



Creating Sustainable Internet of Things Futures: Aligning Legal and Design Research Agendas

Lachlan D. Urquhart*
School of Law and Institute of Design
Informatics, University of Edinburgh
Edinburgh, UK
lachlan.urquhart@ed.ac.uk

Susan Lechelt
School of Informatics and Institute of
Design Informatics, University of
Edinburgh
Edinburgh, UK
susan.lechelt@ed.ac.uk

Melissa Terras
Edinburgh College of Art and
Institute of Design Informatics,
University of Edinburgh
Edinburgh, UK
m.terras@ed.ac.uk

Neelima Sailaja
Horizon Digital Economy Research
Institute, University of Nottingham
Nottingham, UK
neelima.sailaja@nottingham.ac.uk

Anna Marie Rezk
Edinburgh College of Art and
Institute of Design Informatics,
University of Edinburgh
Edinburgh, UK
a.rezk@ed.ac.uk

Teresa Castle-Green
Horizon Digital Economy Research
Institute, University of Nottingham
Nottingham, UK
teresa.castle-
green@nottingham.ac.uk

Dimitrios Darzentas
School of Computing, Edinburgh
Napier University
Edinburgh, UK
d.darzentas@napier.ac.uk

Namrata Primlani
School of Computing, Edinburgh
Napier University
Edinburgh, UK
n.primlani@napier.ac.uk

Violet Owen
ImaginationLancaster, Lancaster
University
Lancaster, UK
r.v.owen@lancaster.ac.uk

Michael Stead
ImaginationLancaster, Lancaster
University
Lancaster, UK
m.stead1@lancaster.ac.uk

ABSTRACT

The way consumer Internet of Things (IoT) devices are built is leading to electronic waste (eWaste) growth. This arises from planned obsolescence, bundling of ‘smartness’ creating more routes to device failure, and lacking hardware modularity and repairability. Understanding how to best tackle these issues requires an interdisciplinary perspective bridging design, law, and the social science research. The legal landscape is shifting, encouraging design of repairable and long-lasting IoT, and reducing routes to redundancy. This one-day workshop explores the interface between design and legal research to address the socio-technical challenges around designing sustainable consumer IoT devices. The workshop will: map out the societal, legal, and environmental implications of IoT; envision the opportunities and barriers to designing more sustainable IoT; and share best practice and tools to help move towards more sustainable IoT futures.

CCS CONCEPTS

- **Human-centered computing** → **Ubiquitous computing**; • **Security and privacy** → **Social aspects of security and privacy**; • **Applied computing** → **Law**.

KEYWORDS

Internet of Things, Privacy, Security, Sustainability, Right to Repair

ACM Reference Format:

Lachlan D. Urquhart*, Susan Lechelt, Melissa Terras, Neelima Sailaja, Anna Marie Rezk, Teresa Castle-Green, Dimitrios Darzentas, Namrata Primlani, Violet Owen, and Michael Stead. 2024. Creating Sustainable Internet of Things Futures: Aligning Legal and Design Research Agendas. In *Designing Interactive Systems Conference (DIS Companion '24)*, July 01–05, 2024, IT University of Copenhagen, Denmark. ACM, New York, NY, USA, 5 pages. <https://doi.org/10.1145/3656156.3658391>

1 INTRODUCTION AND BACKGROUND

The domain of sustainable interaction design [1] has long been interested in both understanding the sustainability of and increasing the lifespan of consumer electronics [23]. This has involved exploring barriers and design strategies for enabling circular practices like repair and reuse [11–13] There is a growing recognition that current approaches to designing Internet of Things (IoT) devices are not socially or environmentally sustainable [14, 22] because IoT couples an ongoing service relationship around data, software, and



This work is licensed under a Creative Commons Attribution International 4.0 License.

DIS Companion '24, July 01–05, 2024, IT University of Copenhagen, Denmark
© 2024 Copyright held by the owner/author(s).
ACM ISBN 979-8-4007-0632-5/24/07
<https://doi.org/10.1145/3656156.3658391>

increasingly, machine learning, with physical hardware. Due to this, there are many routes to redundancy, leading to a proliferation of electronic waste (eWaste). For example, physical components, such as integrated batteries, are often not designed to be replaceable, and devices are often built as sealed units. This can render a device unrepairable if just one component breaks down, and difficult to repair e.g. due to tamperproof screws. Where they are replaceable, spare parts are often expensive or inaccessible, hampering repair efforts. Hardware can also be remotely “bricked” when the manufacturer chooses to through onboard software. Cessation of software updates can allow devices to become unsafe e.g. with security vulnerabilities. Further, data collection is pervasive for the IoT meaning when devices break or are no longer usable, users may face challenges controlling what happens to their data e.g. relying on community repair [3] or their legal rights to port or erase their data [8]. Business models and financial factors also have impacts e.g. expenses in supporting updates to software that a start-up cannot face [4]. Cumulatively, the current state of consumer IoT can create negative consequences for users and the wider environment, ranging from inconvenience and cost for users (who may lack resources to purchase replacement devices), to adding to global eWaste, which disproportionately impacts countries in the Global South [18].

1.1 Transitioning from Socio-Technical to Legal Challenges

To overcome these challenges, the impact of top-down regulation and legal frameworks on design decisions cannot be ignored. However, this is less well documented within the sustainable interaction design domain to date. Yet, how IoT systems are designed is increasingly under legal scrutiny with various law and policy agendas around the world recognising the current norm of short life devices is not economically, societally, or environmentally sustainable [2]. In Europe, change is driven by Circular Economy and Net Zero [9] initiatives coupled with numerous laws targeting design aspects around security of devices, artificial intelligence, environmental sustainability, consumer protection, and data protection [5–8]. Cumulatively, these different legal frameworks are creating new design requirements, and driving changes with goals of improving the privacy, security, safety, sustainability and human-centredness of IoT devices.

For example, the EU EcoDesign Regulations require more resilient hardware, alongside longer-term access to support and spare parts, which could support community repair [7]. A French index measures and grades device repairability to support consumer choice and encourage companies to improve [10]. The new EU Cyber Resilience Act requires manufacturers to provide cybersecurity support and updates across the device lifespan [6]. Beyond Europe, the US has been passing Right to Repair legislation in different states [16], with similar efforts in Australia too [15]. Grassroots community repair has emerged in response to sustainability challenges with campaigns, repair cafes and upskilling citizen literacy around repair [17]. Yet, the role of the law is complex and at times contradictory. For example, intellectual property (IP) laws have enabled software digital rights management which can prolong manufacturer control and hampers repair efforts [19].

Clearly then, laws are seeking to inform industry practices around consumer IoT in complex ways, whilst also changing at apace. Technologically, IoT already faces issues posed by software, data, and hardware infrastructures, but is also incorporating AI and machine learning, such as computer vision or natural language processing, which bring another layer of sustainability and legal concerns. It is timely to reflect on what law means for design research, and consumer IoT manufacturing design practices. Design Research can play a central role by envisioning what futures we want to achieve, and providing clear recommendations on how design practices around IoT can shift for the better. Yet, the impacts of current IoT systems on society cannot be solved by design research alone due to their legal and social complexity. So interdisciplinary responses are needed, particularly building dialogue with legal research and practice, and this workshop will provide such a space to collectively reason about the problems and how best to respond in practice.

Design Research can help us make sense of and respond to social and legal shifts, from speculative design on sustainable IoT futures [21, 25], to research through design artefacts to translate between design, legal and socio-technical researchers e.g. ideation decks or serious games [20, 24]. Our workshop poses key questions: [1] What role can design research play in designing more sustainable IoT, through both methods and critique? [2] How can law be folded into design research to address challenges and harms of current IoT? [3] What new research agendas can emerge from a closer integration of legal and design research? [4] What roles do a ‘right to repair’ and repair communities have in improving IoT sustainability?

2 WORKSHOP GOALS AND PLAN

The workshop has four major stages, a practical demonstrator and networking sessions to achieve its goals. Workshop organisers will facilitate these stages for up to 20 participants across 6 hours, with 2 breaks, and 1-hour lunch. We will have a pre-workshop website, pre and post workshop social networking, Slack channel, and Miro board for both pre-workshop orientation and capturing discussions at each stage of discussions.

2.1 Mapping the Current Problem Landscape; Envisioning Future Research Directions

Problem Landscape Mapping: The goal is to map out examples of problematic current IoT technologies, from a sustainable design perspective. This sets the scene for us to reflect on how these systems are currently designed, to consider the values underpinning design choices and the impacts on users and society more widely. This first session will open with introductions and an icebreaker, followed by a short scene setting presentation by the organisers with an overview of the day and this first activity. We will provide paper handouts of key questions for groups to structure brainstorming around – i.e. documenting their examples, why they are problematic, what values are implicated, and what the broader impacts are. This will be shared in plenary discussions. Groups will use large sheets in the room with post-its to capture deliberations, and key points from the plenary will also be added to the collaborative Miro.

Envisioning Future Directions: The goal is to consider what alternative IoT futures we want to build. Participants will again work

together in groups to envision what more long-lasting and sustainable IoT could look like. Up to 5 participants will provide short 5-minute scene setting presentations of critical position papers and research through design artefacts as provocations. This will be followed with a group activity to collate examples of best practice current IoT and again each group feeds back to the workshop on what we can learn from these before more open discussion on aspirations for more sustainable, longer lasting IoT. This will lay the groundwork for groups to develop visions of more sustainable IoT futures, establishing key attributes of these futures. We will bring mixed medium creative and crafting materials for group ideation.

2.2 Identifying Legal Triggers and Roadblocks to Change; Developing Research Action Plans

Legal Triggers and Roadblocks: The goal of this section is to reflect on both *what is moving us towards these futures and what is stopping us getting there*. Exploring the interface between law and design research will be key here, to account for how laws are shaping how we build better IoT. A longer talk provides an overview of the legal landscape from the organisers, to establish key provocations from different laws, particularly from Europe with some global examples too. Participants will then critically discuss these law and policy triggers and reflect on what barriers they see to change in IoT design. The goal is to map out a Miro board of triggers and roadblocks based on these discussions.

Action Plans: The goal here is to consolidate discussion from stages 1-3, to *establish practical action plans* for aligning Legal and Design Research. It will be centred around how to address current IoT problems, move us towards our envisioned futures, respond to legal triggers and overcome roadblocks to change. The goal is to develop foundations of an interdisciplinary research agenda around Sustainable and Long-lasting IoT, that accounts for legal requirements and wider societal implications. The session will focus on developing research questions, priorities, and agendas to build this interface between design research, legal, and wider social science research.

2.3 Demonstrator and International Network Building

Demonstrator of Methods and tools: Organisers and workshop participants will share methods and tools they have developed around sustainable IoT. This includes organisers sharing research through design artefacts they have created e.g. the Right to Repair Cards or Fixing the Future Board Game (see appendix). Participants can bring own tools and share insights of what has been learned using these. The tools will be set-up in the room, where beyond the dedicated demonstrator session, participants can explore and discuss these tools during breaks.

Network Building: Our goal is to build an international community and network around the research priorities identified during the day at the interface of Design Research with Law and Social Science research. We will co-create a white paper with participants of key insights, discussion points, challenges. This will be hosted on workshop and collaborator institution websites to share with our wider networks in industry, academia, and grassroots groups.

This will help to coalesce the community around the challenges we establish the workshop. After the workshop we will support longevity of the network and future collaboration through a mailing list, Slack channels and plan satellite future events.

3 OUTCOMES

Key outcomes from this workshop include: establishing the international network of researchers across legal and design research looking at sustainability of IoT; mapping out challenges from current design of IoT; showcasing tools developed by participants and organisers; establishing roadblocks and triggers to change and how to address these; examining the interface between design research and law for designing more sustainable IoT; mapping out an agenda of priorities for change, including what problematic design practices need to be addressed and how; and envisioning what more sustainable IoT futures would look like.

ACKNOWLEDGMENTS

Thanks for funding from the UK EPSRC Fixing the Future: Right to Repair for Equal-IoT Project EP/W024780/1.

REFERENCES

- [1] Eli Blevis. 2007. Sustainable interaction design: invention & disposal, renewal & reuse. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '07)*. Association for Computing Machinery, New York, NY, USA, 503–512. <https://doi.org/10.1145/1240624.1240705>
- [2] Christopher Boniface, Lachlan Urquhart, and Melissa Terras. 2024. Towards a right to repair for the Internet of Things: A review of legal and policy aspects. *Computer Law & Security Review* 52 (4 2024), 105934. <https://doi.org/10.1016/j.clsr.2024.105934>
- [3] Jason Ceci, Jonah Stegman, and Hassan Khan. 2022. No Privacy in the Electronics Repair Industry. In *2023 IEEE Symposium on Security and Privacy (SP) (pp. 3347-3364)*. IEEE, (11 2022). <http://arxiv.org/abs/2211.05824>
- [4] Jiahong Chen and Lachlan Urquhart. 2022. 'They're all about pushing the products and shiny things rather than fundamental security': Mapping socio-technical challenges in securing the smart home. *Information & Communications Technology Law* 31, 1 (1 2022), 99–122. <https://doi.org/10.1080/13600834.2021.1957193>
- [5] EU Artificial Intelligence Act. 2024. Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL. *LAYING DOWN HARMONISED RULES ON ARTIFICIAL INTELLIGENCE (ARTIFICIAL INTELLIGENCE ACT) AND AMENDING CERTAIN UNION LEGISLATIVE ACTS COM/2021/206 final* (2024).
- [6] EU Cyber Resilience Act. 2023. Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL. *on horizontal cybersecurity requirements for products with digital elements and amending Regulation (EU) 2019/1020 COM/2022/454 final* (2023).
- [7] EU EcoDesign Rules. 2023. Commission Regulation (EU) 2023/1670 of 16 June 2023. *laying down ecodesign requirements pursuant to Directive 2009/125/EC of the European Parliament and of the Council and amending Commission Regulation (EU) 2023/826 (Text with EEA relevance)* (2023).
- [8] EU General Data Protection Regulation. 2016. Regulation (EU) 2016/679 of the European Parliament and of the Council. *of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (GDPR)* (2016).
- [9] EU Green Deal. [n. d.]. European Green Deal. *Striving for the first climate neutral continent*. [n. d.].
- [10] French Repair Index. 2020. *LOI no 2020-105 (2020). du 10 f' evrier 2020 relative ' a la lutte contre le gaspillage et ' a l' ' economie circulaire (1)*. *Journal Officiel de la R' epublique Française 0035 du 11/02/2020* (2020).
- [11] Jackson Houston, Lara Houston, and Steven J Jackson. 2017. Caring for the "Next Billion" Mobile Handsets Caring for the "Next Billion" Mobile Handsets: Proprietary Closures and the Work of Repair. In *Proceedings of the Eighth International Conference on Information and Communication Technologies and Development (2016)*, 1–11.
- [12] Elaine M. Huang and Khai N. Truong. 2008. Breaking the disposable technology paradigm. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, New York, NY, USA, 323–332. <https://doi.org/10.1145/1357054.1357110>

- [13] Sunyoung Kim and Eric Paulos. 2011. Practices in the creative reuse of e-waste. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, New York, NY, USA, 2395–2404. <https://doi.org/10.1145/1978942.1979292>
- [14] Susan Lechelt, Katerina Gorkovenko, Luis Soares, Chris Speed, James Thorp, and Michael Stead. 2020. Designing for the End of Life of IoT Objects. In *In Companion Publication of the 2020 ACM Designing Interactive Systems Conference*. 417–420. <https://doi.org/10.1145/3393914.3395918>
- [15] Kayleen Manwaring, Matthew Kearnes, Bronwen Morgan, Paul Munro, Roberta Pala, and Shanil Samarakoon. 2022. What does a right to repair tell us about our relationship with technology? *Alternative Law Journal* 47 (3) (2022). <https://ssrn.com/abstract=4139295>
- [16] Aaron Perzanowski. 2022. The Right to Repair: Reclaiming the Things We Own. *Cambridge University Press* (2022). <https://doi.org/DOI:10.1017/9781108946926>
- [17] Matthew Pilling, Michael Stead, Adrian Gradinar, Christian Remy, and Thomas Macpherson-Pope. 2022. Preparing to Repair: Using Co-Design and Speculative Design Methods to Explore the Future of IoT Right-to-Repair with Citizens and Communities. In *Cumulus Detroit 2022: Design for Adaptation*.
- [18] Mohammad Rashidujjaman Rifat, Hasan Mahmud Prottoy, and Syed Ishtiaque Ahmed. 2019. The Breaking Hand. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. ACM, New York, NY, USA, 1–14. <https://doi.org/10.1145/3290605.3300253>
- [19] Anthony Rosborough. 2020. Unscrewing the Future: The Right to Repair and the Circumvention of Software TPMs in the EU. *Journal of Intellectual Property, Information Technology and E-Commerce Law* 11, 1 (2020), 26–48. <http://nbn-resolving.de/urn:nbn:de:0009-29-50832>
- [20] Neelima Sailaja, Teresa Castle Green, and Kinga Lewandowska. 2024. Fixing the Future Game. *University of Nottingham* (2024).
- [21] Michael Stead and Paul Coulton. 2022. A more-than-human right-to-repair. In *DRS2022. Bilbao, Design Research Society Conference*. <https://doi.org/10.21606/drs.2022.718>
- [22] Michael Stead, Paul Coulton, Joseph Lindley, and Claire Coulton. 2019. *The Little Book of SUSTAINABILITY for the Internet of Things*.
- [23] James Thorp, Susan Lechelt, Luis Soares, Katerina Gorkovenko, Chris Speed, Michael Stead, Nick Dunn, and Daniel Richards. 2022. Towards Sustainable Internet of Things Objects Design Strategies for End-of-Life. In *Cumulus Conference Detroit 2022: Design for Adaptation* (7 2022).
- [24] Lachlan Urquhart, Anna Rezk, Christopher Boniface, Nidhi Dubey, Susan Lechelt, and Melissa Terras. 2024. Right to Repair Cards. *University of Edinburgh* (2024).
- [25] Lachlan D. Urquhart, Glenn McGarry, and Andy Crabtree. 2022. Legal Provocations for HCI in the Design and Development of Trustworthy Autonomous Systems. In *Nordic Human-Computer Interaction Conference*. ACM, New York, NY, USA, 1–12. <https://doi.org/10.1145/3546155.3546690>

A APPENDIX

A.1 SAMPLE OF TOOLS FOR WORKSHOP



Figure 1: Right to Repair Ideation Cards [24]



Figure 2: Fixing the Future Board Game [20]