



Ethical Reasoning in the Engineering Curriculum

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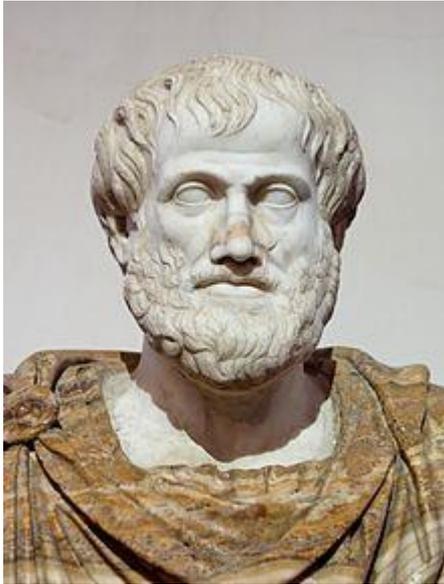
Fox or Hedgehog?



R. Ocone, C. Ocone, "Hedgehog or Fox", TCE, Issue 883, 52-53, 2012

R. Ocone, "The Fox or the Hedgehog: One Idea or Many?", in "Yearbook of Biosecurity Education", 2013

The “Ancient” Philosopher



Ethics is “practical wisdom” (*phronesis* in Greek)

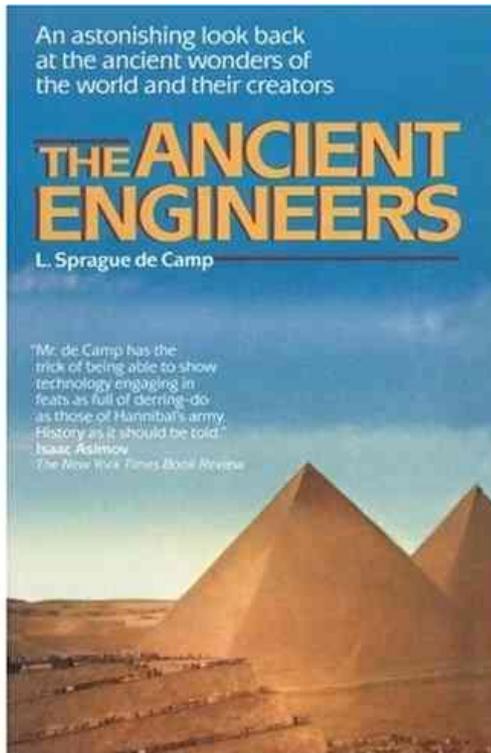
Gaining “practical wisdom” requires acquiring practical experience

... young people become accomplished in geometry and mathematics ... prudent young people do not seem to be found

Prudence is concerned with particulars as well as universals

Nicomachean Ethics 1142 BC

The “Ancient” Engineer

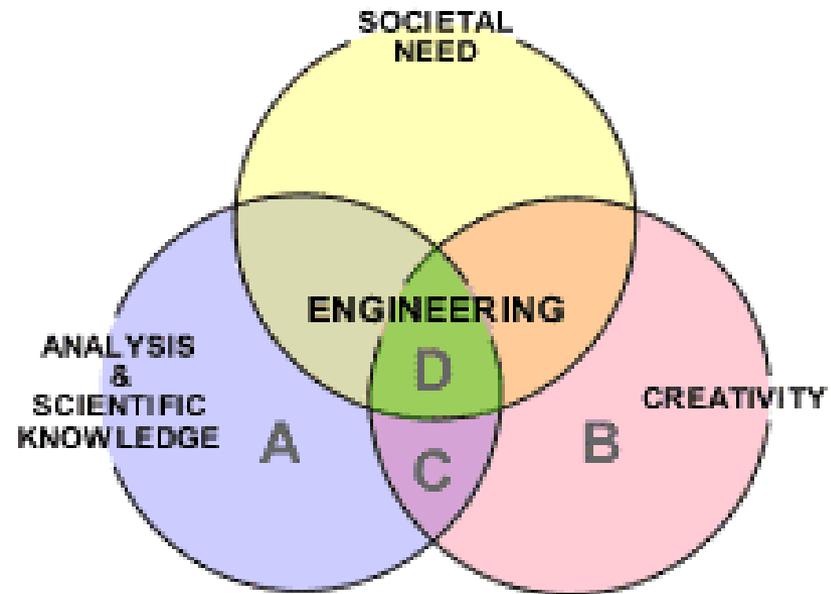
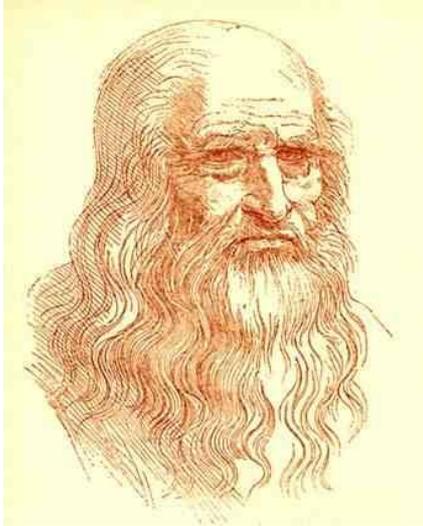


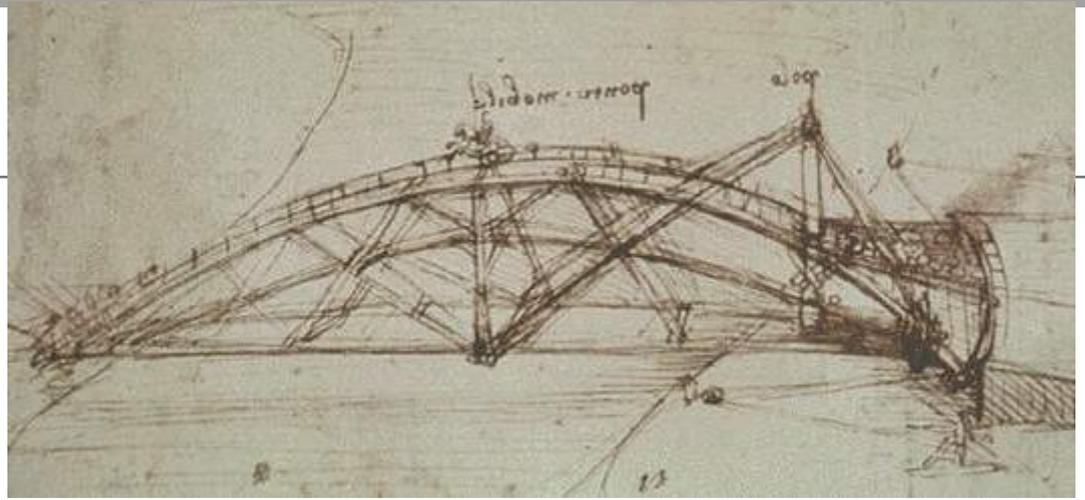
“Civilisation is a matter of power over the world of nature and skill in exploiting this world. It has nothing to do with kindness, honesty, or peacefulness.”

“No doubt it would be a good thing if they were universal, but the engineer is not the man to ask this of. “

“He can heat your house, dam your river, or build your space ship, but it is hardly fair to expect him also to make you love your fellow man.”

The “New” Engineer





Designed in 1502 to cross the Golden Horn in Istanbul.

With a length of 1,155 feet it would have been the world's longest bridge.

The sultan Bajazet II rejected the plan because he did not believe it would work:

Was the Sultan concern with the safety?

Was he worried that Leonardo never accompanied the drawing with calculations?

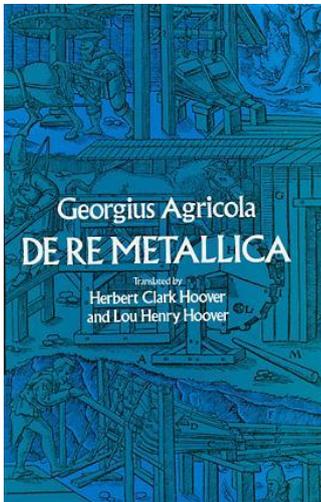
Was he worried about the investment (and his reputation)?



Some Ethical Considerations from the Past

“ ...**mining is a perilous occupation to pursue**.....; and there is **no compensation** which should be thought great enough **to equalise the extreme dangers to safety and life**.but since things are like this **rarely happen**, and only in so **far as workmen are careless**, they do not deter miners from carrying on their trade any more than it would deter a carpenter from his....”

Georgius Agricola “De Re Metallica”, ca 1550”



Statement of Ethical Principles

(expressing the beliefs and values of the engineering profession)

Accuracy and Rigour

Honesty and Integrity

Respect for Life, Law and Public Good

Responsible Leadership



Teaching Ethics to Engineers:

The Beginning

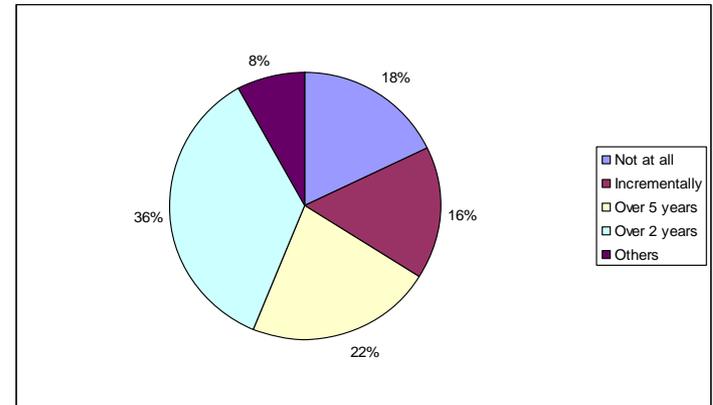
263 HoDs were contacted, 56 reply (21%). Those surveyed were asked to indicate the extent to which they already deliver the learning outcomes identified in the curriculum map

The results:

- Hardly at all 6
- Some delivery 26
- Significant delivery 13
- Substantial delivery 4
- Delivery of nearly all learning outcomes 4
- Other 3

Total 56

Given the high degree of self-selection involved in the returns, this suggests that ethics teaching has taken hold in only a small proportion of Departments.



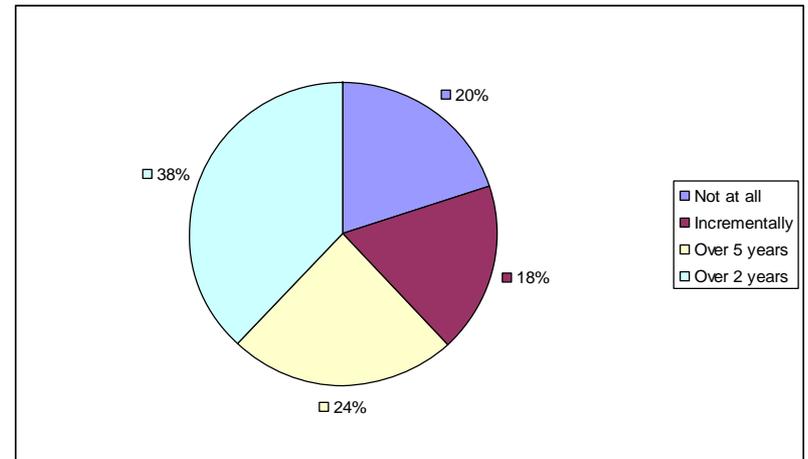
The Beginning

Departments were asked if they planned to increase the delivery of the learning outcomes

The results:

- In the next 1-2 years 20
- Over 5 years 12
- More incrementally 9
- Not at all 10
- Others 4

Total 55



There are signs that the teaching of ethics is planned to increase

The Good News*

4.11 Ethics culture

IChemE recognises that modern chemical engineering degrees need to include an emphasis on ethical considerations. These include, for example, the understanding of the nature of professional responsibility; being able to identify the ethical elements in decisions; being able to address and resolve problems arising from questionable practice; the development of critical thinking skills and professional judgement. The study of engineering ethics helps students to prepare for their professional lives and to develop clarity in their understanding and thought about ethical issues and the practice in which they arise. The study of ethics helps students to develop widely applicable skills in communication, reasoning and reflection. Ultimately, ethics culture should be embedded within the curriculum and aimed at the development of a professional ethical identity to carry forward in the working life.

* <http://www.icheme.org/accreditation>

The Less Good News

IChemE Accreditation: minimum credit allocation guidance

Credit basis = European Credit Transfer System (ECTS)

| | Master level | Bachelor level | Further Learning to Master level |
|---|--|--------------------------|--|
| Underpinning mathematics and science | 20 | 20 | |
| Core chemical engineering | 85 | 85 | |
| Engineering practice | 10 | 10 | |
| Design practice | 10 | 10 | |
| Embedded learning (SHE, sustainability) | Sufficient demonstration | Sufficient demonstration | Sufficient demonstration |
| Embedded learning (Transferable skills) | Sufficient demonstration | Sufficient demonstration | Sufficient demonstration |
| Advanced chemical engineering (depth) |) 55 ECTS minimum as) total – with a minimum) of 10 ECTS in each) category | – |) 55 ECTS minimum as) total – with a minimum) of 10 ECTS in each) category |
| Advanced chemical engineering (breadth | | – | |
| Advanced chemical engineering practice | | – | |
| Advanced chemical engineering design practice | 5 ECTS minimum | – | 5 ECTS minimum |
| Total specified content | 185 | 125 | 60 |

Learning about Ethics helps Students to:

- Be able to **identify** the ethical element of any decision
- **Understand** the nature of professional and personal responsibility
- Be able to **address** problems arising from questionable practice using appropriate tools
- Develop critical thinking skills and **judgment**
- **Understand** practical difficulties and use suitable approaches and techniques to help people produce better outcomes
- **Develop** an ethical identity to carry forward to their working life

Approaches

- A number of ways to teach Ethics in Engineering have been proposed (Davis, 1999, reports eight different ways)
 - However, they could all be reduced to two main broad routes:
 - Devise and give a specific module on Ethics
 - **Where?**
 - **Who?**
 - Integrate Ethics into the curriculum
 - **Where?**
 - **Who?**
 - **When?**
-

Engineering vs. Philosophy and Medicine

- **Analysis** (the “modern” philosopher)
 - Understanding an ethical problem or an ethical theory and dispassionately comparing the application of different theoretical approaches
- **Synthesis** (engineer)
 - Finding “*solutions*” to ethical problems (the best course of action)

The engineer is embedded in the process being prepared for dealing with specific kinds of ethical problems that will arise in real practical situations –
ethics in the context of making a practical decision

Engineering vs. Philosophy and Medicine

- **Medics**
 - One-to-one relationship –responsibility to an individual patient or client (usually)
- **Engineers**
 - Human relationships less direct and immediate
 - Long-term and distributed-impact decisions



Ethical problems harder to detect and best course of action more difficult to identify

Ways of teaching

- Look for ways to incorporate ethics into the existing curriculum – approach ethics laterally
- Use case studies and role play to illustrate and explore dilemmas
- Allow students to discover for themselves – through role play and debate
- Involve multidisciplinary teams, including philosophy, sociology, politics
- Invite practising engineers to speak – bring ethics to life
- Aim at developing skills, rather than teaching rules

The Integrated Approach

- **Advantages:**
 - Opportunity for the students to see “Ethics into action”
 - Ethics is presented as intrinsic in the discipline; it demonstrates as Engineering is an ethical profession in its essence.
-

The RAE Curriculum Map

| 1. LOCATION | | | 2. LEARNING OUTCOMES | 3. CONTENT | 4. PROCESS |
|-------------|---|------------------------------------|---|--|---|
| Level | Focus | Points of Delivery | Students should be able to: | Topics | Example Techniques |
| 1 | Awareness of issues, obligations and responsibilities; sensitising students to ethical issues | Induction | <ol style="list-style-type: none"> give examples of ethical issues related to engineering; recognise ethical responsibilities of engineers; describe in outline an ethical framework for engineering. | Professionalism; codes of conduct; obligations to the public | Interactive small group sessions during student induction; developing 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 (this topic could be introduced at Level 2) | Identify existing modules which can be modified to establish a clear ethical focus for the engineering programme. Each module will have illustrations, topics and exercises covering key ethical issues. Introductory modules to engineering would be ideal starting points. |
| 2 | Resolving practical problems; enabling students to identify ethical issues and to examine and weigh up opposing arguments | Modules | <ol style="list-style-type: none"> identify ethical issues related to an engineering situation; suggest ways to deal with ethical issues in engineering; illustrate the ethical dimension of practical engineering | Ethical cases in engineering; developed study of the ethical framework introduced at Level 1 | Existing modules can be modified to include topics and exercises which address ethical issues from a practical standpoint. Give an ethical angle to traditional engineering exercises. Encourage group work and use familiar, non-specific engineering situations by way of introduction, such as plagiarism and negotiation. |
| | | Placement preparation | | Professional practice of oneself and others; differentiating between good and bad employers | Set up role-playing scenarios and debates between students; run intensive workshops for placement preparation. |
| 3 | Reflection and critique of ethical issues; consolidation of ethics skills and practice; specialist study | Design Project | <ol style="list-style-type: none"> undertake an ethical audit; discuss ethical dilemmas in engineering; 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 by holding group debates. |
| | | Ethics-specific optional modules | | Philosophy of engineering; further ethical theory; engineering ethics and environmental ethics | Present case studies and dilemmas and give students practice in solving morally ambiguous scenarios. Encourage analysis, synthesis and report back of ethical issues. |
| 4 | Further reflection and critique of ethical issues; specialist study | Research-oriented module on ethics | <ol style="list-style-type: none"> articulate ethical problems in engineering; reach an ethically justified or morally reasoned practical solution to an ethical problem with an appropriate plan of action; propose policy relating to ethical questions in engineering | Research principles and ethics; risks and benefits of novel technologies; broader context of engineering; business ethics; corporate social responsibility | Present case studies and dilemmas and give students practice in solving morally ambiguous scenarios. Encourage written analysis and reports. |

Anatomy of the Map

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

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

Identifying Topics

- Look for issues that appear in codes of conduct
- Teach good ethical behaviour as well as disasters
- Raise ethical issues in design projects and encourage students to look for them
- Draw on your own experiences and decisions

Planning for Ethics Teaching

All engineering teachers and curricula are different

- no prescribed way of implementing the map
- customise the map so ethics naturally accompanies the technical engineering

Ethics provision should be regular but not necessarily frequent

- ideally - engineering ethics will be a continuous thread woven through the course

Ethics is easy to include

- there are ethical issues relating to virtually all aspects of engineering

Planning for Ethics Teaching

Ethics theme team

- a multidisciplinary team for planning and implementing ethics teaching

Champions

- people committed to bringing ethics into the curriculum
- power brokers – e.g. Directors of Learning and Teaching

Outside help

- visiting professor committed to engineering ethics
- experienced teacher of ethics

Assessing for ethics

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
- Ethical audits of projects
- Peer assessment – student assessing each others' work

Try to assess whether students can spot ethical issues, as well as assessing how they would deal with them

Ethics and Accreditation

What accreditors should do:

- **Ask students:** Do not ask 'have you been taught ethics?' but ask students questions about scenarios to get an impression of whether they are able to identify the ethical issues in those scenarios.
- **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.

**Will we be obliged to teach
Ethics into the engineering
curricula?**

The “old” philosopher, the “new” engineer

Ethics goes beyond the dilemma and the application of ethical principles

Ethics in engineering implies understanding the social impact of engineering work

The ancient Greek world as the era of “involuntary” ethics where the individuals lived in immediate symbiosis and harmony with their community

Nowadays, we tend to identify “culture” with “thinking”; classical philosophers did not consider philosophy as a purely intellectual activity – to them it was part and parcel of everyday life.

Ethics was not just a concept, but rather “action”, i.e. acting in and for the society.

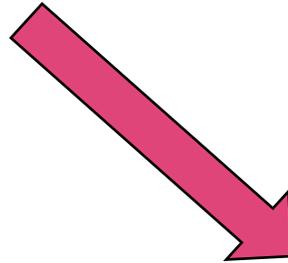
The Ancient Engineer

The Ancient Philosopher



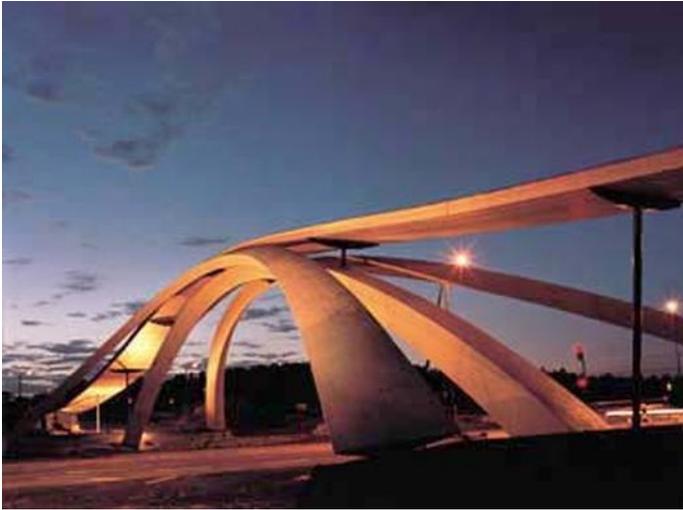
The New Philosopher

The New Engineer



The New Engineer





Vebjoem Sand saw the model of Leonardo's bridge at an art exhibit in Stockholm and decided it had to be built.

In 1995 he contacted the Norwegian Highway Authority and political leaders gaining support for what Sand describes as "the primordial bridge, the perfect blend of art and function".

"Vitruvius says that small models are of no avail for ascertaining the behaviour of large ones; and I here propose that this conclusion is a false one"
--Leonardo (~1500)

