# Creating Sustainable Internet of Things Futures:

Aligning Legal and Design Research Agendas.

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**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 to 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 how to move towards more sustainable IoT futures.

CCS CONCEPTS • **Human-centered computing -> Human computer interaction (HCI) ->** Ubiquitous computing; Ubiquitous and mobile computing theory, concepts and paradigms • **Security and privacy ->** Human and societal aspects of security and privacy -> Social aspects of security and privacy • **Applied computing ->** Law, social and behavioural sciences -> Law

**Additional Keywords and Phrases:** Internet of Things, Privacy, Security, Sustainability, Right to Repair.

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## 1 INTRODUCTION AND BACKGROUND

The domain of sustainable interaction design [1] has long been interested in understanding the sustainability of and increasing the lifespan of consumer electronics [24]. This has involved exploring barriers and design strategies for enabling circular practices like repair and reuse [12,13,14]. There is a growing recognition that current approaches to designing Internet of Things (IoT) devices are not socially or environmentally sustainable [15, 23] because IoT couples an ongoing service relationship around data, software, and 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 disproportionally impacts countries in the Global South [19].

### 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 [7] initiatives coupled with numerous laws targeting design aspects around security of devices, artificial intelligence, environmental sustainability, consumer protection, and data protection [5,6,8,9]. 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 EcoDesign Regulations require more resilient hardware, alongside longer-term access to support and spare parts, which could support community repair [6]. 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. [5]. Beyond Europe, the US has been passing Right to Repair legislation in different states [18], with similar efforts in Australia too [16]. 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. [21].

Clearly then, laws are seeking to inform industry practices around consumer IoT in complex ways, whilst also changing at apace. Technologically, IoT already faces these 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 [22,25], research through design artefacts to translate between design, legal and socio-technical researchers e.g. ideation decks or serious games [11,20]. 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 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 participants 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.

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## REFERENCES


[1] Blevis, E. (2007, April). Sustainable interaction design: invention & disposal, renewal & reuse. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 503-512).

[2] Boniface, C. Urquhart, L and Terras, M. (2024) Fixing the Future: Right to Repair for Internet of Things. *Computer Law and Security Review*

[3] Ceci, J., Stegman, J. and Khan, H., 2023, May. No privacy in the electronics repair industry. In *2023 IEEE Symposium on Security and Privacy (SP)* (pp. 3347-3364). IEEE.

[4] Chen, J and Urquhart L. (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 and Communication Technology Law* 31(1)

[5] 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

[6] EU EcoDesign Rules 2023 - Commission Regulation (EU) 2023/1670 of 16 June 2023 laying down ecodesign requirements for smartphones, mobile phones other than smartphones, cordless phones and slate tablets 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)

[7] EU Green Deal "A European Green Deal: Striving for the first climate neutral continent.

[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 (General Data Protection Regulation)

[9] 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

[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 Offciel de la R´ epublique Française 0035 du 11/02/2020,

[11] Fixing the Future Game (2024) – developed by N Sailaja, T Castle Green, K Lewandowska. University of Nottingham.

[12] Houston, L. and Jackson, S.J. 2016. Caring for the" next billion" mobile handsets: opening proprietary closures through the work of repair. *Proceedings of the Eighth International Conference on Information and Communication Technologies and Development* (2016), 1–11.

[13] Huang, E. M., & Truong, K. N. (2008, April). Breaking the disposable technology paradigm: opportunities for sustainable interaction design for mobile phones. In *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 323-332).

[14] Kim, S., & Paulos, E. (2011, May). Practices in the creative reuse of e-waste. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 2395-2404).

[15] Lechelt, S., Gorkovenko, K., Soares, L. L., Speed, C., Thorp, J. K., & Stead, M. (2020, July). Designing for the end of life of IoT objects. *In Companion Publication of the 2020 ACM Designing Interactive Systems Conference* (pp. 417-420).

[16] Manwaring, K. (2022) What does a right to repair tell us about our relationship with technology. *Alternative Law Journal* 47 (3)

[17] Pilling, M. Stead, M. Gradinar, A. Remy, C. and MacPherson-Pope, T. (2022) Preparing to Repair: Using Co-Design and Speculative Design Methods to explore the Future of IoT Right-to-Repair with Citizens and Communities. *Cumulus Detroit 2022: Design for Adaptation.*

[18] Perzanowski, A. (2021) The Right to Repair: Reclaiming the Things We Own. Cambridge University Press.

[19] Rifat, M.R., Prottoy, H.M. and Ahmed, S.I., 2019, May. The breaking hand: Skills, care, and sufferings of the hands of an electronic waste worker in Bangladesh. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems* (pp. 1-14).

[20] Right to Repair Cards (2024)– developed by L Urquhart, A Rezk, C Boniface, N Dubey, S Lechelt and M Terras. University of Edinburgh.

[21] Rosborough A J (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)

[22] Stead M. R and Coulton, P. (2022) A More than-Human-Right-to-Repair. *DRS2022. Bilbao, Design Research Society Conference.*

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

[24] Thorp, J., Lechelt, S., Soares, L., Gorkovenko, K., Speed, C., Stead, M., & Richards, D. (2022, July). Towards Sustainable Internet of Things Objects Design Strategies for End-of-Life. In *Cumulus Conference Detroit 2022: Design for Adaptation.*

[25] Urquhart, L McGarry, G. and Crabtree, A. Legal Provocations for HCI in the Design and Development of Trustworthy Autonomous Systems. *Proceedings of NORDICHI '22*


## APPENDIX 1. SAMPLE OF TOOLS FOR WORKSHOP

Figure 1: Right to Repair Ideation Cards [20] and Fixing the Future Board Game [11] 2024.