



# Human-centred engineering: What it is and the ethics behind it

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# Why won't people listen to us?

- Engineering educator Mortimer E. Cooley wrote a thoughtful book on the role of education in preparing engineers for society, *Scientific Blacksmith* (1947):

The problems before the peoples of the world today are largely engineering problems.... what can explain the lethargy of the peoples of all nations in turning to the engineer, who alone can be presumed to be able to solve engineering problems?



# Aren't we always right?

- Unfortunately, sometimes we get it wrong. To quote NASA (1999): “The MCO [Moon Climate Orbiter] had been on a trajectory towards Mars since its launch on December 11, 1998... On September 29, 1999, it was discovered that the small forces DV’s reported by the spacecraft engineers for use in orbit determination solutions was low by a factor of 4.45 (1 pound force=4.45 Newton-sec)” and it crashed.



# But isn't technology all we need?

- Does technology solve people's problems? This is such a basic question it doesn't seem to make sense. However, to give you an extreme alternative view, Jacques Ellul (1967), a techno-skeptic, asks, if our goal is just happiness, why bother with hygiene, knowledge, and nourishment when we can just drug people to make them happy.



# More than ‘maximising happiness’

- Understanding that our goal is more than just “maximising happiness” we can look at widely respected statements of human need. At least 6 of the rights in the UN Universal Declaration of Human Rights (1948) address needs which make definite technical demands (health, education, shelter, saving of life, meeting potential, assisting dignity)
- The more recently adopted UN Sustainability Development Goals are also widely understood to require technology.



# UN Sustainable Development Goals



# Barriers to beneficial technology (I)

- **Technology won't work**
  - It shouldn't be
  - It can't be influenced
- **Technology doesn't work**
  - A basic problem exists
  - Parties don't work together
  - Affected by external factor
- **Technology is prevented from working**
  - Enforced prohibition
  - Prevented by Intellectual Property rules
  - Other legal barriers
  - Code as law
  - Accidental regulation
  - Internal barriers



# Barriers to beneficial technology (II)

- **Technology works but is unusable**
  - User unaware
  - User can't use it
  - User doesn't want it
  - User doesn't like it
- **Technology works, is usable, but not economic**
  - Victim of competition
  - Victim of crisis
  - Killed by monopoly
  - No economic benefit
  - Not market aligned
  - Users can't afford it
- **Technology works, is usable, is economic, but not funded**
  - Politically opposed
  - Not a priority

# Some IEEE initiatives

- IEEE's tagline is Advancing Technology for Humanity
- IEEE is grappling with the challenge of how the world can use technology better. A result has been to focus on ***policy*** and ***ethics***. Our Global Public Policy Committee is grappling with the challenges of globally relevant, regionally sensitive policy positions and white papers. Policy work has long existed in the US, but is only now being developed in other regions.



# IEEE and ethics

- Ethics has become an enormously important field, both because of our increasingly technical world, but also because of the multi-billion dollar settlements now being imposed on major corporations such as BP and VW. This year IEEE is launching its TechEthics program.



# IEEE SSIT focus

- SSIT is focussing on 5 pillars
  - Technology for development and humanitarian relief
  - Technology and sustainability
  - Social inclusion in the development and use of technology
  - Ethics in technology
  - Understanding the impact of the future uses of technology (eg ethics and AI)



# Engaging other professions

Key to SSIT's approach is engaging other professions, for which we need to recognise their own controversies. Business theorist Michael Porter (probably due to his engineering training) provides easily accessible arguments for technologists: "In neoclassical thinking, a requirement for social improvement—such as safety or hiring the disabled—imposed a constraint on the corporation... The concept of shared value, in contrast, recognises that societal needs, not just conventional economic needs, define markets." (2011, with Mark Kramer)



# Engaging other professions (cont)

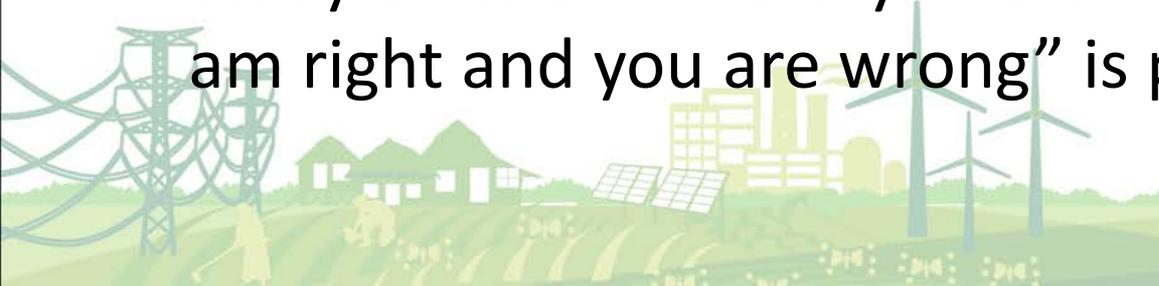
We need to develop a “deep” multi-disciplinarity: The technologist doesn’t need the skill to conduct an (e.g.) sociological experiment, but must have the skill to understand one, to criticise one, to suggest one. And vice versa.

Perhaps most importantly, technologists are the ones best placed to understand the limits of our own knowledge, and potentially the unknowability of some technologies now being built.



# Science & Technology Studies

- One area that can assist us in wider engagement is the field of Science & Technology Studies (STS), researchers in the social sciences and humanities.
- In the past, this was a difficult conversation, reflecting CP Snow's 1959 *The Two Cultures*. As late as 1978, STS researcher Langdon Winner wrote, "Technological society ... has never shown any great commitment to self-reflection, self-criticism, or the study of its own history". Fortunately the period of "I am right and you are wrong" is passing.



# Science & Technology Studies (cont)

- The engagement between IEEE and STS has included an SSIT panel at last year's 4S conference, and attendance of Judy Wajcman, London School of Economics, at our Thinking Machines in the Physical World conference at this university a few weeks ago.
- The STS community is important in promoting a fact-based public discussion of technology and its adoption. Providing access and dialogue between the STS and technologists' communities will help reduce the frustrating confusion that faces us today.



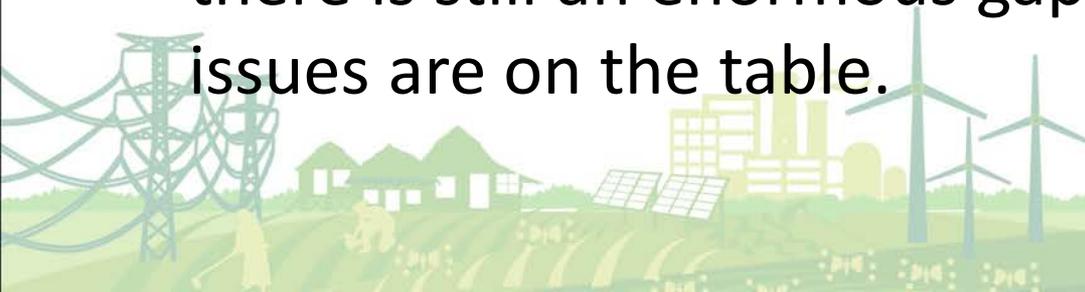
# ‘Appropriate technology’

- One area where we have learned from the STS community is “appropriate technology”, described by E.F. Schumacher (1973) in *Small Is Beautiful*. He placed an “intermediate” technology between large-scale technology development, and limited poverty-reinforcing tools found in the developing world.
- At the time this was not well received in the technology community: “This term seems like a ... smear. Those who use it are characterizing others as advocating ‘inappropriate technology’.”



# ‘Appropriate technology’ (cont)

- The conference we are holding this week would be unthinkable if we were frozen in a technologically determinist mindset that there is one “right” technology for all purposes. The phrase “hammer looking for a nail” sums up this understanding.
- This 1970s discussion laid the basis for looking more broadly at the context of technology, especially issues of gender equity and social inclusion. While there is still an enormous gap to be addressed, the issues are on the table.



# National inclusion

- In addition to gender and social inclusion, national inclusion has shown its importance time and again. Inclusion and technology development are closely related. Technology adoption theory shows that the process of technology adoption changes the technology itself. Things that don't work are fixed. New opportunities are developed. Only countries engaged at that time get a say. This will have impacts from jobs to social development.



# National inclusion example

- Indian Statistical Institute founder Prasanta Chandra Mahalanobis had a strong personal interest in statistical error (observation, measurement, sampling) due to his 1920s work on anthropometry. ISI was one of three leading centres of statistical expertise by the 1940s. His novel approach to India's 1951 national census created techniques which today analyse big data.



# Inclusion is time critical

- If India had waited to receive US or European statistical approaches, both India and the world would be poorer today. There was one chance to influence the next generation of statistics, and Mahalanobis was there.
- Today we face the same challenges. If we ***don't*** adopt gender friendly, socially inclusive approaches in building the next generation of sustainable energy technologies, that absence will remain with us for the life of these technologies.



# Innovation and human existence

- It has been said that we live only by the grace of invention. Not only in the past, as humans have always been technology inventing and using beings, but in the future, to address the challenges highlighted by this conference, the UN SDGs, and the many daily crises we see in our media.



# Innovation waste

- Technologies wear out. Hydroelectric dam systems silt up, antibiotics become vulnerable to mutating diseases, security systems are hacked.
- We need to keep running to stay in the same space.
- When premature aging of technology is by accident, or due to technology limitations, this is unfortunate.
- When it happens deliberately, as in the over-prescription of antibiotics or the wastefulness of arms races, it is tragic. New technologies are a great bounty, and require hard work to create.

# Source of Innovation

- Where does invention come from? This question lies outside the fields of expertise of technologists. Business theorist Michael Porter (1990) responds to the 1942 view of Joseph Schumpeter: “...it is the smaller firms and ‘outsiders’ who are the real energies of creative destruction.”



# Examples of Innovation

- We could expect that, “New ideas are conceived in the intellects of individual scientists, and they are particularly likely to originate where there are many well-trained intellects, and above all where intellect is valued.” Examples are Paul Baran’s packet switching and Satoshi Nakamoto’s 2008 blockchain proposal.



# Concluding thoughts

- Technologists care
  - Technologists are often assumed to be *utilitarian*, with our goal of efficiency being reduced to “the greatest good for the greatest number”.
  - “Advancing technology for humanity”, however, is an *ethical* aspiration, to live a good life (Aristotle) or to hold true to beliefs (often theistic).

