

ENGINEERING ETHICS:  
RESPONSIBLE INNOVATION & VALUE  
SENSITIVE DESIGN

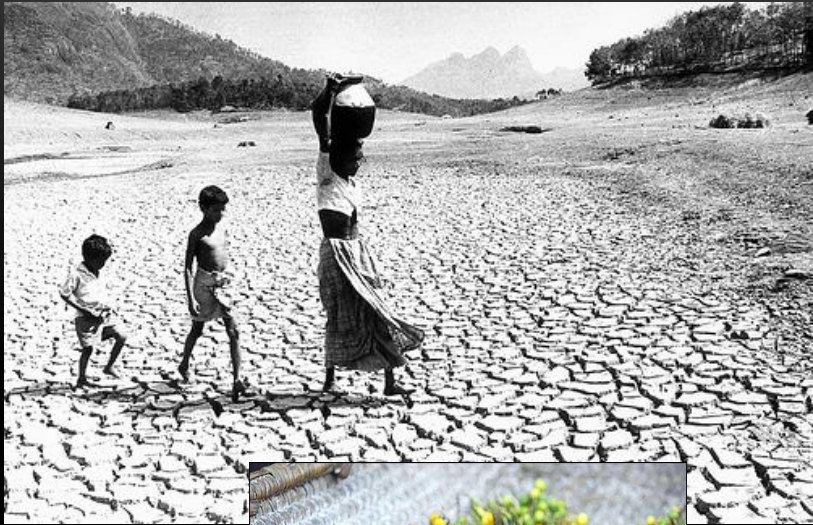
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Jeroen van den Hoven

Professor of Ethics and Technology

Delft University of Technology

# GRAND CHALLENGES 21<sup>ST</sup> 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 MILENNIUM GOALS

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





# UN SUSTAINABLE DEVELOPMENT GOALS



# UN SUSTAINABLE DEVELOPMENT GOALS

## GLOBAL COMPACT: UN & BUSINESS ALLIANCE

- People
  - Planet
  - Prosperity: “flourishing lives”
  - Peace
  - Partnership
-



# UN SUSTAINABLE DEVELOPMENT GOALS

The United Nations summit for the adoption of the post-2015 development agenda



SUSTAINABLE DEVELOPMENT  
KNOWLEDGE PLATFORM



SIGN IN/CREATE ACCOUNT

Keywords...

Search

HOME INTER-GOVERNMENTAL COOPERATION MULTI-STAKEHOLDER ENGAGEMENT TOPICS SD IN ACTION NEWS & RESOURCES ABOUT

## Technology

### Facilitation mechanism

Background

News

Decisions

Documents

Publications

National Reports

Statements

Meetings & Events

Multi-stakeholder partnerships and voluntary commitments

## Technology facilitation mechanism

Paragraph 123 of the Addis Ababa Agenda Action and Paragraph 70 of the Post-2015 Development Agenda Outcome Document call for 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



### UN inter-agency task team on science, technology and innovation for the sustainable development goals

Promote coordination, coherence, and cooperation within the UN System on STI related matters, enhancing synergy and efficiency, in



### Multi-stakeholder forum on Science, Technology and Innovation

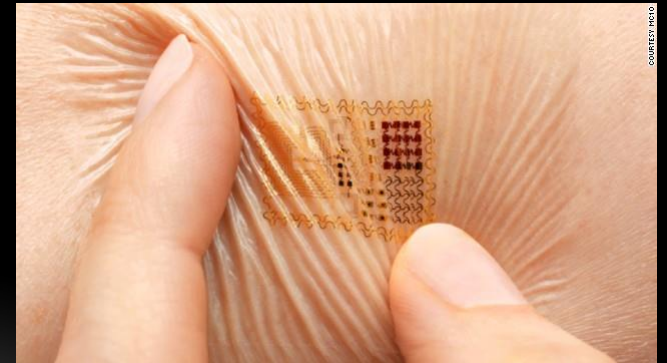
Venue for facilitating interaction, matchmaking and the establishment of networks between relevant stakeholders and multi-stakeholder partnerships, within and beyond the



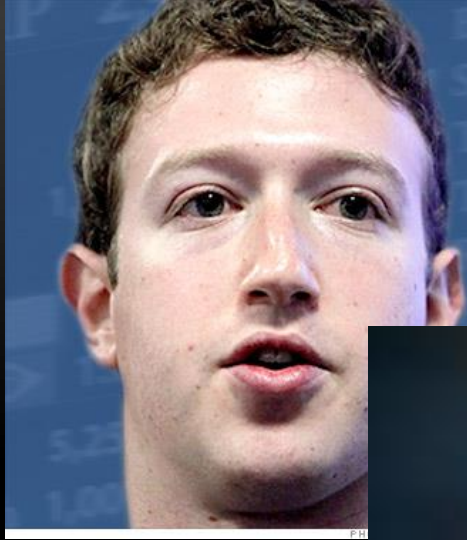
### Online Platform

Comprehensive mapping of, and serve as a gateway for, information on existing science, technology and innovation initiatives, mechanisms and programmes, within and beyond the United Nations.

# LIFE ALTERING INNOVATIONS

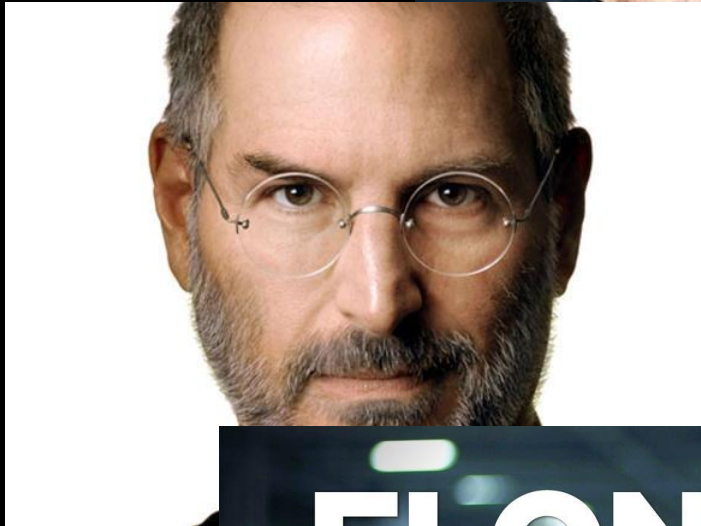






534 million shares

\$20.3 billion





# RESEARCH AND DEVELOPMENT/INNOVATION

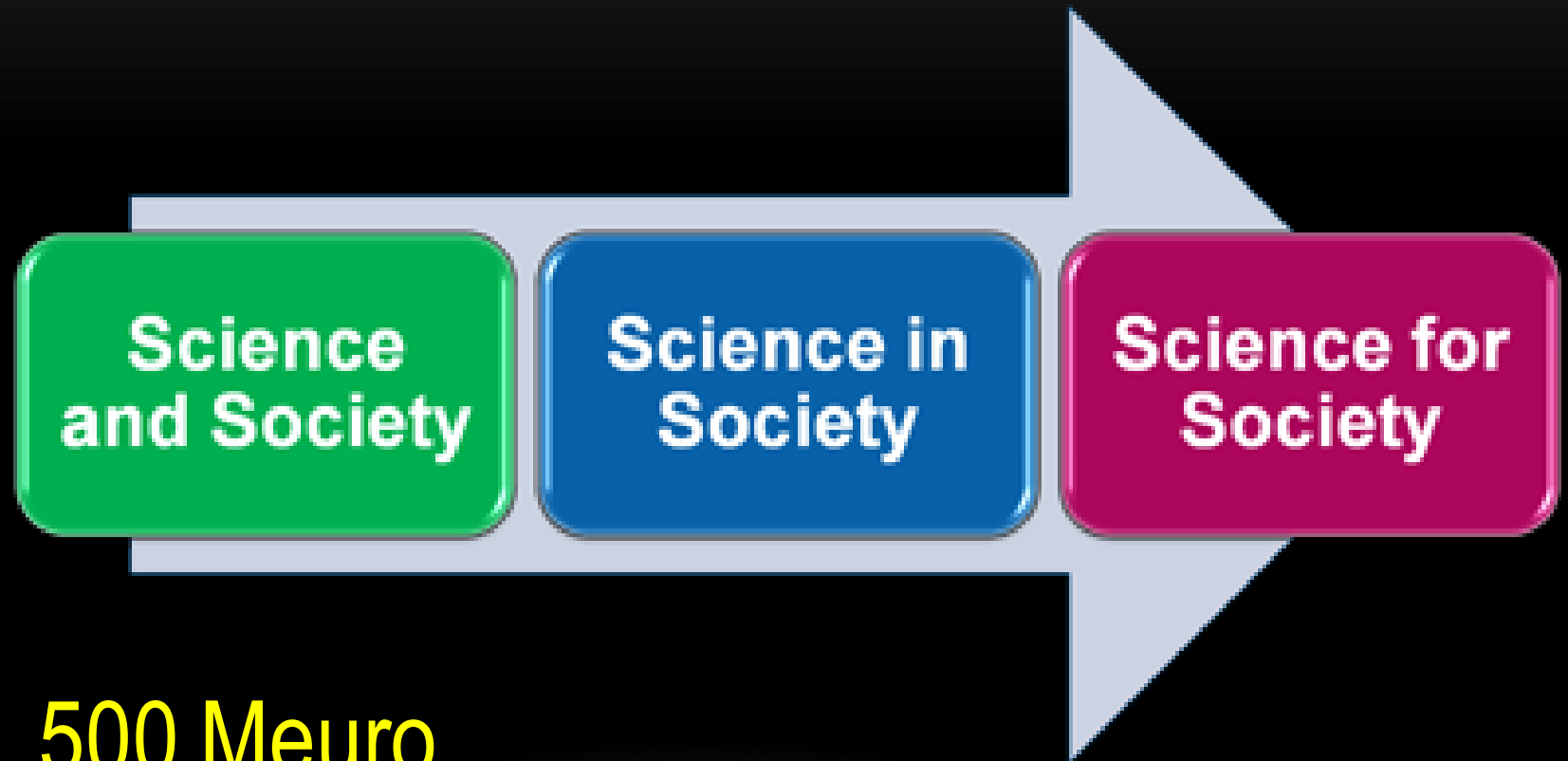


# EUROPE





# RRI: RESPONSIBLE RESEARCH AND INNOVATION



**500 Meuro**



# EXPERT GROUP REPORT TO EUROPEAN COMMISSION



“Options for  
Strengthening  
Responsible  
Research and  
Innovation”  
Van den Hoven,  
e.a.

# LUND DECLARATION: GRAND CHALLENGES



# 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



# FOLDABLE CONTAINER



**SUSTAINABILITY**

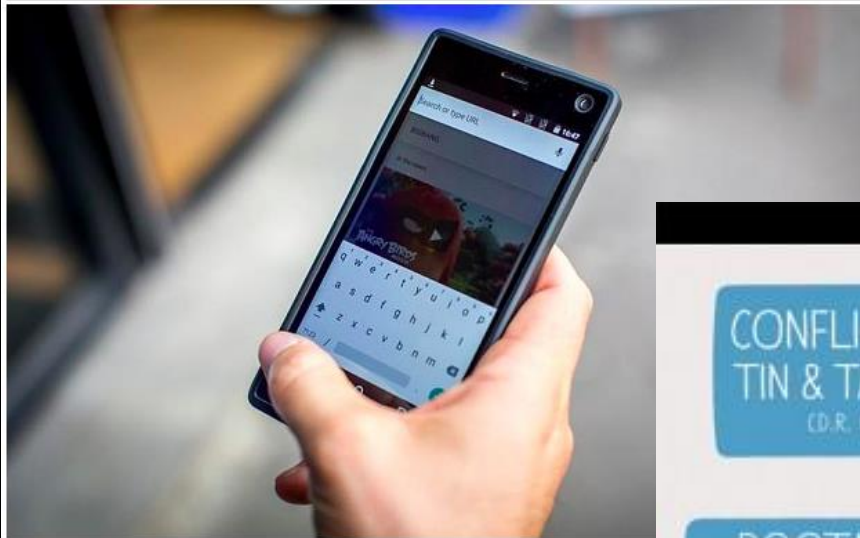




## 'Ethical' Fairphone 2 smartphone launched to combat electronic waste

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

 196   0  59  255  Email



The new Fairphone 2







# DATA CENTRE

- Mobile Datacentres and Glasshouses



# STREET LIGHTING ON DEMAND



Safety, Security, & Sustainability

# ELEMENTAL WATER MAKERS

- Desalination
- Reverse Osmosis



Constant operation

Accommodates  
fluctuations of  
solar and wind  
power

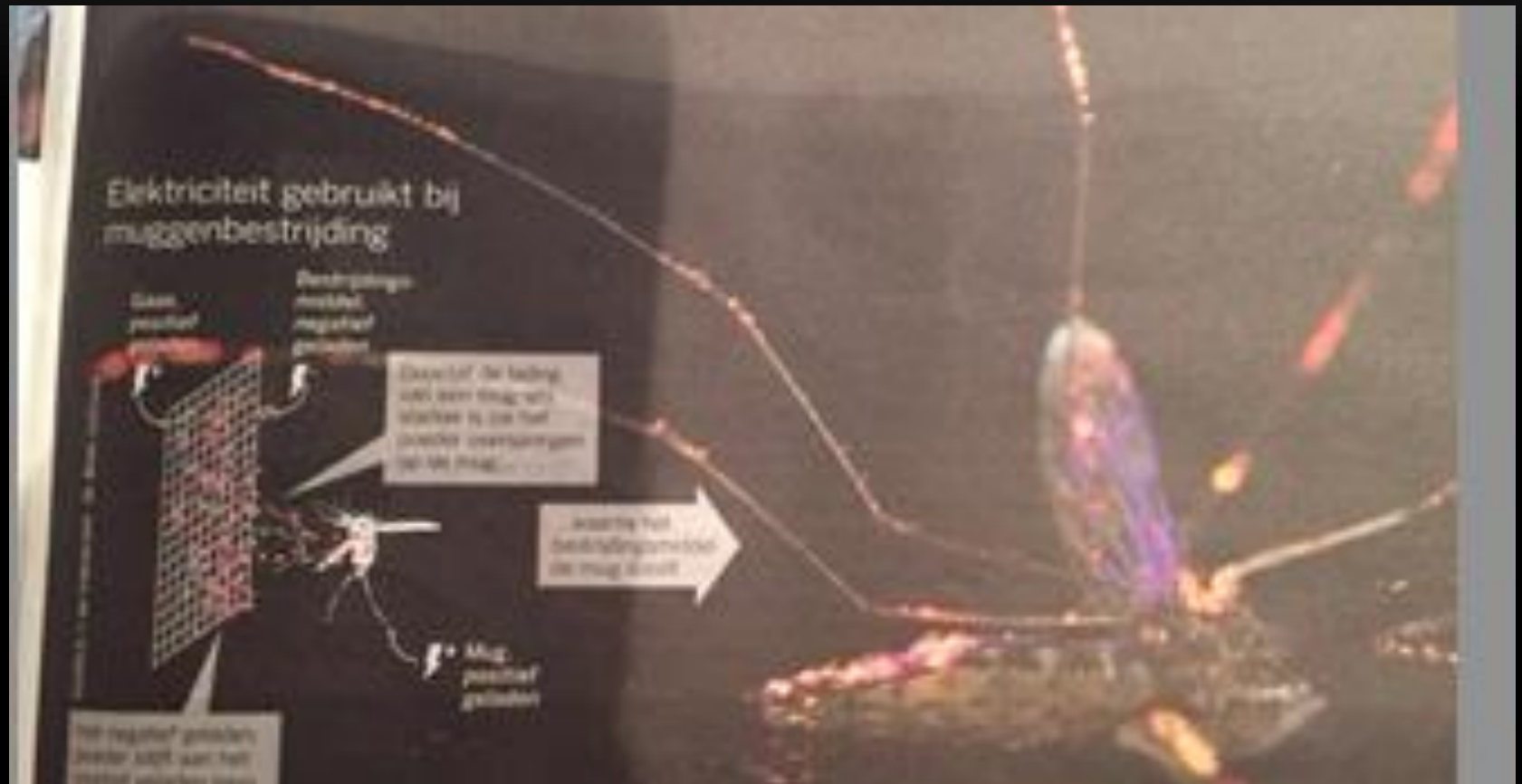
No CO2 emissions

3300 Gallons of  
fresh water a day

# ENERGIZE THE CHAIN

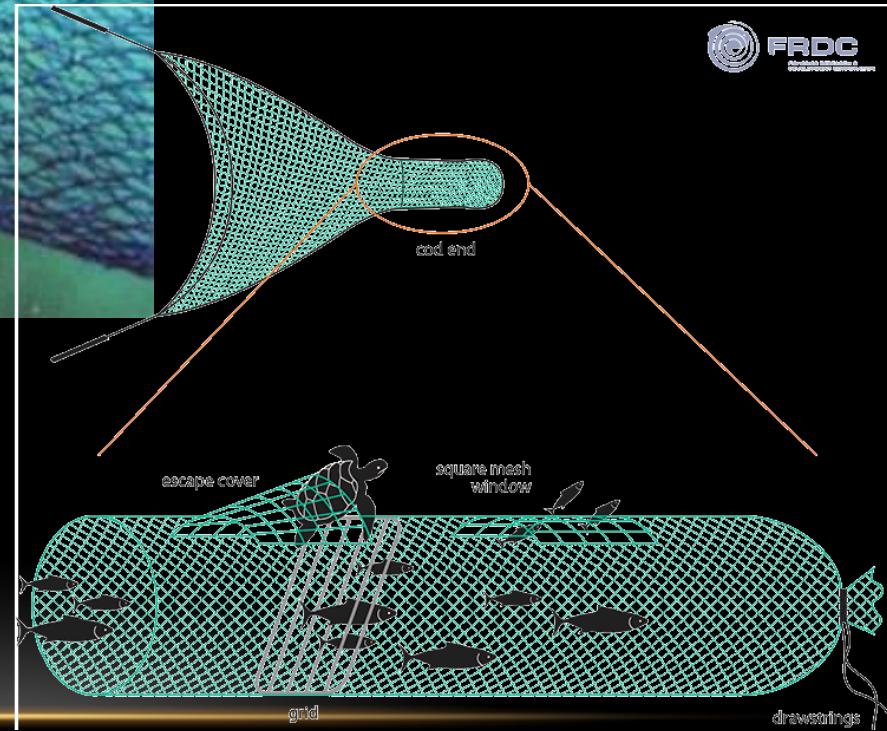


# RESPONSIBLE INNOVATION: FIGHT MALARIA





# TURTLE EXCLUDER DEVICES (TED'S)



# COLA LIFE



## The Colalife Anti-Diarrhoea Kit (ADK)

### Lid/soap tray & soap

- Re-usable lid
- Separates the soap from the other components of the kit

### Container/measure/mixer/cup

- Holds and protects the ADK components in transit
- Acts as a measuring jug for the ORS - calibrated at 200ml
- Mixing device and storage vessel (with lid)
- Cup for administering the ORS solution
- Attractive and distinctive
- Fits in the unused space in a Coca-Cola crate
- Re-usable



### Heat-sealed film

- Tamper evidencing
- Water proofing
- Micro-porous
- Transparent

### Low Osmolarity Oral Rehydration Salts

- Eight 4.12g sachets to make up 200ml of solution

### Zinc supplements

- 10 scored and sweetened Zinc Sulfate tablets

### IEC Materials

- Concertina information leaflet which also carries:
  - the ADK branding
  - unique ADK ID for authentication
  - recommended retail price





# AFSLUITDIJK



# BUILDING WITH AND FOR NATURE



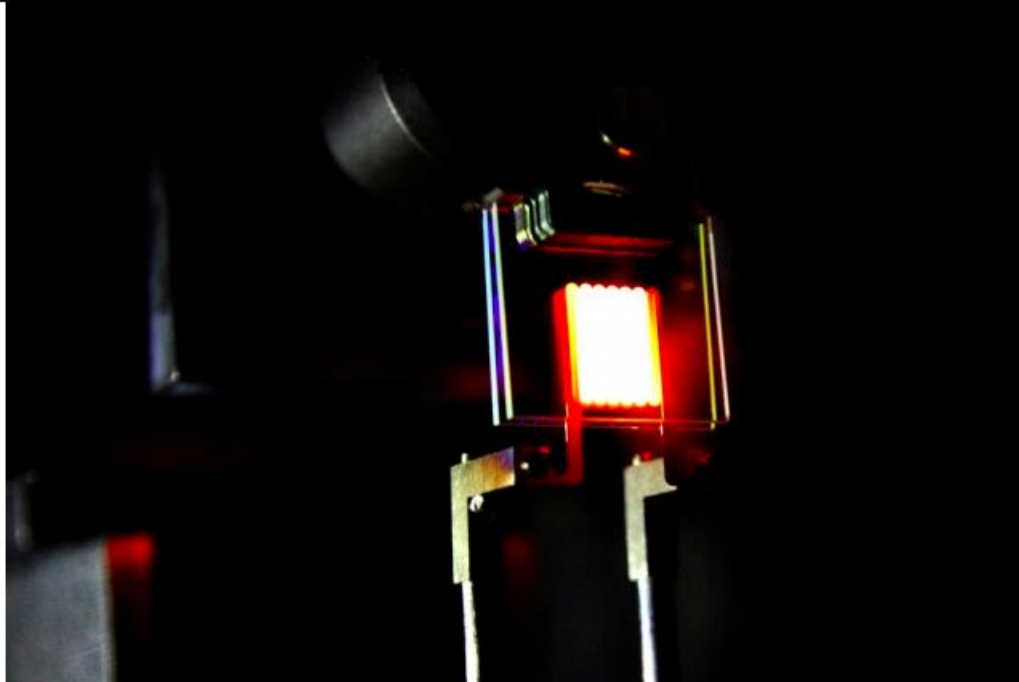




# MOBILITY, RECREATION, WILD LIFE







 FULL SCREEN

A proof-of-concept device built by MIT researchers demonstrates the principle of a two-stage process to make incandescent bulbs more efficient. This device already achieves efficiency comparable to some compact fluorescent and LED bulbs.

Courtesy of the researchers

## 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





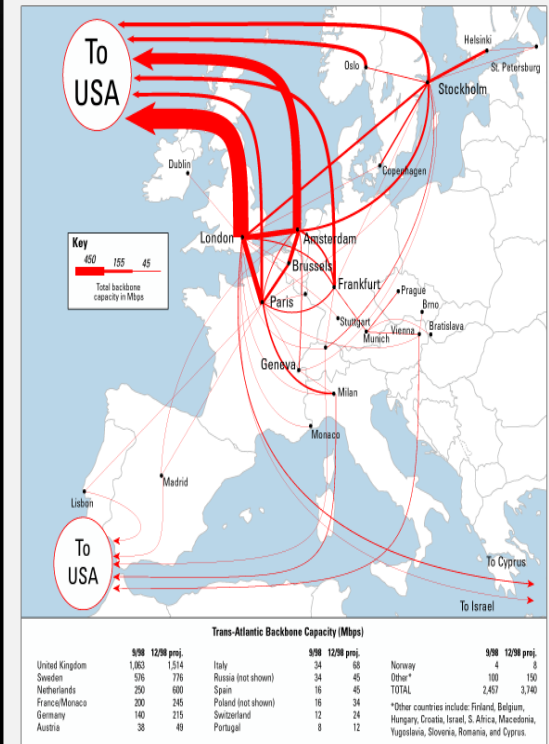
# FINANCE



銘柄	変動	銘柄	変動	銘柄	変動	銘柄	変動	
1056	-19	1887	952	-21	加藤製	486	-17	
2430	-15	トヨタ	354	-22	油研工	379	-17	
1400	+14	東田工	2415	-45	タタノ	1088	-39	
867	-2	株本チ	883	-15	フナチ	695	-8	
734	-26	大同工	428	-15	CKD	1782	+68	
405	-17	TCM	424	-6	平和	1732	+11	
717	+1	日コパ	212	-6	SANKYO	7520	-40	
422	-11	木村化	505	-22	金銀株	2200	-5	
885	0	大崎電	1370	-38				
1841	-64	オムロン	2940	+15				
2255	-15	日東工	2190	-75				
619	-11	IDEC	2005	-95				
1354	-28	エスビー	4680	-160				
6170	-50	GSJ79	333	-13				
9180	-190	信村大興	669	-26				
298	-10	メルコ	3250	-10				
646	-21	NEC	689	-22				
689	-28	富士通	933	-35				

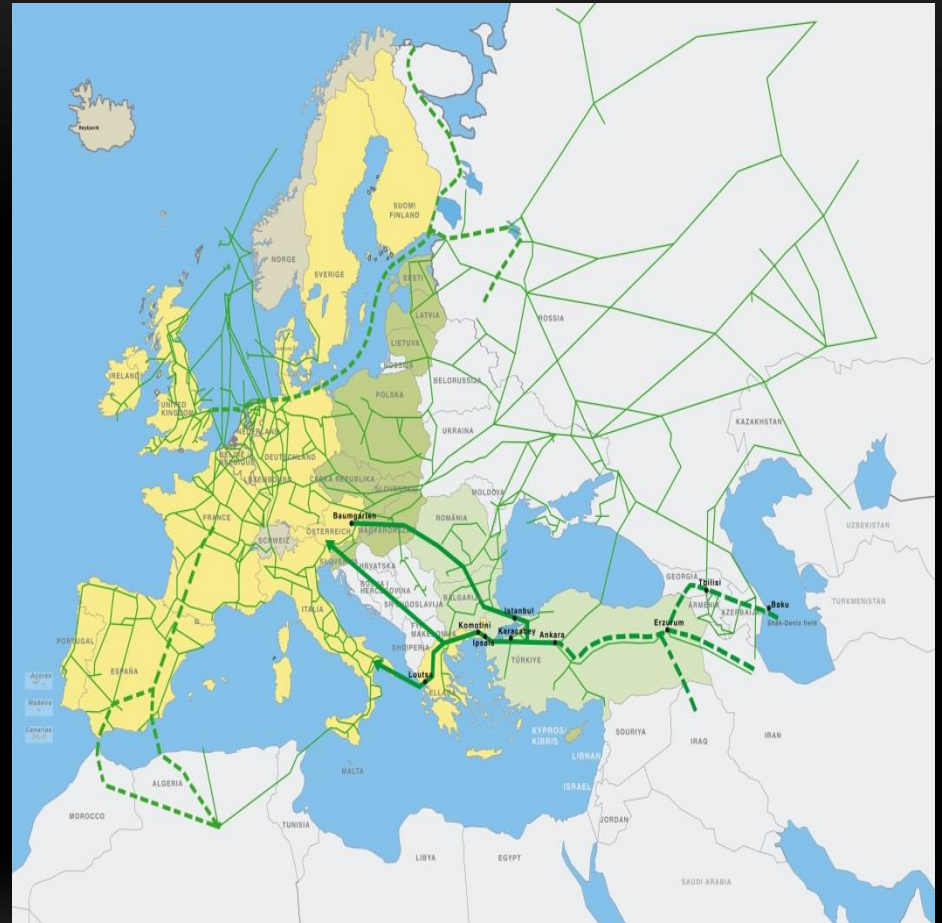
# INTERNET & GAS

Figure 5. European Internet Backbone Connectivity



Note: Table and map based on Summer 1998 survey of European ISPs with backbone connections above 2 Mbps.  
 Source: Europe data from Robert Cohen, Cohen Communications Group, tel +1 212 986 7720, bochen@mail.bway.net.  
 Israel figures from Sharon Chan, California State University.

Map design by TeleGeography, Inc. © 1998





# SMART CITIES

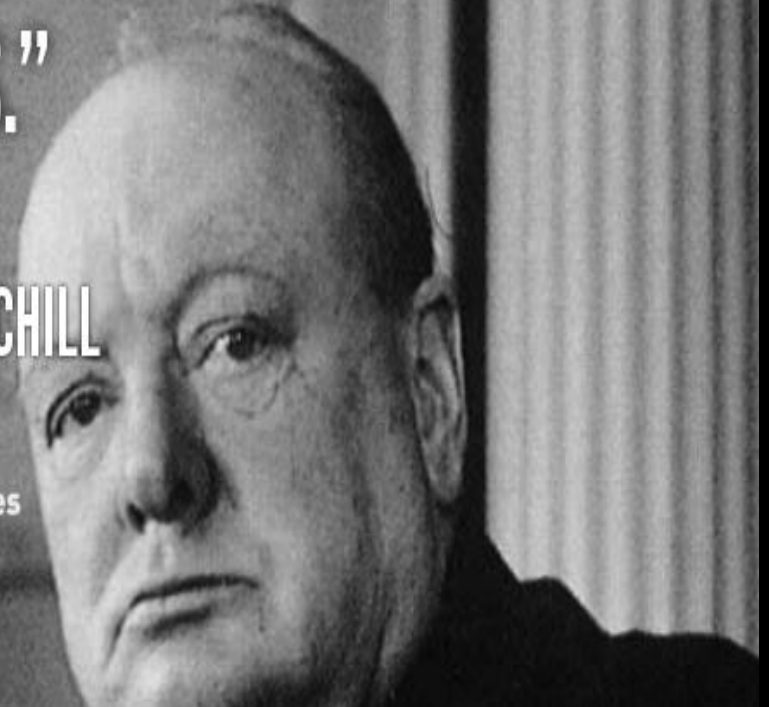


CHURCHILL

**“WE SHAPE OUR BUILDINGS; THEREAFTER THEY  
SHAPE US.”**

**WINSTON CHURCHILL**

© Lifehack Quotes



Responsibility  
Privacy  
Accountability  
Agency  
Autonomy  
Sustainability  
Safety  
Security

Values  
Norms  
Laws  
Ideals  
Ethics  
Principles

Express  
Implement

Computers  
Oiltankers  
Airplanes  
Reactors  
Roads  
Internet  
Electricity  
Grids  
Hospitals

Artefacts  
Architectures  
Materials  
Standards  
Security  
Systems  
Infrastructure

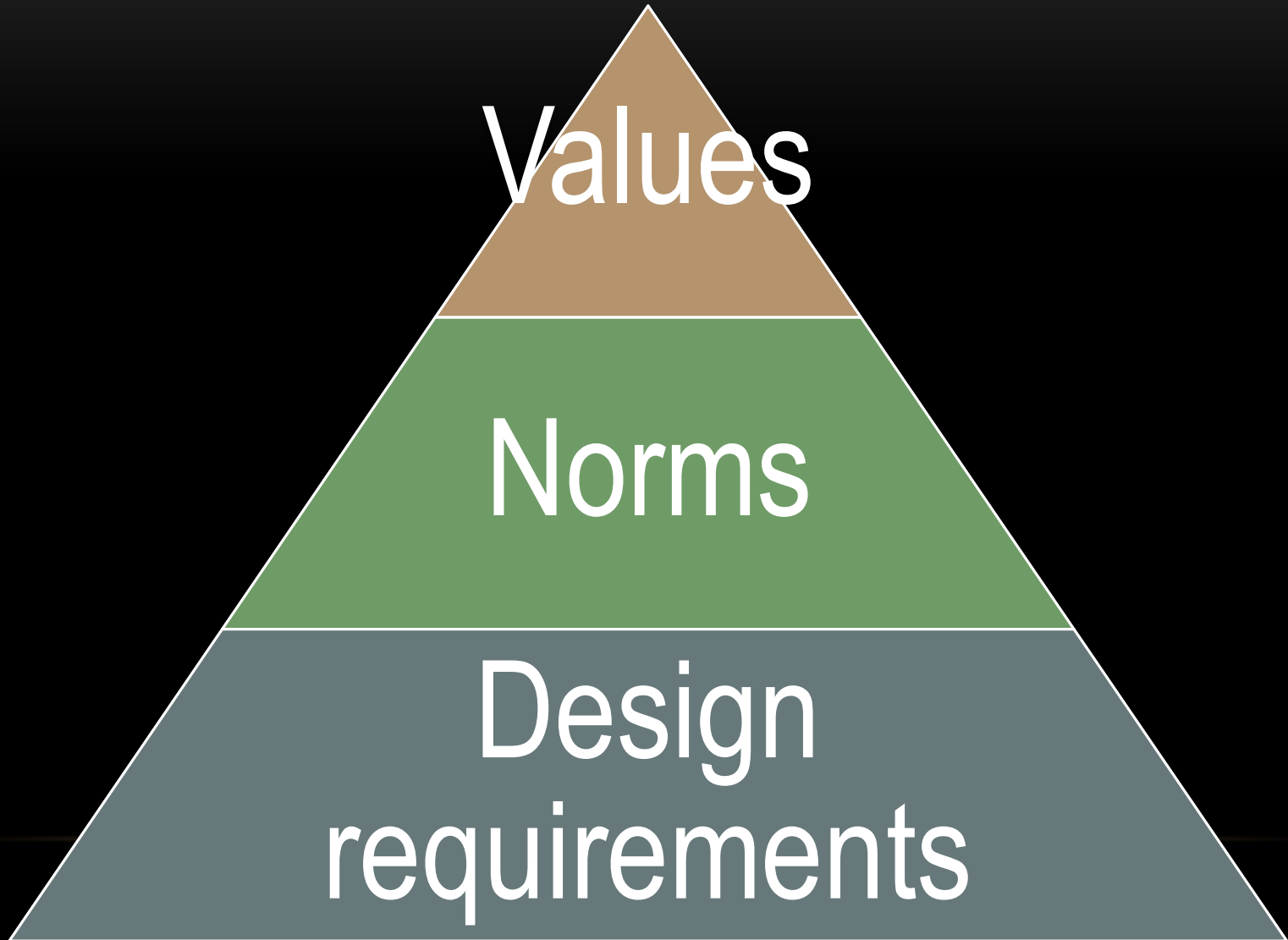
Justify  
Audit

KEY PROBLEM

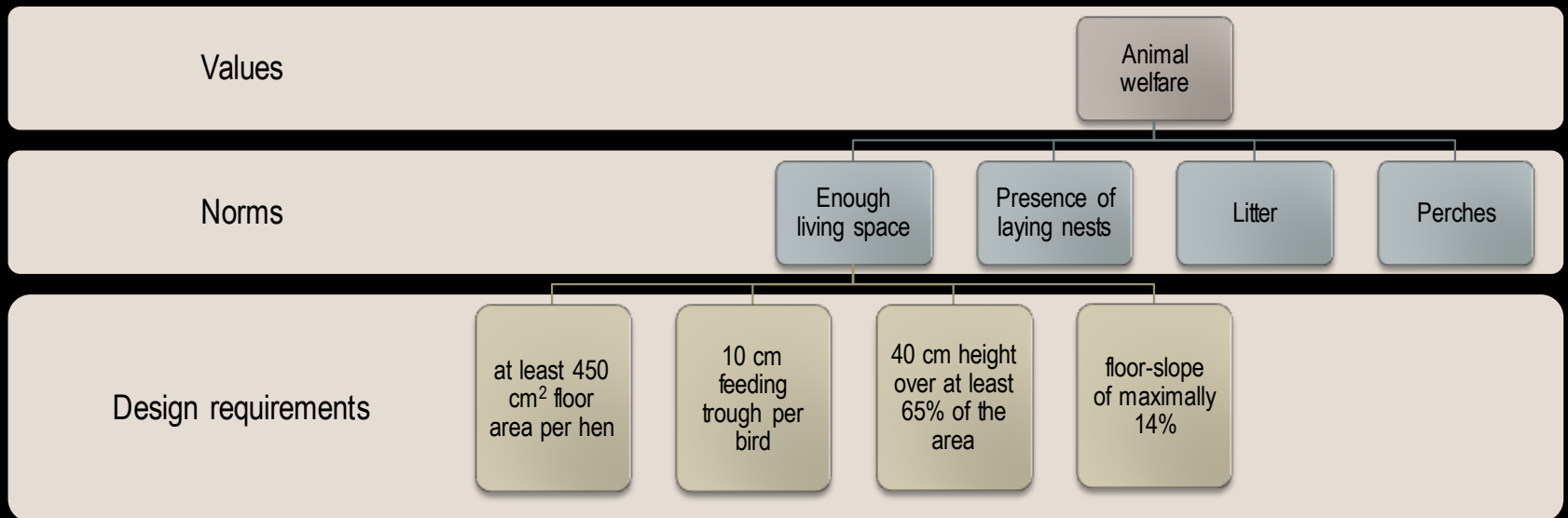
21ST CENTURY: VALUE SENSITIVE DESIGN

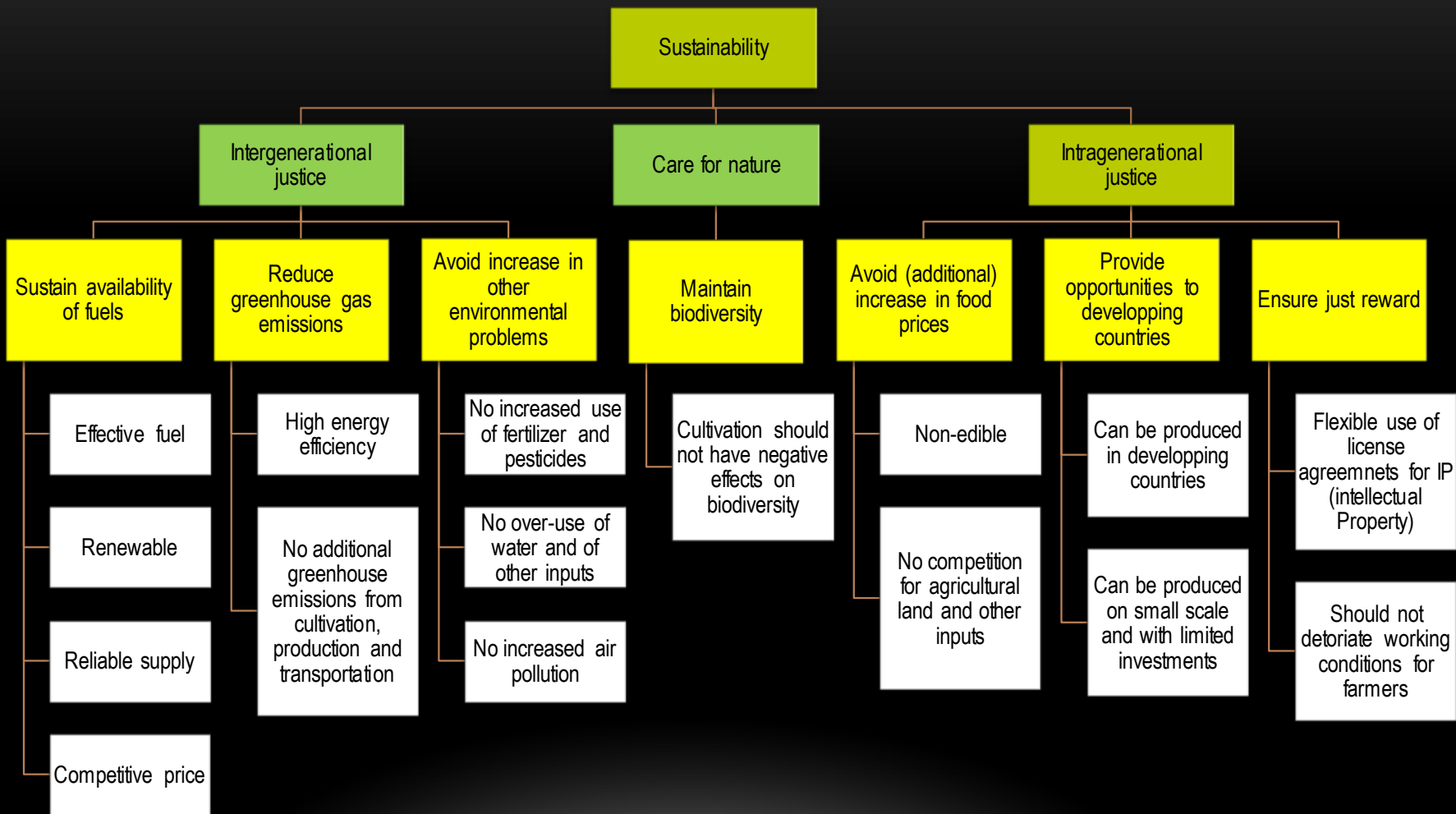


# VALUES HIERARCHY



# EXAMPLE OF VALUES HIERARCHY





Sustainability

Intergenerational justice

Care for nature

Intragenerational justice

Sustain availability of fuels

Reduce greenhouse gas emissions

Avoid increase in other environmental problems

Maintain biodiversity

Avoid (additional) increase in food prices

Provide opportunities to developing countries

Ensure just reward

Effective fuel

High energy efficiency

No increased use of fertilizer and pesticides

Cultivation should not have negative effects on biodiversity

Non-edible

Can be produced in developing countries

Flexible use of license agreements for IP (intellectual Property)

Renewable

No additional greenhouse emissions from cultivation, production and transportation

No over-use of water and of other inputs

No competition for agricultural land and other inputs

Can be produced on small scale and with limited investments

Should not deteriorate working conditions for farmers

Reliable supply

No increased air pollution

Competitive price

# 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

Jeroen van den Hoven  
Pieter E. Vermaas  
Ibo van de Poel  
*Editors*

## Handbook of Ethics, Values, and Technological Design

Sources, Theory, Values and  
Application Domains



SpringerReference

# 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

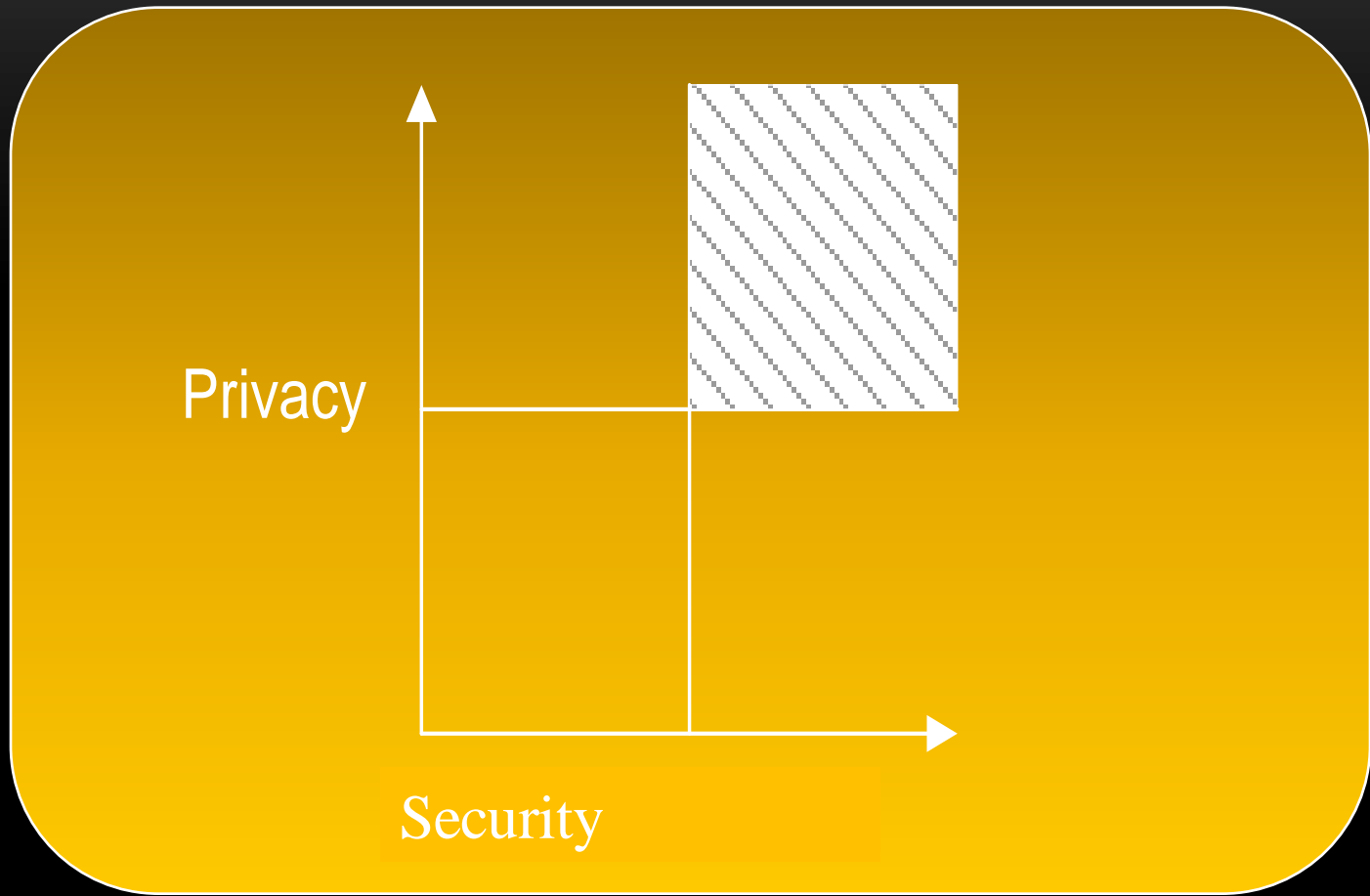


WE ALSO WANT PRIVACY



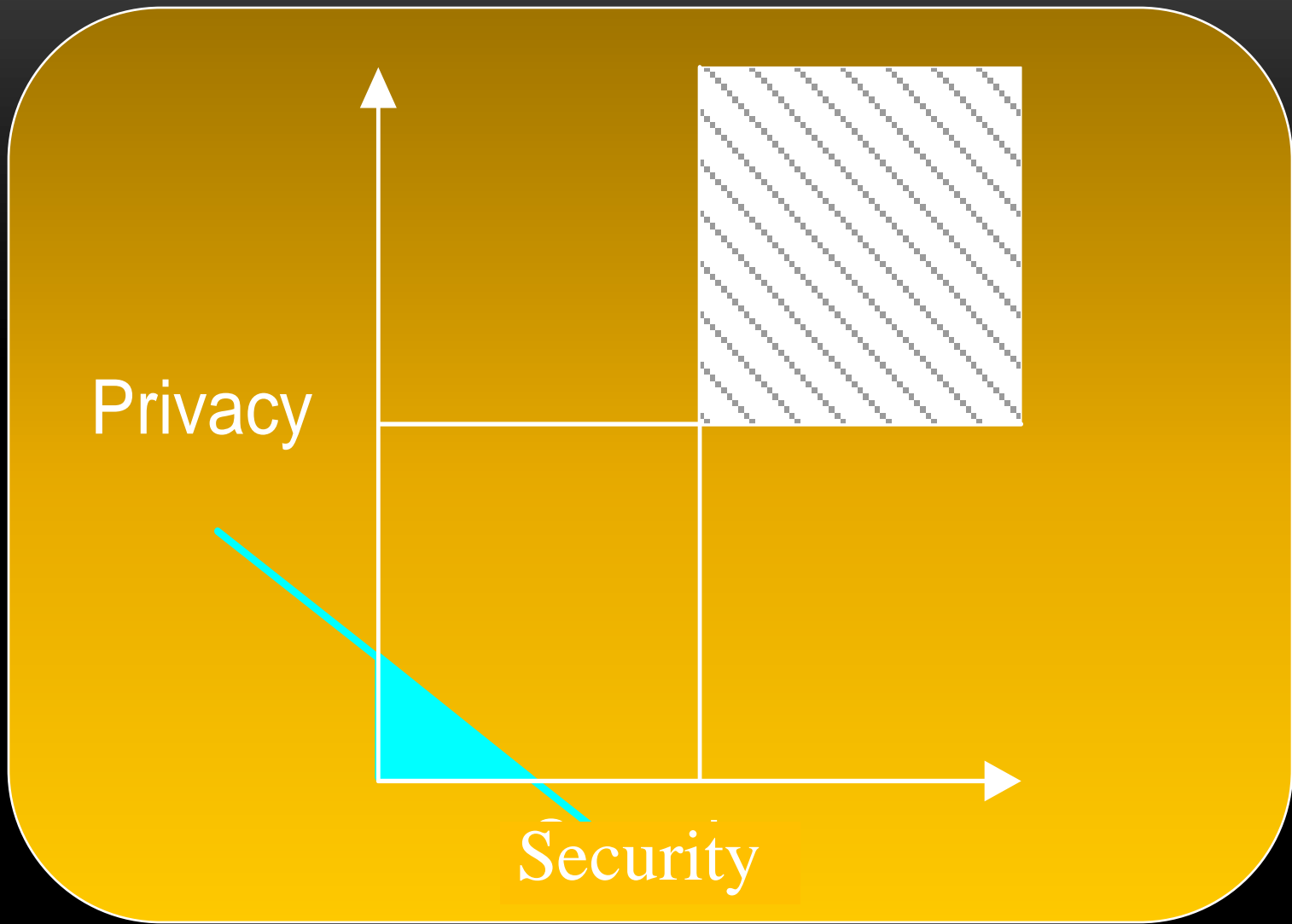
# SECURITY



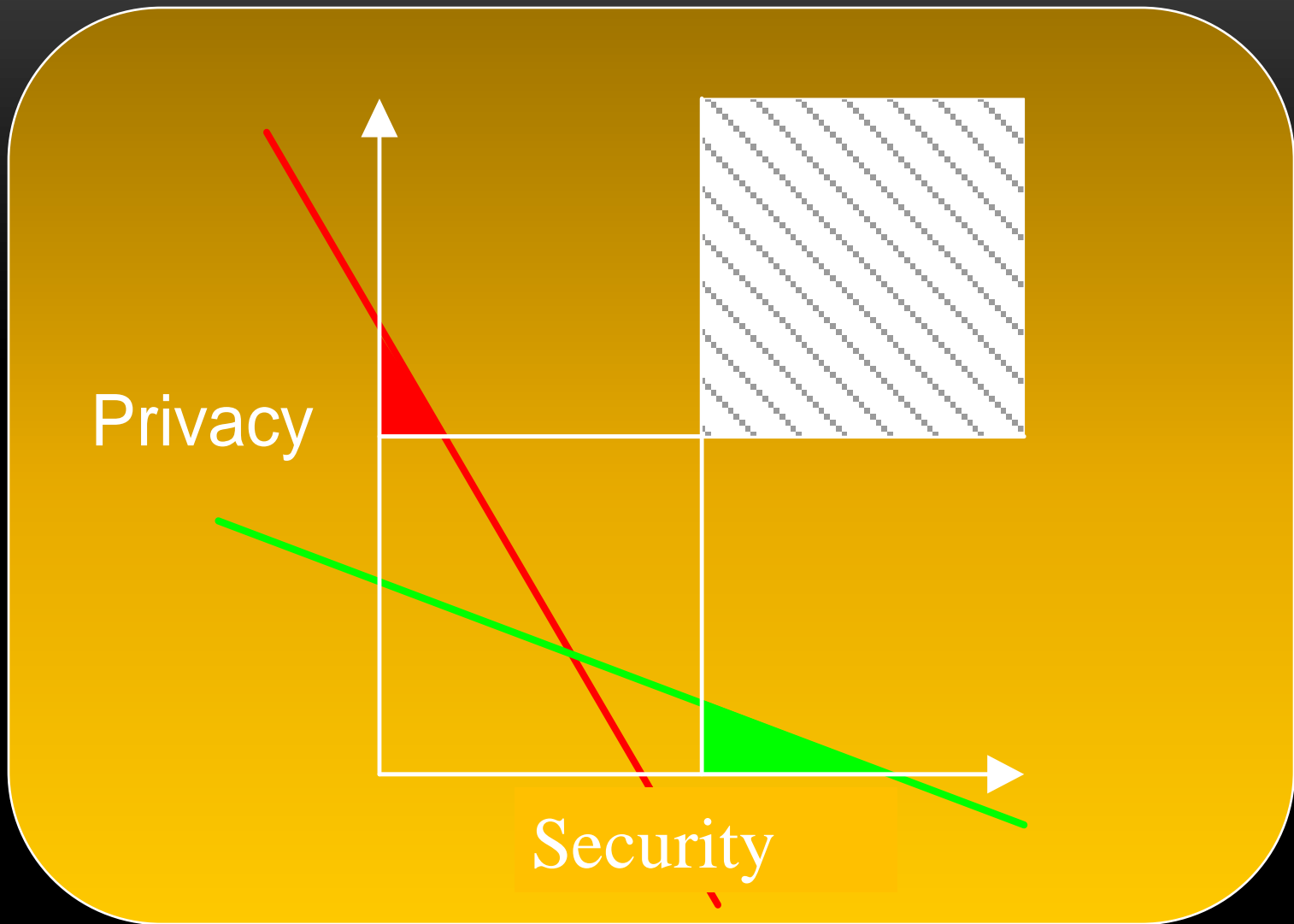


**MORAL OVERLOAD**

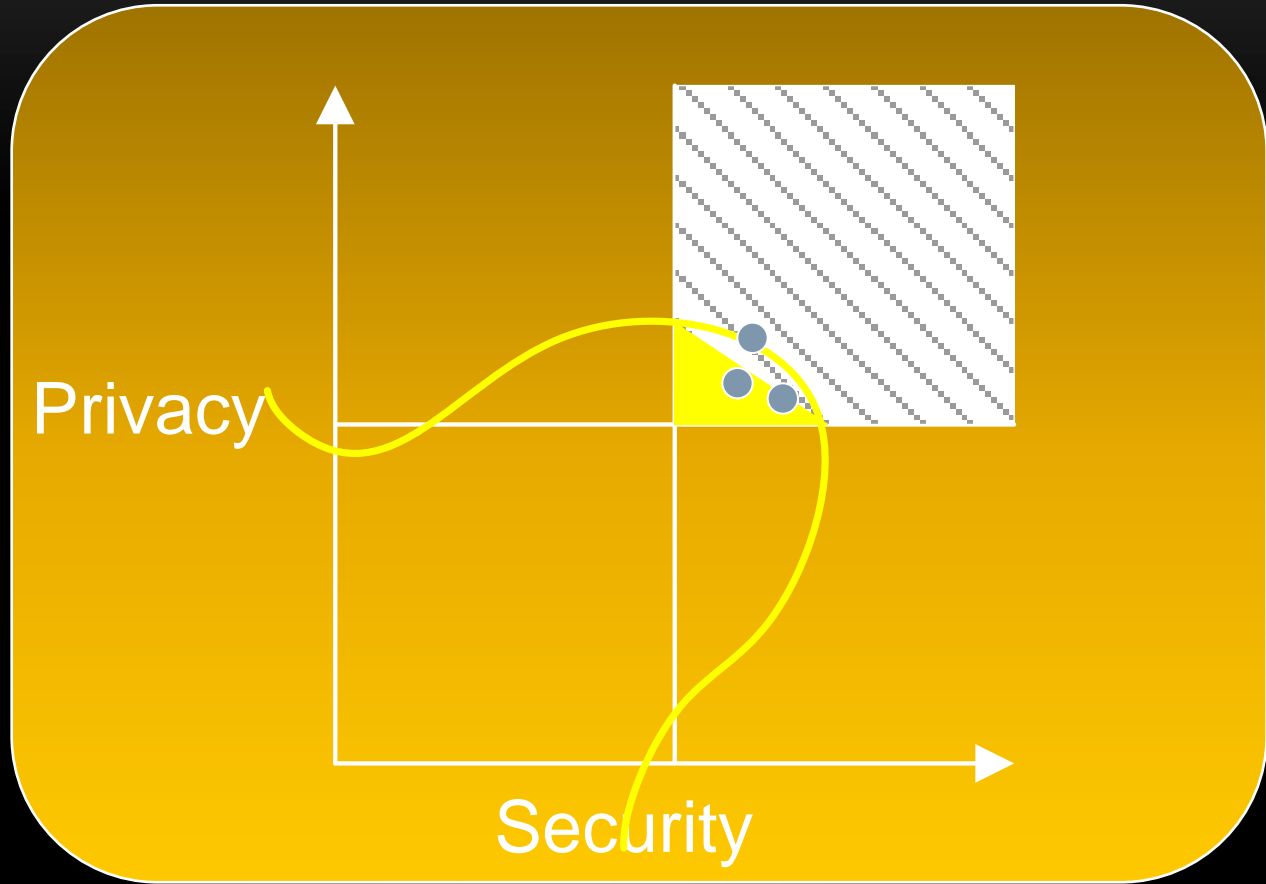




**NO PRIVACY, NO SECURITY (1.0)**



# 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



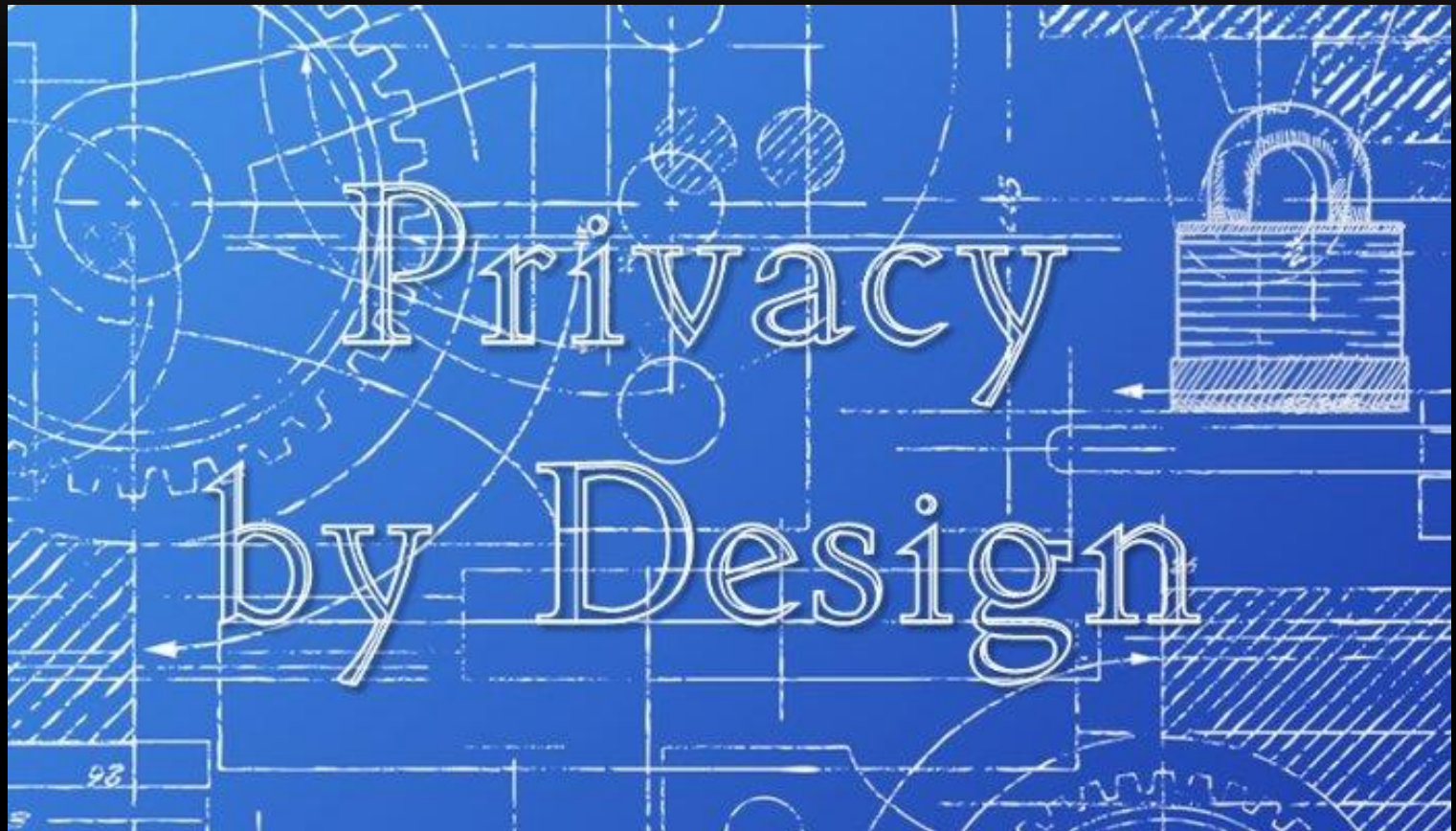
If a contingent state of the world at time  $t_1$  does not allow us to satisfy two or more of our moral values or moral obligations at the same time, but we can bring about change by innovation in the world at  $t_1$  that allows us to satisfy them all together at a later time  $t_2$ , then we have a moral obligation at  $t_1$  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

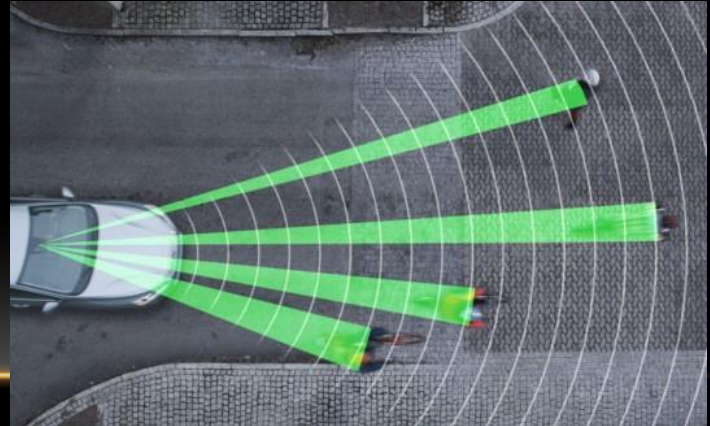


# ZERO VISIONS

- ZERO Road Traffic Accidents Sweden
- ZER Emissions
- ZERO Prevenatble Children death



# VOLVO AIMS FOR ZERO ACCIDENTS





© Rex Features





# SOLVING MORAL OVERLOAD BY DECEPTION

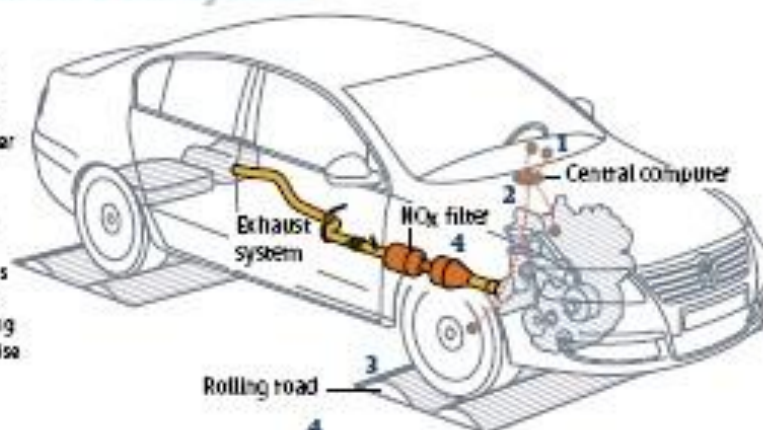


## How VW cheated the system

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 'dyno 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

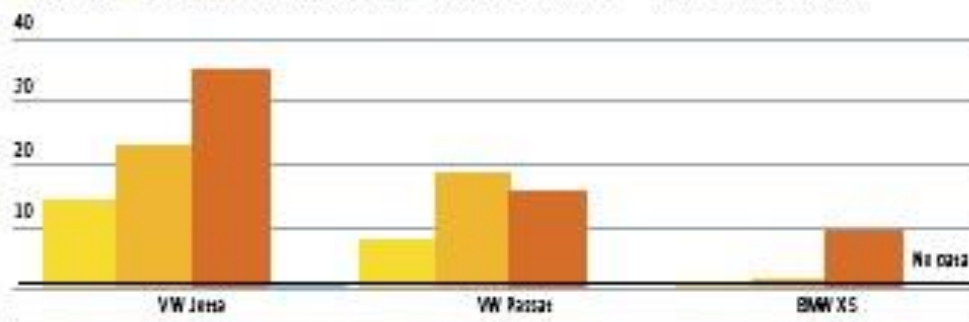


4  
The ERA says it was the NO<sub>x</sub> filter whose behaviour was changing in the different calibrations

## Emission tests

Average NO<sub>x</sub> emissions as deviation ratio

● Highway ● Urban ● Rural-up/downhill ● Under lab conditions — NO<sub>x</sub> Government limit



SOURCE: THEICIT.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**