

# Reading the road:

challenges and opportunities of responsible research and  
innovation in helping develop sustainable societies



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Informatics Europe  
26 October 2021



UNIVERSITY OF  
**OXFORD**



Responsible  
Technology  
Institute



# Human Centred Computing at Oxford



We research methods and approaches at building computing systems responsibly, in ways that actively support individual autonomy, wellbeing, and promote and protect human values.

Our areas span responsible innovation, usable privacy and at the intersection of HCI, CSCW, machine learning, psychology, law, policy, and social science.

[www.cs.ox.ac.uk/research/HCC](http://www.cs.ox.ac.uk/research/HCC)

image credit: Andy Bright, <https://www.flickr.com/photos/flat61/3883611573>

# Outline of Talk

- Growing RI (Responsible Innovation)
  - where have we come from?
- Embedding RI
  - how was RI rolled out?
- Institutionalising RI
  - where are we now?
- The road ahead
  - where might the future lie?

# Growing RI - every new technology raises questions

- Who benefits?
- What are the risks?
- What if we're wrong?
- What are the alternatives?
- Who decides?
- Who's in control?
- Who's responsible?



But we can only see to a limited extent what these will be

# Anticipation

- Building capacity
- Like exercise, or rehearsal, oriented in a non-predictive way toward an undefined future
- What if ...?
- What else might it do ...?

# Science for Society

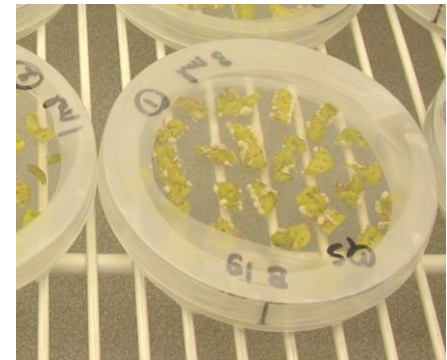
- Beyond risks and regulation
- What kind of society do we want?
- Who decides?

What kind of society do we want to create, and how can technology help us do that?

D H Guston, E Fisher, A Grunwald, R Owen, T Swierstra & S van der Burg  
(2014)

# Growing RI - technology push

- 1990s introduction of genetically modified crops in Europe
- Public backlash against GM foods and biosciences in general
- Regulators discussed risk to human health and environment
- Public feared unintended, unpredictable effects
- Did not take account of public concerns
- Dismissed fears and attempted to educate
- Strategy ineffective
- Needed more participatory strategies



[https://en.wikipedia.org/wiki/Genetically\\_modified\\_crops#/media/File:Transformation\\_with\\_Agrobacterium.JPG](https://en.wikipedia.org/wiki/Genetically_modified_crops#/media/File:Transformation_with_Agrobacterium.JPG)

*"We need ambition at a policy level to support  
the best science **for** the world and  
not just the best science **in** the world"*

Morten Østergaard. Former Minister of Science, Denmark



# Context of Responsible Innovation

- Initiatives across policy, academia and legislation emerged over a decade ago
- Address uncertainties and risks associated with novel areas of research
  - Nanotechnology (Fisher and Rip 2013)
  - Geo-engineering (Stilgoe et al 2013)
  - Synthetic Biology (Tucker et al 2006)

# Context of Responsible Innovation

- Expanded to include Computer Science, Robotics, Informatics and ICT more generally (Grimpe et al 2014)
- A cross-cutting issue at Horizon 2020, the EU Framework Programme for Research and Innovation 2014-2020
- Commitment from Engineering and Physical Sciences Research Council (EPSRC)

# What is RI Responding To?

- Many of the problems are a legacy of failing to attend to potential negative impacts of innovations
- Increasing public and media concern over negative consequences of innovation
- Technologies are becoming ever more potent
  - Nanotechnology seeks the ability manipulate matter at a fundamental level
  - Synthetic biology aims to create new forms of life
  - AI and automated decision making
  - Transhumanism – enhancing human intellect and physiology



‘doing science and innovation with society and for society’, including the involvement of society ‘very upstream’ in the processes of research and innovation to align their outcomes with the values of society

RRI tools project 2014

# Responsible Innovation

Responsible Innovation is a set of good practices for ensuring that research and innovation benefits society and the environment

To increase participation of variety of stakeholders

To encourage all stakeholders to anticipate and reflect on the consequences of scientific and technological innovations

RI frameworks

- <https://www.rri-tools.eu/>
- <https://www.orbit-rri.org/>
- <https://epsrc.ukri.org/research/framework/area/>



*The 6 pillars of RI*

# The Area Framework

**Anticipate** – describing and analysing the impacts that might arise.

- Foresight, technology assessment, and scenario development
- But also informal, everyday decisions
- What if? What else ...?



<http://fromoverhere.net/2012/08/strategic-foresight-and-crowd-sourcing/>

# The Area Framework

**Reflect** – reflecting on the purposes of, motivations for and potential implications of the research.

- Make visible dominant values: “holding up a mirror” to one’s own assumptions
- Pausing for a moment
- Systemic context



<http://geopolicraticus.tumblr.com/post/43206182652/the-reflexivity-of-philosophical-reflection>

# The Area Framework

**Engage** – opening up visions, impacts and questioning to broader deliberation, dialogue, engagement.

- Inclusive
- Participatory
- But also encourage users to reflect on their own assumptions; open up the design space



<http://www.theguardian.com/books/booksblog+booker-prize>



# The Area Framework

**Act** – using these processes to influence the direction and trajectory of the research and innovation process itself.

- How will we be responsive to the concerns raised through our RI mechanism?
- How can we do this systematically through the research and innovation process?



<http://www.keystroke.ca/blog/>



# Embedding RI – FRRIICT

- Foster a network of researchers concerned with RI in ICT
- Develop an RI Observatory to be a repository for information and disseminate best practice
- Undertake detailed case studies across the ICT spectrum
- Create calls for proposals
- Conduct a landscape study of RI in ICT
- Develop a Framework for Responsible Research and Innovation in ICT

# Embedding RI – FRRIICT: findings

## Professional Responsibility

- not framed in terms of RI - varying beliefs on who they are responsible to (self, data, participants, project, institutions, public)

## Technology is agnostic (or value-free)

- division between research, products and use
  - ▶ basic vs applied research - no immediate impact
  - ▶ a neutral activity - for its own sake
  - ▶ far removed in the chain from discovery to product
  - ▶ performance not **use** of that performance
  - ▶ no immediate implications to society

*“I don’t think I’ve come across an unethical scientist. ... if a problem occurs it’s maybe that they just haven’t considered the true implications of where there could be problems down the line. I think it’s more that it hasn’t occurred to them rather than they’ve considered it and decided to go with it for the hell of it anyway”*

*“The ... research that we do doesn’t inherently tell you how to use this research. So, we built a robot that can throw balls 6m compared to 1m... So, there is not kind of moral value associated with that, it’s more of a performance. We’re focused on the performance. How you use that performance is not our part.”*

# Embedding RI – NQIT-RI: findings

- Focus on public engagement
- Routes to policymaking and change
- (Non)neutrality of technology
- Difficulty of anticipation
- *De facto* RI
- National and global impacts

*“maybe I wouldn’t feel wholly responsible since ... people ... can do bad things with many things”*

*“we do talk, what is the best way to move forward and what would be the best mode of operation ... these are important issues to discuss.”*



# Embedding RI - ORBIT

- Funded by EPSRC to provide:
  - Leadership
  - Community
  - Knowledge-exchange
  - Training
  - Consultancy
  - A spinout company



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**ORBIT**

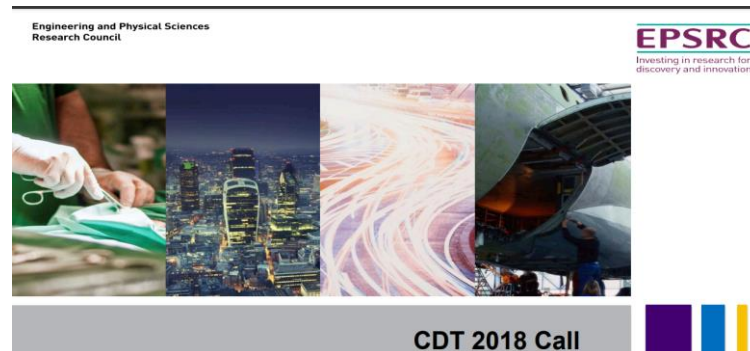
[www.orbit-rri.org](http://www.orbit-rri.org)



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# Embedding RI – Centres for Doctoral Training

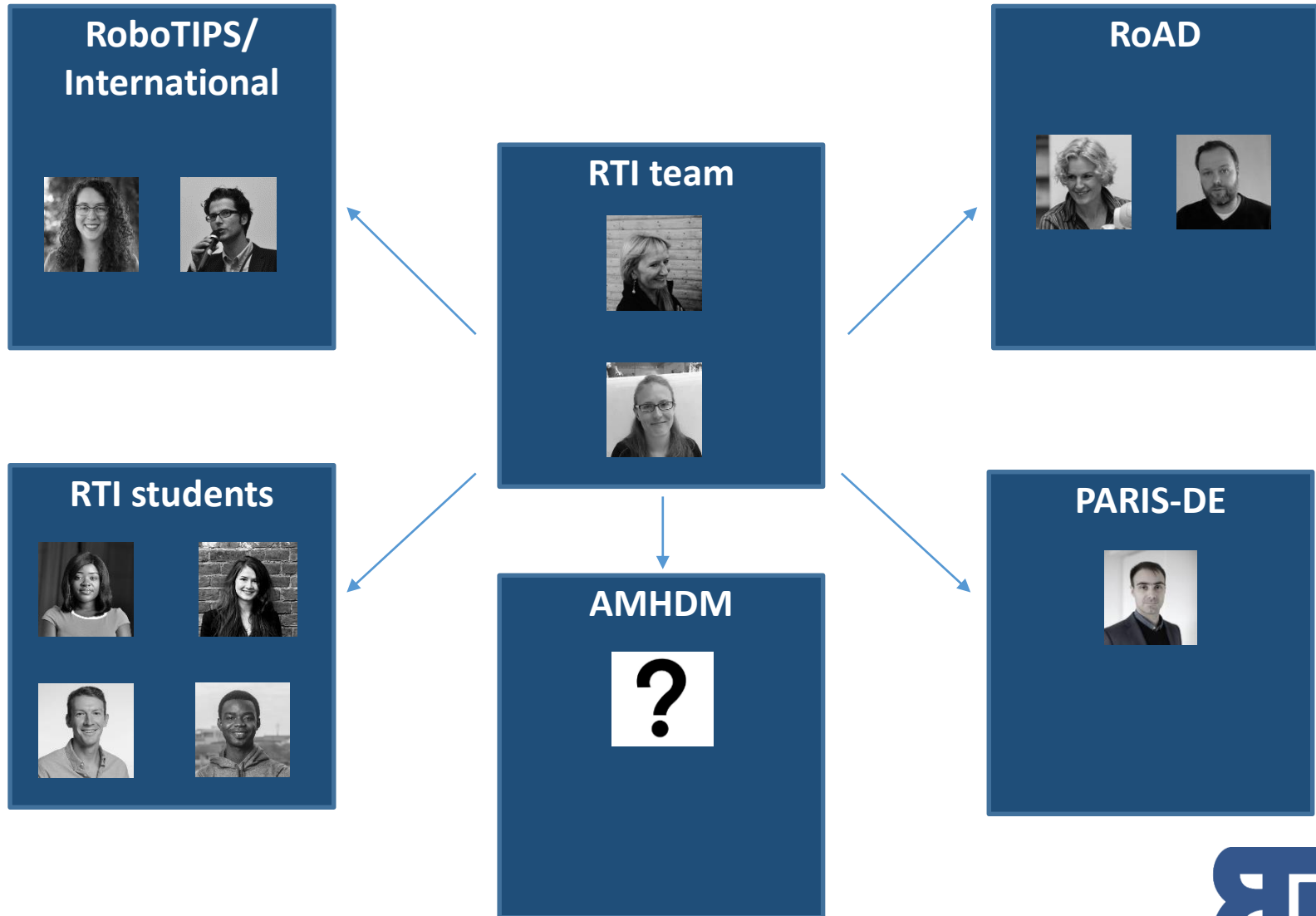
- Multi-disciplinarity
- Uniqueness of CDTs - industry partnerships
- First attempt to roll out RI to a new generation



# Embedding RI – research study on CDTs

- Differing interpretations of RI depending on:
  - previous experience
  - disciplinary field
  - industrial/commercial connections
- Varied training offering
  - may be bundled with ‘soft’ skills training
  - often identified with ethics
  - supervisory staff may or may not be trained
- Range of meanings of ‘embedding’

# Embedding RI – RTI





# Responsible Technology Institute (RTI)

- International centre of excellence on responsible technology
- International focus on the societal challenges presented by new and emergent technologies
- Unpack complexities around understandings of responsibility and different regulatory environments
- Address gaps that exist in industry-related approaches to responsible technology

# Institutionalising new norms - the road ahead

- New ways of doing things cannot be ‘taken for granted’
- Institutionalising new norms requires discarding old norms (Randles & Laasch 2016)
  - Likely to encounter resistance (Pansera et al 2020)
  - Requires assessment and accountability (Owen et al 2021)
  - Often focused solely on economically-beneficial innovation (Genus & Iskandarova 2018)
- Grassroots change (Lindner et al 2016, Grimpe et al 2020)



# The road ahead for change - challenges

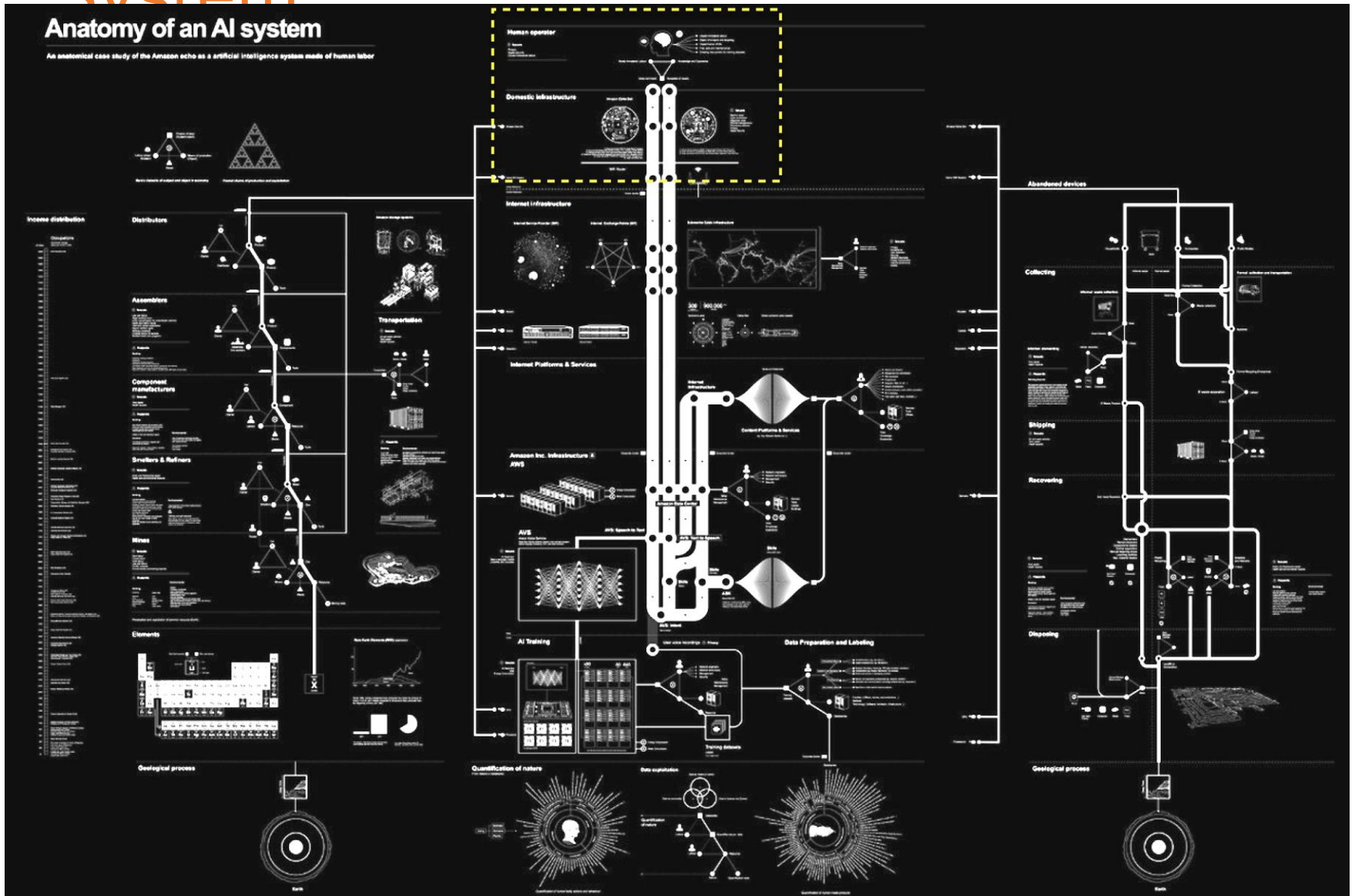
- How do we extend the scope of responsibility?
  - Sustainability is not yet made explicit
  - Equality, diversity, and inclusivity
- Who needs to be involved?
  - Universities/research environment
    - Not resting on the shoulders of individual scientists.
    - How to bring in change so it is not a ‘checkbox exercise’?
  - Industry
    - Difficult to apply to existing processes?
    - No incentives
    - Allure of ethics-washing
  - Governance/policymakers
    - Agility vs thorough consideration of implications/tradeoffs
    - How to encourage global/international responsibility?
  - Public
    - Meaningful stakeholder engagement/inclusivity?
- How do we encourage global/international responsibility?

# Sustainability – PARIS-DE

- EPSRC Digital Economy call for ‘Sustainable Digital Society’
- Embedding sustainability in ICT
  - Paris-compliance-by-design
  - Creation of virtual ‘design lab’
- Measuring the carbon footprint of the project itself
- Not all about the carbon footprint - environmental and social justice



# Sustainability - 'Anatomy of an AI System'



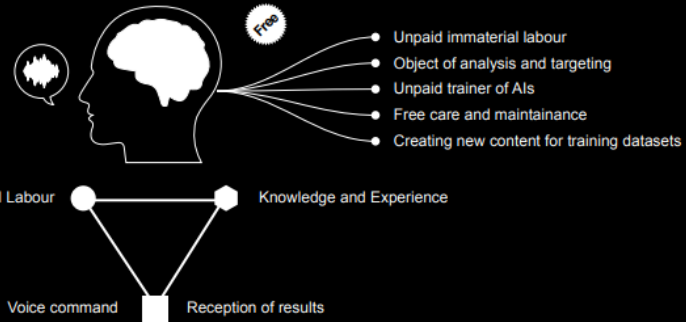
Crawford, K. and Joler, V. (2019) The Anatomy of an AI System <https://anatomyof.ai/>

# Sustainability - Social-digital costs

## Human operator

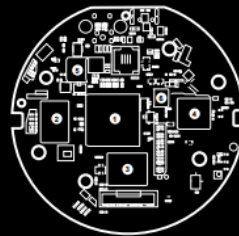
### Issues

- Privacy
- Digital security
- Unpaid immaterial labour

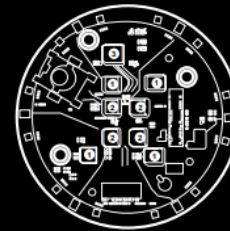


## Domestic infrastructure

Amazon Echo Dot



- (1) Texas Instruments DM3725 Digital Media Processor
- (2) Micron MT46H64M32LFBQ 256 MB (16 Meg x 32 x 4 Banks) LPDDR SDRAM
- (3) Samsung KLM4G1FEPD 4GB High Performance eMMC NAND Flash Memory
- (4) Qualcomm Atheros QCA6234 Integrated Dual-Band 2x2 802.11n + Bluetooth 4.0 SoP
- (5) Texas Instruments TPS65910A1 Integrated Power Management IC
- (6) Texas Instruments DAC



- (1) National Semiconductor LP55231 Programmable 9-Output LED Driver (x4)
- (2) Texas Instruments TLV320ADC3101 92dB SNR Low-Power Stereo ADC (x4)
- (3) Texas Instruments SN74LVC74A Dual Positive-Edge-Triggered D-Type Flip-Flops

### Issues

- Right to repair
- Open schematics
- Diagnostic tools
- Planned obsolescence
- Proprietary software
- Privacy
- Digital Security

WiFi Router



Amazon Echo Dot

Home WiFi Routers

Visible Infrastructure  
Invisible Infrastructure

Home border

# The road ahead – an end-to-end process

- Universities/training
  - Embedding in next generation
    - RI assessment – ThesisPlus (Randles)
  - No research without responsibility
  - Responsible for spinouts' activities?
  - Need for recognition at highest levels of management (ProVC)
- Industry
  - *de facto* RI - good but needs coherence & incentives
  - Responsible engagement – where does the money come from?
  - More than one bottom line – 'shareholder value' not the only measure of success
- Public
  - Constant recycling
  - Engagement – two-way dialogue not one-way 'education'
  - School curriculum – responsible mindsets can start young
- Policy makers/funders
  - Raising awareness through calls and requirements
  - Assessing RI in proposals
- Government/governance
  - Parliamentarians – simulations and concrete cases (Responsible Robotics)
  - Legislation/regulation (eg NS&I Act)

*“Responsible Innovation means taking care of the future through collective stewardship of science and innovation in the present”*

*(Stilgoe, Owen and Macnaghten 2013)*



# References

- <https://www.heise.de/newsticker/meldung/Amazon-reveals-private-voice-data-files-4256015.html>
- <https://anatomyof.ai/>
- Callaghan, M., Schleussner, CF., Nath, S. *et al.* Machine-learning-based evidence and attribution mapping of 100,000 climate impact studies. *Nat. Clim. Chang.* (2021). <https://doi.org/10.1038/s41558-021-01168-6>
- Owen, R., Pansera, M., Macnaghten, P., & Randles, S. (2021). Organisational institutionalisation of responsible innovation. *Research Policy*, 50(1), 104132. <https://doi.org/10.1016/j.respol.2020.104132>
- Jirotko, M., Grimpe, B., Stahl, B., Eden, G., & Hartswood, M. (2016). Responsible research and innovation in the digital age. *Communications of the ACM*.
- Owen, R., Stilgoe, J., Macnaghten, P., Gorman, M., Fisher, E., & Guston, D. (2013). A framework for responsible innovation. *Responsible innovation: managing the responsible emergence of science and innovation in society*, 31, 27-50.
- Stilgoe, J., Owen, R., & Macnaghten, P. (2013). Developing a framework for responsible innovation. *Research Policy*, 42(9), 1568-1580.
- D H Guston, E Fisher, A Grunwald, R Owen, T Swierstra & S van der Burg (2014) Responsible innovation: motivations for a new journal, *Journal of Responsible Innovation*
- Stilgoe, J. (2015). *Experiment Earth: Responsible innovation in geoen지니어ing*. Routledge.
- Lucivero, Federica, et al. "Data-driven unsustainability? An interdisciplinary perspective on governing the environmental impacts of a data-driven society." *An Interdisciplinary Perspective on Governing the Environmental Impacts of a Data-Driven Society* (June 19, 2020) (2020).
- Crawford, Kate. *The Atlas of AI*. Yale University Press, 2021.
- Inglesant, P., Ten Holter, C., Jirotko, M., & Williams, R. (2021). Asleep at the wheel? Responsible innovation in quantum computing. *Technology Analysis and Strategic Management*.
- Ten Holter, C., Inglesant, P., & Jirotko, M. (2021). Reading the road: challenges and opportunities on the path to responsible innovation in quantum computing. *Technology Analysis & Strategic Management*, 1-13. <https://www.tandfonline.com/doi/full/10.1080/09537325.2021.1988070>