



The Royal Academy
of Engineering



Engineering Ethics and Accreditation

**A report of a workshop held on Friday 14th March 2008 at
The Royal Academy of Engineering**

Engineering Ethics and Accreditation

This is a report of a workshop jointly hosted by The Royal Academy of Engineering and the Engineering Council UK (EC^{UK}). The purpose of the meeting was to establish the priority that should be given to ethics content when assessing engineering degrees for accreditation and what accreditors – from institution staff to accreditation visitors – should be looking for when considering the ethics content in an engineering degree. The event was attended by university teachers, accreditors and engineering institution staff involved in the accreditation process. What follows is a summary of the presentations given and group discussions at the event. Powerpoint presentations are available online at: <http://www.raeng.org.uk/policy/ethics/events.htm>

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Presentations

Introduction and Welcome

Andrew Ramsay, Director, EC^{UK}

Engineers have had a reputation as people who simply solve problems. It is my belief that engineers should become more difficult to employ. It is important that engineers question, argue and look into the established assumptions when they are set a problem or enter into a contract. This event is an opportunity to look at one of the important ways in which we can encourage engineering students to start to question what they are told and to start to question what they are doing. It also deals with the current issue of how, now we have moved toward an outcomes-based approach of assessing and accrediting degrees, it has become more important to have good, sound ways of assessing the components of degrees and the competencies that graduates are supposed to have at the end of a degree. Today's event gives us an opportunity to discuss how to do this in the context of ethics.

Ethics in Engineering

The Royal Academy of Engineering and EC^{UK}'s Statement of Ethical Principles, its purpose and meaning for engineering

Professor Ernest Shannon FEng

I am going to outline the background to how the statement of ethical principles emerged. As long as human beings have lived together there have been attempts made to agree what is and what is not acceptable conduct. The bible records God's advice to Adam and Eve on acceptable behaviour in Eden, and his meeting with Moses when he passed down the Ten Commandments. Clay tablets and blocks of stone containing rules of conduct have been found when excavating the ruins of ancient civilisations. The best example of this is a granite block inscribed with 282 laws ascribed to Hammurabi, from ancient Mesopotamia some 4000 years ago. Three of those laws have some bearing on engineering.

Arguments on individual and group behaviour centre on defining the difference between good and evil and right and wrong. They usually focus on the intentions people have toward other individuals, including non-human members of society. There exists an academic dispute concerning whether morality exists only in the presence of a society. Philosophical arguments tend in all directions. Moral codes exist that recommend heavy restrictions on human behaviour as well as those that recommend totally free self-determination, as well as a variety of intermediate positions. Morals are largely influenced by religion or theology, but secular ethical codes are also followed. Moral codes may be thought to arise from the commandments of God or may be based on humanitarian principles of reciprocal behaviour and prevention of suffering, or objective ethical theories such as utilitarianism.

Codes of conduct have been of interest to professional organisations for hundreds of years. In the 19th century the development of such codes was central to the

establishment of medicine, law and engineering as professions that could be trusted by society. Formal codes specifying standards of acceptable behaviour between professionals and their clients, employers and the public are predated by examples of guidance such as the Hippocratic Oath.

In the 20th Century professional codes were more widely adopted, often in response to high profile controversies. In the physical and biological sciences the emphasis placed on codes is much less acute than engineering or medicine; because the conflicts of interest that motivated many of the codes were less evident and because some sought to characterise science as a 'value-neutral activity.' Following the Second World War the lack of a formal code for scientists as a group and the level of awareness of ethical considerations was considered to be a matter requiring attention on an international scale. In November 1997, UNESCO approved the creation of the World Commission on the Ethics of Scientific Knowledge and Technology (COMIST). The establishment of this body reflected the increasing importance of ethical considerations in the light of cultural and social affects created by the rapid development of scientific knowledge and technology.

The task of COMIST is to formulate on a scientific basis ethical principles that can shed light on the various choices and impacts occasioned by new discoveries. It seeks to motivate scientists by adding an ethical dimension to their intellectual freedom. Thus discussion on scientific ethics entered the diplomatic arena. In early 2003 the UK Foreign Secretary announced that the Government intended to commence work on a scientific code of conduct. This initiative was taken up by individuals from the Foreign and Commonwealth offices, the Ministry of Defence and the then Department for Trade and Industry.

Officials met at The Royal Society to discuss how the initiative should be taken forward. Not everyone was comfortable with what was being proposed for the UK science community and reservations about the utility of the code were expressed by some industry and funding council representatives. The UK House of Commons Science and Technology Committee however urged British learned societies and funding councils to consider introducing a code of ethical conduct as a prerequisite of membership and to run training programmes to heighten awareness of issues involved. It went on to say that if the scientific community does not take action to regulate itself then it risks having ill-judged restrictions placed on it by politicians. It also noted that an ethical code of conduct for scientists has value in promoting awareness and providing a basis for better education of researchers. Learned and professional societies and research councils should develop an understanding of what such a code involves and should enforce it by denying grants or refusing membership. By insisting that a code of ethics is unworkable they are ducking their responsibility.

In its response the UK Government agreed that UK researchers should be aware of ethical issues relating to science and its wider applications and consulted the research community on whether such a code was likely to deliver. The proposal was well-received by universities, professional bodies and others; it was generally agreed that it would raise awareness among scientists of their professional, ethical and legal responsibilities.

The outcome was a code entitled 'Rigour, Respect and Responsibility – a Universal Code for Scientists' and was published by the then Government Chief Scientist Sir David

King in 20005. It has three main headings: Rigour, honesty and integrity; Respect for life, the law and the public good; Responsible communication – listening and informing.

In parallel with the discussions in the scientific community there was a debate led by The Royal Academy of Engineering ECUK going on for engineering. This began by looking at the codes of conduct published by the different institutions, remarking on the diversity of wording and the apparent failure by most to follow the guidelines issued by the Engineering Council in the 'UK-SPEC' document, which gives a list of headings on which institutions are encouraged to reflect in the development of ethical codes.

In his Lloyd's Lecture, 'Engineering Ethics – Do Engineers Owe Duties to the Public', John Uff illustrated the diversity of wording by quoting sentences in institutional codes relating to health and safety. These suggest different emphases on and prioritisation of the importance of health and safety; and it is difficult to justify the wide variations in codes from a legal or other point of view. There were however a number of common principles relating to health, safety and the environment which can be linked to specific duties created by common law or statute. It is these that the guidance from ECUK to engineering institutions seeks to address. This advice requires institutions to place a personal obligation on members to act with integrity in the public interest and to exercise all reasonable professional skill and care.

Whilst a universal code of conduct for engineers is considered desirable, it is apparent that most institutions are reluctant to change the wording that they have evolved over time. The basis of each code is a set of rules designed to address member behavioural problems encountered in practice. As a result codes have evolved in different ways, covering different circumstances. Attempts by the Academy and ECUK working group on ethics to agree the wording for a universal code of conduct failed because the document became very unwieldy and even contradictory. It became apparent how difficult devising a universal code of conduct would be.

Through researching approaches taken by different professional organisations, the group became aware of the Universal Ethical Code for scientists. The scientists believed that their code was applicable to engineering without adaption, however the working group felt otherwise and developed the statement of ethical principles. This incorporates all of the principles in the scientific code, but extends them into the realms where one is applying knowledge as well as creating knowledge.

It is based on four statements. Accuracy and rigour; Honesty and integrity; Respect for life law and the public good and Responsible leadership – listening and informing. These mimic those in the code for scientists, but make some subtle changes in the wording. Following the launch of this statement in 2005 it was further refined after a consultation process with the institutions and republished a year later.

Whilst it is illusionary to imagine that a written code of conduct can resolve all ethical dilemmas or uncertainties, they can aid in setting out how dilemmas are approached and how responsibility should be distributed between individuals and organisations. Professional institutions offering codes can help individual decision making by providing a sense of the wider context in which engineers should place their individual efforts. The statement of ethical principles has been widely endorsed and it is hoped that it will be used in future to shape the individual codes of institutions but more importantly to see if the profession can rise to the challenge of having a universal code. This would not be

unique, many professions in other countries have done this. There remains the challenge of creating a universal code – I believe that we can, though I don't underestimate how difficult that will be. The working group did begin the development of a set of guidance notes that would expand on the statement and give some advice on interpreting it. This was never published, as extending the words meant extending the opportunity to debate whether the wording was right. But the framework exists for the profession to take up that challenge.

The Curriculum Map

An introduction to The Royal Academy of Engineering and Engineering Professors' Council's curriculum map for incorporating ethics into the engineering degree

Professor Ian Howard

My job is to present to you the form of and the thinking behind the curriculum map. This is the second manifestation of the map and the committee of which I am a member has been thinking about the map and leading sessions like this on the various aspects of teaching engineering ethics.

Why do we need a curriculum map? We need to understand the nature of professional and personal responsibility. Although, in terms of engineering, it is the professional responsibility that we are thinking of, we cannot ignore personal responsibility. We should be able to identify the ethical elements in any decision, this is going to be particularly important for students. We need to be able to identify questionable practice and address problems that arise from it. And we need to be able to develop critical thinking skills and judgement, in the ethical area of engineering responsibility. All of us educators deal with that in terms of developing the technical abilities of our students but we need to accompany that with social and professional skills and a proper ethical awareness of what professional life is going to be. Our students ought to understand practical problems and how to deal with them to produce better outcomes. What we are trying to do is to introduce into the student environment simulations of the kinds of problems that they are likely to encounter as they move into the world of work.

Because we are dealing with young people who are still developing their identity and personality, developing a professional ethical identity helps them to develop a personal ethical identity. If they are clearer about their own personal ethical standing, they are better able to conduct themselves with other people in groups.

If we look at other professions, they have been dealing with ethics for some time. Why now for engineers? Look at these recent newspaper headlines:

- Investigation uncovers offshore tax havens that enable Tesco to avoid paying tax on profits from sale of UK properties
- Addicts face losing welfare payments if they fail to participate in treatment programmes
- Professional women pay the price of starting family by downgrading to employment well below their skill levels, says study

These are relevant as they demonstrate that students live in a world where such ethical issues are aired everyday. Without some ethical guidance they may feel that they are moving into a world without trust where responsibility can be avoided. The important thing for engineers is that responsibility and trust are central to how we want to practice. Introducing to students the rigour of proper ethical professional responsibility is as important as the technical requirements that go with it. That is why now is the time to introduce ethics to engineering.

We call this a curriculum *map*. What counts as a map? A map can represent many things. It can represent a landscape, or it can represent something like a railway line. It can be a topographical representation full of rich detail; or it can focus on specific aspects of the landscape and abstract away from the topography, representing features relevant to something such as laying a railway. I hope that we have constructed the curriculum map in such a way that leaves out a lot of prescriptive detail about teaching ethics, allowing the map to be useful to a wide range of engineering educators, relevant to their particular needs.

I am going to unpack the map by looking at one of the levels in the map. The map is divided into four columns:

- The **Location** explains the focus appropriate for each level and indicates where ethics *may* be usefully introduced at that level
- **Learning Outcomes** illustrate the expected learning outcomes at each level – what students out to be able to do
 - The map as a whole shows how students *might* progress throughout the degree programme
- **Content** indicates possible ethics topics that *might* be relevant for students at each level
- **Process** gives examples of teaching methods that are suited to teaching ethics at each level
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Looking at level 2, which represents the second level of engagement, so this material could be included in the second year of a degree, but it is also appropriate for it to be covered in the third or fourth year of a degree as an introduction to other issues. At this level we would expect the students to be resolving practical problems and identifying ethical issues and examining and weighing up opposing arguments. There will be modules to deal with this in a conventional course and in a sandwich course placement preparation would be a major part of this level.

The content might be ethical case studies – case studies are found by many teachers of ethics to be enormously important, professional practice is important for those students going into an industrial placement. Included in example techniques are role-playing scenarios – very useful if people have the time to develop them – and, the important thing, modify existing modules where possible to include topics and exercises where ethics comes in naturally to integrate ethics into the existing engineering programme.

The map is a guide and not a prescription. What we want to try and do is to encourage people to use the map to help them get a clear and coherent development of engineering ethics in the course as it exists for them and in the plans that they have for developing that course. We hope people will be able to develop their own material on ethics that will fit into their course rather than bolting it on to a course. This way they can integrate ethics into their own curriculum and it is our view that this is the best way to incorporate ethics into engineering education. Our view is that engineering ethics should be a distinct theme that runs through the course from level one. Like engineering design, it should be a thread that runs through all the levels of the degree. Indeed, design and engineering ethics go together because these are practical disciplines.

We know that all engineering teachers and curricula are different, so there is no prescribed way of implementing the map. We want people to customize the map. We

think ethics issues should be regular, but not necessarily frequent. There are ethical aspects relating to virtually all areas of engineering, so wherever you have a case study relating to a real situation, there are ethical issues associated with it that can be developed. We do not need to add extra content to the course.

We think that to introduce ethics into a course, leadership is essential. We recommend that wherever possible departments institute an 'ethics theme team'. Their job is to plan and implement the teaching. To do that they need champions who are committed to bringing ethics into the curriculum and have the influence to make that happen – ie, the team would need some powerbrokers. We also recommend that, wherever possible, this team includes some outside help, so visiting professors are a natural sort of person to bring into the team, if they are committed to engineering ethics, as they can introduce to students the world of practice. Experienced teachers of ethics could come from engineering disciplines, or they could be specialists in applied ethics or members of philosophy departments interested in applications of ethics in engineering.

Finally, an example of how we have developed engineering ethics in my own institution, the University of Sheffield. We did it without the curriculum map, as we did not have one. If I had, in 1998, when I was given the job of introducing engineering ethics into our course, something like a curriculum map, my job would have been vastly different. I was thrown into it and had to drown or swim – I chose to swim.

Our course is called the Professional Responsibility of Engineers, and it is suffused with ethics all the way through. First delivered in 1999, the current course leader in John Yates, also the Head of Department. We chose to do it as a stand-alone course in year 3. It has since its inception changed a great deal. It was 12 lectures and 6 case studies, it is now 3 engineering ethics themes. The course development team and the director of undergraduate study have plans to spread the third year course all the way through the syllabus from year one to year four, and the curriculum map will be a great help to them in making this change. They will do this not by creating new courses, but taking the engineering ethics components and attaching them to technical engineering education and case study work and attach them in places where they are appropriate in every year and every level of the course.

Engineering Ethics and Accreditation

What challenges does ethics pose for the accreditation process?

Professor Neal Juster, chairman of the IMechE Academic Assessment Committee

I am here from the Institution of Mechanical Engineers where I am Chair of the Academic Assessment Committee. In my day job I am Vice-Principal of the University of Glasgow and until a year and a half ago I was Dean of Engineering at Strathclyde University. I am going to talk about why we accredit courses, how we go about the accreditation process, talk about UK-SPEC and how we go about looking for something like ethics when we go about our accreditation.

Why do we accredit? Two reasons, one is that we are trying to find out whether the learning outcomes of a degree actually match what UK-SPEC says that they should be. UK-SPEC is the UK standard for professional engineering competence. So we are really looking at competencies. We have to check whether the students graduating from a course really exhibiting those learning outcomes?

The Institution of Mechanical Engineers has a license both to accredit Incorporated Engineer and Chartered Engineer status from the Engineering Council UK. We accredit degrees that cover the cognate areas of mechanical engineering. It is quite difficult to define where the boundaries of that lie – it used to be very easy, but we now have areas like sports engineering and engineering management.

I am going to talk about how the Institution of Mechanical Engineers goes about the accreditation process. Other institutions may do it slightly differently, though they will be looking at the same things.

What is the procedure we use for accreditation? We are only able to accredit people for five years, so we have to visit universities at least every five years. For an IMechE visit, four of us will visit a department – two from academic backgrounds, one from an industrial background and one member of staff from the institution. Sometimes a range of degrees will be accredited at one time, and a much wider team will visit from the Engineering Accreditation Board, covering all the disciplines, with at least two people per discipline.

Prior to the visit we ask for documentation from the institution to establish that the degrees they are putting forward for accreditation cover the cognate areas of mechanical engineering. We will also want to see whether external examiners and QAA audits can give us confidence that you are teaching to a reasonable standard.

At the visits we have to review documentation and assessments, meet with key staff and look at the key facilities. That takes place in one day. This means that we have to make choices about which learning outcomes we will consider. At the end of the visit we will do a report to the academic standards committee and the university may have to submit an action plan to make some changes. We may only accredit for a shorter period, if we are unhappy with anything and need to wait for you to change your courses.

For a brief look at accreditation history, we can look back to SARTOR (Standards and Routes to Registration). SARTOR was very much input-driven, specifying the number of modules on each topic that a degree had to include. It was quite restrictive in terms of what could be included in a degree programme. It was also driven by input standards – so if you did not have enough high quality school leavers driven to a course then it was felt that you could not be delivering high quality graduates at the end of the course.

UK-SPEC has changed that. We are now looking at outputs – at whether learning outcomes are being delivered. The universities can define their own content. They can decide, for example, not to teach any fluids past the first year if they do not feel it is important for the outcome of their students. Whilst we may disagree with this, we cannot dictate what goes in the course. We can have a discussion about it but our job is to assess whether the learning outcomes in UK-SPEC are delivered by that degree.

The Accreditation Handbook is not a very long document. It has four general learning outcomes and 26 specific learning outcomes for the bachelor's programme. The masters programme has further learning outcomes and there is a separate set of learning outcomes for incorporated engineer. The four general learning outcomes are Knowledge and Understanding; Intellectual Abilities; Practical Skills and General Transferable Skills. The 26 specific learning outcomes are listed underneath these headings.

Where does ethics appear? Under Knowledge and Understanding it says that 'they must appreciate the social, environmental, ethical, economic and commercial considerations affecting the exercise of their engineering judgement'. And specific learning outcome S5 stipulates: 'Understanding of the need for a high level of professional and ethical conduct in engineering'. The word 'ethics' does not actually appear in the document; these are the only two places where ethics is mentioned.

We ask universities to fill in a matrix, which lists learning outcomes and the modules the university teaches, and universities tick the boxes to indicate which learning outcome is being met in which module. In this example, we can see that S5 is marked 4 times. We are there for one day. We do not have a huge amount of time. There is no way we could check every ticked box to assess whether the learning outcomes are being met in the relevant modules. So we decide in advance which learning outcomes we will look at. Then we sit with the team and ask how they think those learning outcomes are being achieved. For example, we will ask staff how they are incorporating sustainability into their programme, and then we will ask the students where sustainability comes up in the course. We look at the module descriptions to see whether the right words are there, and then we look at the outputs, in terms of course assignments, exam papers, assessments and any course notes that have been given out, to give ourselves the confidence that where learning outcomes are claimed to be met they really are being met. We rely on external examiners to ensure that the right standards are being met, but our concern is whether, when a department claims that an outcome is being met, the methods of assessment show that it really is being met.

There are 26 learning outcomes for the BEng programme. With ethics, we would not expect there to be a module called 'ethics'. The curriculum map itself suggests that this would not be a central way to teach ethics. We would be looking for a thread through the whole course, or places where it has been embedded in the course, where

everything members of staff do promotes the consideration of ethics. So we would look for the word 'ethics' or 'ethical' in the course descriptors. Is it in assignments as part of the design module – when you are design in something do you have to have a discussion or write a report about the ethical implications of what you are trying to design? Are there case studies in modules that might be called things like 'professional development', 'engineering in society', 'engineering management'? Are there visiting practitioners coming in, giving seminars as part of these programmes? Is ethics embedded in group and individual work?

The parallel with ethics is sustainability. The whole engineering profession is keen to ensure that sustainability is embedded in a programme. You rarely see a module called sustainability, but you are looking for areas in the courses where students could be made aware of sustainability issues. Similarly, you are looking for areas where ethics can be incorporated into the curriculum.

Discussion

What ethics topics might be covered in engineering programmes?

Personal, professional and cultural ethics

Should engineering ethics include personal ethics? Do personal and professional ethics need to be in agreement? Should we be encouraging or helping students to develop their personal ethics? There is an argument to suggest that personal and professional ethics should be kept separate; however, a student who has developed ethical beliefs of their own may be more empowered to challenge unethical behaviour in an engineering company they join. The potential difference between personal and professional ethics is a useful topic for discussion. It is interesting to explore how far a student's personal ethical beliefs will affect their working life – for example, should a pacifist student object if research they do might have some downstream application in military engineering?

Learning to deal with ethical conflict will be a central aspect of engineering ethics teaching. Students need to be prepared for dealing with conflict between business and professional ethics, and potentially with the conflict between different ethical cultures, if they are to work on international engineering projects.

Should engineering ethics seek to give students guidance on what to do in particular situations, or should it avoid pushing them to conclusions, instead encouraging them to take a critical view? In general, it was agreed that 'awareness not indoctrination' was the aim of engineering ethics teaching. Engineering students need the skills to be aware of and sensitive to ethical issues so that they can judge for themselves the best path to take in any given situation.

Plagiarism, fairness and intellectual property

All students have to be aware of the unacceptability of plagiarism. Hence, when the rules and expectations regarding plagiarism are explained to them in their induction, the ethical aspects of plagiarism can also be explored. This could involve looking at concepts such as fairness and, later in the degree, intellectual property and intellectual property rights.

Whistleblowing

This is a controversial topic as it is generally understood that whistleblowing can have dramatic consequences for the whistleblower, and implies a serious breakdown of internal corporate communications. However, ethics teaching could cover this in terms of processes alternative ways of reporting or drawing attention to bad practice. It is also useful to consider the engineer's responsibility to take action when off duty – for example, reporting to the relevant authorities – if they witness engineering work which they feel is dangerous or might lead to hazards.

Bribery

Bribery is an important area for students to consider, as this might be an issue they face in their career. This could involve looking at what counts as bribery and how perceptions and acceptability of bribery might differ in another country. What should the engineer do if they are expected to pay a bribe in return for work? How can they take action to help eradicate bribery?

Competence

It is essential that engineers always work within their areas of competence. Therefore it is worthwhile encouraging students to look at how to judge the limits of their and others' competence and exploring the consequences of engineers working outside their areas of competence. This can be done in the context of teaching technical topics – highlighting the importance of responsibility for carrying out thorough analyses and keeping knowledge up to date.

Sustainability

Sustainability is an issue that is having increasing coverage in the engineering degree. The ethical issues concerning sustainability could usefully be explored, looking at duties to the environment and to communities. Looking at the affects of engineering on the environment and society can highlight interesting dilemmas that students can be encouraged to weigh up.

Risk and safety

Risk and ethics are closely related topics. Therefore, teaching on risk analysis is a good point at which to raise ethical issues. Health and safety is also a good vehicle for introducing ethical issues. These could include responsibility for safety and how to weigh up the options between introducing safety features and minimising costs and complexity in a project.

Preparation for work – Professional practice and corporate social responsibility

In general, ethics teaching should prepare students for the world of work. Therefore, ethical issues should be closely allied with professional practice. Issues relating to good conduct as a student could also be linked to good professional conduct, making the issue of professionalism relevant to the students' experience. Deeper questions might be explored, such as: is engineering morally neutral? Is an unethical engineer a bad engineer, or a bad person who is a good engineer? Questions like this are relevant to the issue of the consequences of failing ethics courses (see below).

Most large employers of engineers have a corporate social responsibility strategy or policy, therefore students could be introduced to the concept of CSR and where ethics fits, or should fit, into it.

Legal and ethical issues

Ethical issues will often arise when covering legal topics. This gives an opportunity to highlight the ethical aspects of legal issues – for example, conflict of interest is both a legal and an ethical issue. It may also be valuable to discuss the differences and

possible tensions between the law and ethics. Are there cases where following the law is not sufficient for ethical practice?

Ethical skills

In general, engineering ethics is about developing skills rather than teaching rules or facts. Students need practice in recognising ethical dilemmas or problems and weighing up options and coming to a decision in a sound manner. Ethical skills can also be closely allied to communication skills – the ability to present a case, construct an argument and justify a course of action in an articulate manner.

It is important to make engineering students aware that ethical issues are not clear-cut 'yes or no' issues. There are many instances in which debate will result in no right answer. For example, one could have a dilemma of the sort where one might have to choose between running a road through an ancient burial site or a nature reserve with rare species in it. In such cases a decision must rest on a balance of opinion. Students must be aware of this process for reaching difficult decisions.

How can ethics be incorporated into the engineering degree?

Distinct modules v. embedding

It was agreed generally that engineering ethics should be embedded in the degree, occurring at all levels from the very beginning of a degree. This is effective in linking ethics intrinsically to technical and practical subjects in engineering. In addition the engineering degree is very full and it can be a challenge to find room for ethics. However, embedding ethics into the degree does not require finding time for more teaching. The RAEng/EPC curriculum map gives ideas of where ethics can be placed. The map gives ideas for where to incorporate ethics – it does not have to be followed faithfully and it is not the case that all of the topics/suggestions in the map should be taken up in one degree course.

This is not to say that there is no value in running a stand-alone module. This can cover the ethical theory that underpins ethical decision making processes that students will have to engage in. Modules can, of course, be run in parallel with an embedding of ethics into the course and can simply be an option for those who want to explore these issues in more depth, or could be run as a way to introduce ethical topics that will be revisited throughout the course.

Since ethics should start at year one, teachers need to be aware therefore of any experience of ethical issues that students are likely to have had before they arrive at university. It may be useful to assess their initial sensitivity to ethical issues (see below).

Embedding ethics in coursework

Final year projects are an opportunity to consider ethical impacts in more detail. They could include a written section or a presentation on the ethical issues raised by a student's project.

Ethical audits of projects are a valuable exercise. Every design study, project, visit report could have a tick box list or statement which students complete to show that they have considered the health and safety, sustainability, economic and ethical considerations concerning where they have been and what they have done. These would be examinable in accreditation visits.

Ethics in professional experience

The student's ethical awareness will only really be exercised when they are working as a professional engineer and facing ethical challenges. So university teaching can only achieve so much. However, work placements may be a good opportunity to encourage students to deal with ethical issues. Students could be encouraged to highlight any ethical issues they were aware of when writing reports on their placement activities.

Examples from Professional practice

There is value in inviting visiting professors or speakers to talk about ethical issues in professional practice. This could demonstrate to students the relevance of ethics, prepare them for the kinds of issues that they may face and instigate discussion on professional responsibility.

Departmental Ethos

An ethical culture is essential. As in health and safety, ethics should be embedded in the culture, from the top of the organisation through all levels. So, as well as delivering teaching on ethics to undergraduates, good ethical procedures and debate on ethics need to be prominent in an institution. Therefore ethos of the department teaching ethics is critical. Students cannot be expected to have an awareness of or ability to discuss ethical issues unless it is inculcated in the ethos of the department.

Ultimately, whatever is done in the teaching of ethics, it should not be a tick-box exercise but should be a matter of making ethics an intrinsic part of the way a department teaches students and prepares them for their professional lives.

Assessment and measuring ethical awareness

Assessment is essential to ensure that students take ethics content seriously. Students are outcomes-driven so there is a vital need for assessed tasks, which will encourage students to engage properly with the ethics agenda.

Assessment is also essential for providing evidence for accreditors that ethics is being covered in a degree. If it is a learning outcome required by UK-SPEC, it has to be assessed. Assessment is the measure of outcome.

Should ethics be assessed in different ways to other subjects or topics? Is ethics quantifiable? A variety of assessment methods is essential, and assessment should fit the nature of the module into which ethics is embedded. Online tests, presentations, essays, parts of other assessments (such as ethical audits of projects) are all valuable methods of assessment.

It is also valuable to test whether a student's ethical awareness has developed. It would be useful to have simple online tests in order to gauge levels of awareness when students arrive at university and to track whether their awareness develops as they progress through the degree. This is separate to assessment and is useful in establishing a student's level when they start the degree, in order to aim ethics coverage at the appropriate level, and is useful in discerning whether coverage of ethics is effective.

Teaching methods

Case studies are very valuable in teaching ethics, as they place ethical issues in real, practical contexts. Videos and short films can also be used.

Engineering ethics – issues for accreditors, institutions and universities

How accreditors should assess ethics content

Ask students: Do not ask blunt question of a student eg, 'have you been taught ethics?'. Instead ask students questions about scenarios to get an impression of whether they are able to identify the ethical issues in those scenarios. Eg, describe a scenario where something is done unethically, or where a dilemma could arise, to see whether students are sensitive to these issues.

Look at module descriptions: do these say whether and where the ethical aspects of a topic will be explored?

Assessment: look at assessments to see if ethics is a part of assessment, or, if relevant, pieces of ethics coursework to see how it is covered and assessed.

Support for staff

Staff teaching ethical issues for the first time may need support. Although ethics can be naturally integrated into the engineering degree this does not necessarily mean that teaching ethics is easy. It may require new teaching methods and will involve academics dealing with new concepts that might not be intuitive. Support could be provided in terms of further training, or the establishment of an 'ethics theme team', where engineering academics, learning and teaching deans and academics who teach applied ethics can discuss the best ways to integrate ethics into the course and thus advise course teachers.

Consequences of 'failure'

What should the consequences be of students failing ethics assessments? Should a student be able to pass a degree whilst failing the ethics components? Should this matter?

In general, this is a matter for universities to decide. Accreditation criteria cannot state that someone has to pass an ethics module to receive a degree, however, accreditation criteria can put a strong emphasis on ethics. If it is felt that it is of great importance that a practising engineer can deal with ethical issues, more emphasis should be put on ethics in accreditation criteria.

Limits of teaching ethics

Universities do not deliver chartered engineers. A great deal of students' ethical development will take place when they are working as professional engineers.

It is important to realise that the academic part of formation is only the first part. There are other steps that an engineer must pass to be chartered, and often these other steps, including general experience in industry, can prepare students for dealing with ethical issues.

There is continual pressure to add more aspects to the engineering degree. Universities cannot cover everything that is relevant to the engineering profession, but must expect that some skills will come through experience and CPD. It is more important that a culture of discussing ethical issues is created rather than spending extra time looking at ethics in isolation.

Role of institutions

There is a leading role for institutions to make it clear that ethical issues are now a key part of accreditation criteria and a key part of what engineers do. Accreditors have to look at many learning outcomes. If ethics is important, if it is to be embedded in the degree and assessed and time is to be spent on it, then the message needs to come from the top that ethics is an important issue.