examine the basic concepts at the core of any ethical framework, considering what is the appropriate way to conceptualize these concepts in a global context. Charles E. Harris, Jr. in "Engineering Responsibility for Well-being" highlights the prominent role that a concern for well-being plays in engineering codes. He proposes an interpretation of the conception of well being that draws on Martha Nussbaum's capability approach. After discussing the implications of engineering for capabilities, Harris argues that promoting well being so conceived requires engineers to cultivate certain virtues. Harris ends by discussing the different virtues engineers need when they are designing in developing and developed nations. Developing societies should prioritize the virtues of empathy and compassion, while developed countries should emphasize a concern for the environment; sensitivity to the effects of technology, especially on society and human relationships; and creativity.

An adequate framework for engineering ethics must consider the relationship between engineering and development. In "Towards an Ethics of Technology and Human Development," Ilse Oosterlaken assumes that development ethics should be a part of any humanitarian engineering curriculum, and she proposes making a theoretical contribution to development ethics. Development is about making people's lives better and therefore about promoting well being. The ethics of technology and philosophy of technology rarely address technology in the context of poverty reduction or development in the global South, and development ethics that focus on global justice rarely mention technology. One area in which these scholarly endeavors could be joined is computer and information technology. Unfortunately there is relatively little work that combines information technology and development for underserved societies.

In order to explore and advance the ethics of technology and human development, Oosterlaken believes that it is necessary to investigate development ethics as it relates to engineers. This requires an exploration of the connections of engineering ethics to the ethics of technology and philosophy of technology. This can be done through a discussion of the application of the capability approach to technology, an approach that is already very influential within development ethics. Understanding the relation between technical artifacts and human capabilities requires us to move back and forth between a narrower ("zooming in") and a broader ("zooming out") approach. The narrower approach allows us to see the specific features or design details of technical artifacts, and the broader view allows us to see how technical artifacts are embedded in sociotechnical networks and practices. An example is the introduction of podcasting devices in rural Zimbabwe, which provide information about cattle management. From the narrower perspective attention was given to technology choice and the details of design; for example, the decision was made to use voice-based technology. Since many of the people were illiterate, a text-based technology would not lead to an expansion of human capabilities. A design change was later made to replace loudspeakers with headphones since it was determined that they would fit in with existing cultural practices. From the broader sociotechnical perspective, new cultural practices such as collective listening, discussion sessions, and demonstration meetings were encouraged. However, some of the broader sociotechnical aspects, such as the inability of the farmers to obtain some of the medicines recommended by the podcasts, could not be changed. While the project was not set up with the capability approach in mind, it did have an impact on the capabilities of the people. Furthermore, this impact depended both on the technical artifacts and their design, and on the broader sociotechnical networks in which the artifacts were embedded. Thus insights from STS and philosophy of technology were necessary in order to make the capability approach relevant to engineering.

Another central theme increasingly prominent in discussions of ethics, especially in a global context, is climate change. In addition, over the past 30 years there has been a significant attempt to think about the possible relation between the disciplines of ethics and economics. In "Ethics, Economics and the Environment" Khalid Mir focuses on how we should conceptualize the problem posed by climate change and the role of philosophy and economics in formulating this problem. Mir argues that engineers need to carefully consider the impact their decisions have on the environment and that the standard ethical approach used by economists in evaluating environmental damage—utilitarianism—is an insufficiently rich approach toward that end. This chapter begins by asking what motivates engineers and why, if at all, they should be concerned about ethics. Mir argues that engineers play a crucial role in shaping our world and the world in which future generations will live. Because of this, engineers must be attentive both to the ultimate aims of technology and to the various means devised for achieving them. Mir's key claim is that new forms of ethical thinking are required because of the circumstances created by our choices of technology and the lifestyles we have adopted. Mir also offers a critique of the utilitarian model of ethics in engineering, arguing that we should conceive of ourselves as part of a continuous moral community in which future generations are dependent on us, just as we were dependent on those before us. This approach creates a basis for emphasizing that each generation needs to be better stewards of the environment. In addition, if we conceive of future generations as dependent on us, we have a basis for our obligation to preserve, regenerate, and renew what we didn't create ourselves but simply inherited.

The final chapter of Part I concentrates on the construction industry as a case study. In "Ethics for Construction Engineers and Managers in a Globalized Market" George Wang and John Bruckeridge discuss the impact of globalization on the construction industry, illustrating some of the general dynamics noted by Lynn and Salzman. Wang and Bruckeridge focus specifically on the increasingly global scope of economic interaction. They note, for example, that managers of construction companies in the United States and Australia increasingly come from developing countries. More and more construction companies pursue projects in international markets. Foreign investors also buy or establish joint ventures with domestic companies. In many countries corruption is a problem for the construction industry, and Wang and Bruckeridge trace the differences in levels of corruption to differences in host country and sending country constraints, as well as to variations in professional norms. This is precisely the kind of variation Sugrue and McCarthy consider. Wang and Bruckeridge argue for the necessity of global professional registration that includes a professional ethics component.

The chapters in Part II concentrate on engineering ethics education. In "Overcoming the Challenges of Teaching Engineering Ethics in an International Context: A U.S. Perspective," Brock Barry and Joseph Herkert provide an overview of the ways globalization complicates engineering ethics teaching. The authors start from the assumption that teaching engineering ethics is challenging in countries such as the United States because many faculty members in engineering disciplines are uncomfortable teaching the material, due to their lack of credentials in the area. This discomfort is compounded in the international context. Against this background, the authors critically assess available instructional material, including videos, journals, textbooks, and online resources. One prominent limitation, they argue, is that current material is designed with a Western context in mind.

One chapter examines the study of engineering ethics in one specific non-Western context. Ruth I. Murrugarra and William A. Wallace consider Chile in

"A Cross Cultural Comparison of Engineering Ethics Education: Chile and United States." They discuss the adaptation of an ethics course, originally designed by and for a Western audience, to a Chilean classroom, with the purpose of assessing the impact of an educational experience emphasizing ethical behavior. To evaluate the efficacy of the course students were asked to fill out surveys during the first and final lectures of the class in order to gauge the students' perspectives on the relative importance of different values in life. For the Chilean course offering the course material was altered to provide either Spanish translations or alternate readings in Spanish. SIMULATE was used in English, but with clarifications provided for words/phrases/concepts that are specific to the U.S. setting. The responses from the surveys were analyzed for differences in nationality and ethnicity, and for the influence of team interaction on the surveys. American and Chilean students were found to hold the same values in similar importance, whereas immigrant groups differed vastly. The values of the students after taking the class were seen to change across all groups.

The final four chapters consider how engineering ethics education could be modified to better accommodate the globalization of the engineering profession. Research ethics is an area that is common to all engineering fields. In "Responsible Conduct of Research Training for Engineers: Adopting Research Ethics Training for Engineering Graduate Students," Sara Jordan and Phillip Gray argue that Responsible Conduct of Research (RCR) training provides a model for developing a global engineering ethics curriculum. In order to be relevant and truly global in character, engineering ethics should articulate universal standards, while taking into account differences in local contexts. They argue that RCR training integrates "near-universal" norms and provides a general framework for research practice that captures the commonalities among different fields of academic and professional study. Because it is research that unites all areas of inquiry, training in research ethics can serve as the foundational starting point for engineering ethics courses globally. Jordan and Gray include a case study of RCR training that occurred at a research university in Hong Kong, discussing the different perceptions of research integrity among postgraduate students in fields as varied as engineering and the social sciences. They conclude with recommendations for RCR courses that target engineers.

In "Training Engineers in Moral Imagination for Global Contexts" William Frey takes as his point of departure a different resource for global engineering ethics education: the moral imagination. Moral imagination is "the ability in particular circumstances to discover and evaluate possibilities not merely determined by that circumstance or limited by its operative mental models, or merely framed by a set of rules or rule-governed concerns." Referring to works by Charles Dickens, Frey warns against the pitfall of what he calls "telescopic philanthropy" when faced with ethical questions in the engineering profession. He then offers four guidelines for cultivating moral imagination in students: (i) recognizing the thinking of very different people; (ii) addressing foreign cultures from suitable points of view; (iii) using emotions like empathy, care, compassion, and hope; and (iv) realizing that good intentions are not enough. In teaching moral imagination, the author suggests three skill sets that engineering ethics programs should strive to cultivate:

an (i) ability to engage in role-playing, (ii) ability to recognize the different frames of a situation, and (iii) ability to engage in dramatic rehearsals. These skills help educators to prepare their students for the challenges posed by globalization. While moral imagination alone will not be sufficient to train engineers to work in global settings, engineers in multidisciplinary teams would be able to use the technique effectively. Moral imagination is especially useful in helping engineers become aware of the different responses people in different cultures have to situations and so to be more attuned to the increasingly "global" dimensions of their work. The essay focuses on engineering work in Puerto Rico, but has wide implications for teaching what some have called "techno-socio sensitivity" in the global context.

Sarah K.A. Pfatteicher's chapter "Sifting, Winnowing, and Scaffolding: Structured Exploration for Engineering in a Modern World" takes up themes considered by Jordan and Gray as well as by Frey. She notes that globalization tends to emphasize uniformity and commonality, but the global context is characterized by important cultural and religious differences. To equip engineering students to adapt to our continuously changing and diverse world, Pfatteicher argues, engineering ethics education should teach students the skills of "sifting and winnowing." Specifically, engineering education should not focus exclusively or even primarily on giving students information about the content of codes or extant standards; rather, it should cultivate in students the ability to distinguish the good and the bad, or the ethical and unethical, in the many different and often unforeseeable situations they will confront in their lives. To illustrate the sort of engineering ethics program she has in mind, Pfatteicher provides examples of what such an education might look like at the module, course, and program levels.

In "Toward a Global Engineering Curriculum," Eugene Moriarty maintains that "globalization" refers to increasing economic, political, and social integration, motivated by capitalism and transnational corporations. The globalization process is often relatively free of moral considerations. Although globalization can produce beneficial consequences, it can be responsible for perpetuating poverty and social inequality, and promoting ecological degradation, militarism, and nondemocratic forces. Globalism, Moriarty argues, can provide a perspective that corrects the ill effects of globalization. Globalism is a perspective that embodies the idea that we share a fragile planet and that we must embrace a concern for the environment and the values of sustainability, social justice, and community, as opposed to mere individualist self-seeking. Commitment to the values of globalism requires moving from what the author calls "standard engineering" to what philosopher Albert Borgman calls "focal engineering." The Accreditation Board for Engineering and Technology (ABET) has recently introduced requirements that point engineering curricula in a more global direction, mandating that engineering students demonstrate skill in communication, ability to work in multidisciplinary teams, and the broad education necessary to understand the impact of engineering on society and the environment. These requirements promote the values Borgmann associates with focal engineering with its concern for the particular rather than the general, the community rather than the individual, and the environment. While the ethics of Standard Engineering is based largely on the admonition to "do no harm," the ethics of Focal Engineering is based on the admonition to "do good."

Moriarty notes that some innovative engineering curricula point toward this new emphasis on global engineering. The University of Rhode Island offers an International Engineering Program, a 5-year course of study that consists of a BS in engineering and a BA in a language. Baylor University requires a course that combines technical writing and engineering economics, and another course on technical entrepreneurship in a global economy. Global engineering would focus on such problems as world hunger, low education levels, and environmental destruction.

Acknowledgements The material in this book is based upon work supported by the National Science Foundation under Grant No. 1066174/1240693. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation. This Book was also made possible by the NPRP Grant 4-1195-6-032 from the Qatar National Research Fund (a member of Qatar Foundation). The statements made herein are solely the responsibility of the author(s).

References

Gardoni, P., & Murphy, C. (2013). A scale of risk. *Risk Analysis*. doi:10.1111/risa.12150.

Harris, C. E., Pritchard, M., & Rabins, M. (2009). *Engineering ethics: Concepts and cases*. Belmont: Wadsworth Cengage Learning.

Love, A., & Russon, C. (2004). Evaluation standards in an international context. *New Directions for Evaluations, 104*, 5–14.

Murphy, C., & Gardoni, P. (2011). Evaluating the source of the risks associated with natural events. *Res Publica, 17*(2), 125–140.

Murphy, C., Gardoni, P., & Harris, C. E., Jr. (2011). Classification and moral evaluation of uncertainties in engineering modeling. *Science and Engineering Ethics, 17*(3), 553–570.

Nissenbaum, H. (2001). How computer systems embody values. *IEEE Computer, 120*, 118–119.

Nissenbaum, H. (2004). "Will security enhance trust online, or supplant it?". In P. Kramer & K. Cook (Eds.), *Trust and distrust within organizations: Emerging perspectives, enduring questions* (pp. 155–188). New York: Russell Sage Publications.

Smith, J., Gardoni, P., & Murphy, C. (2013). The responsibilities of engineers. *Science and Engineering Ethics*. doi:10.1007/s11948-013-9463-2. pp. 1–20.

Stukalina, Y. (2007). Globalisation and engineering education: Preparing students for professions of the 21st century in science and technology. *Transport and Telecommunication, 8*(1), 30–39.

Weil, V. (1998). Professional standards: Can they shape practice in an international context? *Science and Engineering Ethics, 4*, 303–314.