The new Engineer and the old Philosopher
Hedgehog or Fox?

(Engineering the Future)

Raffaella Ocone

Chemical Engineering

School of Engineering and Physical Sciences

Heriot-Watt University, Edinburgh

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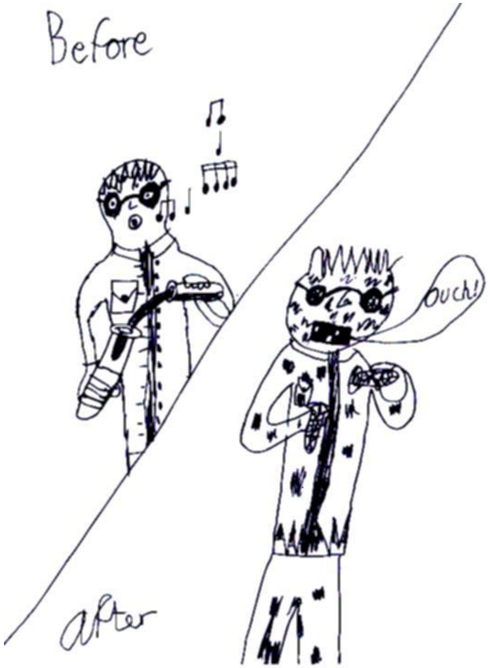
The Engineer

"Scientists discover the world that exists; engineers create the world that never was"

Theodore von Karman, Aerospace Engineer



Fox or Hedgehog?

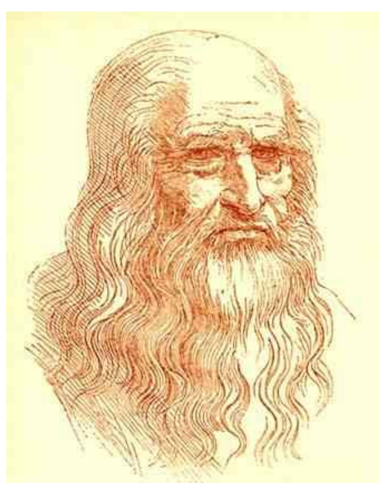
"The fox knows many things; the hedgehog knows one big thing."

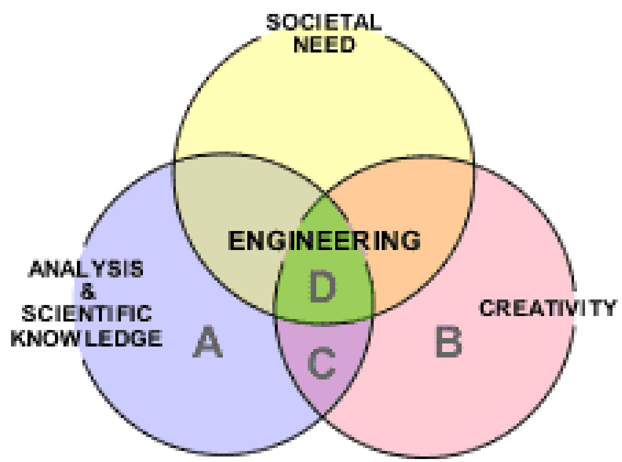
–Archilochus 8th Century BC

It is not all about engineering

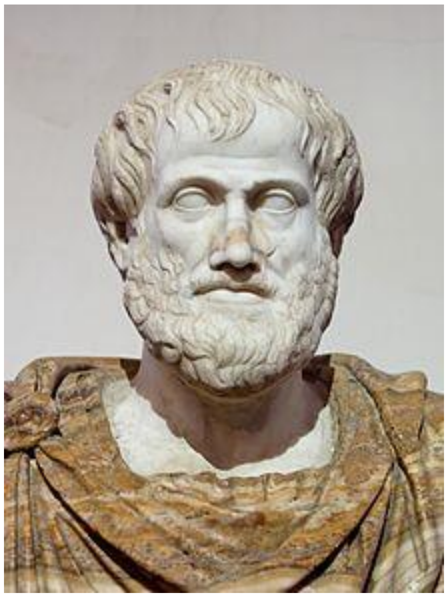
Ethics in Engineering

- Interest in society and the environment





The “Ancient” Philosopher



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

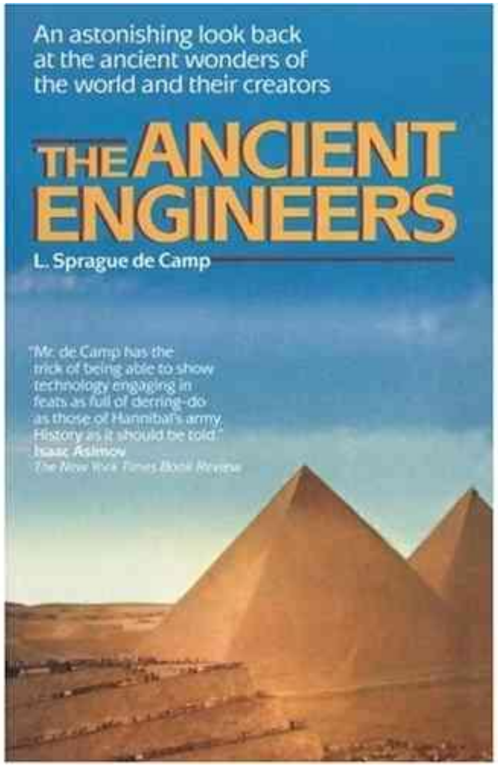
Gaining “practical wisdom” requires acquiring practical experience

… 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**."

Why does Engineering need Ethics?

Engineering as a practical and creative art has two aspects: doing and making, and the human and social context in which this occurs

The Code of Conduct is an expression of professional ethics, however, we should be careful of not confusing ethics with blind conformance to rules –the aim is not to give students knowledge of one more tool (like maths or IT)

An important component of professional behaviour has to be **judgement of rules,** whether the rule is right in the specific circumstances and is it being applied with integrity

Ethics is not an exact science

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

Teaching 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
  - Integrate Ethics into the curriculum

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.

Ethics in Engineering Degrees

- **Teaching** – who? how? when...
- **Assessing** – how? when?...
- **Accrediting** – who? how?...

LEARNING OUTCOMES

Educate the Educators & the Assessors

R Ocone, "Ethics and accreditation"
Education for Chemical Engineers ***8*** *(2 0 1 3) e113–e118*

The Curriculum Map

<table>
<tr><th colspan="3">1. LOCATION</th><th>2. LEARNING OUTCOMES</th><th>3. CONTENT</th><th>4. PROCESS</th></tr>
<tr><th>Level</th><th>Focus</th><th>Points of Delivery</th><th>Students should be able to:</th><th>Topics</th><th>Example Techniques</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Awareness of issues, obligations and responsibilities; sensitising students to ethical issues</td><td>Induction</td><td rowspan="2">1. give examples of ethical issues related to engineering;
2. recognise ethical responsibilities of engineers;
3. describe in outline an ethical framework for engineering.</td><td>Professionalism; codes of conduct; obligations to the public</td><td>Interactive small group sessions during student induction; developing case studies from newspaper or magazine articles.</td></tr>
<tr><td>Modules</td><td>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)</td><td>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.</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Resolving practical problems; enabling students to identify ethical issues and to examine and weigh up opposing arguments</td><td>Modules</td><td rowspan="2">1. identify ethical issues related to an engineering situation;
2. suggest ways to deal with ethical issues in engineering;
3. illustrate the ethical dimension of practical engineering</td><td>Ethical cases in engineering; developed study of the ethical framework introduced at Level 1</td><td>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.</td></tr>
<tr><td>Placement preparation</td><td>Professional practice of oneself and others; differentiating between good and bad employers</td><td>Set up role-playing scenarios and debates between students; run intensive workshops for placement preparation.</td></tr>
<tr><td rowspan="3">3</td><td rowspan="3">Reflection and critique of ethical issues; consolidation of ethics skills and practice; specialist study</td><td>Design Project</td><td rowspan="3">1. undertake an ethical audit;
2. discuss ethical dilemmas in engineering;
3. justify an ethical stance.</td><td>Ethics audit of final year project</td><td>Self study and application to a student led project.</td></tr>
<tr><td>Core Modules</td><td>Ethically ambiguous scenarios</td><td>Challenge students to defend their actions from an ethical standpoint by holding group debates.</td></tr>
<tr><td>Ethics-specific optional modules</td><td>Philosophy of engineering; further ethical theory; engineering ethics and environmental ethics</td><td>Present case studies and dilemmas and give students practice in solving morally ambiguous scenarios. Encourage analysis, synthesis and report back of ethical issues.</td></tr>
<tr><td>4</td><td>Further reflection and critique of ethical issues; specialist study</td><td>Research-oriented module on ethics</td><td>1. articulate ethical problems 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</td><td>Research principles and ethics;
risks and benefits of novel technologies; broader context of engineering; business ethics;
corporate social responsibility</td><td>Present case studies and dilemmas and give students practice in solving morally ambiguous scenarios. Encourage written analysis and reports.</td></tr>
</table>

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

Engineering Ethics Topics

- **Sustainability**: duty to the environment and future generation
- **Cultural diversity** and international engineering projects
- The **engineering profession** and its relation to society
- The positive contribution engineers make to **society** – looking at case studies with ‘happy endings’

Technology

Some questions

- What is “technology”?
- Does “technology” need classification?
- When can a technology be considered “entrenched”?
- Which kind of *intervention* is required in the development of a new technology?
- ….

Technological Innovation

- Research
- Development
- Production
- Marketing
- Diffusion into society

↓

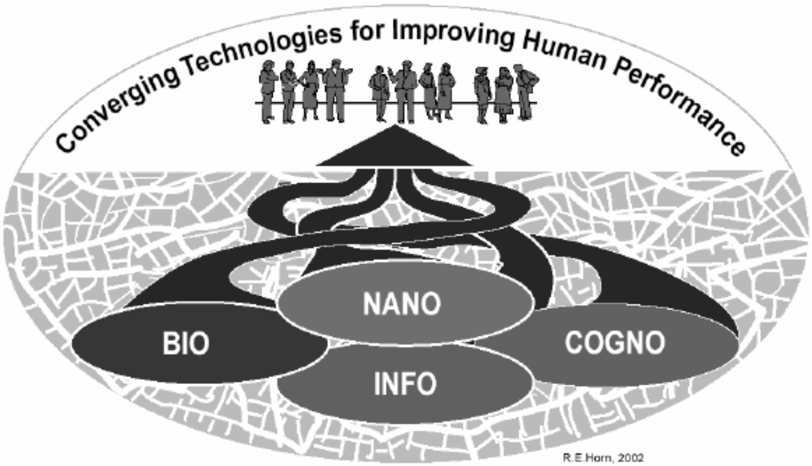
All stages have been accomplished
→ **Fully Developed** (Entrenched) Technology

Products, uses, regulations, and social impacts
are already in existence

21st Century (my personal analysis)

- **1st Decade**
  - "**Converging Technologies** for Improving Human Performance" (CTIHP) (2002)
    - Nanotechnology
    - Biotechnology
    - Information Technology
    - Cognitive Science
- **2nd Decade**
  - Sustainable Development Goals
  - **Emerging Technologies**
- **3rd Decade** (and beyond)
  - **Responsible Technologies**
    - (Transhumanism?)

"Converging Technologies for <u>Improving</u> Human Performance" (CTIHP)



Changing the societal "fabric" towards a new structure
(upper figure by R.E. Horn)

- Those technologies are at different stage of their technological development (in some case still emerging)
- They can imply substantial modification of both the world (environment) and of the human being

Engineering vs. Philosophy

- **Analysis** **(the “new” philosopher)**
  - **Understanding an ethical problem or an ethical theory and dispassionately comparing the application of different theoretical approaches**

- **Synthesis** **(the engineer)**
  - **Finding “*solutions*” to ethical problems (the best course of action)**

**The engineer is embedded in the process,
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. 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

Ethics is doing the right thing

(even when no one is looking)

BUT

How do we “define” the *right thing*??

How do we know what *is right*?

Ethical Debate

Questions & Challenges

- **What is ‘ethics’ and is it relevant to me / my job?**
- **Isn’t ethics common sense?**
- **Why should I be ethical?**
  - It’s the right thing to do?
  - It’s good for business?
  - It’s my duty as a professional?
- **What is the relation between ‘ethics’, values / principles, and codes of conduct?**
- **Who provides professional ethics training, and why?**

The Relevance of Ethics

- **To society**?
  - Many technical issues have ethical implications
    - *Is nuclear power the answer to energy crisis?*
    - Should we destroy fragile environments to extract scarce resources?
    - .....
    - .....
- **To me**?
  - Tell your view....

Statements 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

ROYAL ACADEMY OF ENGINEERING

Those principles are now included in the IChemE accreditation guidelines

Ethical Consideration: *a posteriori* approach

- Ethics is about Synthesis
  - Finding "*solutions*" to ethical problems (the best course of action)
  - Making use of previous "data"

The engineer is embedded in the process
being prepared for dealing with specific kinds of ethical problems
that will arise in real practical situations
They evaluate and direct a greater set of existing phenomena

Ethics in the context of making a practical decision

The ethics of entrenched technologies can lead to better informed ethical evaluations

Ethical Consideration: *a priori* approach

- Ethics is about Synthesis
  - Finding "*solutions*" to ethical problems (the best course of action)
  - Making use of *speculative* "data"

Based on research and development of the technologies, redirection possible on the basis ethical assessments

Ethics can help at the development stage of the technology, however the limitation is making use of speculative data

Artificial Intelligence

- **A *pervasive, enabling* technology** → its consequences will affect various areas and disciplines, the environment, the human being… chemical engineering is not immune to its consequences

- **Already widely in use**

Do we understand AI and its implications?

If handled carefully, AI could bring excellent opportunities for the wealth and security of our society

HOWEVER

IT IS ALREADY HERE (and the totality of ethical issues associated with it are not completely understood and tackled)
REGULATION still in need

Responsible of Emerging Technologies

- **To society**?
  - Many technical issues have ethical implications
    - *Intervene as soon as possible, using data, real and speculative scenarios..*
  - **To me (as a professional)**?
    - Work with uncertainty –not new for engineers, but the context is completely new
    - Should we use a “risk-assessment” route? How do we manage the risk?

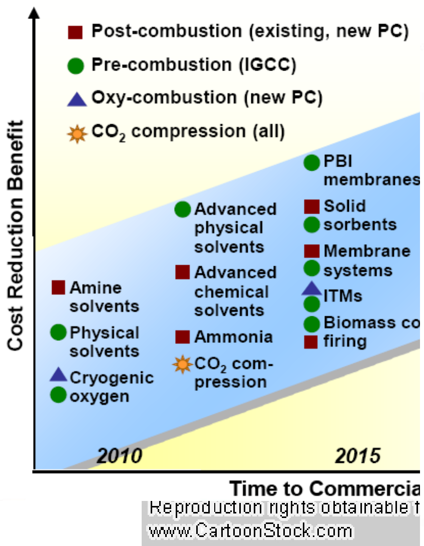

SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS

The Challenges of the 3rd Decade

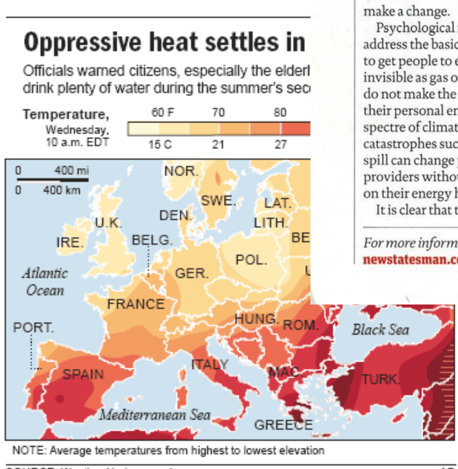
- **Climate Change**
- **Energy security**
- **AI**
- **Cobots**
- **Quantum Computers**
- **Extended reality**
- …

COLLABORATION & SYSTEM APPROACH
WORK WITH POLICY MAKERS
DIVERSITY
TRAINING

A Technologica



Ethical Fix



Supported by

Perspectives on Energy

What is the future of consumer energy demand?

Changing behaviours

Governments, activists and scientists are united on one fact: consumer behaviour is key to creating energy efficiency. But studies have found that only about 20 per cent of people are willing to change their behaviour. How can the other 80 per cent be engaged?

When policymakers first launched energy efficiency campaigns around 30 years ago, they focused on educating consumers and encouraging them to cut back. Over the years, this has been refined, with standards for energy-efficient appliances and new buildings introduced. Yet, despite such moves, energy consumption continues to grow in both absolute and per capita terms.

A big problem is getting people who already lead busy lives to change their behaviour. In these straitened times, a large group of consumers is struggling financially and does not think about the future.

Telling people they consume more energy than their neighbours makes them more likely to take notice

In such circumstances, obligatory higher prices are not an attractive way of getting people to change their habits. Moreover, studies show that hikes must be substantial before the average consumer starts to notice. The focus is now shifting to alternative methods, including peer pressure.

Psychological studies have shown that people are influenced by comparison. Thus, telling people that their energy consumption is higher than their neighbours' makes them more likely to take notice and make a change.

Psychological methods of this sort address the basic problem that it is difficult to get people to engage. With something as invisible as gas or electricity, most consumers do not make the direct connection between their personal energy usage and the distant spectre of climate change. Thus, huge catastrophes such as the Gulf of Mexico oil spill can change public perceptions of energy providers without having a knock-on effect on their energy habits.

It is clear that there are big challenges ahead.

For more information on Perspectives go to: **newstatesman.com/energy**

THE EXPERT

"Behaviour doesn't happen in a vacuum"

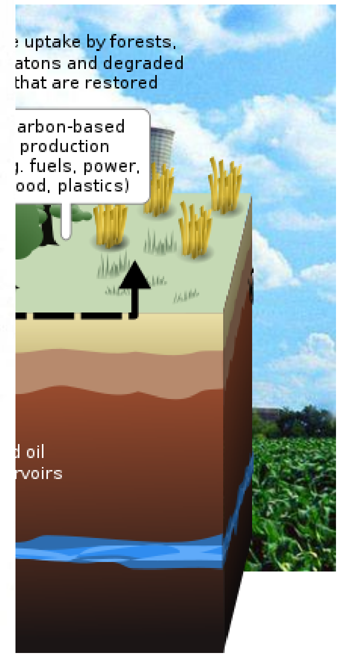
Dr Sarah Darby, deputy programme leader, Environmental Change Institute, Oxford University

Do most energy customers still need to be persuaded that cutting energy consumption is worth all the bother?
They don't on the whole think in terms of cutting energy consumption, they think in terms of the way they live their lives. And if their bills are getting really high – and they are, of course, for a lot of people – then that's a worrying thing. They will start to be motivated when they begin trying to get those bills down.

So the real motivation is when people realise they want to save money?
For a lot of people it is. For other people, they may just be thinking about the way they live their lives and the impact they have on the environment. Motivations differ, but what is often missing is how those two link up.

Perhaps we should simply encourage people to turn the lights off when they leave the room?
Well, it certainly helps . . . but behaviour doesn't happen in a vacuum; behaviour happens in particular buildings in particular places.

From a transport point of view, for example, you can walk across the road to your village shop, or you may have to drive ten miles into the nearest town once that shop closes. If you



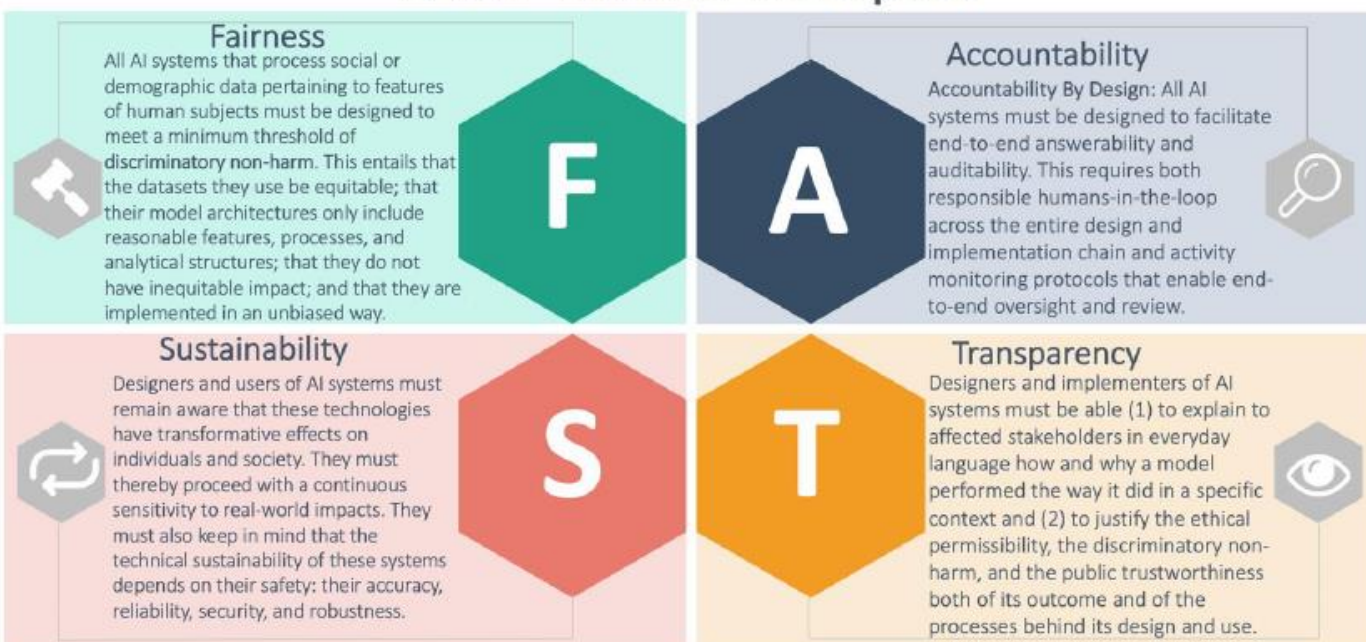
Climate Change and AI

- **AI’s relevance to help tackle and fight climate change is undiscussed** (e.g., enable smarter decision-making for decarbonising industries and transportation; understand how to allocate renewable energy; etc.)

HOWEVER

- **Ethical concerns are become more and more relevant** and those are linked largely to the machine-learning technology:
    - Public surveillance
    - Intentional misuse of data
    - Privacy
    - Transparency
    - Data bias that can lead to discrimination and inequality

FAST Track Principles



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

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

Multicultural student groups

- Students on engineering degrees often come from a variety of different cultures and backgrounds

  - Consider how familiar students are with debating issues in the classroom – don’t assume all students will easily engage in debate

  - Take language into account in assessment – don’t rely on long essays which may be challenging for overseas students

  - Try to make assessment varied and fair for all students

Internationalisation of Engineering Degrees

- The "challenge" of diverse cultures
- Morality vs Ethics –Individual vs Profession –Personal Standards vs Code of Conducts

Standards in Public Life

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

Questions

- How do we make sure that Ethics is our *modus operandi*?

- Should PEI take the lead?

  - ***Act*** with competence
  - ***Comply*** with the rules
  - ***Adhere*** to the codes of conduct

Is compliance with professional codes sufficient?

- Should a “**Hippocratic Oath**” for Engineers be introduced?

    - Ethics as ***awareness*** of the social impact of engineering work
    - Development of ***“involuntary”*** ethics where the individuals live in immediate symbiosis and harmony with their community
    - ***Ethics not just as a concept, but as an “action”*** (i.e. acting in and for the society).

Not a new idea

Ritual of the ***Calling of an Engineer*** (Canada, since 1922)

Leonardic Oath (Dreher, 2011)

The “new” engineer will learn from the “ancient” philosopher

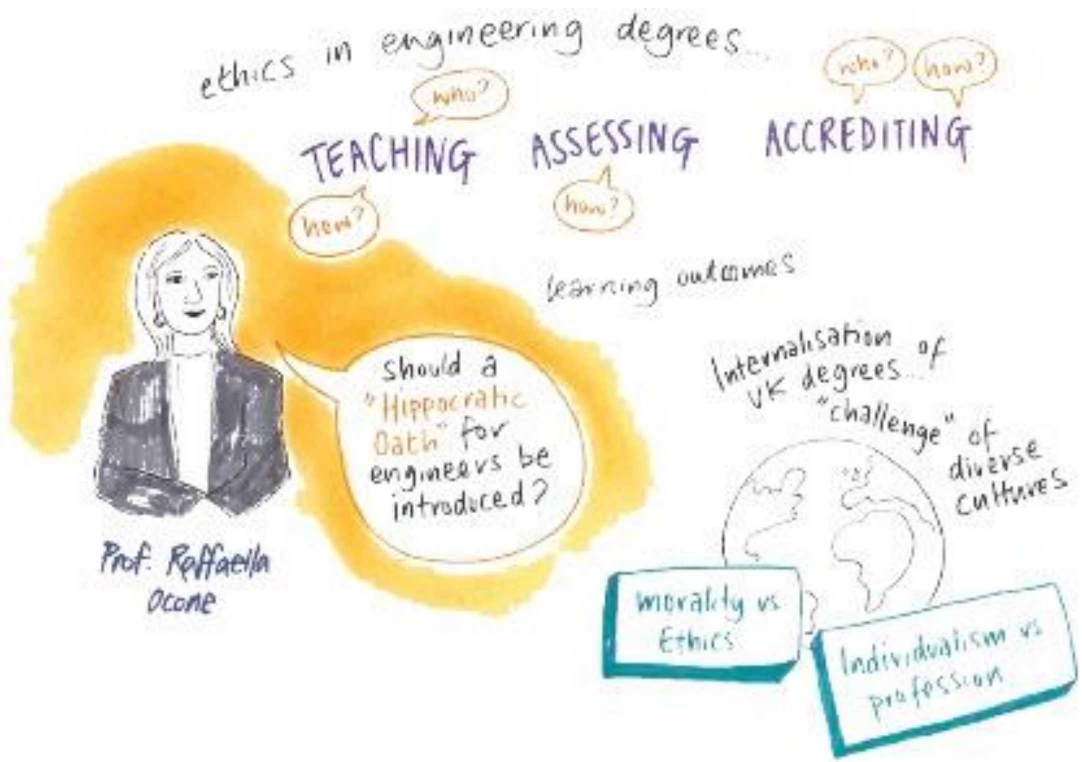
Ethics goes beyond the dilemma and the application of ethical principles

Ethics in engineering (technology) 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


ethics in engineering degrees...
who?
TEACHING
how?
ASSESSING
how?
who?
how?
ACCREDITING
learning outcomes
should a "Hippocratic Oath" for engineers be introduced?
Prof. Raffaella Ocone
Internalisation of UK degrees...
"challenge" of diverse cultures
morality vs Ethics
Individualism vs profession

Thank you!


"Being a good Engineer transcends Engineering itself"