Case Studies in Design Informatics 1 - INFR11094
Week 6 – 21st October 2024

Connected Devices and Sustainability

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Considerations for using LLMs and AI in your own work

- You might be inspired to use LLMs/AI in your own design process
- Do not use AI to simply generate a response to your assignment and submit this as your own work - this is regarded as academic misconduct (see [1] for UoE guidelines)
- Check terms of service for Generative AI tools - there may be limitations on how their output can be used
- **Always acknowledge the use of Generative AI**! Which tools did you use and how?

[1] https://registryservices.ed.ac.uk/sites/default/files/2024-10/Generative%20AI%20Guidance%20for%20Students%20October%202024.pdf

Guiding questions

- What other tools might I use to support this part of the creative process? (Example: Flickr Commons vs. Midjourney)
- What are the limitations of Generative AI & the dangers of relying on it in this context (e.g., trust, bias, originality?)
- What are the relative benefits and risks/implications of using it? (e.g., better output vs. environmental implications, potential of bias)

Tasks for the next 7 days:

1. Your prep work for next week's lecture
    i. Watch this!: https://www.youtube.com/watch?v=xy9yxeaFP74
    (this is a very short and simple introduction to what Blockchains are)
    ii. And this!: https://www.youtube.com/watch?v=SSo_EIwHSd4
    (which is a slightly more detailed description of how Blockchains work)
    iii. And possibly this … https://www.youtube.com/watch?v=QJn28fFKUR0
    (which, though it says it's simple, is quite detailed but has some useful examples)
    iv. Then read this!: Chris Elsden, Inte Gloerich, Anne Spaa, John Vines, and Martijn de Waal. 2019. Making the blockchain civic. Interactions 26, 2 (March - April 2019), 60–65. https://doi.org/10.1145/3305364
    (a text with some authors you may know that relates Blockchains to design issues)
    OR: watch this: https://youtu.be/3hgU4gudHf8?si=8zqs2kcAz7880CZW
    (a video that discusses some similar ideas)

2. Complete your Class Notebook submission with questions as usual

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In today's lecture…

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)
    - Design to support others in understanding sustainability (Fixing the Future project)

1. Exploring the issue of sustainability in context of connected devices

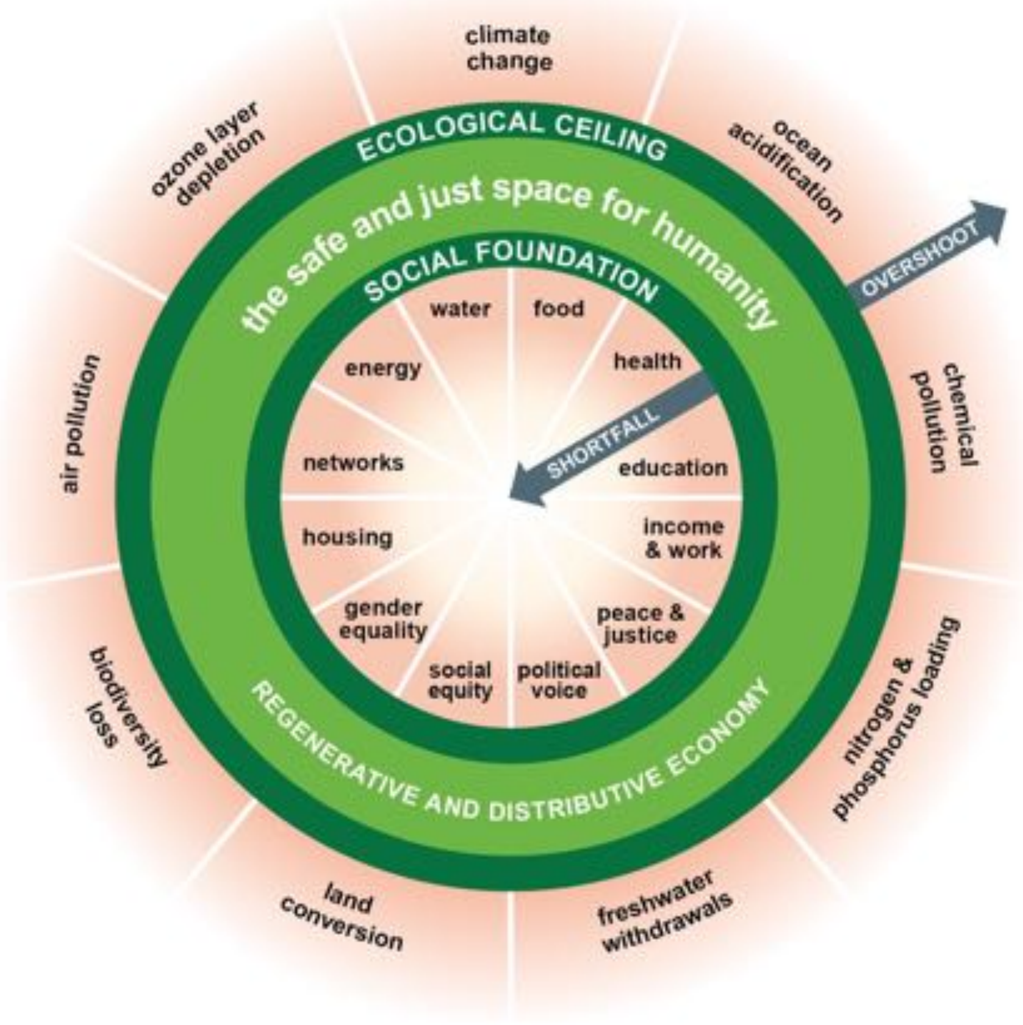
What does sustainability mean to you?

https://miro.com/app/board/uXjVLQyNK4c=/?share_link_id=955983838917

UN Sustainable Development Goals: improving the lives of populations around the world and mitigating the hazardous man-made effects of climate change.

Triple Bottom Line

Image: https://uwex.wisconsin.edu/



Doughnut Economics

Image: https://doughnuteconomics.org/

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

Image credit: Little Printer

Image credit: Wilson

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Image credit: Dzone

Image credit: Little Printer

Image credit: Wilson

The issue of electronic waste (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

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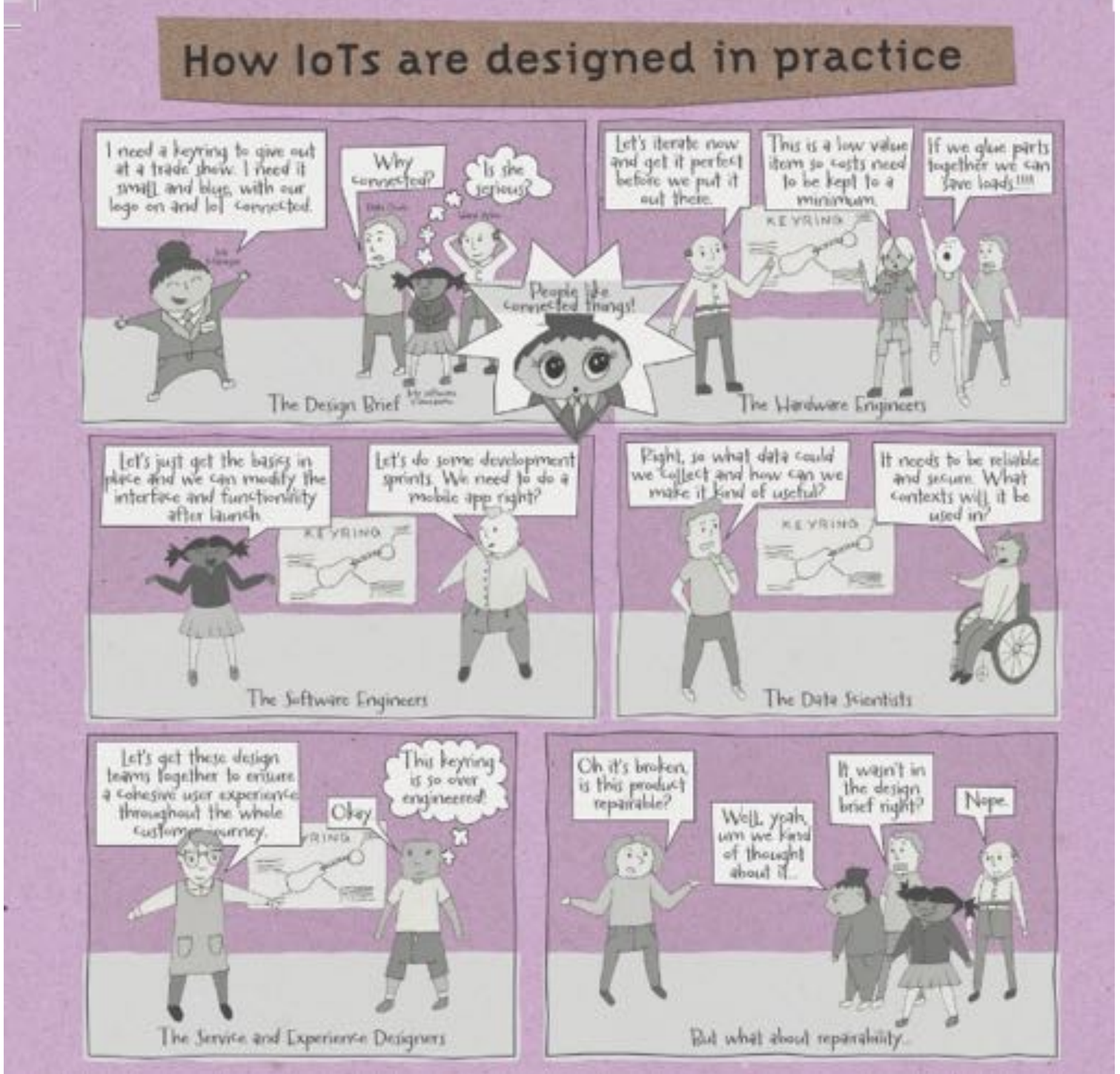
4. Difficulties in repair



Owen, Violet, et al. "What Might a More Sustainable Internet of Things Look Like?" Zine 2024: Fixing the Future Collective." (2024). https://sflab.eecs.kth.se/pub/pj7s6ahe/release/6

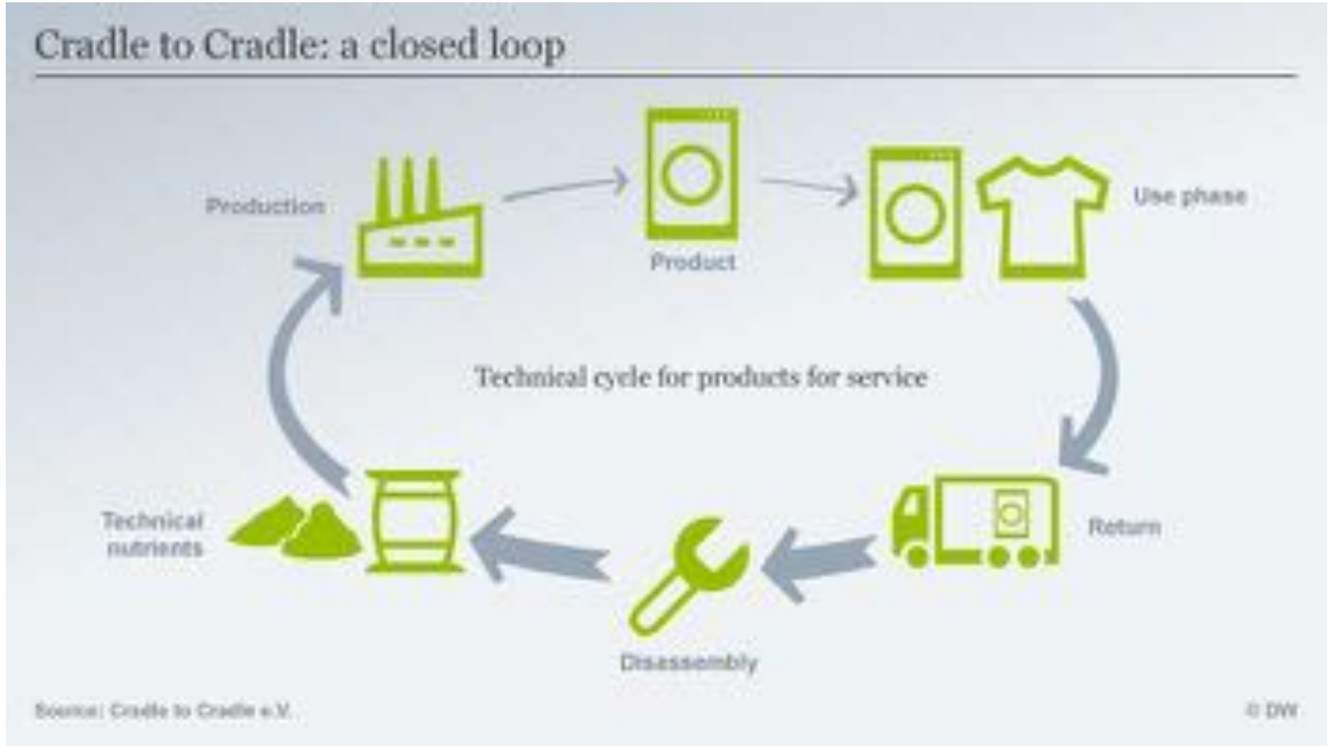
Student question!

What is the difference between the sustainable design of a conventional object and an IoT object?

Relevance to Design Informatics

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

In an ideal world…

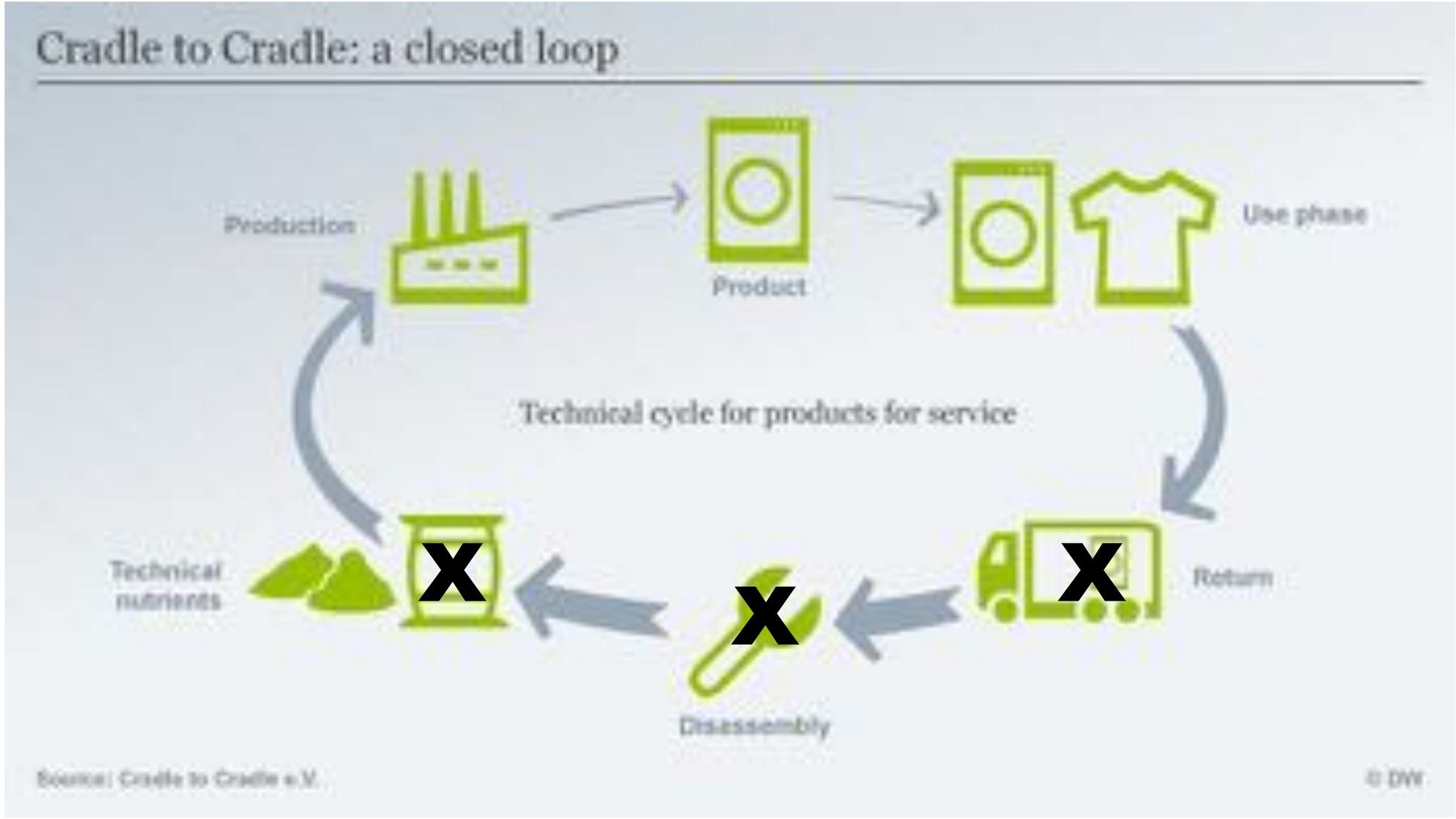


https://www.dw.com/en/cradle-to-cradle-living-in-a-world-without-waste/a-43740165

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…


Cradle to Cradle: a closed loop
Production
Product
Use phase
Technical cycle for products for service
Technical nutrients
Return
Disassembly
Source: Cradle to Cradle e.V.
© DW

2. Introducing frameworks for sustainable interaction design

How to use a framework?

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

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

Eli Blevis. 2007. Sustainable interaction design. https://doi.org/10.1145/1240624.1240705

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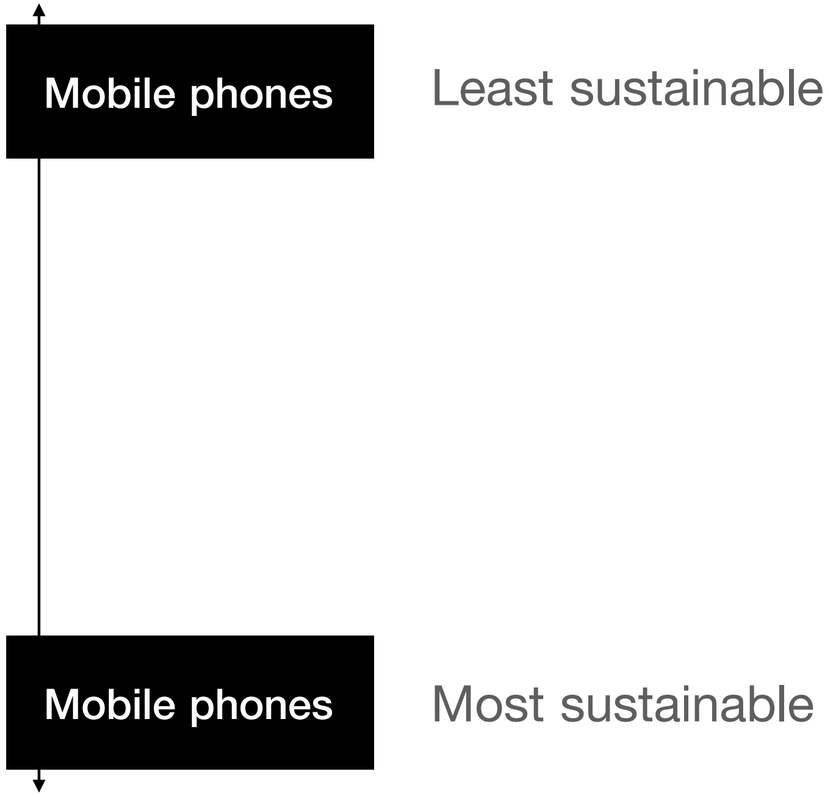

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Sustainable Interaction Design Principles & Strategies

Renewal and Reuse: Considering how objects can be repaired, reused, renewed to support longevity

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Linking Invention and Disposal: Considering what will happen to an object/system once it becomes disused or obsolete

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Using Natural Models and Reflection: Making the world of the artificial more like the natural world - thinking in terms of ecosystems, and waste being a resource for the future

Eli Blevis. 2007. Sustainable interaction design. https://doi.org/10.1145/1240624.1240705

A few examples…

"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

A few examples…

- x Renewal and Reuse
- x Linking Invention and Disposal
- ? Promoting Quality & Equality
- x Decoupling Ownership and Identity
- x Using Natural Models and Reflection

Eli Blevis. 2007. Sustainable interaction design. https://doi.org/10.1145/1240624.1240705

A few examples…

- 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/

A few examples…

- ✓ Renewal and Reuse
- ✓ Linking Invention and Disposal
- ✓ Promoting Quality & Equality
- x Decoupling Ownership and Identity
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https://www.fairphone.com/en/

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A few examples…

- Renewal and Reuse
- Linking Invention and Disposal
- ✓ Promoting Quality & Equality
- ✓ Decoupling Ownership and Identity
- Using Natural Models and Reflection

Designing for heirloom quality

Eli Blevis. 2007. Sustainable interaction design. https://doi.org/10.1145/1240624.1240705

A few examples…

- Renewal and Reuse
- Linking Invention and Disposal
- Promoting Quality & Equality
- ✓ Decoupling Ownership and Identity
- Using Natural Models and Reflection

Designing for transfer of ownership

Eli Blevis. 2007. Sustainable interaction design. https://doi.org/10.1145/1240624.1240705

Student questions...

- Technology is growing so rapidly I think it is close to impossible to build something that will cater for decades.
- The author points out that IoT products are made from cheap, disposable materials and aren't designed for repair or recycling, leading to electronic waste when new versions come out. Does defining a long-term product model from the outset risk limiting innovation by restricting future design improvements?

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

Student questions…

- Could designs which go against consumer buying habits, lower the user experience and purchase rates?
- Given that many companies have a financial/profit-driven interest in making their products not last as long as their materials theoretically could, how do we go about encouraging repairability?

: https://uwex.wisconsin.edu/

Student questions…

- IoT projects usually require the joint participation of multiple roles, such as designers, engineers, data analysts, and users. Is it our responsibility as designers to enable these roles to collaborate together?

Design for sustainability is a “wicked problem"

- **Wicked problems:** problems with many interdependent factors making them seem impossible to solve, requiring deep understanding of systems and stakeholders involved
- E.g., 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? How can a sustainable model be profitable?
- What incentivises companies to move toward more sustainable models? E.g., legislation?

A few key takeaways:

- Sustainability requires systems thinking at the scale of:
  - Business models
  - Legal obligations
  - 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

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

Role of Design Informatics & HCI

What can our field do to support system change?

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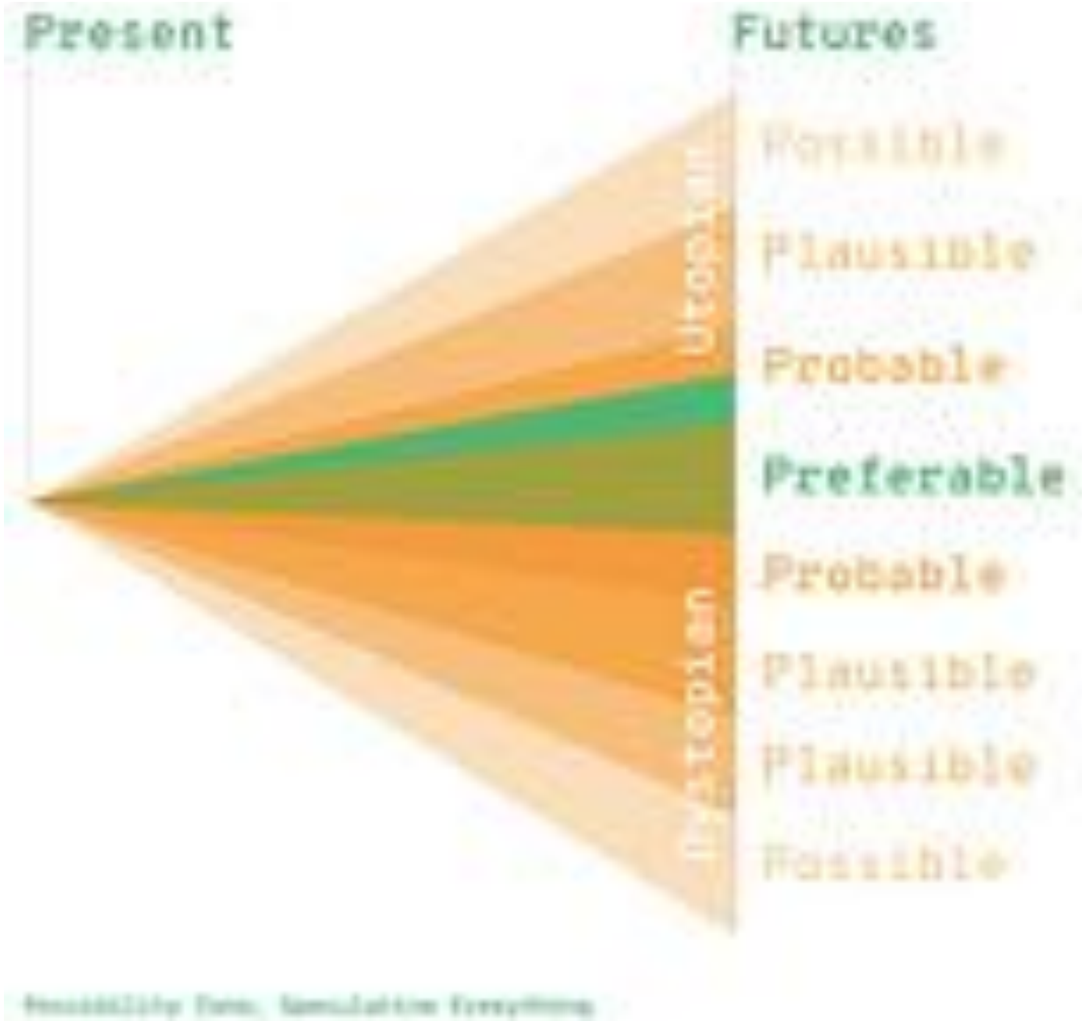
3. Design fictions for speculating on futures

Futures Cone



Dunne and Raby. 2013. Speculative Everything.

Probable: current trends and developments that are very likely to happen - the traditional design space

Plausible: based on what we know now about tech developments, this is a credible future situation that could occur based on current developments.

Possible: this includes examples of futures that are more extreme – less likely, less grounded in what we know and do now, but can still be useful for exploring futures

Preferable: this is the future people would prefer. You find this out by using the design fiction to discuss what would be preferable, or build a fiction based on research already done

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

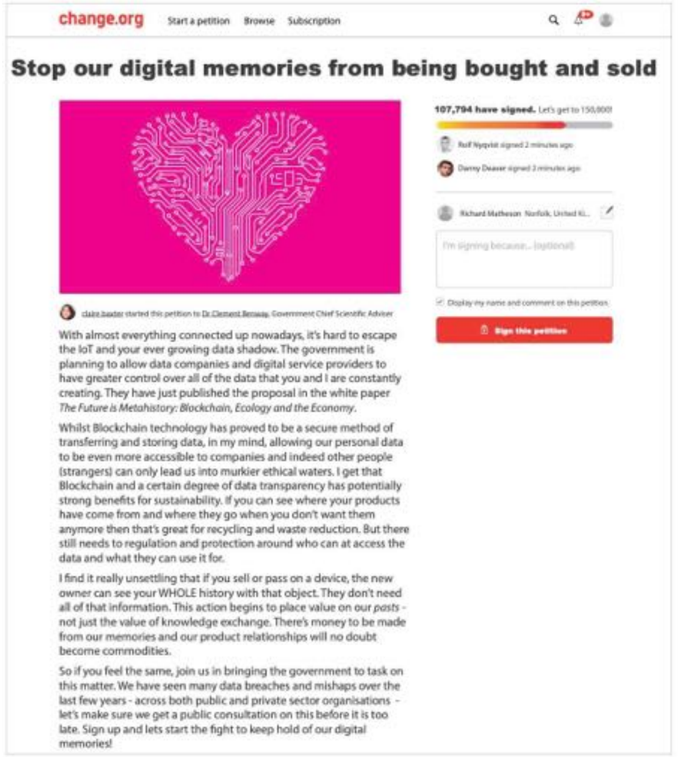
Examples:

- 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

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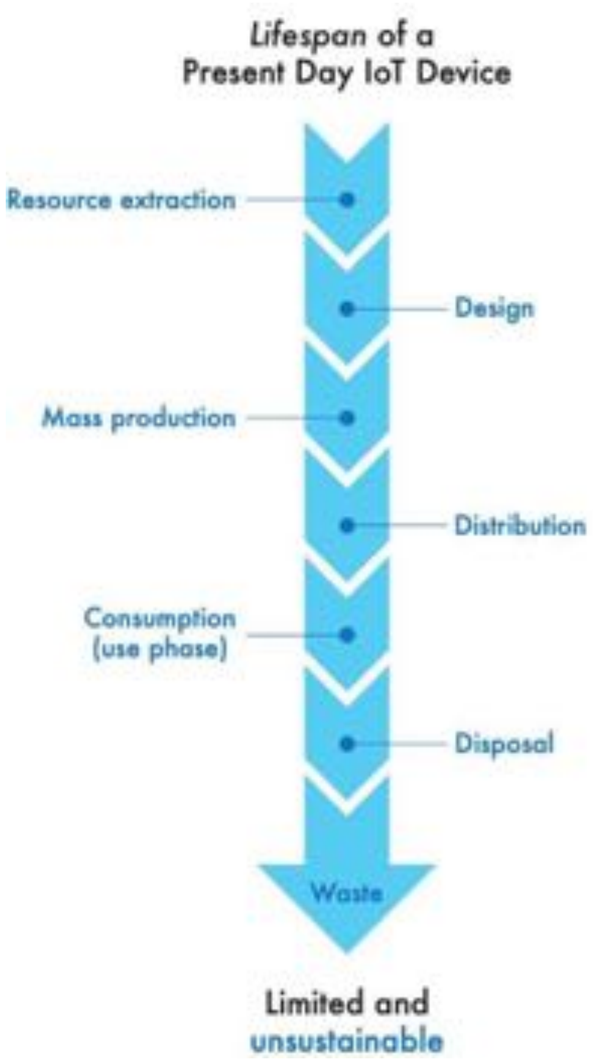

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What is a Spime?

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

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.

What do Spimes question?

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.

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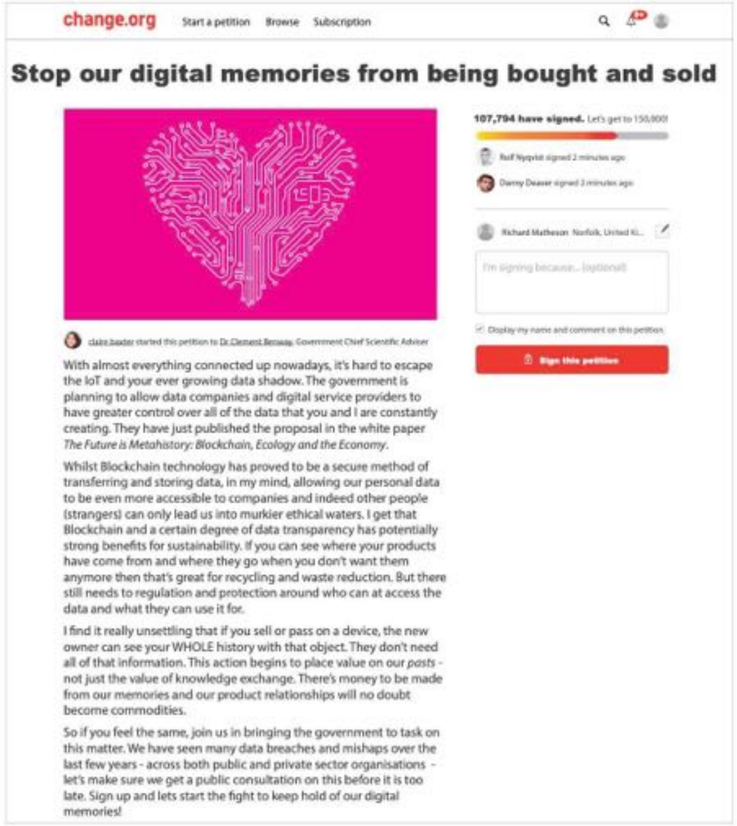
What do Spimes question?

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.

What do Spimes question?



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 Nygvist signed 2 minutes ago

Danny Deaver signed 3 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 Beneaig, 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.

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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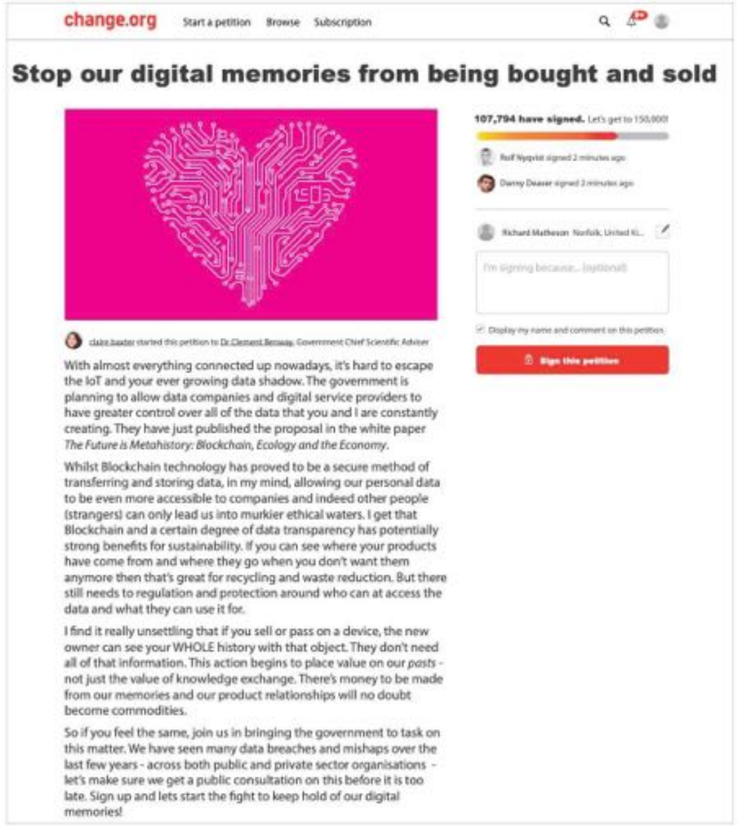
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Ethics and ownership

- 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.

(Lots of) student questions!

- Spimes connects via the internet and continuously tracks data, does this in turn pose a risk to the privacy of the user's information?

- We often buy household appliances thinking it will last a few years (it is an economic buy), but in reality, they break after a while. That is why I think the toaster was modeled, however, how do they model these appliances without being able to predict the technologies that is yet to come? It is more sustainable to turn the toaster into a spime object or keep it remain as a not IoT product? Is it necessary to use spime on every devices?

- The concept of spime feels somewhat utopian. Even though the entire lifecycle of spime products could be designed for recycling and remanufacturing, how can we address the energy emissions generated during the recycling process? Simply creating sustainable objects isn’t enough if the energy required for recycling or remanufacturing adds to environmental harm.

(Lots of) student questions!

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= a sign of an effective design fiction!

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.

Reflecting on Spimes in context of sustainability

https://miro.com/app/board/uXjVLQyNK4c=/?share_link_id=955983838917

4. Supporting others in understanding sustainability

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/

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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?

Lots and lots of sub-projects!

- **Repair cafes:**
  Supporting repairers in repairing niche IoTs using LLMs
- **Device owners:**
  Supporting kids in gaining electronics repair skills
- **Designers and manufacturers:**
  Supporting design teams in adhering to sustainability legislation
- **Policymakers:**
  Feeding into future policy work

Lots and lots of sub-projects!

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  Feeding into future policy work

Re:Play

How to support children in learning and getting excited about electronics repair? (e.g., learning basic soldering skills)

Violet Owen et al. (2024). Fostering IoT Repair Through Care: Learning from Emotional Durable Gaming Practices and Communities. In ACM DIS 2024. https://doi.org/10.1145/3656156.3663702

https://www.research.lancs.ac.uk/portal/en/publications/replay(075abb25-2b08-4ef5-b7e3-1cbc498fc204).html

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Re:Play

Idea to utilise principles of **emotionally durable design**:

"Product longevity needs to be concerned with not only the physical lifetime but also the psychological lifetime of the product as there is little use in designing products to last longer if the user has no desire to keep them."

Violet Owen et al. (2024). Fostering IoT Repair Through Care: Learning from Emotional Durable Gaming Practices and Communities. In ACM DIS 2024. https://doi.org/10.1145/3656156.3663702

Haines-Gadd, M., Chapman, J., Lloyd, P., Mason, J. and Aliakseyeu, D. Emotional Durability Design Nine—A Tool for Product Longevity. Sustainability, 10, 6 (2018- 06-11 2018), 1948

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Re:Play

- How to design an object that fosters repair skills, that people would want to keep and cherish over time?
- Based on observation that many people *"still owned gaming consoles dating back to as early as the late 1980s. They described how they had tried to keep these functional, from simple methods such as buying adapter cables, to more comprehensive repair methods such as following instructional repair videos"*

Violet Owen et al. (2024). Fostering IoT Repair Through Care: Learning from Emotional Durable Gaming Practices and Communities. In ACM DIS 2024. https://doi.org/10.1145/3656156.3663702

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Re:Play

- A ‘broken’ game console that has a number of issues which the user fixes.
- Goal to support skills together with longevity of ownership
- Evaluation still ongoing

Violet Owen et al. (2024). Fostering IoT Repair Through Care: Learning from Emotional Durable Gaming Practices and Communities. In ACM DIS 2024. https://doi.org/10.1145/3656156.3663702

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Student questions!

- Given that many companies have a financial/profit-driven interest in making their products not last as long as their materials theoretically could, how do we go about encouraging repairability?
- Have there been attempts to legally challenge planned obsolescence of products?

Lots and lots of sub-projects!

- **Repair cafes:**
  Supporting repairers in repairing niche IoTs using LLMs
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Translating Legal Frameworks for Designers

Table 1: An overview of relevant areas of law identified in the UK legal landscape

Instrument	Year	Area of focus	Adopted from EU?	Relevance to repair
General Product Safety Regulations	2005	All consumer products	Yes	Focused on minimising harms through deterioration, inadequacy for use, and raising consumer safety needs.
Consumer Rights Act	2015	All consumer products	No	Sets base standards of acceptable functionality, redress and expected lifespans.
Waste Electrical and Electronic Equipment Regulations	2013	Electronic waste	Yes	Requirements for how eWaste must be handled; including specifying specific materials, to support easier recycling.
Data Protection Act	2018	Data	Yes	See General Data Protection Regulation below (UK passed DPA 2018 to bring GDPR into UK law post Brexit).
The EcoDesign for Energy-Related Products and Energy Information Regulations	2021	Household electrical goods	No	Sets key standards for energy efficiency, material lifespan, and changeability of certain parts; creates the baseline of the UK "Right to Repair" specific regime.
Product Safety and Telecommunications Infrastructure Act	2022	Telecommunications	No	Mandates standards of security, updates, maintenance, and interoperability of connected consumer products; can prolong the lifespan of devices by reducing scope for bricking due to updates or next-generation obsolescence.
(PSTI) Security Requirements for Relevant Connectable Products Regulations	2023	Telecommunications	No	
Code of Practice for Consumer IoT Security	2010 (ongoing)	Cybersecurity	No	In tandem with the PSTI, ensures baseline standards of security by design.

Urquhart, LD, et al. (2024) The Right to Repair (R2R) cards. in NordiCHI '24: https://doi.org/10.1145/3679318.3685341

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.

Urquhart, LD, et al. (2024) The Right to Repair (R2R) cards. in NordiCHI '24: https://doi.org/10.1145/3679318.3685341

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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.

Urquhart, LD, et al. (2024) The Right to Repair (R2R) cards. in NordiCHI '24: https://doi.org/10.1145/3679318.3685341

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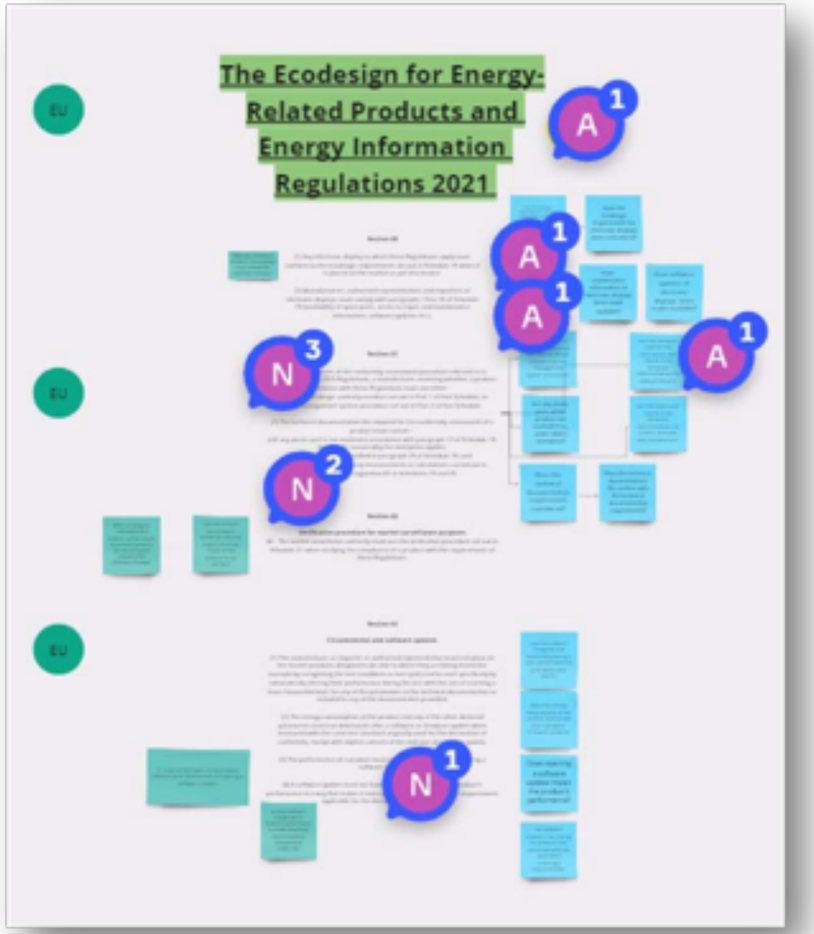
Translating Legal Frameworks for Designers



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?

Urquhart, LD, et al. (2024) The Right to Repair (R2R) cards. in NordiCHI '24: https://doi.org/10.1145/3679318.3685341

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Translating Legal Frameworks for Designers

- Supported formulation of solutions
- Helped ideation and education
- Provided provocations for change
- A tool to spark conversations across domains of expertise
- *But… how much detail to provide? How to ensure the language is understandable?*

Urquhart, LD, et al. (2024) The Right to Repair (R2R) cards. in NordiCHI '24: https://doi.org/10.1145/3679318.3685341

A note on card decks

- Card decks are also a design artefact in their own right
- Design Informatics not always about designing technology, but can also be about designing things that help others to think about or design technology!
- We'll see another card deck in this week's tutorial

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., designing artefacts, developing design fictions and creating design toolkits

Further Reading

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