ENGINEERING ETHICS:
RESPONSIBLE INNOVATION & VALUE
SENSITIVE DESIGN

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GRAND CHALLENGES
21ST CENTURY
ENGINEERING ETHICS

- Engineering, Applied Science, Technology, Innovation involved in the origin and/or in solution of the world’s problems

- Engineers need to understand where they fit in
FIRST QUESTION: THIS IS SMART AND INNOVATIVE, BUT IS IT GOOD?
CHALLENGES

- Clean drinking water
- Food production
- Climate Change
- Overfishing
- Deforestation
- Sustainable Energy
- Waste Management
- Affordable Health Care

- Cyber-security
- Mobility and Transport
- Urbanization
- Internet Governance
- Poverty
- Hunger
- Failing states
- Child mortality
- Orphan diseases
UN MILLENNIUM GOALS

- Poverty reduction
- Primary education
- Gender Equality
- Infant mortality
- Maternal Health
- Combat disease
- Global sustainability
- Global development
UN SUSTAINABLE DEVELOPMENT GOALS

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 AND JUSTICE STRONG INSTITUTIONS
17. PARTNERSHIPS FOR THE GOALS

THE GLOBAL GOALS
For Sustainable Development
UN SUSTAINABLE DEVELOPMENT GOALS

GLOBAL COMPACT: UN & BUSINESS ALLIANCE

- People
- Planet
- Prosperity: “flourishing lives”
- Peace
- Partnership
Technology facilitation mechanism

Paragraph 123 of the Addis Ababa Agenda Action and Partners’ Pledge of the Post-2015 Development Agenda Outcome Document calls for the establishment of a technology facilitation mechanism, to be launched at the UN Summit for the adoption of the Post-2015 Development Agenda in order to support the sustainable development goals.

The mechanism will comprise of:

- a United Nations inter-agency task team on science, technology and innovation for the sustainable development goals
- a collaborative annual multi-stakeholder forum on science, technology and innovation (STI) for the sustainable development goals
- An online platform as a gateway for information on existing STI initiatives, mechanisms and programs
LIFE ALTERING INNOVATIONS
RESEARCH AND DEVELOPMENT/INNOVATION

The Framework Programme for Research and Innovation

Horizon 2020

€80 billion
EUROPE
RRI: RESPONSIBLE RESEARCH AND INNOVATION

Science and Society  Science in Society  Science for Society

500 Meuro
EXPERT GROUP REPORT TO EUROPEAN COMMISSION

“Options for Strengthening Responsible Research and Innovation”
Van den Hoven, e.a.
LUND DECLARATION: GRAND CHALLENGES

se2009.eu
ROME DECLARATION ON RESPONSIBLE INNOVATION

Responsible Research and Innovation (RRI)

The Rome Declaration, November 2014

We call on European Institutions, EU Member States and their R&I Funding and Performing Organisations, business and civil society to make Responsible Research and Innovation a central objective across all relevant policies and activities, including in shaping the European Research Area and the Innovation Union.

Strategies and actions to advance engagement in Europe

“RRI a Central Objective across All relevant policies and activities…”
RESPONSIBLE INNOVATION

Dutch Research Council Program
'Ethical' Fairphone 2 smartphone launched to combat electronic waste

The Fairphone 2 aims to challenge the "throwaway" nature of consumer electronics and ever-shorter product cycles.
TIDAL ENERGY

Grevelingen Tidal Energy Proposal (Van Lier-Lels, May 2012)
DATA CENTRE

- Mobile Datacentres and Glasshouses
STREET LIGHTING ON DEMAND

Safety, Security, & Sustainability
ELEMENTAL WATER MAKERS

- Desalination
- Reverse Osmosis

Constant operation
Accomodates fluctuations of solar and wind power
No CO2 emissions
3300 Gallons of fresh water a day
ENERGIZE THE CHAIN
RESPONSIBLE INNOVATION: FIGHT MALARIA
TURTLE EXCLUDER DEVICES (TED’S)
COLALIFE

The Colalife Anti-Diarrhoea Kit (ADK)

- Lid/soap tray & soap
  - Re-sealable lid
  - Separates the soap from the other components of the kit

- Container/mixer/cup
  - Acts as a measuring cup for the ORS, calibrated at 200ml
  - Mixing device and storage vessel
  - Made of clear, food-grade material

- Heat-sealed film
  - Tamper-evident
  - Viable packaging
  - Water-resistant
  - Transparent

- Low Osmolarity Oral Rehydration Salts
  - Light, 1.7g packet
    - Solves up to 200ml of solution

- Zinc supplements
  - 10 scored and blistered zinc sulfate tablets

- IEC Materials
  - Instructional information leaflet
    - Describes the kit
    - Kit branding
    - Version ADK for authenticity
    - Recommended retail price
AFSLUITDIJK
BUILDING WITH AND FOR NATURE
MOBILITY, RECREATION, WILD LIFE
A nanophotonic comeback for incandescent bulbs?
Researchers combine the warm look of traditional light bulbs with 21st-century energy efficiency.
RRI

• (A) obtain – as much as possible – the relevant knowledge on (i) the consequences of the outcomes of your actions and on (ii) the range of options open

• (B) evaluate both outcomes and options (under A) effectively in terms of relevant moral values (including, but not limited to wellbeing, justice, equality, privacy, autonomy, safety, security, sustainability, accountability, democracy and efficiency).

• (C) use these considerations (under B) as requirements for design and development of new technology, products and services leading to moral improvement, i.e.
SECOND QUESTION: CAN WE BUILD OUR VALUES INTO OUR TECHNOLOGY?

•
L. WINNER: DO ARTEFACTS HAVE POLITICS?
VALUES BUILT INTO SYSTEMS

- Interfaces
- Infrastructures
- Algorithms
- Ontologies
- Code
- Protocols
- Integrity constraints
- Architectures
- Governance arrangements

- Identity Management Systems
- Authorization Matrix
- Procedures
- Regulations
- Incentive structures
- Auction mechanisms
- Voting mechanism
- Monitoring and inspection
HEALTH CARE
FINANCE
SMART CITIES
“WE SHAPE OUR BUILDINGS; THEREAFTER THEY SHAPE US.”

WINSTON CHURCHILL
KEY PROBLEM
21ST CENTURY: VALUE SENSITIVE DESIGN
VALUES HIERARCHY

- Values
- Norms
- Design requirements
EXAMPLE OF VALUES HIERARCHY

Values

Animal welfare

Norms

Enough living space
Presence of laying nests
Litter
Perches

Design requirements

- at least 450 cm² floor area per hen
- 10 cm feeding trough per bird
- 40 cm height over at least 65% of the area
- floor-slope of maximally 14%
Sustainability

Intergenerational justice
- Sustain availability of fuels
  - Effective fuel
  - Renewable
  - Reliable supply
  - Competitive price
- Reduce greenhouse gas emissions
  - High energy efficiency
- Avoid increase in other environmental problems
  - No additional greenhouse emissions from cultivation, production and transportation
  - No over-use of water and other inputs
  - No increased air pollution

Care for nature
- Maintain biodiversity
  - Cultivation should not have negative effects on biodiversity
  - No increased use of fertilizer and pesticides

Avoid (additional) increase in food prices
- Non-edible
- No competition for agricultural land and other inputs

Provide opportunities to developing countries
- Can be produced in developing countries
- Can be produced on small scale and with limited investments

Intragenerational justice
- Flexible use of license agreements for IP (intellectual Property)
- Should not deteriorate working conditions for farmers
DESIGN FOR X

- Design for privacy
- Design for security
- Design for inclusion
- Design for sustainability
- Design for democracy
- Design for safety
- Design for transparency
- Design for accountability
- Design for human capabilities
VALUE PLURALISM

- Privacy
- Autonomy
- Equity
- Justice
- Dignity
- Wellbeing and Happiness
- Safety
- Security
- Sustainability
- Health
- Friendship
- Solidarity

CONFLICT DILEMMA

- Dependability
- Usability
- Resilience
- Reliability
- Efficiency
- Flexibility
THIRD QUESTION: CAN TECHNOLOGY HELP TO OVERCOME VALUE CONFLICTS?
THE PROBLEM OF MORAL OVERLOAD
SUSTAINABLE UNSAFE BUS
MORAL OVERLOAD

- Prosperity **AND** sustainability
- Security **AND** Privacy
- Efficiency **AND** Safety
- Accountability **AND** Confidentiality
SMART ELECTRICITY GRIDS & SMART METERS
ELECTRONIC PATIENT RECORDS

300 Million: failed Innovation
WE WANT SUSTAINABILITY
WE ALSO WANT PRIVACY
SECURITY
MORAL OVERLOAD

Privacy vs. Security

Diagram illustrating the concept of moral overload with a shaded area representing the intersection of privacy and security concerns.
NO PRIVACY, NO SECURITY (1.0)
PRIVACY OR SECURITY (2.0)
PRIVACY & SECURITY (3.0)
HIGHER ORDER OBLIGATION

- Ruth Barcan Marcus
- If there is an obligation to do both A and B
- We have a second order obligation to see to it that we can do both A and B
If a contingent state of the world at time t1 does not allow us to satisfy two or more of our moral values or moral obligations at the same time, but we can bring about change by innovation in the world at t1 that allows us to satisfy them all together at a later time t2, then we have a moral obligation at t1 to innovate.
MORAL AXIOM

If you can change the world by innovation today so that you can satisfy more of your obligations tomorrow, you have a moral obligation to innovate today.
Privacy by Design
PRIVACY RESPECTING TECHNOLOGY

Next Generation
Privacy Enhancing Technologies

Marc Sel
Director of Information Protection
PwC Enterprise Advisory Services

PRICEWATERHOUSECOOPERS®
MORAL OVERLOAD

Green Party: Sustainability
MORAL OVERLOAD

Government: Economic growth
VALUE SYNERGY

Sustainability and Growth

ich bin ein berliner.
ZERO VISIONS

• ZERO Road Traffic Accidents Sweden
• ZER Emissions
• ZERO Prevenatable Children death
VOLVO AIMS FOR ZERO ACCIDENTS
SOLVING MORAL OVERLOAD BY DECEPTION
How VW cheated the system

1. Speedometer, steering wheel sensors and air pressure sensors send data to central computer.

2. Computer recognises that it is under test conditions and switches on a ‘dynamic calibration’, which alters the working of the engine to minimise emissions.

3. If road, rather than rolling road, conditions are detected the computer uses a ‘road calibration’, which bypasses the emissions reduction mechanisms to favour engine performance and efficiency.

4. The EPA says it was the NOx filter whose behaviour was changing in the different calibrations.

Emission tests

Average NOx emissions as deviation ratio

- Highway
- Urban
- Rural-up/dowhill
- Under lab conditions — NOx Government limit

![Emission test chart]

Source: thecit.org
Winterkorn personally visited the lab's then Palo Alto location in January 2010, touting his company’s expansion efforts. "We want to take Volkswagen to the top of the industry by 2018," Winterkorn told reporters. "We aim to be the most eco-friendly automaker in the world ... "For Volkswagen, ‘green mobility’ means setting new ecological standards in automobile manufacturing in order to put the cleanest, most economical and at the same time most fascinating cars on the road."
VALUES AS DRIVERS OF INNOVATION

• Moral Progress by Innovation
• Transforming the world by design so that we can respect more obligations and responsibilities than before
ENGINEERING ETHICS

• Engineers can, we ought and we do increasingly try to solve grand challenges by innovation.

• Engineers can, ought and do increasingly use moral values as ‘non functional of supra functional requirements’ in engineering design.

• Innovation is thereby becoming an important moral concept in the sense that it is concerned with amplification of the set of obligations we can satisfy (definition of Moral Progress).

• Not by tweaking our value systems, but by tweaking the world.