

An Engineering Ethics Curriculum Map

Introductory notes

1. The Map sets the scene within which an appropriate programme of teaching and learning can be developed that addresses the ethical dimension of engineering effectively. Such a programme has to strike the balance between being conceptually grounded and practically applicable. The Map presents a non-prescriptive view of an ethical dimension at each level. We recognise that the Map will be subject to local variation and interpretation. We also expect that it might take several iterations for a particular programme to arrive at this end point. There are examples below of how the Map might look in practice and how such curriculum development might be implemented.
2. In designing the map, we have assumed that the engineering profession will demand that ethical aspects of engineering are included within all undergraduate engineering programmes from level 1 through to level 4/M. Programmes at all levels are therefore likely to have a mandatory element of engineering ethics. Some may also have optional elements. We believe that engineering students should begin to learn about the ethical dimension of engineering from the onset. The Map primarily focuses on the mandatory element.
3. Evidence has shown that the introduction of engineering ethics as a significant theme in the curriculum provides distinctive added value. The curriculum is enriched and made more relevant to the practice of engineering. Additionally, this theme contributes to other learning outcomes by helping students to improve core skills such as communication, reasoning, deduction and reflection. Generally students enjoy activities and learning associated with this theme.
4. The aim of the programme is to develop each student's clarity of both ethical understanding and good ethical practice, in preparation for their professional life. By the end of an undergraduate programme engineering students should:
 - a. understand the relationship between ethically bad/good practice and bad/good specification, management or development of engineering systems,
 - b. be able to identify occurrences of this relationship,
 - c. be able to address problems arising from questionable practice using appropriate ethical tools, and
 - d. understand practical difficulties and use suitable approaches and techniques to help people produce better outcomes.

In the Map these are expressed as Learning Outcomes for each level (1.1, 1.2, 1.3, 2.1, 2.2, 2.3, 3.1, 3.2, 3.3, 4.1, 4.2 and 4.3).

5. 5. The pedagogic focus should be on developing skills and judgement as well as providing exposure to ethical concepts and ideas. Students should be able to recognise the various problems and pitfalls that emerge unexpectedly in real human engagement, and be able to adopt sound and morally defensible responses at the time of the engagement.
6. The Map has the structure of a framework with four facets: location, learning outcomes, content and process. By using this framework, we can systematically define, monitor and review what is to be addressed, how it is to be addressed, when it is to be addressed and to whom it is to be addressed.
7. **Location** has three elements; level, focus and point of delivery. The framework defines the focus of ethical consideration at each level of an undergraduate programme. This consideration can be at different points of delivery within a level depending on the specific design of a particular programme, and may even encompass the next level, up or down.
8. **Learning Outcomes** includes the fact that students are *personally* about to begin upon a profoundly important moral journey and *professionally* starting to immerse themselves in a mêlée of ethical dilemmas, disagreement and obfuscation.
9. **Content** is a catalogue of topics that we have identified as being suitable for inclusion in an engineering undergraduate programme. The developers of each programme of study will decide which are mandatory and which are optional items.
10. **Process** comprises possible teaching techniques that can be used to consolidate learning, to hone ethics reasoning skills and to facilitate the promotion of ethical professional behaviour by graduates as they enter the world of work.
11. Departments should express their responsibilities in promoting this aspect of the curriculum through positive leadership, helpful attitudes and clear actions, and by taking a holistic view of the curriculum to embed ethics throughout.

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1. LOCATION			2. LEARNING OUTCOMES	3. CONTENT	4. PROCESS
Level (typical course)	Focus	Points of Delivery	Students should be able to:	Topics	Example Techniques
1 (1 st Yr BEng)	Awareness of issues, obligations and responsibilities. Sensitise the students. Ensure delivery of engineering soundness includes ethical consideration	Induction	<ol style="list-style-type: none"> 1. Give examples of ethical issues related to engineering 2. Recognise ethical responsibilities of engineers 3. Describe in outline an ethical framework for engineering 	Professionalism, code of conduct, obligations to the public	Interactive small group sessions during student induction. Students develop case studies from newspaper or magazine articles
		Modules		Duty of care, trust, introduction to applied ethics, ethical dimensions to engineering problem solving. Introduction to a theoretical ethical framework based on deontology (duty), rights, utilitarianism, autonomy/consent and virtues. (Second item could be introduced at Level 2)	Existing core modules identified to be modified to establish a clear ethical focus for engineering programme. Each module will have illustrations, topics and exercises covering key ethical issues. Introductory modules to engineering would be ideal starting points.
2 (2 nd / 3 rd Yr BEng)	Addressing practical problems. Students are able to identify ethical issues and are able to examine and weigh up arguments on either side.	Modules	<ol style="list-style-type: none"> 1. Identify ethical issues related to an engineering situation 2. Suggest ways to address ethical issues in engineering 3. Illustrate the ethical dimension of practical engineering 	Ethical cases in engineering. Further use of the ethical framework introduced at Level 1	Existing modules modified to include topics and exercises which address ethical issues from a practical standpoint. Dilemma training. Traditional engineering exercises given ethical twist. Group work. Use familiar, non-specific engineering situations by way of introduction, for example plagiarism/cheating, principles of negotiation
		Placement preparation		Professional practice of self and others Being able to differentiate between the good and bad employer	Intensive workshop for placement preparation. Presentations where students defend a pro/con stance on an issue, Role-playing scenarios

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3 (Final Yr BEng)	Reflection and critique of ethical issues, consolidation of ethics skills and practice, specialist study	Design Project	<ol style="list-style-type: none"> 1. Undertake an ethical audit 2. Discuss ethical dilemmas in engineering 3. Justify an ethical stance 	Ethics audit of final year project	Self study and application to a student led project
		Core Modules		Ethically ambiguous scenarios	Challenge students to defend their actions from an ethical standpoint. Group debates.
		Ethics-specific optional modules		Philosophy of engineering Further Ethical Theory: Engineering Ethics and Environmental Ethics	Case studies, dilemma exercises Practice solving morally ambiguous scenarios. Analysis, synthesis and report back of ethical issues
4 (MEng)	Further reflection and critique of ethical issues, specialist study	Ethics-specific research-oriented module	<ol style="list-style-type: none"> 1. Articulate ethical dilemmas in engineering 2. Reach an ethically justified or morally reasoned practical solution to an ethical problem with an appropriate plan of action. 3. Propose policy relating to ethical questions in engineering 	Research principles and ethics, Risks and benefits of novel technology Broader context of engineering Business Ethics Corporate Social Responsibility	Case studies, dilemma exercises Practice solving morally ambiguous scenarios. Analysis and report writing

Implementation of the Map

1. Strategy

The strategy for embedding ethics within the engineering curriculum should be holistic. Departments should establish a long term plan with review points to realise a full implementation of the Map over a realistic period, which might be several academic sessions.

The strategy should cover aims and objectives, coverage, modes of delivery, student resources (including electronic resources, the provision of staff development, and monitoring) and evaluation.

Departments should also consider how this developing curriculum fits with the inclusion of key skills, and how it might link with the continuing professional development of graduates as they start their careers.

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We recommend that each Department tasks a team of representative engineering tutors with implementing the Map. It may be necessary to bring in some expertise in teaching engineering ethics to advise and train the team, and to provide them with resource packs. Some Departments might consider the benefits of including philosophers, ethicists and others with expertise in the teaching of applied ethics within the teaching programme.

2. Scenarios

The three scenarios set out below provide examples of how the curriculum could be enhanced to include ethics at three stages within a strategic implementation. The items listed are those introduced at each stage.

2A. First steps in ethical sensitivity

Level 1

- Include an engineering ethics game as part of student induction
- Provide students with appropriate code of ethics from a professional body
- Include some examples in Introduction to Engineering module

Level 2

- Provide a briefing session for placement students on possible ethical issues they might encounter and provide some guidance how to handle these

Level 3

- Introduce a simple ethics audit for student projects

2B. Halfway house

Level 1

- All appropriate level 1 modules use illustrations, topics and exercises covering key ethical issues

Level 2

- Introduce dilemma training as part of the placement preparation

Level 3

- Core module includes a group debate on a hot topic which challenges students to defend their proposed actions from an ethical standpoint.

2C. An ethically mature curriculum

Level 1

Already sufficient at previous stage

Level 2

All appropriate level 2 modules use illustrations, topics and exercises covering key ethical issues

Level 3

Engineering Ethics optional module available to all students

Core module includes ethical analysis education

Student projects include a detailed ethical audit and report

3. Tutor training/development

Tutors will need to receive appropriate opportunities for the development of their own skills so that they feel confident in including ethical perspectives in engineering modules. An awareness of the main ethical concepts should also be fostered; this should help the tutors themselves professionally.

This could be done by holding workshops on curriculum development, teaching and learning, case study development, student projects, and student placements.

A tutor guide could be developed providing help in adding the ethical dimension to the student learning experience. Good practice and resources could be shared using an online virtual learning environment.

4. Assessment

Assessing students on engineering ethics is challenging. There are many ways to do this. For example:

- Technical assignments in modules might lend themselves to adding an ethical element that students have to consider. Assessment could be done in the normal way.
- Student projects could include a mark allocation for the thoroughness of the ethical audit
- Group debates could be assessed including a peer review element on the basis of defence on a particular ethical stance.
- Placement assessment could include an ethics review report of the host organisation, given appropriate debriefing of the host.