Image: The Global E-waste Monitor 2020.

Sustainability and Connected Devices

Dr. Susan Lechelt
CDI1, Design Informatics

What we will do today

1. Explore the issue of sustainability in context of connected devices
2. Introduce frameworks for sustainable interaction design
3. Consider other roles for designers in context of sustainable design:
    - Design fictions for speculating on futures (Spimes)
    - Toolkits for supporting others in making sustainable decisions (Fixing the Future project)

What does sustainability mean to you?

https://miro.com/app/board/uXjVNdQg3x0=/?share_link_id=552010586037

SDGs: improving the lives of populations around the world and mitigating the hazardous man-made effects of climate change.

Sustainability and Design

- Sustainability ***in*** design:
  - How can digital and material technologies be designed to be more sustainable?
- Sustainability ***through*** design:
  - How can technology design support people in adopting more environmentally sustainable behaviours?

Mankoff, J. C., et al. (2007. Environmental sustainability and interaction. In EA *CHI'07*

What do we mean by “connected devices”?

- Devices that connect with each other or other systems via the Internet
- Some form of physicality
- Commonly embedded with processing chips, sensors and software
- Often bespoke hardware / encasings

What do we mean by “connected devices”?

Encompass a range of categories:

- “Common” computing devices: e.g., laptops, smartphones, smart speakers, smart watches
- Special purpose/designerly devices: e.g., posture trackers, smart basketballs, social robots
- Infrastructure: monitoring in fulfilment centres, sensors in smart cities

Image credit: Dzone

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Image credit: Dzone

Relevance to Design Informatics

- Allows us to explore sustainability dimensions of both the digital and physical
- Principles overlap more broadly with other design artefacts - e.g., tangible interfaces

The issue of e-waste

UN Report on e-waste (2019):

"The world produces as much as 50 million tonnes of electronic and electrical waste (e-waste) a year, weighing more than all of the commercial airliners ever made. Only 20% of this is formally recycled."

"The e-waste produced annually is worth over $62.5 billion, more than the GDP of most countries. There is 100 times more gold in a tonne of e-waste than in a tonne of gold ore."

Why are connected devices such a big driver of e-waste?

1. Sheer quantity.

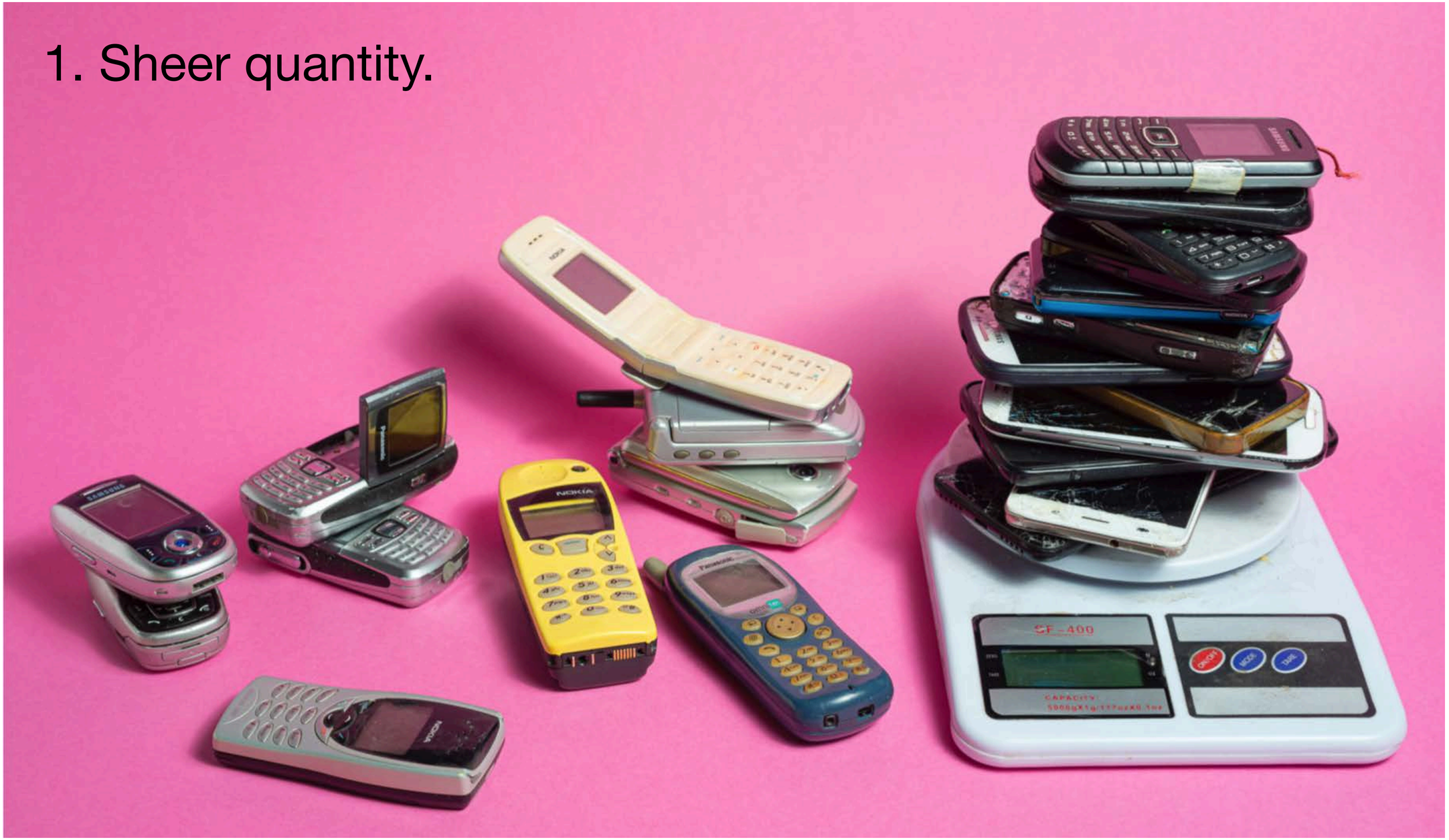


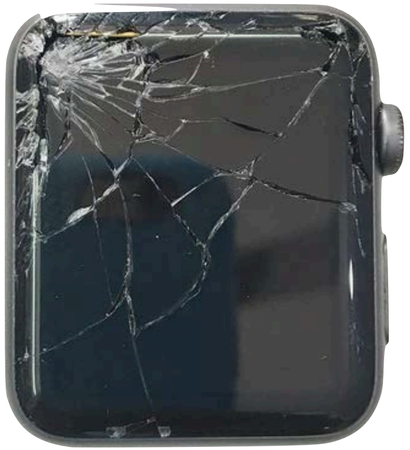
Image: The Global E-waste Monitor 2020.

2. The trend of purchasing new “better” products even when old ones still function

Apple Series 1

Apple Series 5

3. Loss of intended function through breakage and “bricking”



(Traditional Loss of Function)
Material:
Broken inputs
Broken outputs

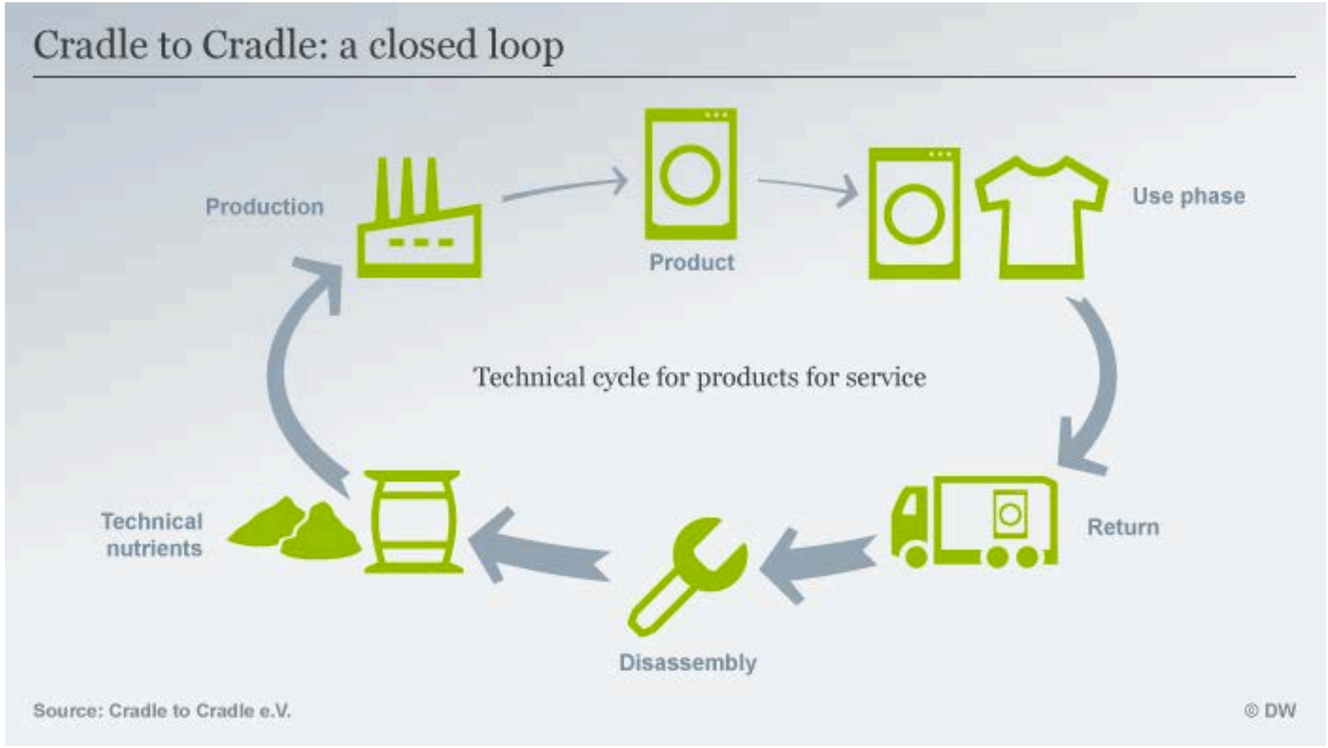
Staples Connect hub is dead as IoT graveyard grows

Social robot Jibo does one last dance before its servers shut down

Kuvee smart wine bottle joins the IoT graveyard

(New Form of Loss of Function) Data:
“Bricking” by the manufacturer
Loss of function despite
material qualities being intact

In an ideal world…

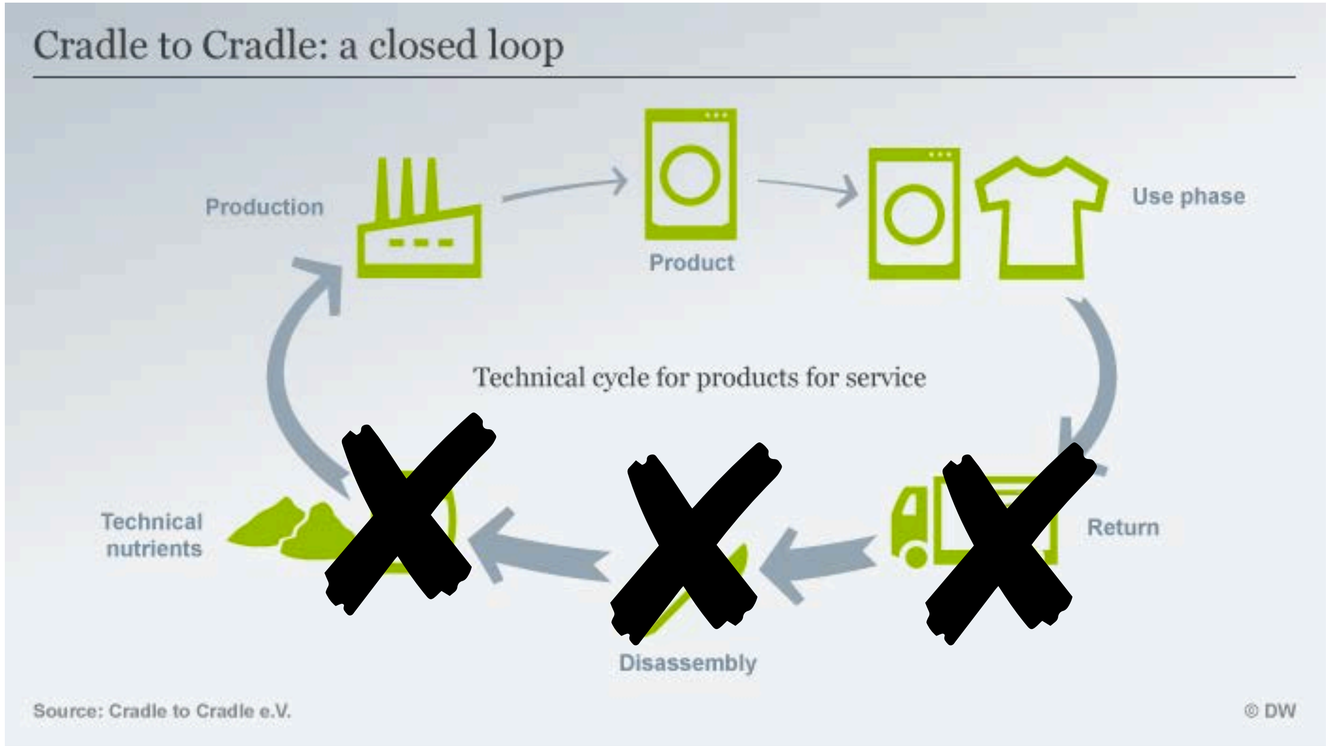


https://www.dw.com/en/cradle-to-cradle-living-in-a-world-without-waste/a-43740165

Cradle to Cradle: "the design and production of products of all types in such a way that at the end of their life, they can be truly recycled/upcycled, imitating nature's cycle with everything either recycled or returned to the earth, directly or indirectly."

- Andrew Sherrat, Encyclopedia of Corporate Social Responsibility

In reality…



https://www.dw.com/en/cradle-to-cradle-living-in-a-world-without-waste/a-43740165

Connected devices aren't always returned or recycled they often can't be completely disassembled, and so, they often don't serve as nutrients for further production

This creates a need for further extraction of raw materials in order to manufacture new electronic components to sustain consumption patterns

Student questions!

- Are there new business models that can address the problems associated with disposal of digital technology and promote sustainable ways of being?
- Can capitalist economies survive without planned obsolescence, and if so, how?
- Should designer be responsible to the long-term use of products, or how can they be responsible to that?

Thinking about the broader system

- What influences the owner’s decisions?
- How easy is it to return / recycle a product?
- How easy / accessible is repair?
- What is the role of business models?
- What incentivises companies to move toward more sustainable models?

How can design frameworks guide our thinking?

Rubric of Material Effects

Cause **Disposal**

Enable **Salvage**

Use / Provide for **Recycling**

Provide For **Remanufacturing for Reuse**

Provide For **Handing Over to Others**

Support **Longevity of Use**

Support **Sharing**

Achieving **Heirloom Status**

Finding **Alternatives to Use of Physical Resources**

Cause **Active Repair of Unsustainable Use**

Least sustainable

Most sustainable

Blevis, 2007

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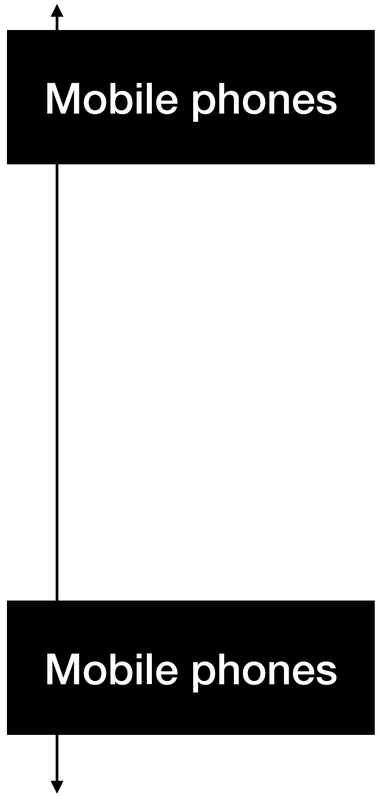


Least sustainable

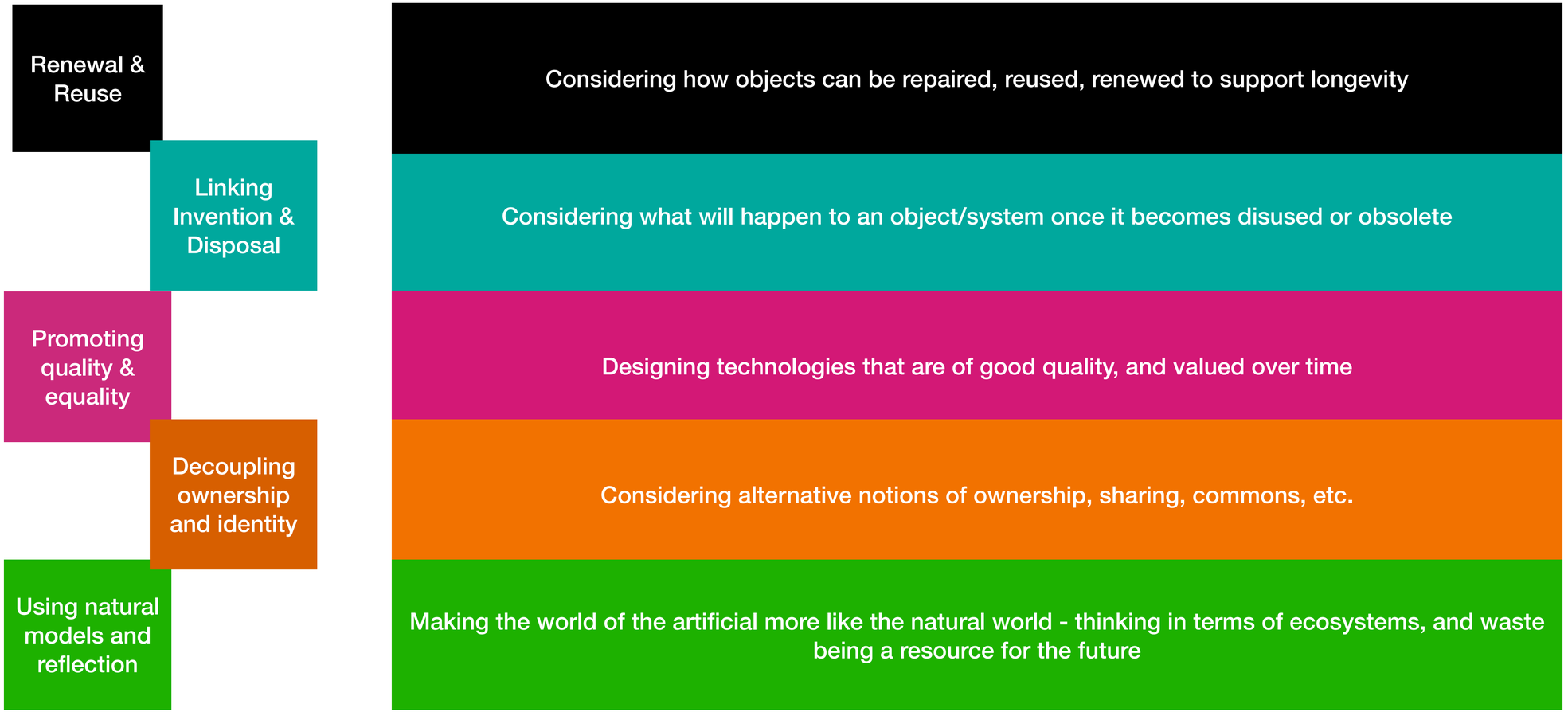
Most sustainable

Blevis, 2007

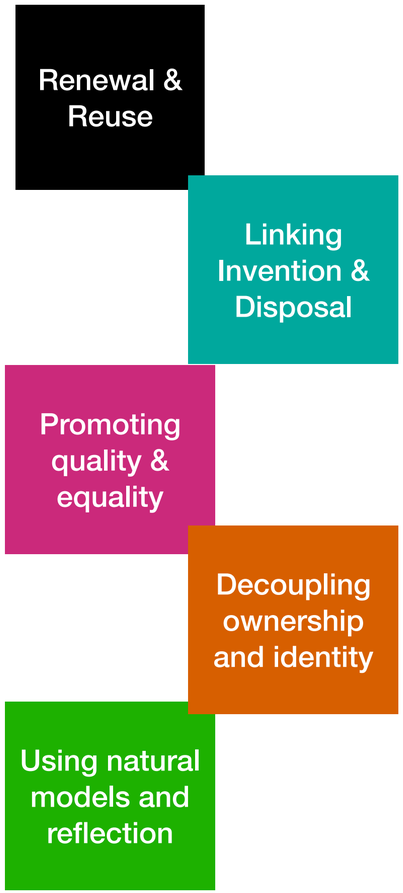
How to use a framework?

- Understanding the problem space
- Critiquing the status quo
- Considering futures

Sustainable Interaction Design Principles & Strategies



Sustainable Interaction Design Principles & Strategies



Refurbishment schemes

Takeback schemes

Designing modular components

Foreseeing the end of life from the beginning

Designing for heirloom quality

Valuing the old, rather than consuming the new

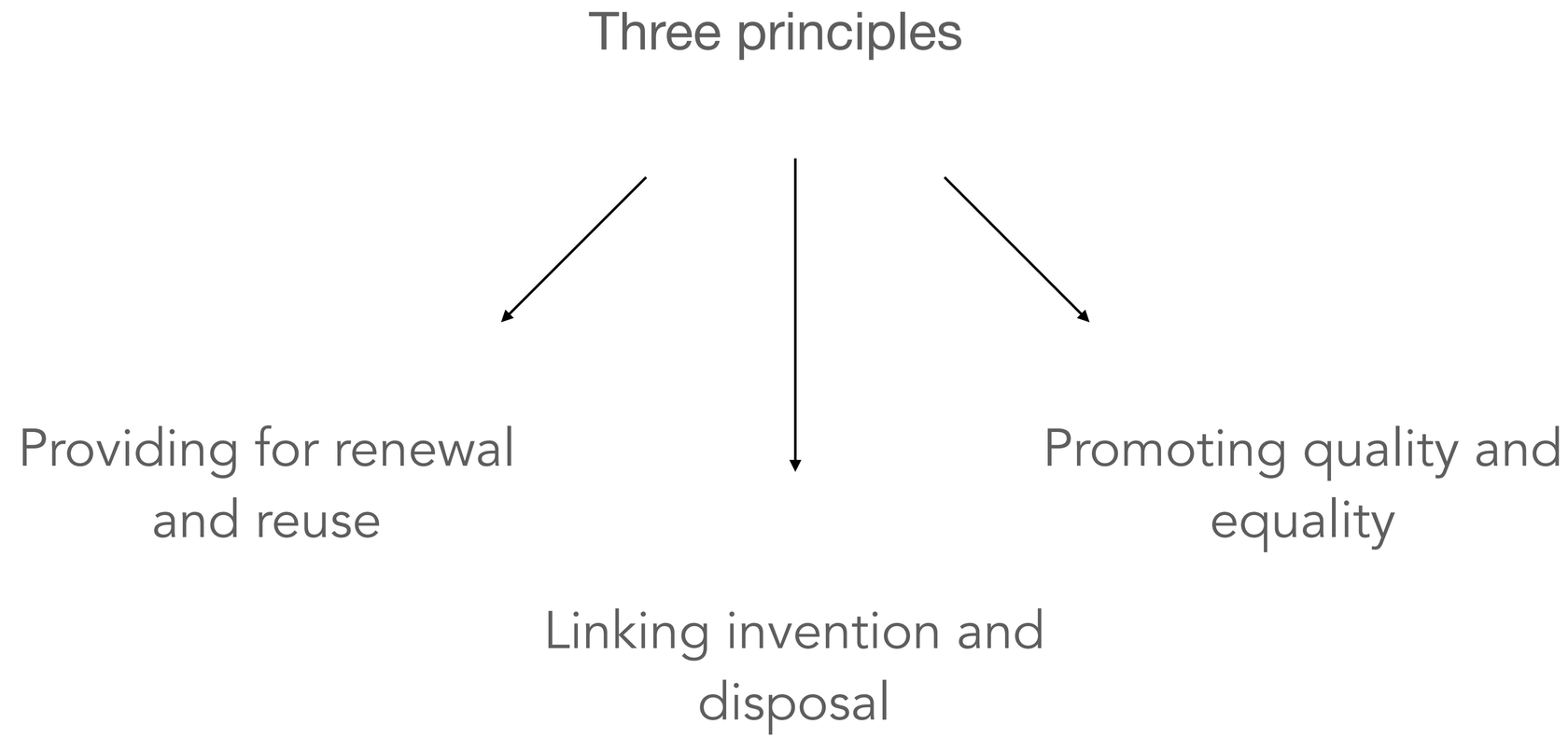
Designing for transfer of ownership

Using recycled/ recyclable materials

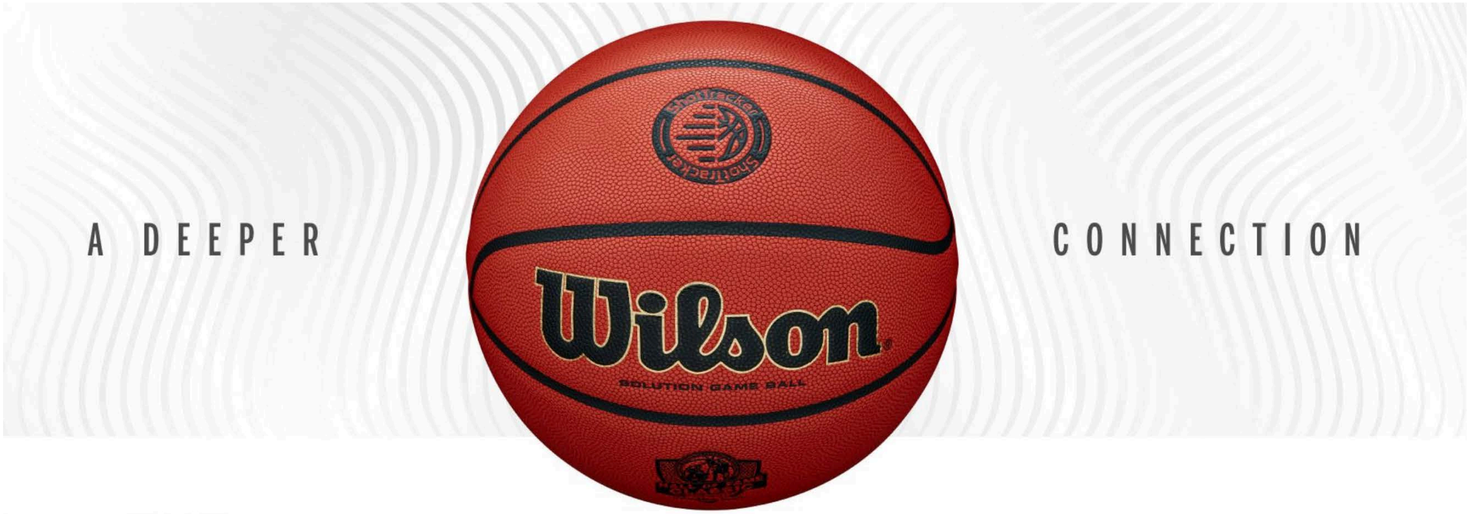
Making renewal/reuse of the device easy and convenient

Providing/guiding the owner to appropriate recycling infrastructures

Motivating the owner to make sustainable decisions

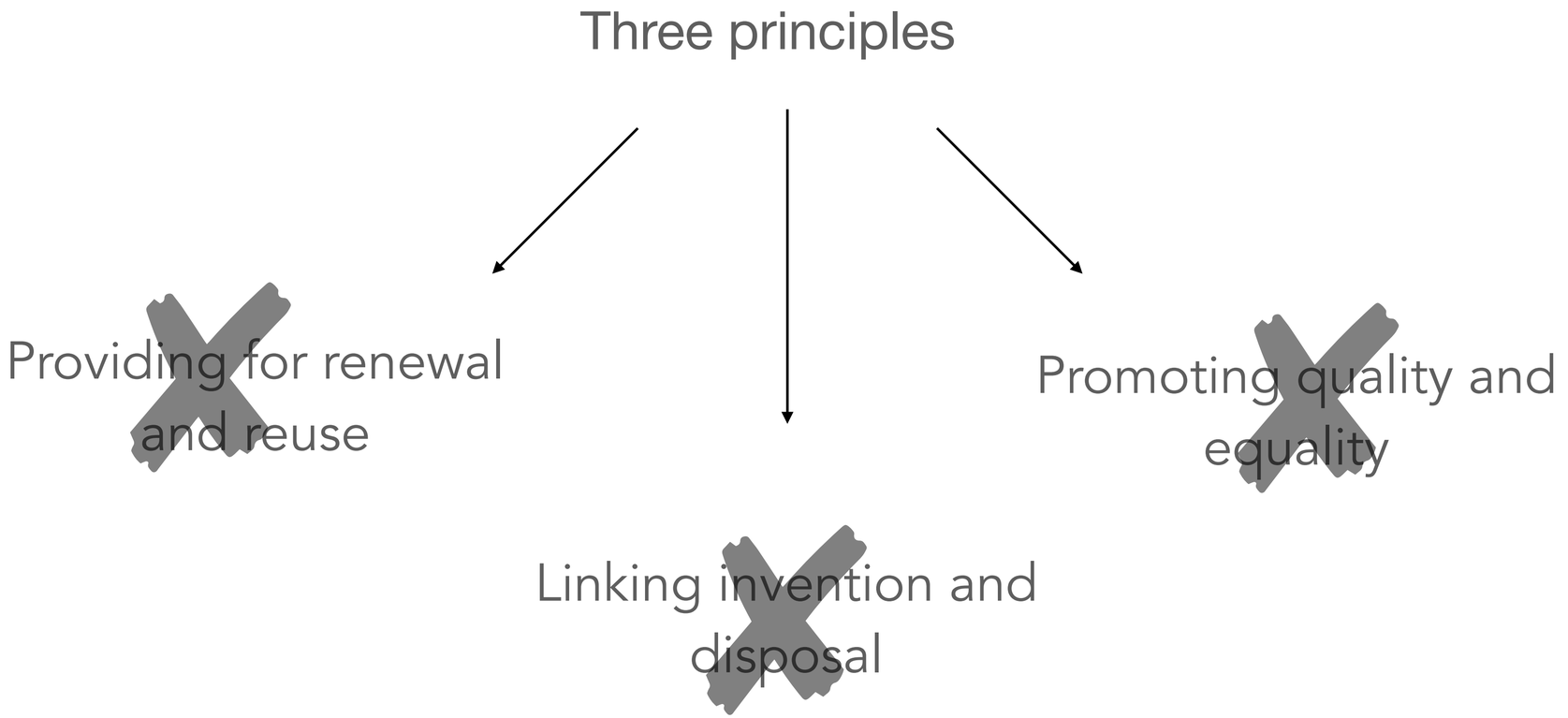

Three principles
Providing for renewal and reuse
Linking invention and disposal
Promoting quality and equality

Example 1: The Wilson Bluetooth Basketball



"The challenge of putting a replaceable battery inside without messing up performance was too great, leading the engineers who built it to throw up their hands and say, when the battery fails, so does the connectivity." [Higginbotham, 2018]

https://www.wilson.com/en-gb/explore/labs/basketball/wilson-x


Three principles
Providing for renewal and reuse
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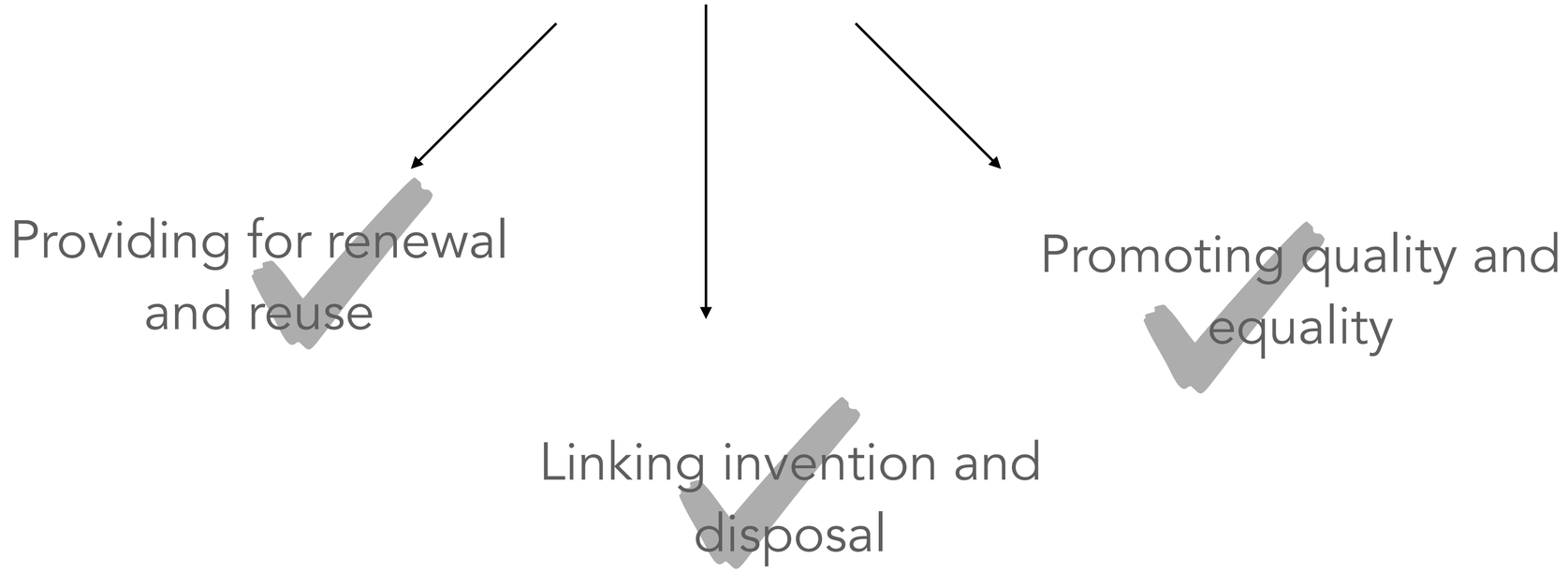
Example 2: The Fairphone

- Modular smartphone designed for sustainability
- Easily interchangeable modules to support upgrading/replacing parts to extend the lifespan of the phone
- Schemes to support recycling

https://www.fairphone.com/en/

To ensure sustainable “end of life” practices, the design of the product should account for:



The Fairphone: Some questions

- By design, it reaches a sustainably-minded audience -> would it work as well for other audiences?
- Modularity requires foresight to imagine future components. Constrains future design?

A few key takeaways:

- Sustainability requires systems thinking at the scale of:
  - Business models
  - Owners' needs and motivations
  - Broader culture and society
- Frameworks like Blevis' can help us critique existing products and help us think about how to design more sustainably in the future

Break time!

Student question! (Teams)

- Does sustainable design hinder creativity?

Role of Design Informatics & HCI

What can our field do to support system change?

- Understanding the problem space
- Designing better alternatives
- **Speculating on futures**
- **Educating stakeholders**

Design as Speculation:
Design Fiction & Spimes

What is a Design Fiction?

- It is an example of “speculative design” – approaches to design that attempt to ***explore future situations*** and scenarios
- It focuses on creating design concepts that “ask questions” rather than proposing clear solutions – it’s a way of iterating the development of technologies and to ***question the impacts*** technology-led developments may have on societies
- It asks you to situate your design concepts in the future, but focus on ***“mundane” and “everyday” situations*** – rather than fantastical, silly, overtly dramatic contexts
- It can provide a way to explore the ***unintended and unknown consequences*** of new, emerging and future technologies

What is a Design Fiction?

- It can be used as an **end-point** of a design project – e.g., you could create a set of design fiction materials that represent a future situation based on research you have done
- But it is most often used as part of a **step in a design process** – e.g., how people respond from your design fiction can inform a design iteration

Spimes and Design Fictions

- Near future
- Mundane and everyday situations (e.g., toaster, clothing iron)
- Intended to question the impact of current IoT and spark discussion about alternatives

Stead, M. R., Coulton, P., Lindley, J. G., & Coulton, C. (2019). The little book of sustainability for the Internet of Things.

Entry Points into Design Fictions

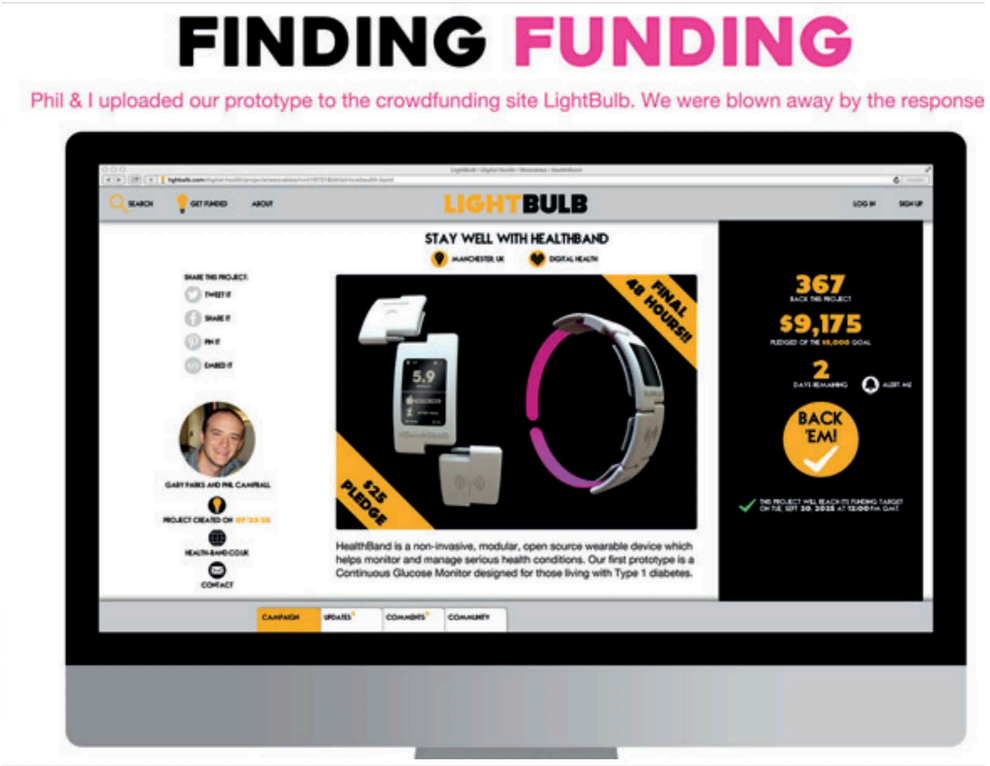
Support people in engaging with the issues a design fiction intends to surface

Examples:

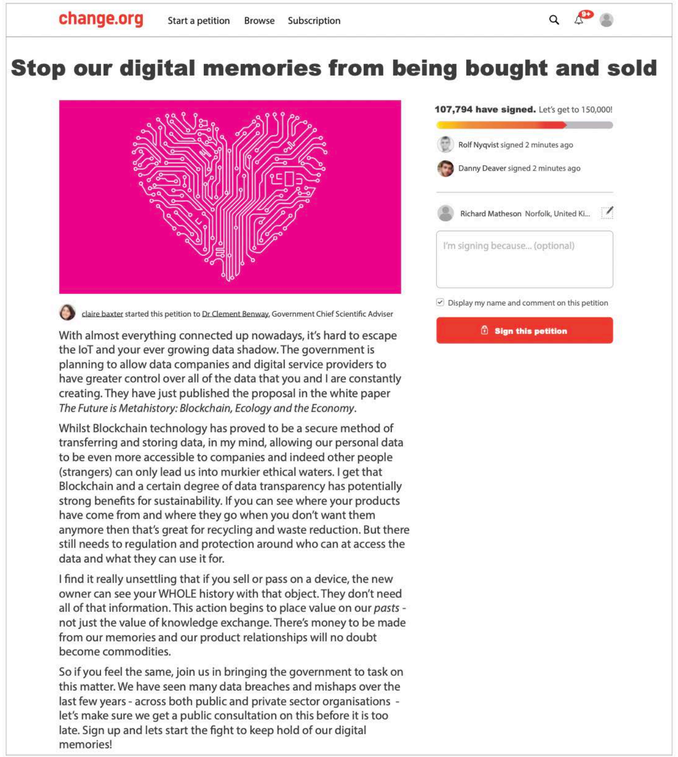
- A storyboard
- A written scenario
- A video
- Physical objects that represent a future system
- A range of objects and other materials that act as “entry points” to a future world where new systems exist

Entry points: What does a world of Spimes look like?

Images of future products



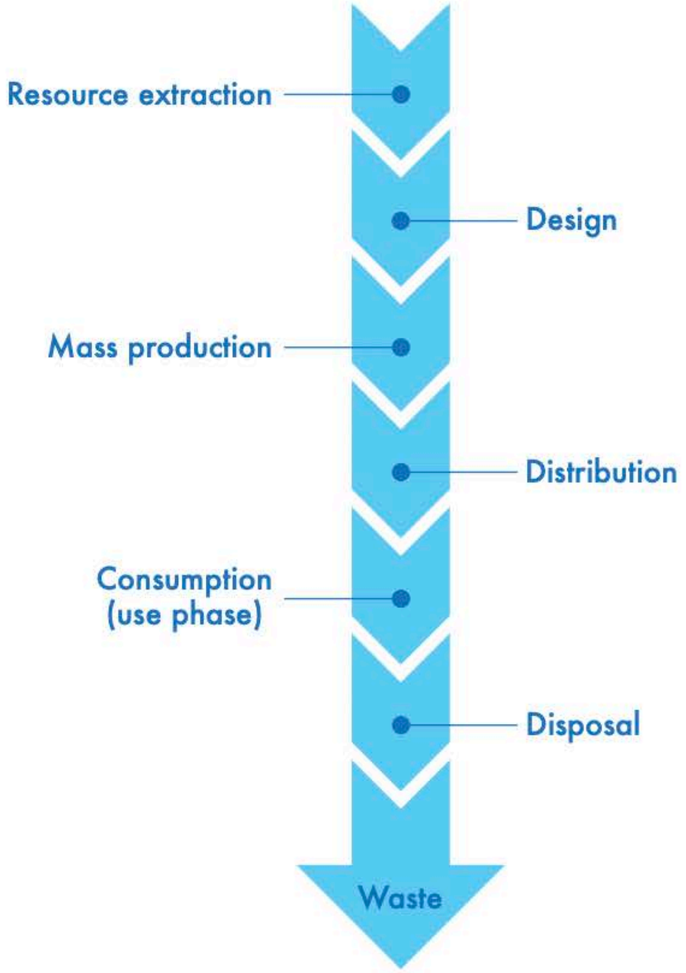
Crowdfunding campaigns



Petitions

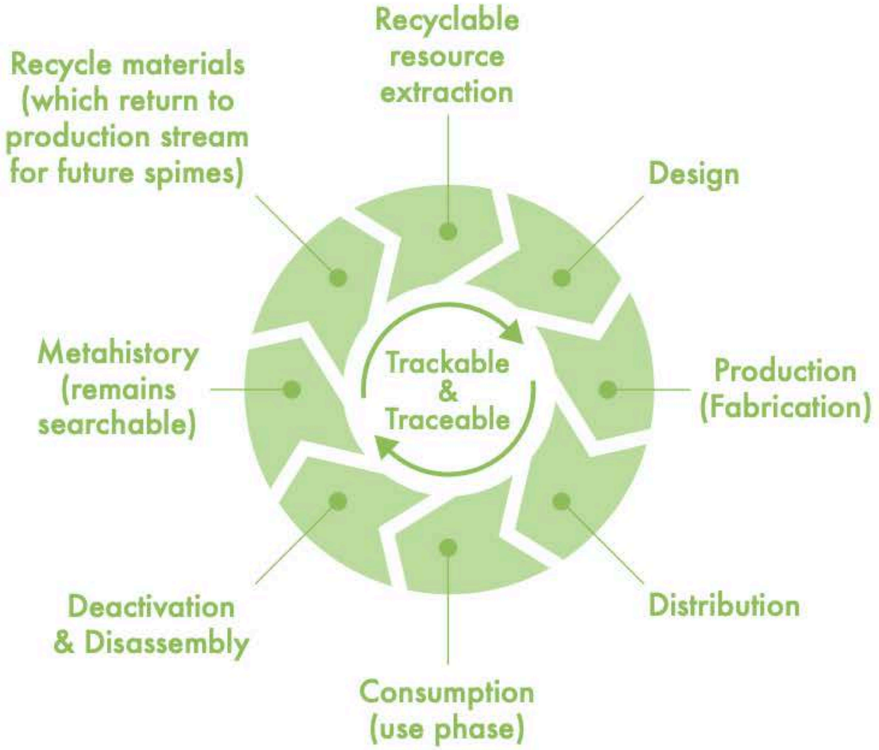
Stead, M. R., Coulton, P., Lindley, J. G., & Coulton, C. (2019). The little book of sustainability for the Internet of Things.

Lifespan of a Present Day IoT Device



Limited and unsustainable

Lifecycle of a Potential Near Future Spime Object



Cyclical and sustainable

Stead, M. R., Coulton, P., Lindley, J. G., & Coulton, C. (2019). The little book of sustainability for the Internet of Things.

What is a Spime?

- Spime: “space” and “time”
- Physical object together with informational support to make industrial, distribution and consumption processes visible, obvious, and potentially, more sustainable

Stead, M. (2017). Spimes and speculative design: Sustainable product futures today. *Strategic Design Research Journal*, *10*(1), 12-22.

Sterling, B. (2005). 2005. Shaping Things. Cambridge, MIT Press, 144 p.

What do Spimes question?

Toaster for Life

"The 'mass produced' toaster's design integrates features which enable its users to effectively repair it, upgrade it, customise it, and recycle it, while all of the device's parts and components are inherently trackable."

Stead, M. R., Coulton, P., Lindley, J. G., & Coulton, C. (2019). The little book of sustainability for the Internet of Things.

What do Spimes question?

Business models and behaviours:

- Shift to business models without ***planned obsolescence*** (the practice of building products that are designed to break, or be used only for a short period of time)
- Involving consumers more actively in repair
- Sustainability links: longer lifecycles, renewal and repair

Stead, M. R., Coulton, P., Lindley, J. G., & Coulton, C. (2019). The little book of sustainability for the Internet of Things.

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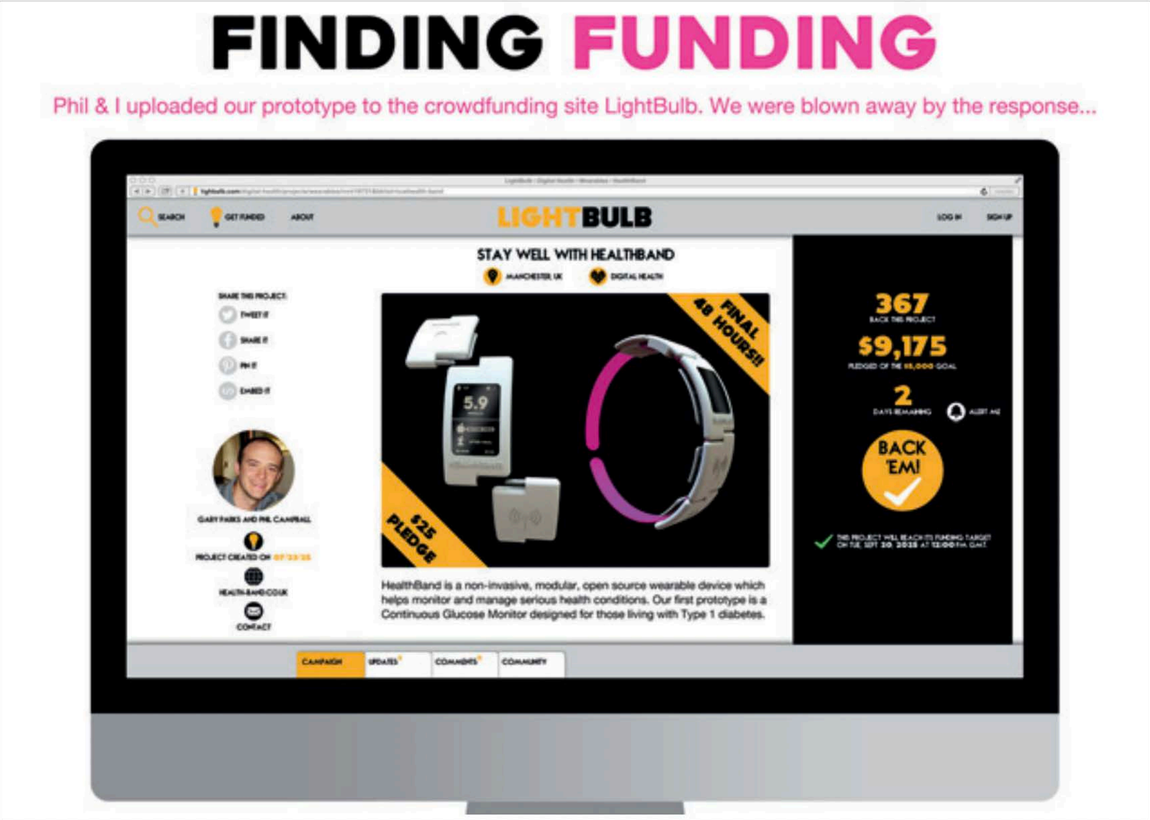
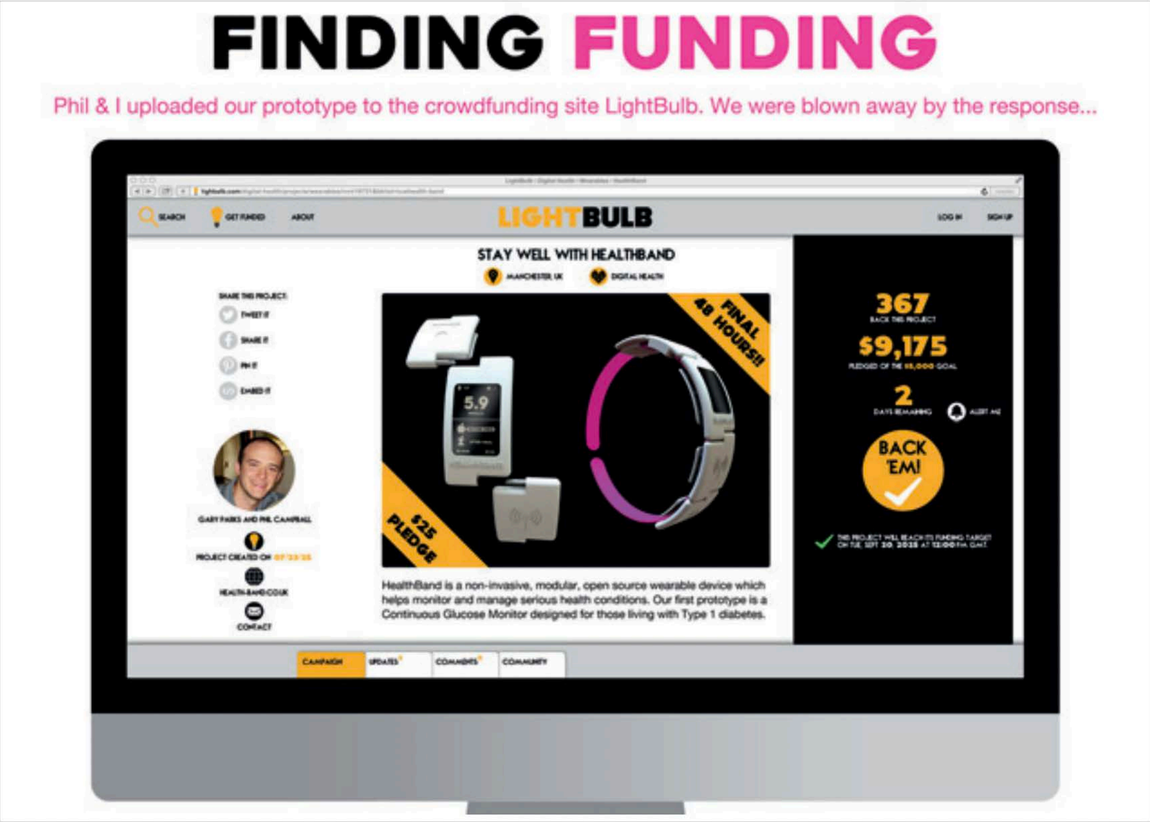


Health Band

A provocation about a DIY medical wearable device that integrates open source hardware, crowdfunding and the maker movement. People can snap in health modules that are tailored to their needs (e.g., a Dementia memory care module, Parkinson's stabiliser module or Diabetes monitor)

Stead, M. R., Coulton, P., Lindley, J. G., & Coulton, C. (2019). The little book of sustainability for the Internet of Things.

What do Spimes question?



Policy and innovation

- What types of legislation would need to be developed to accommodate and nurture decentralised and democratised IoT design culture?
- How could this allow for localised production while maintaining adequate product safety and quality standards?
- Sustainability links: local production, interchangeable components, knowledge sharing

Stead, M. R., Coulton, P., Lindley, J. G., & Coulton, C. (2019). The little book of sustainability for the Internet of Things.

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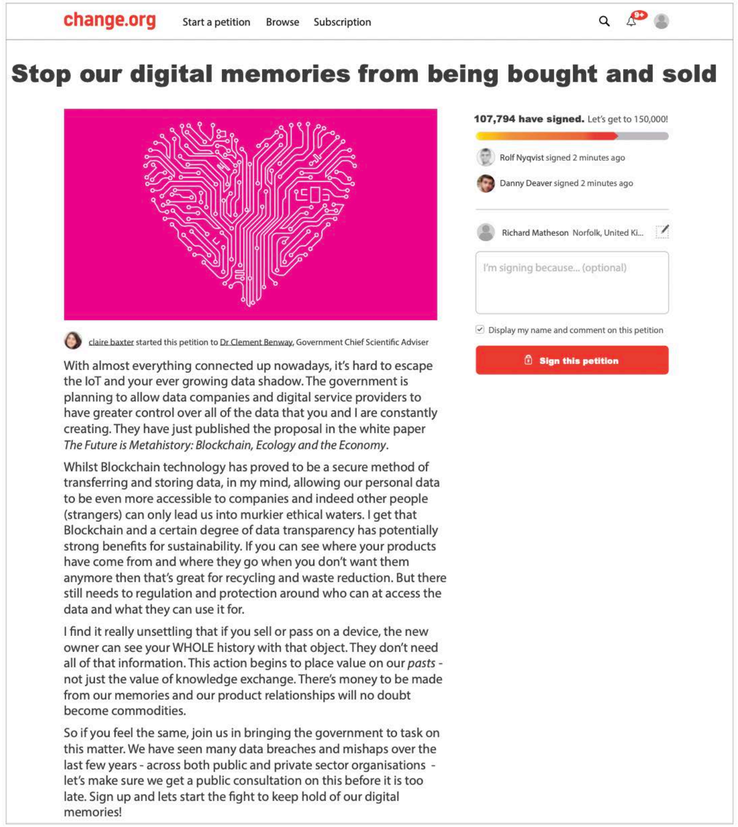

change.org Start a petition Browse Subscription

Stop our digital memories from being bought and sold

107,794 have signed. Let's get to 150,000!

Rolf Nyqvist signed 2 minutes ago

Danny Deaver signed 2 minutes ago

Richard Matheson Norfolk, United Ki...

I'm signing because... (optional)

Display my name and comment on this petition

Sign this petition

claire baxter started this petition to Dr Clement Benway, Government Chief Scientific Adviser

With almost everything connected up nowadays, it's hard to escape the IoT and your ever growing data shadow. The government is planning to allow data companies and digital service providers to have greater control over all of the data that you and I are constantly creating. They have just published the proposal in the white paper *The Future is Metahistory: Blockchain, Ecology and the Economy*.

Whilst Blockchain technology has proved to be a secure method of transferring and storing data, in my mind, allowing our personal data to be even more accessible to companies and indeed other people (strangers) can only lead us into murkier ethical waters. I get that Blockchain and a certain degree of data transparency has potentially strong benefits for sustainability. If you can see where your products have come from and where they go when you don't want them anymore then that's great for recycling and waste reduction. But there still needs to regulation and protection around who can at access the data and what they can use it for.

I find it really unsettling that if you sell or pass on a device, the new owner can see your WHOLE history with that object. They don't need all of that information. This action begins to place value on our *pasts* - not just the value of knowledge exchange. There's money to be made from our memories and our product relationships will no doubt become commodities.

So if you feel the same, join us in bringing the government to task on this matter. We have seen many data breaches and mishaps over the last few years - across both public and private sector organisations - let's make sure we get a public consultation on this before it is too late. Sign up and lets start the fight to keep hold of our digital memories!

The Future is Metahistory

Explores the concept of future devices that generate and store data about their provenance and use. This includes data about when they have been used, how much energy they have used throughout their lifecycle, and what materials they are made of.

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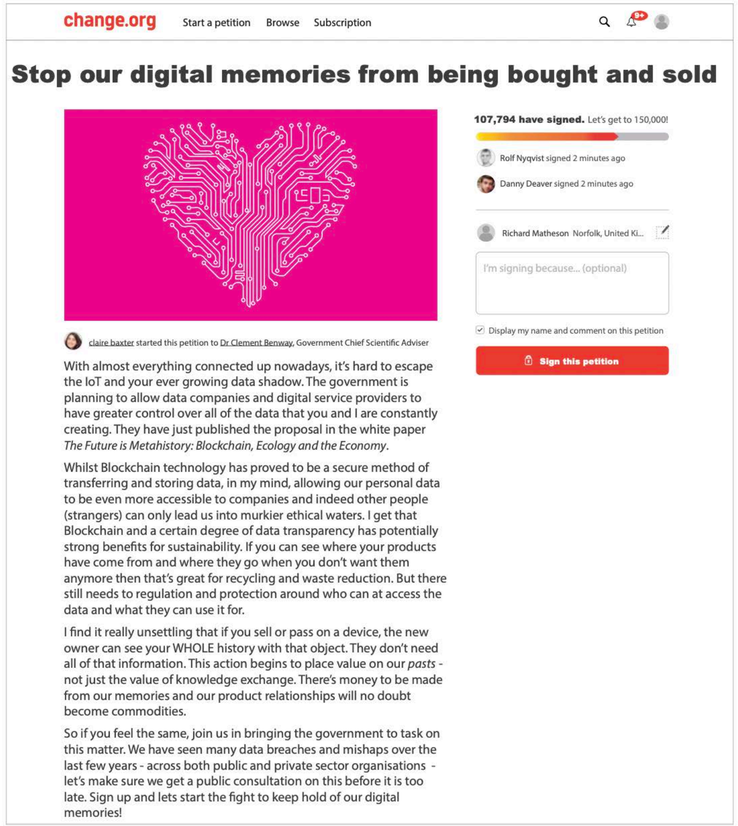

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Ethics and ownership

- What are tradeoffs between openness and transparency and personal data?
- Is storing so much data over time sustainable?
- Sustainability links: openness and transparency about materials and device use

Stead, M. R., Coulton, P., Lindley, J. G., & Coulton, C. (2019). The little book of sustainability for the Internet of Things.

Spimes: Final remarks

- Not aimed to be solutionist
- Looking into a possible future
- Questioning what issues might arise
- Thinking about the broader system that influences the lifecycle of a technology

Stead, M. R., Coulton, P., Lindley, J. G., & Coulton, C. (2019). The little book of sustainability for the Internet of Things.

Student question!

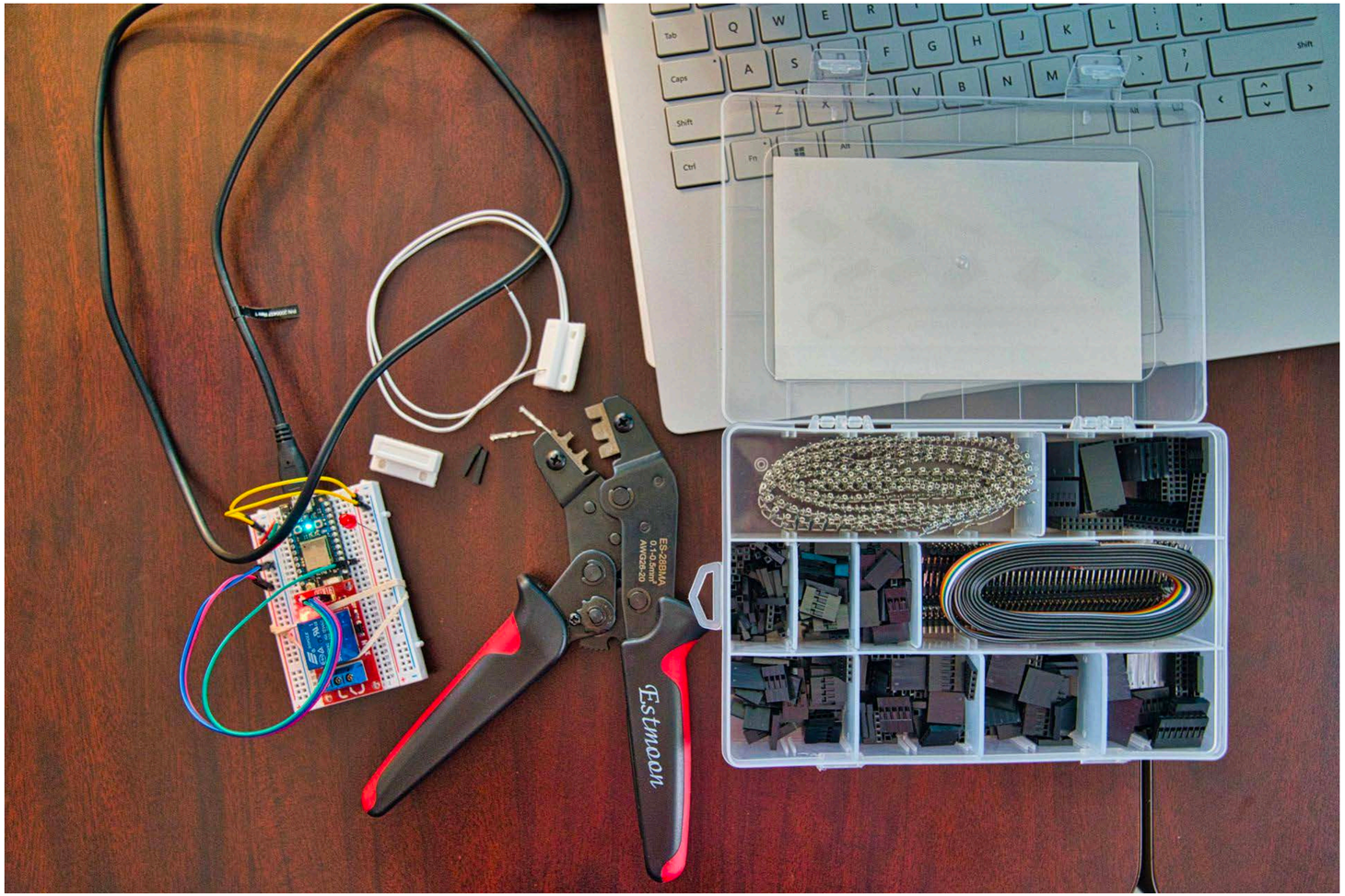
- Don’t Spimes raise issues in terms of data generation and privacy?

Reflecting on Spimes in context of sustainability

https://miro.com/app/board/uXjVNdQg3x0=/?share_link_id=552010586037

Fixing the Future project

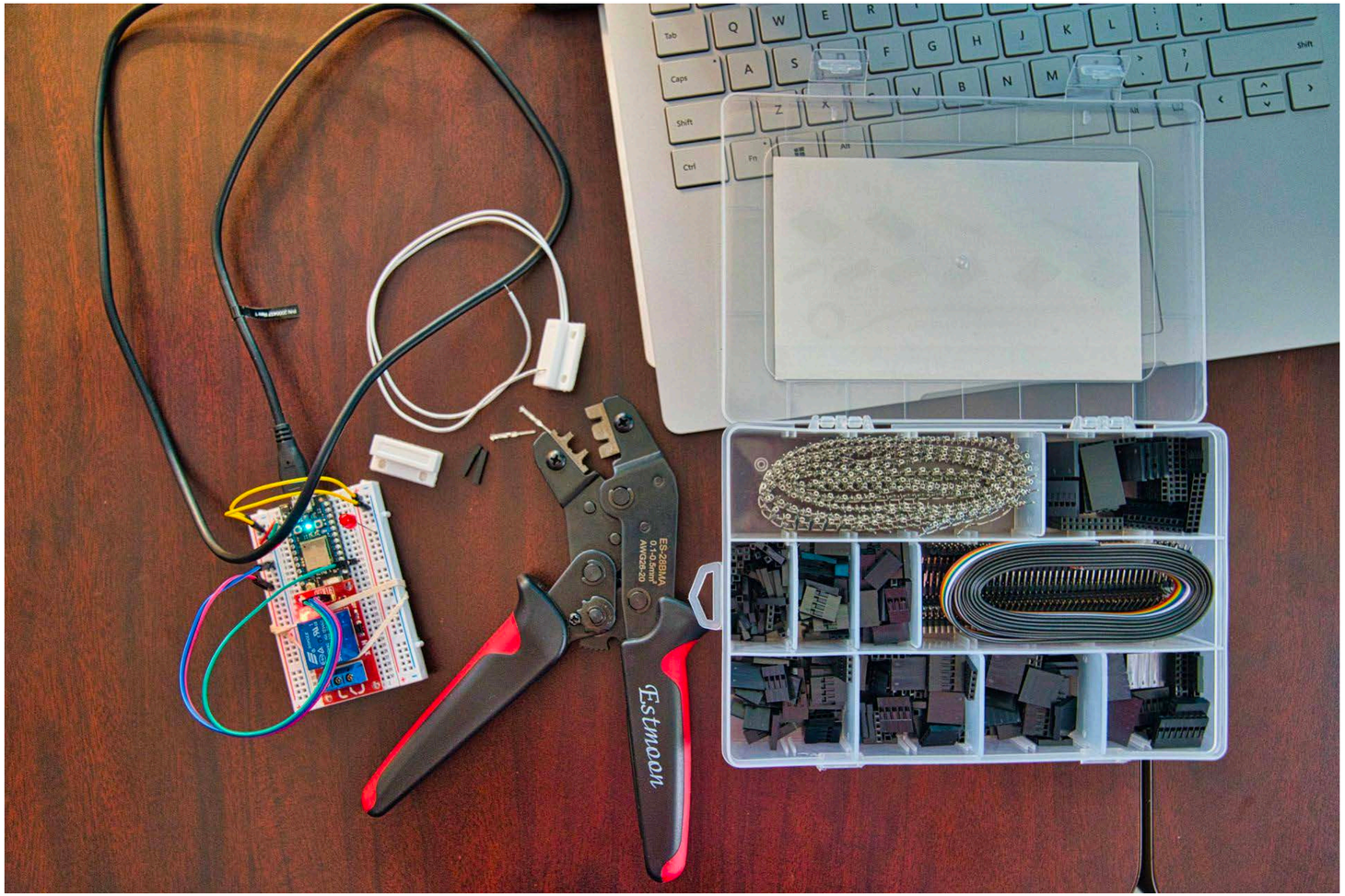
Investigating how to support equity, inclusion and sustainability in the digital economy through supporting repairability in the consumer Internet of Things (IoT)



https://ftf.wp.horizon.ac.uk/

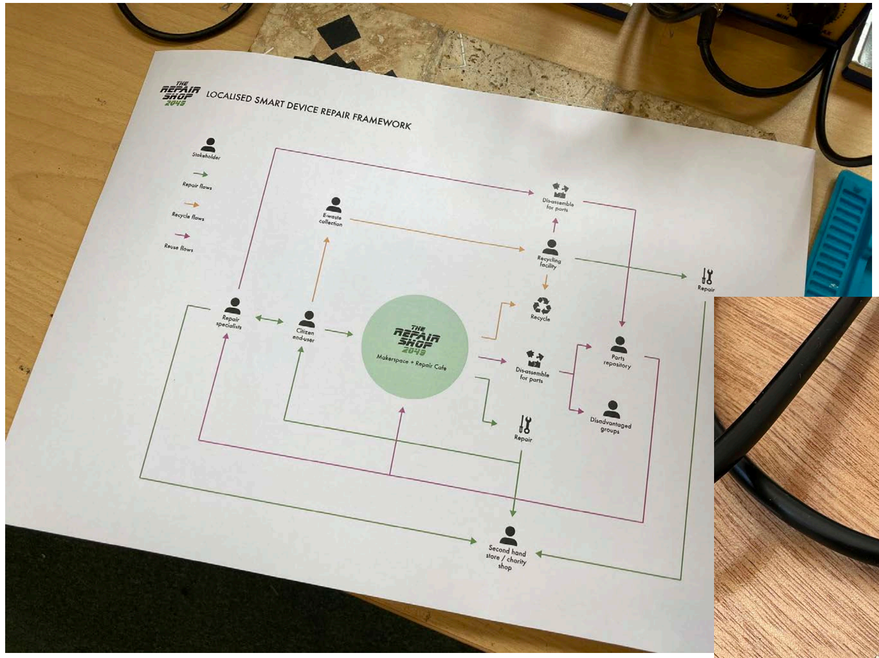
Stakeholders

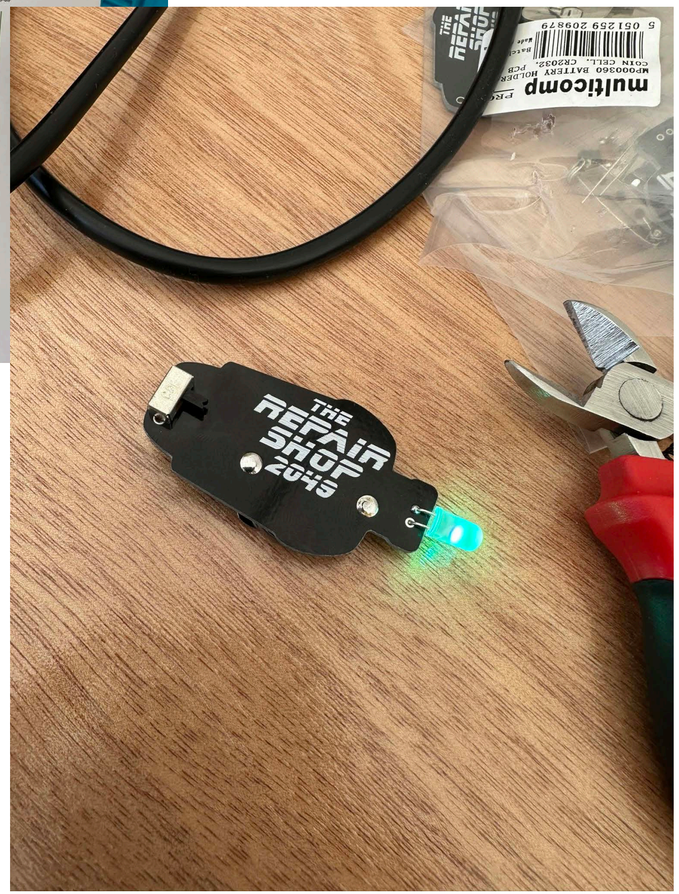
- **Repair cafes:**
  What challenges do they face when repairing IoT products?
- **Device owners:**
  How to support repair knowledge in the community?
- **Designers and manufacturers:**
  How to navigate the legal landscape of repair
- **Policymakers:**
  How can design be better regulated to support IoT repairability?



Repair Shop 2049

- What might a repair shop look like in 25 years?
- How can we support communities in learning about repair, in relation to IoT?

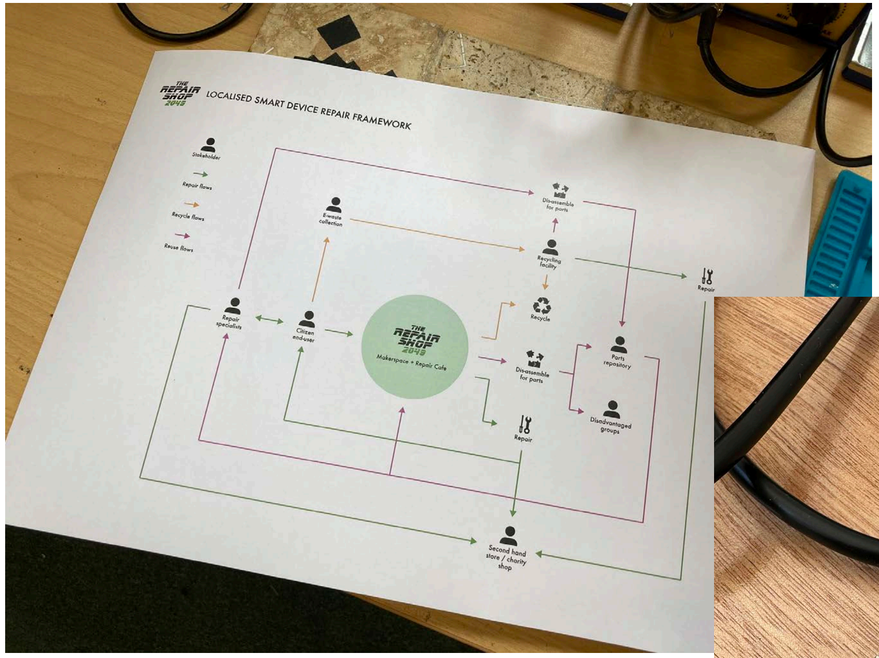


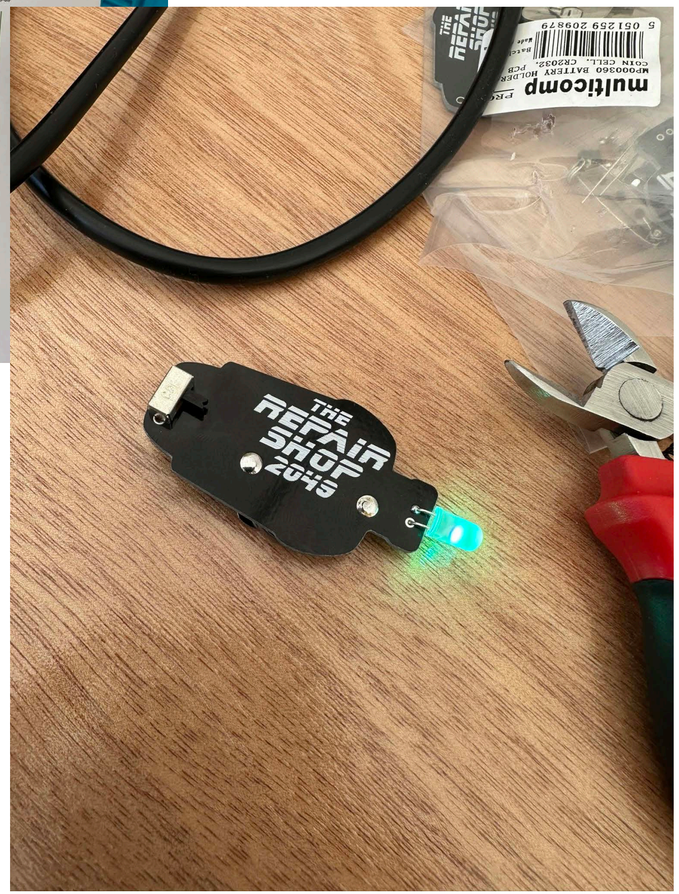


Work led by Michael Stead, https://www.lancaster.ac.uk/news/fixing-the-future-for-smart-devices-the-repair-shop-2049-team-at-bluedot

Repair Shop 2049

- Community-focussed design work
- In collaboration with the Blackburn Making Rooms
- Development of paper-based activities
- Development of introductory repair activities (e.g., learning basic soldering skills)





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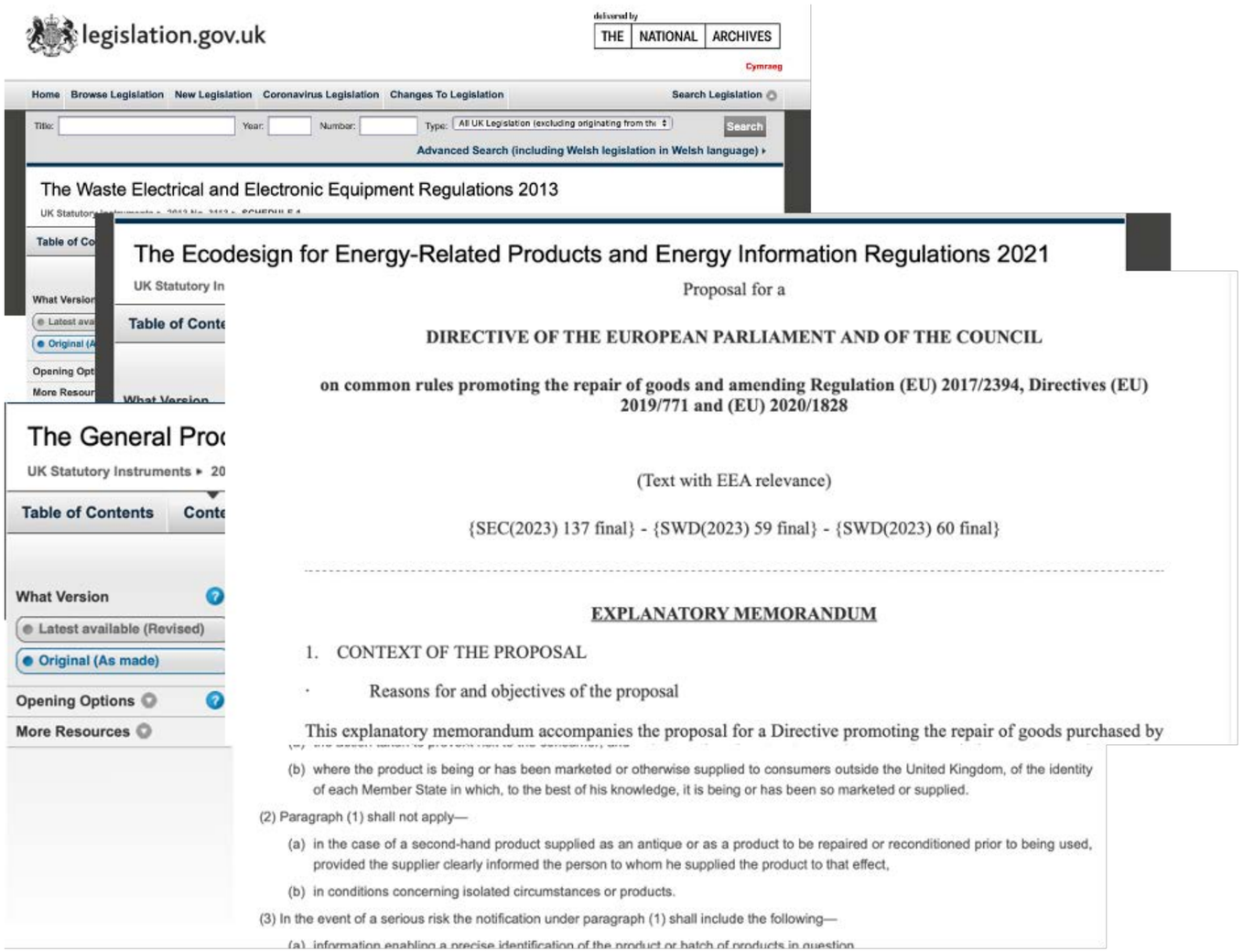
Translating Legal Frameworks for Designers

- IoT device designers are not lawyers.
- And legislation surrounding consumer rights, manufacturer obligations, and industry standards have undergone many changes and additions in the recent past.
- They are also expected to be updated moving forward.



Work led by Christopher Boniface, Nidhi Dubey, Anna Rezk and Lachlan Urquhart

Translating Legal Frameworks for Designers

-> developing a "law-to-design" card deck.

- This aims to simplify the various legal frameworks into a digestible form for product designers.
- The goal is to foster the future design of more repair-friendly and sustainable IoT products.

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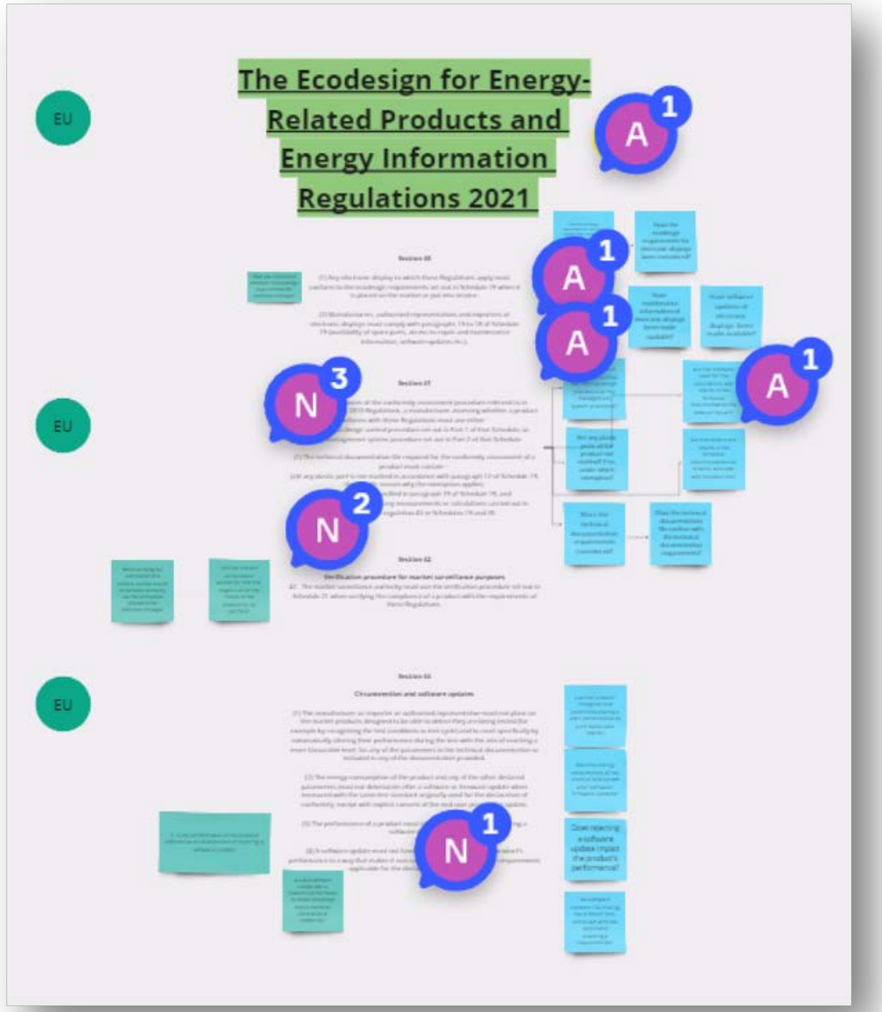
Translating Legal Frameworks for Designers



OBLIGATIONS

Lifecycle stage	High-level category	Miro prompts (long)	Miro prompts (short)	Refined prompts
Before	Design conformity	Have you ensured that an authorised representative has carried out an assessment of the product's conformity with all the relevant requirements of the applicable implementing	Has an assessment of the product's conformity with all the relevant requirements been carried out?	How is the product's compliance with relevant requirements being assessed?

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Key takeaways

- Design has a role in innovating more sustainable technologies
- But also in supporting conversations about sustainability
- …And in supporting other people’s understandings of sustainability
- Many ways to do this - e.g., design fictions and design toolkits

Tasks for next week:

1. **Preparation for next week:**

   - *Read*: Cárdenas Gasca, A. M., Jacobs, J. M., Monroy-Hernández, A., & Nebeling, M. (2022, June). AR Exhibitions for Sensitive Narratives: Designing an Immersive Exhibition for the Museum of Memory in Colombia. In *Designing Interactive Systems Conference* (pp. 1698-1714). https://dl.acm.org/doi/pdf/10.1145/3532106.3533549

   - *Watch*: the short video here: https://www.commarts.com/project/11275/the-whole-story-project-ar-app

2. **Complete your Class Notebook submission in MS Teams**

Further Reading

- Stacey Higgenbotham (2018). The Internet of Trash: IoT has a Looming E-Waste Problem. IEEE Spectrum
- Eli Blevis (2007). Sustainable Interaction Design: Invention & Disposal, Renewal & Reuse. ACM CHI
- Eli Blevis (2006) Advancing sustainable interaction design: two perspectives on material effects. Design philosophy papers 4, no. 4 (2006): 209-230.
- Vanessa Forti et al. (2020) The Global E-waste Monitor 2020. https://www.itu.int/en/ITU-D/Environment/Documents/Toolbox/GEM_2020_def.pdf
- Mankoff, J. C et al. (2007. Environmental sustainability and interaction. ACM CHI
- Stead, M. R., Coulton, P., Lindley, J. G., & Coulton, C. (2019). The little book of sustainability for the Internet of Things.
- UN Report: Time to seize opportunity, tackle challenge of e-waste. (2019) https://www.unenvironment.org/news-and-stories/press-release/un-report-time-seize-opportunity-tackle-challenge-e-waste
- Cross, J., & Murray, D. (2018). The afterlives of solar power: Waste and repair off the grid in Kenya. Energy research & social science, 44, 100-109.
- https://ftf.wp.horizon.ac.uk/