HANDBOOK OF ENGINEERING ETHICS EDUCATION

THEMATIC PARTS

Theme 1: Foundations of engineering ethics education

As an introductory section to the book, we aim to discuss some main foundational issues that underpin engineering ethics education. The issues covered range from the purpose(s) of engineering ethics education, the relationship between engineering ethics education and the field of ethics, individual judgment and decision-making vs. collective, power issues related to engineering ethics education, how engineering ethics education relates to reason and emotion.

> **Chapter 1.1:** The purpose(s) of engineering ethics education. While such education is called for by accreditation bodies or governmental authorities, the focus will be on the debate about what engineering ethics education intends to achieve. Potential answers concern moral sensitivity, knowledge about codes and standards, moral reasoning, commitment to doing good.

> **Chapter 1.2**: How engineering ethics education makes use of normative ethical theories, such as consequentialism, deontology, virtue ethics, relational ethics, ethics of freedom, justice/fairness, environmental ethics, and combinations thereof such as reflexive principlism, and what ethical theories are excluded or marginalized from engineering ethics education.

> **Chapter 1.3**: The individual and the collective in engineering ethics education. The chapter is intended to give an overview of ethical decision-making models as well as other heuristics and contrast them with dialogical/discursive/deliberative approaches. The chapter will discuss the pros and cons of these different approaches.

> **Chapter 1.4**: Codes and professional organizations in engineering ethics education. How are professional codes used within engineering ethics education, and are there potential power issues at stake from professional organizations on the curriculum?

> **Chapter 1.5**: Reason and emotion in engineering ethics education. There has been a critique that emotions have been downplayed, and what it would mean to take both reason and emotion seriously.

Theme 2: Interdisciplinary contributions to engineering ethics education

Engineering is an interdisciplinary and applied field that draws on foundations in disciplines including mathematics, natural sciences, computer science, and management studies, as well as social sciences and the arts. Education is equally an interdisciplinary field, drawing notably on psychology, philosophy, sociology, and social policy studies. It follows that understanding engineering ethics education equally requires a multidisciplinary foundation.

The goal of this section is *to provide an understanding of foundational concepts, approaches, and problematics* that are central to engineering ethics education and which will reoccur throughout this handbook. In this section, these concepts, approaches, and problematics are explored *within the context of the disciplines from which they emerge.*

Each chapter will introduce the main bodies of research/thinking in the domain as well as current or emergent issues.

Chapter 2.1: Philosophical and religious foundations in global perspective

Chapter 2.2: Sociological, Postcolonial and Critical Theory foundations

Chapter 2.3: Psychological foundations

Chapter 2.4: Management & Organisational studies foundations

Chapter 2.5: Engineering Design foundations

Chapter 2.6: Environmental Science foundations

Theme 3: Teaching methods in Engineering Ethics Education

The role of the section is to map the established and emergent methods used to teach engineering ethics. Current research shows a deep fragmentation of pedagogical approaches and confusion as to which approach is most suitable in preparing socially responsible engineers. There are limited empirical findings to serve as guidance in the implementation and teaching of engineering ethics. However, there is a significant body of knowledge in relation to other STEM fields, medicine, or business studies that can serve as inspiration.

The section dialogues with the other Handbook sections concerned with theoretical frameworks and assessment strategies, given that a coherent curriculum strategy requires alignment. It is important to address the topics falling under these sections in conjunction, given that lack of clarity and alignment might lead to missed educational opportunities.

There are seven chapters under this section, intended to cover the following themes:

Chapter 3.1: Literature review mapping the use of different teaching methods. The chapter might include the distribution of different methods, the connection with learning goals and assessment, student reception of different approaches.

Chapter 3.2: Case studies and dilemmas in engineering ethics education. The chapter might reflect on ways of expanding and broadening case instruction, such as roleplaying, micro vs macro ethical case studies.

Chapter 3.3: Project-Based Learning and Challenge Based Learning

Chapter 3.4: Value Sensitive Design and Design-Based Learning in engineering ethics education

Chapter 3.5: Field learning in engineering ethics education. The chapter might include humanitarian engineering, service learning, community-oriented teaching approaches or international experiences

Chapter 3.6: Arts-based methods in engineering ethics education. The chapter might consider the use of film, theatre, graffiti, literature, visual arts or other artistic forms.

Chapter 3.7: Reflective and dialogue-centered approaches. The chapter might include individual and group reflections, debate, peer dialogue, storytelling.

Theme 4: Accreditation and Engineering Ethics Education

Accreditation policies and practices have been a driver for the adoption of ethics education within engineering courses worldwide, yet expectations have been difficult to define and assess. The outline for this section on accreditation, as related to engineering ethics education (EEE), reflects the standard sequence for reporting research. The six-chapter topics are proposed as:

Chapter 4.1: Background history of ethics in accreditation.

Chapter 4.2: Contextual mapping of ethics education and accreditation nationally and internationally.

Chapter 4.3: Overview of literature and analysis of the types of research that have been published in EEE

Chapter 4.4: Comparative analysis of accreditation processes and implications at global and international levels.

Chapter 4.5: Comparative analysis of accreditation processes and implications for ethics education at the local level.

Chapter 4.6: A synthesis of the prior chapters in the section that identifies challenges, poses questions for future research and recommends ways to, for instance, ensure space for ethics in accreditation systems.

Theme 5: Ethical issues in different engineering disciplines

This section will contain chapters coining the ethical challenges in different engineering disciplines. Each of the chapters will portray which ethical issues, dilemmas and challenges are discussed in the discipline, and how they might be addressed by the discipline's students and practitioners. The ethical issues that will be included in the chapters cover both processual issues like user-involvement, codes of conduct, early warning systems, distribution of responsibility, ethical design, etc. as well as the wider ambiguous implications of technology and engineering solutions in relation to digitalization, nuclear power and

energy, human rights and dignity, pollution / environmental impacts and climate change, colonization, big tech's influence on technological solutions, military technologies, technological accidents, etc. Chapters will also outline how these issues, dilemmas, and challenges are being approached and suggested solved in engineering ethics education in the different disciplines. The idea of the section is to prepare a matrix to identify similarities and differences regarding the topics suitable for inclusion in the ethics education of different engineering disciplines, and how the ethical issues, dilemmas, and challenges are approached differently in different disciplines. The matrix will be included in the introduction to the Handbook.

The following engineering disciplines will be addressed in separate chapters:

Chapter 5.1: Software engineering

Chapter 5.2: Chemical engineering

Chapter 5.3: Biotechnology

Chapter 5.4: Civil engineering

Chapter 5.5: Mechanical / aerospatial engineering

Chapter 5.6: Electrical / electronic engineering

Chapter 5.7: Environmental engineering.

Potential authors can suggest additional engineering disciplines, which they suggest included in this section of the handbook.

Theme 6: Assessment of different aspects of Engineering Ethics Education

This section will deal with the difficult and challenging topic of **assessment** in engineering ethics education and will focus both on the assessment of students and the evaluation of courses. **Assessing students** in ethics education always has to find a balance between measurability on the hand and aiming for the richness of topics (competencies like moral reasoning or moral attitudes). **Course evaluation** faces a similar challenge. What should be the aims of an ethics course, and how can it be judged to be good (enough)? Often, satisfaction is considered, but what can be reasonably said about the course's effectiveness in realizing moral sensitivity or moral attitude.

We invite contributions for the assessment of

Chapter 6.1: Course and curriculum quality

Chapter 6.2: Answering the need of industry, local communities, and other stakeholders

Chapter 6.3: Moral reasoning, ethical judgement, moral awareness, moral sensitivity

Chapter 6.4: Views on knowledge, science, engineering

Chapter 6.5: Competencies such as critical thinking

Chapter 6.6: Attitudes and character

Chapter 6.7: Limitations and critical perspectives on assessments