UbiFix: Tackling Repairability Challenges in Smart Devices

The First International Workshop exploring the Technical, Social, and Legal aspects of IoT repairability

Neelima Sailaja, Teresa Castle-Green
Horizon Digital Economy Research
University of Nottingham
Nottingham, United Kingdom
first.last@nottingham.ac.uk

Paul Coulton, Michael Stead, Joseph Lindley
Imagination Lancaster
Lancaster University
Lancaster, United Kingdom
first[letter].last@lancaster.ac.uk

Lachlan Urquhart
Department of Law
Institution/University of Edinburgh
Edinburgh, United Kingdom
lachlan.urquhart@ed.ac.uk

Dimitrios Darzentas
School of Computing, Engineering and the Built Environment (SCEBE)
Edinburgh Napier University
Edinburgh, United Kingdom
d.darzentas@napier.ac.uk

ABSTRACT

IoT products are increasingly becoming the default, with non-IoT versions of common hardware (e.g., TVs and printers) harder to find. Alongside this adoption surge, lack of support, outdated security, and planned obsolescence present concerning sustainability issues, contribute to eWaste growth and widen digital divides globally. This workshop aims to present and discuss legal, social, technical, and design aspects of repair practices, engaging the Ubicomp community by exploring challenges and opportunities for more repairable IoT devices. Focusing on diverse repair scenarios, the workshop seeks to establish a concise, holistic, and inclusive agenda for this research domain's future. Participants will map key research questions to support the movement towards more repairable technology.

CCS CONCEPTS

• Human-centered computing~ Human computer interaction (HCI) • Human-centered computing~Ubiquitous and mobile computing

KEYWORDS

IoT, Sustainability, Repair, Smart Devices

ACM Reference format:

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[†]Author Footnote to be captured as Author Note

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1 Introduction

As wireless connectivity and automation integrate into household items, IoT products increasingly become the norm. It is now harder to find non-IoT alternatives for devices like smart TVs and printers. Known IoT brands often offer lower prices to encourage adoption, such as Amazon Echo. Additionally, cheaper IoT brands can be found online, but their security and hardware quality may be questionable. While IoT adoption is currently a consumer choice, its rapid growth may lead to citizens having it imposed, like local governments monitoring homes [5]. Alongside this rise in IoT usage, sustainability concerns grow as well.

IoT devices become unreliable when they are damaged, malfunction, or lose support and security. These devices often have planned obsolescence and lack proper management throughout their lifespan. The consequences of this redundancy are not evenly distributed in society [1]. Individuals without the means to repair or replace their IoT devices may be excluded from the digital world. For instance, a broken phone screen could result in the inability to use a track-and-trace app, affecting mobility and ultimately limiting societal participation. This issue also contributes to global divisions, as broken devices turn into eWaste shipped overseas, harming communities in the Global South [3]. The UN e-waste monitor [2] reported that only 17% of the 53.6 million metric tons of electronic waste in 2019 was recycled. With e-waste increasing yearly [4] and estimates of 74 million metric tons by 2030 [2], urgently addressing this problem is vital. Failing to resolve simple household issues like fixing a smart thermostat could, on a larger scale, contribute to a global crisis if not managed carefully.

Repair and reuse of technology are essential response measures here. Solutions involving repair span various societal levels, including legal actions like the Right to Repair or France's repairability scores on products, economic theories and methodologies within the Circular Economy, academic discussions, and the growing presence of repair cafes worldwide.

IoT researchers and designers play a crucial role in these initiatives. They can support the Right to Repair through practical design recommendations for IoT devices (e.g., the Nokia G22 with a repair kit [6]); connect academic insights on the Circular Economy (and repair) to functional design solutions for current and future IoT devices; and assist community initiatives like Repair Cafes by providing design guidelines and guides for repairers and customers in their everyday repair experiences.

However, formal investigations into these possibilities have yet to be conducted. It is crucial to identify the key challenges, opportunities, and expectations of IoT researchers and designers regarding device repair, as it presents global technological, social, and environmental challenges. Ubicomp, with its diverse history of engaging with embedded and ubiquitous technologies such as IoT and smart devices, serves as an ideal platform to initiate this effort. By gathering IoT enthusiasts with various skill sets and from different contexts, who share an interest in the repair and sustainability of smart devices, we can address these challenges more effectively.

The goal of this workshop is to start discussions about repair by examining current methods, obstacles, and support in IoT design, research, and practice. We will also explore future expectations and opportunities while relating it to the broader Ubicomp, HCI, and Sustainability zeitgeist. This will be a key step in moving the focus of IoT towards a more repair-focused, sustainable, and inclusive one.

The workshop will be based on our diverse experience in repairing smart devices, covering legal, social, HCI, computing, and design aspects. This includes investigations around these aspects of this scenario, including a caravan experience that engages users in the act of repair at a community level [7,8].

We will share and compile various repair contexts for smart devices to create a comprehensive map of current processes and barriers. Our goal is to examine potential changes to the status quo, fostering sustainable design practices for future technologies. We will address specific questions during this workshop:

1. Should we prioritize repairability in designing IoT devices and smart technologies?
2. What are the main challenges in making IoT devices repairable by non-experts?
3. How can the Ubicomp community contribute to improving repairability?
4. What are the practical steps to implement these improvements?

The workshop comprises three stages. First, we will present the organizers' perspective on the current state of research in this field, allowing attendees to discuss the successes and failures in incorporating repairability into these contexts. Second, we will guide participants in examining practical design modifications and interventions that would effectively promote repair and support within sample technologies. Third, we will utilize the specific design processes, decisions, and revisions from the first two sections to generate a commentary on how repair has accelerated or impeded the design and adoption of Ubiquitous technologies. The goal is to create a succinct agenda for future research, identifying the questions that need to be addressed to advance the repair movement within technology.

Repair is crucial, but making it accessible and effective can be difficult. Additionally, moving from small-scale repair cafes to having a global influence demands persistent teamwork across different fields. Thus, the workshop's goal is to create a plan to enhance and encourage repair of Ubicomp technologies.

2 Pre-Workshop Plans

The workshop recruitment will take place via the workshop website, offering two ways for participants to express interest: a traditional 'position paper' or a lighter online form on the website to share a repair-related provocation. The position paper must follow the UbiComp submission format, with a 3-page maximum, excluding references, to be submitted on PCS. The accepted papers will be included in the ACM Digital Library and supplemental proceedings of the conference. The paper should depict a repair scenario involving a smart device, ranging from troubleshooting issues, lacking proper guidance or parts, successful or unsuccessful repair attempts, or even a fictional repair story illustrating a specific perspective on smart technology repair. Alternatively, participants may critique or comment on repair support and related practices for smart technologies.

The two-part approach aims to maximize inclusivity by accommodating those who prefer a formal contribution (through a workshop paper) and those who opt for a less academic path. This ensures a diverse range of repair contexts in the workshop, which is crucial for a comprehensive understanding and creating a representative, inclusive future agenda.

We will select participants based on their interest in repair processes and the quality of their submission related to the workshop theme. Our aim is to form a diverse group with varied perspectives, ensuring a dynamic and fruitful session. We will strive for inclusivity, considering factors such as career stage, race, gender, and location.

The participants would be provided access to a Slack channel before the workshop event for the dissemination of information and to provide a platform for the participants to introduce themselves and get involved with the community prior to the event itself, it will provide a persistent means to share content during the workshop and will be leveraged for future collaborations and report writing and special issue engagement post the workshop.

3 Workshop Structure

The workshop is designed for a maximum of 30 participants. Given its interactive and participatory nature, limiting to 30 participants is necessary to ensure equal opportunity for all to participate.

3.1 Activity 1 : Orientation [30 minutes]

The workshop will commence with an introductory session outlining the challenges related to the sustainability of IoT and

smart technologies. The organizing team will lead a presentation highlighting the workshop's objectives and themes. Following the presentation, a warm-up activity will be conducted to familiarize participants with one another and the workshop's goals. Additionally, this session will allocate time for obtaining participant consent before proceeding with the activities. The warm-up activity will involve an engaging ice-breaker, designed to encourage participation from all attendees. Utilizing a straightforward facilitation approach, participants will share their views in a concise manner by completing the phrases, "The best thing about being able to repair IoT is..." and "The worst thing about being able to repair IoT is...". This exercise will facilitate open discussion and set the tone for the rest of the workshop.

3.2 Activity 2 : State-of-the-art showcase [30 minutes]

Here, the organizers will discuss repair as a solution to the issues addressed earlier, covering legal, social, technology and design perspectives. This will include an overview of the Right to Repair movement, its international manifestations, and specific country implementations. Next, the session will explore user's engagement with sustainability and repair, examining its impact on IoT devices. The UK's Repair Cafe culture will be introduced, covering common principles, processes, and variants. Additionally, participants will be introduced to a unique caravan experience [7,8], which equips users with smart devices and encourages them to engage with repair and creation of simple technologies, presented via a live walkthrough or recorded video. Here, participants will receive materials to help them note their thoughts on the strengths and weaknesses of the various repair perspectives and examples presented. These insights will be utilized in the third activity.

Figure 1. The IoT equipped caravan repair experience

3.3 Activity 3 : Critique State-of-the-art [30 minutes]

In this session, participants will engage in a group activity, with the larger group divided into smaller groups of 3-4 people to facilitate in-depth discussions and responses. Within their groups, participants will critique the state-of-the-art repair concepts presented earlier, grounding their arguments in the examples provided in their submissions. Each group will receive a starter kit containing a summary of the key points from the legal, design, and technical perspectives on repair. The kit will also include a guided worksheet for critiquing the concepts, offering space for participants to record their notes and responses. This structured approach will help generate a well-rounded critique of the repair landscape.

3.4 Activity 4 : Rebuild : Break and Make [45 minutes]

Informed by the showcase and prior discussions, participants will now work in their groups to redesign a smart device, incorporating ideas generated from their critique in Activity 3. Each group will be provided with a popular IoT device, accompanied by a story outlining a repair need or fault. Participants will analyze the challenges presented in these repair scenarios and explore how they can apply their critiques to create better solutions. They will be encouraged to "break" conventional norms and "make" new sustainable/ inclusive approaches that enhance device repairability(in terms of design, business models, regulations etc.).

Activity	**Time**
Activity 1 : Orientation	30 minutes
Activity 2 : State-of-the-art showcase	30 minutes
Break	**15 minutes**
Activity 3 : Critique State-of-the-art	30 minutes
Activity 4 : Rebuild : Break and Make	45 minutes
Break	**15 minutes**
Activity 5 : Feedback and Discussion	45 minutes
Activity 6 : Wrap up	30 minutes

Table 1. Summary of Workshop Activities

3.5 Activity 5 : Feedback and Discussion [45 minutes]

In this session, each group will present their work to the entire room, covering the following aspects: their IoT device and repair scenario; the design revisions implemented for easier repair; challenges encountered during these revisions; exploring the balance between what needs to be done versus what can be done; an evaluation of how incorporating repair options improved the situation (or if not, why).

The wider group will have the opportunity to ask questions, raise comments, and discuss any concerns regarding the presented redesigns and repair scenarios. This interactive session will foster collaborative learning and generate further insights into IoT device repairability and design improvements.

3.6 Activity 6 : Wrap up Discussion [30 minutes]

In the final session, the entire group will reconvene to revisit the core research questions outlined in Section 1 of the workshop. The objective of this discussion is to delve deeper into these questions, refining and expanding upon them to gain a more detailed and nuanced understanding. These refined questions will serve as the foundation for post-workshop plans and establish the key elements of a new research agenda focused on the repair of IoT devices. This collaborative effort will ensure a well-rounded perspective and a comprehensive approach to addressing the challenges and opportunities in IoT device repairability.

7 Post Workshop Plans

The workshop's goal is to spark dialogue surrounding repair in IoT devices, exploring how IoT enthusiasts can enable users to repair and reuse their devices rather than exclude and replace. We will use this as a foundation to propose an ACM Special Issue around Repair and Sustainability of SmartTech. The organizers' networks, along with the international Ubicomp community's engagement, would be leveraged to successfully achieve this milestone, and form a foundational academic contribution towards the sustainability of IoT devices. We will publish the workshop outcomes as an academic paper and a report made publicly available on the HorizonDER [9] and workshop websites, and shared with project partners (e.g., BBC, Making Rooms Blackburn, Canadian Government, Which? etc.). This will advance research on repair in academia, support industry and independent initiatives (e.g., BBC's Sustainability initiatives, Restart Projects' FixFest [10], UK Repair Cafes). We will work with HorizonDER to produce a policy report for future calls for evidence from U.K. Parliament around Digital Exclusion.

8 Organising Committee

Neelima Sailaja (Transitional Assistant Professor at the University of Nottingham) is an interdisciplinary researcher working on the socio-technical challenges of technology use. She currently leads the HDI wing of the EPSRC Fixing the Future project focusing on exploring the challenges and responses around repair of smart technologies. She has published over 15 peer reviewed outputs at leading HCI venues and has led workshops exploring the socio-technical implications of technology at ACM CHI and IMX.

Teresa Castle-Green is an inter-disciplinary researcher working on unpacking the socio-technical complexities of design and repair of IoT. She is the HDI Researcher at the University of Nottingham on the EPSRC Fixing the Future project engaging with UK repair communities to investigate ways in which HCI/HDI approaches can support the growing culture of community-based repair.

Paul Coulton is Professor of Speculative and Game Design at Lancaster University. Previously, he led Nokia's Academic Mobile Experiences Group (2006-2012). His current focus is the design challenges presented by IoT and datafication. He is PI on the EPSRC Experiencing the Future Mundane and Uncanny AI projects which explore AI data legibility, agency and negotiability.

Michael Stead is Lecturer in Sustainable Design Futures at Lancaster University. His interdisciplinary research interrogates the environmental and social impacts data-driven technologies pose for sustainability goals like Net Zero 2050 and the Circular Economy. Michael leads Lancaster's work package on the EPSRC Fixing the Future project. He has published over 25 peer reviewed Design/HCI outputs and lead-authored PETRAS' Little Book of Sustainability for the IoT.

Joseph Lindley is a specialist in Design Research and Design Fiction. His focus is on promoting these approaches as strategies to assist emerging technologies in delivering sustainable and equitable futures. He is a member of the ACM Future of Computing Academy, an alumnus of the PETRAS Centre for Excellence for IoT Cybersecurity and a UKRI Future Leaders Fellow.

Lachlan Urquhart is Senior Lecturer in Technology Law and HCI at the University of Edinburgh. He is Director of the Regulation and Design Lab, and Co-Director of SCRIPT and CRISP. He has published over 50 papers in computing, law and ethics exploring socio-technical aspects of designing, living with and regulating emerging information technologies. He leads the EPSRC 'Fixing the Future: Right to Repair and Equal-IoT' project.

Dimitrios Darzentas is a lecturer at Edinburgh Napier University. His multidisciplinary work is situated at the intersection of HCI and Design (Mixed Reality Technologies, Experience Design, Physical/Digital Service Design, Sustainability). His current research interests include Hybrid Physical/Digital Experiences and Socio-Political and Cultural Heritage aspects of Gaming.

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APPENDIX A

Call for Participation

We welcome you to UbiFix 2023, the first international workshop that explores the legal, technical, social and design aspects of IoT repair and sustainability.

IoT products are increasingly becoming the default, with non-IoT versions of common hardware (e.g., TVs and printers) harder to find. Alongside this adoption surge, lack of support, outdated security, and planned obsolescence present concerning sustainability issues, contribute to eWaste growth and widen digital divides globally.

This workshop aims to present and discuss legal, social, technical, and design aspects of repair practices, engaging the Ubicomp community in exploring challenges and opportunities for more repairable IoT devices. The workshop will orient you to the current literature and practice around repair of IoT devices; welcome your critique on the state-of-art; present examples and contexts of IoT repair and sustainability to support the critique; and encourage you to imagine a future where current challenges and barriers are overcome to enable better repairability of IoT.

For participation, you can either upload a three-page position paper (excluding references; UbiComp Submission Template) on the PCS website or submit a lighter online form on the workshop website to share a repair-related provocation. The accepted papers will be included in the ACM Digital Library and supplemental proceedings of the conference. The paper could depict a repair scenario involving a smart device, ranging from troubleshooting issues, lacking proper guidance or parts, successful or unsuccessful repair attempts, or even a fictional repair story illustrating a specific perspective on smart technology repair. Alternatively, you may critique or comment on repair support and related practices for smart technologies. (Online form entries will not be included in the ACM Digital Library).

A diverse group of complementary participants will be selected based on their prior experience of IoT repair and sustainability (or related areas) and the quality/ relevance of their submission to the workshop theme.

Upon acceptance, it is mandatory that at least one author of each accepted position paper must attend the workshop. More details are available at [Workshop Website, url will be established post acceptance].

Best Paper Award

A Best Paper Award will be given to the best submission made to UbiFix 2023. The awardee will be presented with a certificate and small memento at the workshop.

Key Dates [23:59 AoE for all Deadlines]

Paper Submission: 30th June 2023
Notification: 15th July 2023
Camera-Ready Version: 31st July 2023
Workshop: 8th/9th [TBD] October 2023

Workshop Organisers

Neelima Sailaja, University of Nottingham
Teresa Castle-Green, University of Nottingham
Paul Coulton, Lancaster University
Michael Stead, Lancaster University
Joseph Lindley, Lancaster University
Lachlan Urquhart, University of Edinburgh
Dimitrios Darzentas, Napier University

Extended list of partners

BBC R&D
NCC Group
Which?
Active Ingredient
Federal Government of Canada
The Making Rooms

Contact Details:

For any questions, queries or comments please email neelima.sailaja@nottingham.ac.uk or teresa.castle-green@nottingham.ac.uk
Alternatively, you could also visit our workshop website for more information at [url will be established post acceptance]