Chapter 1: ‘Good’ engineering or just good engineering?

Introduction

In preparing this course, the team who worked on it, we reached out to and met with a number of people to get their ideas and input on what should go into it. One group that we reached out to was a biotech startup where we spoke to Fred, an EPFL graduate, and Ewelina. When we asked what had interested them in talking to us, Fred told us that while they are engineering specialists and were confident that they do excellent engineering, they were also aware that they are not ethics specialists. For this reason, they were interested in talking to ethicists and philosophers to get their perspective.

Something that caught our attention in this was the underlying understanding that ‘engineering’ and ‘ethics’ are two distinct and separate areas of expertise. This is a common idea: indeed, in research with engineering students, Johanna Lönngren (2021) found that over the course of their studies, students are implicitly taught to think of engineering and ethics as two distinct spheres of expertise. This happens through a number of mechanisms including

a. ethics is seen as the responsibility of **a department distinct to the engineering students’** own department (e.g. humanities or social sciences, rather than an engineering department)
b. ethics is seen as being focused on choices and decisions which **managers rather than engineers** typically make in their workplace
c. when presented with opportunities for decision-making during their studies, these are often framed as being without ethical implications, centring the question on ‘how to make this’, rather than ‘why make this’, or ‘what is the effect of making this’)

d. ethics is seen as focusing on student's own opinions rather than on disciplinary knowledge, which can give the impression that ethics is 'just common sense', and no actual knowledge is being learned
e. ethics is seen as lacking a formal knowledge and evident in how it is written in 'everyday' language, rather than in scientific or mathematical language, which again emphasizes its distinctness from engineering
f. unlike in engineering, there is a perception that, in ethics, there are no clear criteria for judging whether an answer is right or not, and therefore 'anything goes'.

For Lönngren, all these features work together to create the impression that, for engineers, even when ethics is interesting it is – ultimately – 'somebody else's business'.

There was a notable shift in our conversation with Fred and Ewelina when we asked how their values influenced their work. They immediately talked about the importance of principles like scientific integrity – of doing sound scientific work which produced findings that could be trusted; of pragmatism – producing working solutions which solved actual problems, and of fostering a climate of constructive critique – building a working environment which had a sense of psychological safety and warmth, which would ensure colleagues could do better science through feeling safe to question each other's ideas. It was clear in this that, for them, good engineering was based on *values*. So, viewed through a different question and with different language, engineering and (ethical) values were not separate at all. Indeed, Steen et al. (2021) have argued that responsible engineering innovation is based on (ethical) virtues such as courage, dedication, curiosity, humility, honesty, and compassion, as well as on the practical wisdom to turn these virtues into practices.

So, rather than seeing engineering and ethics as distinct, we can argue that 'good' engineering is inherently ethical, since it puts into practices ethical values.

How ethics is understood in this course

One of the reasons why ethics and engineering are seen as distinct is because ethics is often understood and taught as a particular branch of philosophy; specifically the branch dealing with questions as to what is right and wrong, called *moral* philosophy. Since academics try to use terms in a way that is clearly defined and precise, they will sometimes distinguish between terms that are used in everyday speech as synonyms. For example, van de Poel and Royakkers (2011: 119) distinguish between *Ethics* (which they define as "the systematic reflection on what is moral"), and *Morality* (which is defined as "the whole of opinions, decisions, and actions with which people, individually or collectively, express what they think is good or right"). For them, therefore, the term ethics is used to refer only to the *reflection process*, and does not include, actions or decisions.

Not all researchers focus so narrowly on ethics as only a reflection process. Zhu, Marin, Medeiros Ramos & Sundar Sethy (2025: 33) identify that engineering ethics often does involve a focus on action or "right behaviours". Indeed, those in moral psychology, sociology or anthropology, as well as some philosophers, often take such a wider view of ethics.

In this course, we will use the definition of ethics proposed by the organisational sociologist Stewart Clegg who defined ethics as "**the social organizing of morality, the process by which (accepted and contested) models are fixed and refixed, by which morality becomes ingrained in the various customary ways of doing things**" (Clegg et al. 2007, p. 111). What Clegg and his colleagues describing here is what sociologists would call ethics as being ‘a practice’. The term ‘practice’ is used by sociologists to refer to (i) the things people do in everyday life that are thought of as normal behaviour and (ii) the socially shared or contested knowledge, beliefs and feelings that people have that go with these ‘doings’. Hence, in this course, ‘ethics for life sciences engineers’ is not seen as being only (philosophical) reflection but rather as being the ‘normal’ things life sciences engineers do in their everyday life which are seen to be ‘right’; the ideas, beliefs and feelings which are linked to these things they do; and the debates and contestations among people which produce agreement about or change in people’s ideas as to what is ‘right’.

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The course structure and outline

Chapter 1 introduces the course, including our working definition of ethics.

Before looking at how people *should* make ethical decisions, it is useful to start by looking at how people normally *do* make ethical decisions. This has been the subject of much research in behavioural economics, psychology, social psychology and sociology. This research suggests that many ethical decisions are made intuitively. One of the ways in which our ‘intuitions’ influence our decision making is through emotions. In ethical decision making, there has been some research on emotions which arise with respect to feelings of justice/fairness, harm, responsibility, social belonging, and professional competence of engineers and scientists. These ‘moral emotions’ include Compassion, Shame, Guilt, Pride and Anger. Recognising how intuitions and emotions affect moral reasoning can help us to make better decisions. These emotions and intuitions are the focus of **chapters 2 and 3**.

Engineers and scientists don’t work as solitary individuals alone on an island and unconnected to the wider world; typically, they work in organisations which have their own rules, norms, and practices. This social and organisational context can aid ethical behaviour when lab practices or institutional rules reinforce ethical practices. On the other hand, one of the key features of organisations is that engineering problems and ethical problems are typically shared across different people, and so no single person is responsible for the whole of a decision or for the effects of a piece of work. This gives rise to what is sometimes called the ‘many hands problem’ in engineering and science ethics. These organisational factors are the focus of **chapter 4**.

While chapters 2, 3 and 4 focus on how people actually make ethical decisions (descriptive ethics), ethics is also concerned with how people should make ethical decisions (normative ethics). Since ethical biases are associated with intuitive (“fast”) thinking, a key idea in ethical decision making (as in engineering more generally) is to have a process which slows down thinking enough for people to arrive at good decisions (“slow thinking”). This is the focus of **chapter 5**.

This “slow thinking” ethical reflection process is generally guided by ethical ‘principles’. Since the 1970s the 4 key principles which are commonly referred to in Bioethics are *Non-Maleficence* (a duty not to harm patients or subjects through acts or omissions), *Beneficence* (a duty to be of benefit people and society at large), *Autonomy* (a duty to respect the capacity of patients, subjects and users to make their own informed decisions), and *Justice* (a duty to ensure a fair distribution of risks and benefits across society). These are explored in **Chapter 6**.

These principles are useful for making ethical decisions, but can seem quite distant from real engineering questions. For this reason, both institutions and professions have worked to specify the ethical behaviour they expect of their members. These include institutional rules (like the EPFL rules on research integrity) and codes of professional societies such as the Biomedical Engineering Society Code of Conduct & Policies and the IEEE Engineering Medicine & Biology Society Code of Ethics. These are explored in **chapter 7**.

Life science engineers do not simply apply codes and then make up their *own* mind as to whether their behaviour is ethical: rather they normally have to justify their decisions *before their peers* in some way. The process of submission to external ethical review for research with animals and humans is the subject of **chapter 8**.

Having looked at the factors that actually influence ethical decisions, as well as the practices that are in place to ensure people make good ethical decisions, the last few chapters look at some of the specific ethical issues which arise given the changing nature of life sciences engineering. One such issue is the privacy and autonomy of patients and clients, given (a) the specific nature of life sciences data, and (b) the changing nature of data processing in a world of 'big data'. Issues of informed consent have long been central to life science ethics debates, from the Tuskagee study, which led to a recognition of the need for independent ethical review of research, to the HeLa cells controversy. More recently, 'big data' analysis has changed the ways in which privacy can be understood. These topics are addressed in **chapter 9**.

Another distinctive feature of life sciences engineering is that it often involves working with animals and, more recently, organoids. Ethical issues in animal research and in the use of organoids are addressed in **chapter 10**.

The principle of justice states that researchers have a duty to ensure a fair distribution of risks and benefits across society. But, are all social groups treated equally in life sciences research? This question is explored through a gender lens (though the issues raised could equally be applied to ethnicity or age). In clinical trials, for example, women were long excluded due to risks of impacts on potentially pregnant participants, as well as due to the impacts of menstrual cycles on data. This means many medications were released without being adequately tested on women. There is also evidence of historic assumptions and biases impacting on the extent to which women benefit from life sciences research, including in areas like autoimmune diseases, endometriosis, and menopause, as well as in areas where disease presents differently in women and men, such as cardiovascular disease. This topic is explored in **chapter 11**.

If the principle of justice states that researchers have a duty to ensure a fair distribution of risks, we need to consider how risks are distributed across different countries (through the sourcing or disposal of raw materials, for example) and across generations. The practice of Life Cycle Assessment (LCA) is used to identify potential impacts of engineering decisions across geographic distance and generations. This is explored in **chapter 12**.

Despite the evident ingenuity of life science engineers, many engineered products and processes fail to meet their goals. This is often not due to a lack of technical understanding, but rather due to a lack of understanding of the contexts within which the process and product will be used and the people who will use it. Engineering strategies like participatory design and co-design are potential solutions to this problem. This is the subject of **chapter 13**.

How I (the teacher) affect the course

While, in natural sciences and engineering, it is often assumed that research methods will give rise to the same outcomes irrespective of who the researcher is, social scientists are often less comfortable with this assumption. In order to help reduce the assumptions which researchers make about their own objectivity, in education research (including among educational researchers looking at engineering education), there is now a growing practice of researchers trying to make explicit their disciplinary perspectives in order that readers can make up their own mind about possible biases in the research (Secules et al., 2021). To help you make up your own mind about my biases and assumptions, I will therefore present something about myself.

I (Roland) am a sociologist and an educational scientist, who works in EPFL where I lead the Teaching Support Centre. My educational qualifications include a bachelor degree in sociology and social policy, a second bachelor in mathematics and statistics, as well as postgraduate studies in education for sustainable development, and a doctorate in sociology. The particular definition and understanding of ethics which I use in this course (that of Clegg et al., which I presented above) undoubtedly reflects the fact that my background is sociology, not philosophy.

I have worked for the last thirteen years in engineering education, where I have taught a course to EPFL students on the design of educational tools. As a sociologist working with engineering students, I have tried to ensure my social sciences knowledge and skills can be of benefit to engineers in doing their job. My application of social scientific knowledge to ethics is reflected in the way in which this course focuses on how individual engineers always work in social contexts like teams, organisations, professional bodies and in the context of national regulations and laws in engineering ethics. It is probably also reflected in the way I focus on less visible social connections (like connections with those producing raw materials for engineered artifacts, for example).

My research over the years has focused on questions of diversity, power and inequality in education. My educational diploma also focused on education for sustainable development. These things are also represented in the course, in particular on the decision to include a focus on gender, and on life cycle assessment in the course. I have been teaching educational design to engineers for the last ten years – this has undoubtedly influenced my decision to include a focus on co-design and participatory design as ethical engineering practices. In fact, this course is itself an example of co-design: in writing the course I involved students, engineering practitioners and life sciences professors and teachers in working with me to design the course.

As a researcher, part of my focus has been on the way in which engineering students learn ethics. I was previously co-chair of the Special Interest Group on Engineering Ethics of the European Society for Engineering Education (SEFI), and I have co-edited the most comprehensive overview of the field: *The Routledge International Handbook of Engineering Ethics Education* (Tormey et al., 2025). Within the field of engineering ethics education I have been particularly interested in the way emotion is part of engineering ethics education. This has led to numerous publications including work on ‘compassion and engineering students' moral reasoning’ (Kotluk and Tormey, 2023; 2024a), on ‘different methods of increasing the intensity of compassion in engineering ethics cases' (Kotluk and Tormey, 2024b) and on how sociology and psychology can together inform work on emotion in engineering ethics education (Kotluk, Lönngren and Tormey, 2025). It will be no surprise then that I have included a chapter on emotion in life science engineering ethics, as well as a focus on care ethics throughout the course. Some of my research and writing has been on the positive benefits of interactive teaching on student learning (e.g., Hardebolle et al., 2021). I will therefore definitely run the classes in a very interactive and participative way.

No two teachers will teach a course the same way. I hope that by making explicit my own background, the content of the course will make sense to students, and my own perspective will also be a bit more transparent.

Conclusion

Overall, this course is concerned with the question as to what makes a 'good' life science engineer 'good'? The course seeks to show that ethics for life sciences engineers does not imply turning engineers in philosophers. Rather it means engineering with scientific integrity, with care for people and living organisms and with a recognition of risks. This is specified through the application of principles which in turn are codified in – often enforceable – rules, codes of conduct and codes of ethics. These are operationalised through a range of practices which are normal in life sciences research such as lab practices designed to ensure integrity, cost/benefit analysis in the use of animals, and independent ethical review. They can also be seen in some emerging practices such as LCA, participatory design and co-design.

Of course, life science engineers are faced with questions today – such as questions around privacy in the context of big data, or the use of organoids – which did not even exist a decade ago. They are also faced with a growing awareness of justice issues – such as the gendered dimensions of life sciences research. While life science engineering can provide many answers to known questions, as scientific knowledge develops, so too will new ethical questions.

Appendix to Chapter 1: How the course is assessed

There are two kinds of deliverables from the course:

1. **Weekly questions**. For 10 of the 14 weeks of the course there will be weekly questions to be completed via moodle. This will involve reading the course notes (like this chapter), and answering questions about it. You will need to complete at least 8 of the 10 weeks. For adequately completing the questions each week, you will get 2%, up to a maximum of 16%
2. **Case study analyses**. In week 6, and again at week 14 you will submit an ethical analysis of a bioengineering case study. This will be completed in groups of 2 or 3. You will also analyse case studies each week to give you practice at doing this. The Week 6 submission is worth 24% of the total grade. The final submission is worth 60%. You will get feedback on your week 6 submission to help you improve for the end of semester case study.

Table 1.A: Distribution of grades

Assessment task	*Percentage of total grade*
10 individual weekly tasks completed on moodle. Complete at least 8/10	16%
Case study analysis, completed in teams of 2 or 3 Week 6 Final submission	 24% 50%

Table 2.A: Weekly breakdown of tasks

Week	*In-class theme*	*Outside class work*
1 20/02	Introduction: What is 'ethics' in Life Science Engineering ?	Read these notes then write your positionality statement for the course
2 27/02	Descriptive ethics : how do people actually make ethical decisions ?	Read the notes and answer moodle questions
3 06/03	Emotion in Ethical Decisions: Compassion, Shame, Guilt, Pride and Anger	Read the notes and answer moodle questions
4 13/03	The Social Organisation of Ethics in Life Science Engineering	Read the notes and answer moodle questions
5 20/03	Normative ethics : How should be people make ethical decisions?	Prepare and submit the first case study analysis
6 27/03	Ethical principles in Life Sciences Research and Engineering	
7 03/04	Codes of Ethics in Life Sciences Engineering	Read the notes and answer moodle questions
8 10/04	Peer Review in Life Science Research Ethics	Read the notes and answer moodle questions
9 17/04	Principle of Autonomy: Privacy and Consent in a world of Big Data and Genetic Data	Read the notes and answer moodle questions
	Break week	
10 01/05	Principles of Non-malfeasance and Beneficence: Animals & Organoids in Life Sciences Research	Read the notes and answer moodle questions
11 08/05	Principle of Justice I: Gender, Age, Ethnicity and Life Sciences Research	Read the notes and answer moodle questions
12 15/05	Principle of Justice II: Life cycle analysis in Life Sciences	Read the notes and answer moodle questions
13 22/05	Principle of Justice III: Participatory Design & Co-design	Prepare and submit the final case study analysis
14 29/05	Conclusion & Review	

References

Clegg, S., Kornberger, M., & Rhodes, C. (2007). Organizational ethics, decision making, undecidability. *The Sociological Review*, *55*(2), 393-409.

Hardebolle, C., Verma, H., Tormey, R., & Deparis, S. (2022). Gender, prior knowledge, and the impact of a flipped linear algebra course for engineers over multiple years. *Journal of Engineering Education*, 111(3), 554-574.

Kotluk, N., & Tormey, R. (2023). Compassion and engineering students' moral reasoning: The emotional experience of engineering ethics cases. *Journal of Engineering Education*, *112*(3), 719-740.

Kotluk, N., & Tormey, R. (2024a). The impact of different methods of increasing the intensity of compassion in engineering ethics cases. *European Journal of Engineering Education*, 1-17. https://doi.org/10.1080/03043797.2024.2341758

Kotluk, N., & Tormey, R. (2024b). The impact of varying levels of compassion in ethics education case studies on students' moral reasoning. *Journal of Moral Education*, 1-21. https://doi.org/10.1080/03057240.2024.2411962

Kotluk, N., Lönngren, J., & Tormey, R. (2025) Reason and Emotion in Engineering Ethics Education. In Chance, S., Børsen, T., Martin, D. A., Tormey, R., Lennerfors, T. T., & Bombaerts, G. (Eds). *The Routledge International Handbook of Engineering Ethics Education*. (pp. 76-90) Routledge Taylor & Francis Group

Lönngren, J. (2021). Exploring the discursive construction of ethics in an introductory engineering course. *Journal of Engineering Education*, *110*(1), 44-69.

Secules, S., McCall, C., Mejia, J. A., Beebe, C., Masters, A. S., L. Sánchez-Peña, M., & Svyantek, M. (2021). Positionality practices and dimensions of impact on equity research: A collaborative inquiry and call to the community. *Journal of Engineering Education*, *110*(1), 19-43.

Steen, M., Sand, M., & Van de Poel, I. (2021). Virtue ethics for responsible innovation. *Business and Professional Ethics Journal*. 40(2), 243-268.

Tormey, R., Børsen, T., Chance, S., Lennerfors, T. T., Martin, D. A., & Bombaerts, G. (2024). Mapping engineering ethics education. In Chance, S., Børsen, T., Martin, D. A., Tormey, R., Lennerfors, T. T., & Bombaerts, G. (Eds). *The Routledge International Handbook of Engineering Ethics Education* (pp. 1-18). Routledge Taylor & Francis Group.

Van de Poel, I., & Royakkers, L. (2011). *Ethics, technology, and engineering: An introduction*. John Wiley & Sons.

Zhu, Q., Marin, L., Medeiros Ramos, A., & Sundar Sethy, S. (2025) The purposes of engineering ethics education. In Chance, S., Børsen, T., Martin, D. A., Tormey, R., Lennerfors, T. T., & Bombaerts, G. (Eds). *The Routledge International Handbook of Engineering Ethics Education*. (pp. 27-43) Routledge Taylor & Francis Group.

Outside class work

Reading: Read the week's notes.

Writing: In this chapter I wrote a section describing my 'positionality', i.e., the things in my education and my interests which shaped the way I approach the course. You should now write your 'positionality' statement for the course. What are the important things for you (your education, your experiences, your interests, your hopes for your the future) that shape the way you approach this course on Life Science Engineering Ethics? Your positionality statement should be at least 300 words.