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# The Repair Shop 2049: Co-Designing Sustainable and Equitable Transitions for Smart Device Repair with and for Local Communities

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**Keywords**: Right-to-Repair; Internet of Things; Circularity; Socio-technical Imaginaries; Design for Transitions.

**Abstract**: *The Repair Shop 2049* was a pilot research project which explored the limitations of current *Right-to-Repair legislation* which does not account for the repair of 'smart' *Internet of Things* (IoT) devices. It is estimated that by 2030, there will be over 30 billion 'smart' Internet of Things devices in active use worldwide. Unfortunately, with their lifespans designed to be short, most current IoT devices will end up in landfill in the form of electronic waste. Using the notion of a future high street 'Repair Shop' as its lens, the project team collaborated with partner *The Making Rooms*, Blackburn's community digital fabrication lab, to bring together key stakeholders, including repairers/makers, civic leaders, device end-users and manufacturing representatives, to collectively envision pathways for developing new localised, sustainable IoT device repair ecosystems and circular economies. This paper outlines how the project used novel design research approaches *co-design* and *speculative design* to better understand how citizens' might be empowered to increase IoT device Right-to-Repair within their local communities. We conclude by presenting elements of our findings including an initial vision for a *Localised IoT Device Circularity* framework as co-created with research participants, and a wider *Socio-technical Imaginary for a IoT Repair ecosystem* which illustrates the independent and interdependent relations between *bottom-up* and *top-down* stakeholders that must be negotiated to improve IoT device repair.

## Introduction

In 2021 alone, the world generated 57.4M tonnes of electronic waste (e-waste), a figure which is expected to increase to 74.7 by 2030 (Forti et al, 2020). Mirroring the EU's *Circular Economy Action Plan* (2020), to stymie product obsolescence the UK introduced *Right-to-Repair* (R2R) legislation in July 2021 (Conway, 2021). Whilst the R2R is undoubtedly a step forward in tackling obsolescence and e-waste, the legislation's efficacy is reliant on consumers availing themselves of this right. Given that repairing and maintaining devices will often require specialist knowledge and tools, it is presently difficult to assess how effective this right may prove to be in practice.

This deficiency is compounded by the rapid rise in the unsustainable consumption of so-called 'smart' *Internet of Things* (IoT) devices (Stead et al, 2019). It is estimated that by 2030, there will be over 30 billion active consumer IoT devices worldwide (Vailshery, 2022), yet the current R2R legislation does not account for the repair of IoT repair. Furthermore, IoT devices like phones, voice assistants and wearables (Figure 1) are susceptible to *systemised obsolescence*, in that they can easily become 'bricked' or inoperable when their physical hardware no longer supports the latest software or other changes to digital functionality (Stead & Coulton, 2022).

Thus, to empower citizens and their communities with the capacity to effectively increase IoT product repair, manufacturers must be compelled to create devices which bake in hardware and software repairability. In addition, councils and governments must also invest in accessible community repair infrastructures and facilitate local enterprise in innovating new affordable repair support services. Crucially, transitioning to potential futures which proactively 'level up' the R2R by fostering citizen-focussed repair cultures will require the design of new socio-technical ecosystems which leverage ongoing engagement and collaboration between a wide variety of stakeholders including repair experts, technologists, civic leaders, policy makers and indeed, publics.

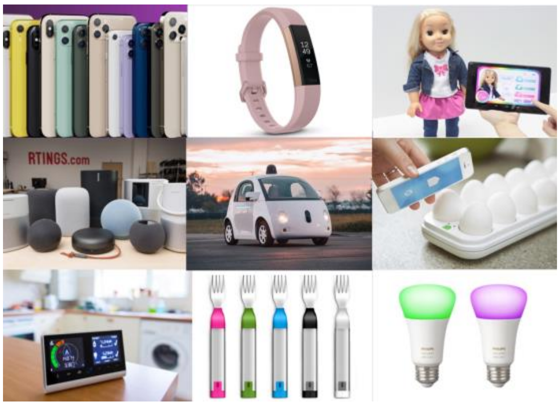


**Figure 1. Everyday IoT devices. © Various, n.d.**

This short paper outlines our pilot project – *The Repair Shop 2049* – which explored how novel design research approaches including *co-design* (Sanders & Stappers, 2014) and *speculative design* (Coulton et al, 2017) could be harnessed to better understand how citizens' might be empowered to increase IoT device R2R within their local communities, as well as start to develop the socio-technical ecosystems needed to support these activities.

## Co-Designing Sustainable and Equitable Transitions

To start to investigate IoT repair, the research team collaborated closely with *The Making Rooms*, a community fabrication lab based in Blackburn, a post-industrial town in the North-West of England. *The Making Rooms* provides the local community with access and training to a variety of digital creative technologies, activities and skills. For example, citizens can learn to 3D print their own designs, code on open-source hardware and explore more traditional craft techniques like screen printing (Figure 2).

Given this inclusive context, the democratic approach of co-design (Simonsen & Robertson, 2013) was considered an appropriate method to utilise to generate research insights. We accordingly ran a series of co-design workshops with key stakeholders including repairers/makers, civic leaders, manufacturing representatives and citizen device end-users.


**Figure 2. Community, creativity, technology: The Making Rooms. © Authors/The Making Rooms (2022).**

To do so, we appropriated Sanders & Stappers' (2014) 'co-design framework' for the substrate for our workshops' delivery. Our augmented version of this framework centres on transitioning to sustainable and equitable futures and can be seen in Figure 3.

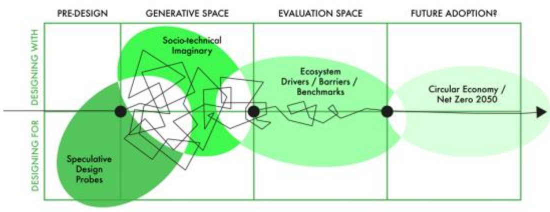


**Figure 3. Co-Designing Sustainable and Equitable Futures framework. © Authors, after Sanders & Stappers (2014).**

Tskeleves et al (2017) stress that it is crucial to include citizens in the developmental phases of technologies, policies and infrastructure that will ultimately have a direct impact upon said citizens when such interventions eventually come into effect across society. Further, empowering people in this way means that they can contribute their own personal experience and knowledge to the discussions and insights that are generated within the creative, collaborative environment (Steen et al, 2011).

## Speculative Repair

To help facilitate our discussions with stakeholder regards future IoT R2R, we incorporated a series of repair-based speculative design probes into the workshops. Sanders & Stappers (2014) contend that this speculative approach allows researchers to create a 'generative space' for both 'designing with' and 'designing for' their participants. We specifically used the speculative design technique *Design Fiction* (Coulton et al, 2017) to create our probes. Our approach built on previous speculative IoT research such as the *Toaster for Life* project (Figure 4) – a fictive IoT device that challenges today's unsustainable IoT status quo by envisioning a mass-produced connected device that is also repairable and reusable through integrated emergent tech including open-source hardware/software, 3D printable modular parts and locally sourced biomaterials (Stead, 2016).


**Figure 4. Toaster for Life – a speculative sustainable IoT device. © Stead (2016).**

We introduced our 'ice breaker' speculative probe – the *Smart Device Bingo game* (Figure 5) – at the beginning of the workshops. We wanted to better understand what types of IoT devices were owned by the participants, which electronic products they believe to be covered by the current R2R, and which devices should be potentially connected to the internet and made 'smart' in the future.

**Figure 5. Smart Device Bingo – a speculative co-design workshop activity. © Authors (2022).**

Secondly, we installed what we termed a *Self Service IoT Repair Station* into the workshop setting (Figure 6). Seeking to visibly demonstrate the range of equipment and expertise required to carry out localised IoT repair, participants were able to tangibly engage with this probe. This 'speculative enactment' technique drew upon Elsden et al's (2017) work in particular.

**Figure 6. Speculative IoT Repair Station. © Authors (2022).**

Figure 7 depicts the outcome of our third speculative activity. We asked participants to work together to identify the key stakeholders – the 'who's who' – required to build an effective and resilient future local IoT repair ecosystem.

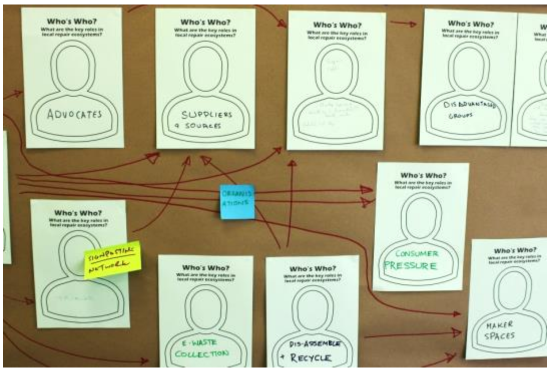


**Figure 7. Who's Who? in Local IoT Repair. © Authors (2022).**

Ultimately, our probes were a means to provoke discourse and ideation practices amongst the workshop participants (Knutz et al, 2014). As Huusko et al (2018) emphasise, such probes can be "used as a workshop tool [but] while the workshop context creates certain needs for the tool, [the probes] can help in building the workshop."

## Analysis
Our 2 workshops with 21 participants produced a gamut of qualitative data. To map and identify key insights from this data, we employed the method *thematic analysis*. Gibbs (2007) explains how this technique can be harnessed to code and index participants' qualitative data, and then categorise the material in order to draw together 'common themes.' Unlike quantitative data, qualitative insights can be strongly reflective of constructivist worldviews and thus, often convey participants' socially constructed nature of reality (Rampino & Colombo, 2012). This attribute is important for our research as we wanted to better understand participants' current experience of IoT repair, as well as, their perceptions and requirements for how it can be improved in the future.

We followed Braun & Clarke's (2006) established *thematic analysis* process of *data familiarisation* and *manual iterative coding*. Due to the dataset's size, it is not possible to detail here all of the collected qualitative material nor the full coding process in this short paper. However, a selection of our coding during the mapping process on a collaborative board can be seen in Figure 8.


**Figure 8. Thematic analysis of workshop data. © Authors (2022).**

## Key Findings
Through our analysis, we identified six key themes. Whilst there were a number of other insights covered, the six themes represent the most prominent recurring topics that were both discussed between multiple participants. Braun & Clarke (2006) describe such an outcome as "patterns of shared meaning underpinned by a central concept."

1. The Difficulties of Repair
Participants discussed how devices' warranties often become void if repair work is attempted by anybody other than the original manufacturer. This annulment can often be triggered even through initial diagnostics to ascertain the root of the problem. Third party repairers were therefore determined to be risk – and therefore repair – averse due to the fears of evoking liability and negating customer warranties. Interestingly, there was also growing concern that should devices become more easily repairable, they could consequently become less reliable and durable due to changes or even deterioration in their physical and digital specifications.

2. Changing Attitudes
Participants felt changing environmental attitudes are likely the result of increased public awareness surrounding the global challenges that modern societies currently face. The prospect of the broadening EU their R2R legislation to include IoT devices was also raised and could lead to reduced e-waste. It was also posited that such a move could also force the hand of the UK government to follow suit and make similar amendments.

3. Opportunities for Education
The participants felt there is potential to improve repair knowledge and education particularly across UK STEM subject curriculums (Science, Technology, Engineering and Mathematics).

4. Distrust in the System
Participants displayed an evident 'distrust in the system' regards both IoT manufacturers' ongoing unsustainable practices, and the lack of local IoT repair infrastructures. They feared the wider introduction of restrictive software by manufacturers to artificially impinge upon – or 'throttle' – their devices' capabilities and consequently limit their hardware and battery lifespan over time. There was also disappointment regards poor local e-waste collection, as well as anger towards the nefarious practices of privileged Global North nations who offset e-waste figures by shipping it to Global South countries rather than improving repair practices.

5. Friction
The term 'friction' was used to describe the barriers faced when trying to dispose of their e-

waste in a sustainably appropriate manner. There is a collective 'want to do the right thing' but it was often unclear what this positive move could or should be and how they might initiate such a shift. They argued improving public awareness would better equip UK communities with basic knowledge for understanding both their repair rights and how to discern if an IoT device is likely to be repairable or requires further investigation from expert repairers.

6. Local Solutions
Collecting e-waste from residents and/or refuse centres for refurbishment and materials and components recovery was posited. Renewed devices might be sold in charity shops, while harvested parts could be dispersed for reuse or recycling. This network could run in conjunction with existing local council and charity networks.

## Co-created R2R Futures

Working with *The Making Rooms* allowed us to focus on a situated context for designing future IoT R2R. Through this context, we were able to better assess and understand the effectiveness of current R2R legislation amongst citizens and communities, as well as consider how far the law must evolve to include IoT repair, which stakeholders should be involved in such developments, and to what extent. In addition, this approach enabled us to begin to consider the role that design-led research can make in facilitating such social and environmental transitions – both in practical and theoretical terms.

### *Localised Circularity*

As well as being effective forums for applying speculative designs, Lyckyi et al (2018) note how participatory activities can also be employed to facilitate "the creation and use of" subsequent speculative design proposals. As depicted in Figure 7, participants were asked to work together to speculate in regards what a future local IoT repair ecosystem might look like – *specifically, could they collectively envision who the key stakeholders in such an ecosystem might be?*

This process led to the co-creation of a *Localised IoT Device Circularity* framework. Figure 9 depicts a graphic iteration of this speculative 'closed loop' vision. It aims for the minimum amount of e-waste to be dispersed to recycling centres, or worse, landfill, by integrating a combination of sustainable channels and responsible stakeholders. It visualises our participants' main concerns regarding the relationship between R2R and IoT devices.

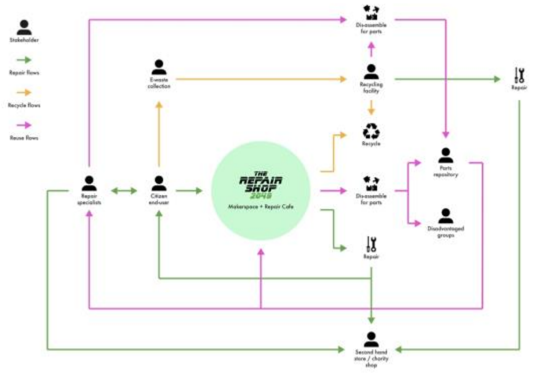

**Figure 9. Localised IoT Device Circularity framework. © Authors.**

### *Repair Imaginaries*

The adoption of systemic lenses when considering contemporary socio-technical challenges is seen as increasingly critical to designing and enacting sustainable and equitable futures (Ceschin & Gaziulusoy, 2016; Design Council, 2021). Mattern (2018) concurs, noting how, to manage care and repair of modern yet often disposable technologies, *'maintenance has taken on new resonance as a theoretical framework, an ethos, a methodology, and a political cause.'* Reflecting this need, we developed a *Socio-technical Imaginary for a IoT repair ecosystem* (Figure 10), based upon the workshop data.

**Figure 10. Socio-technical Imaginary for a IoT Repair Ecosystem. © Authors, after Coldicutt, Williams & Barron (2021).**

To make IoT device repair truly effective on a local level, wider stakeholders would also need to be engaged and galvanised. Figure 10 illustrates the workshops' participants' strong desire for IoT repair practices, skills and technologies to be made accessible by building channels and connections between multiple 'glocal' stakeholders. Core to this vision are key agents of the *open movement* – *Fab Labs* and social innovation like *The Repair Shop 2049* vision – as well as more mindful manufacturers like *Fairphone* (2023) and *Nokia* (2023).

The imaginary also illustrates the ongoing interplay and tensions between the *bottom-up* and *top-down* actors. Due to this complexity, Coldicutt et al (2021) stress how *bottom-up* endeavours are "not always optimised to capture disparate weak signals [and] are often convened to deliberate on issues that can be observed or anticipated by those with traditional power." This tension, they contend, places limits on the potential for alternative 'unofficial' futures to open up. As we move forward, we hope that by listening to a broad spectrum of stakeholders, we can respond to weak signals and collectively challenge the current R2R legislation to co-design resilient IoT repair futures.

## Conclusions

Through this research, we have revealed sevral drivers and opportunities that our stakeholders foresee as necessary to scale up IoT R2R practices and infrastructures on a local level. Equally, key barriers and risks were also identified. A key issue is the lack of public awareness of the current R2R and how it falls short with regards to supporting better repairability of existing IoT, and the volumes of devices that will proliferate society in the years to come. Having said this, the workshops importantly confirmed that there is huge community enthusiasm and drive to make local sustainable change.

Using socio-technical imaginaries as a design frame is a particularly effective approach for creating a shared vision of the social, technological, economic, political, and environmental impacts that must be negotiated to achieve constructive, collective change (Jasanoff, 2015; Speed et al, 2019). This method also corresponds with Ceschin & Gaziulusoy (2016) who argue that while the sustainability of individual products and services is important, we must start to design more holistically for the wider infrastructures and ecosystems that give rise to problems like e-waste. Our design-led approach helps us respond to this challenge. It allows us to begin to explore the futures of local social capital, economics, employment and policy design, and how these factors must all be thoroughly considered, and likely redesigned, to enact better IoT repairability.

Consequently, we contend that our findings, although emergent, begin to contribute to growing discourse which calls for community adaptation towards Circular Economy principles (Ellen MacArthur Foundation, 2021) to redress e-waste as well as wider international imperatives to achieve Net Zero 2050 decarbonisation targets (Global Climate Action, 2020; IPCC, 2021).

## Future Work

This preliminary research has helped to lay the foundations for impactful follow-on work (in the form of further funded research) through which the research team will continue to explore the convergence between IoT R2R ecosystems, sustainable socio-technical development and citizen-driven innovation. Next steps will include new workshops to further solidify the granular connections between key stakeholders, supply chains and physical-digital resources. To aid this process, we will also produce more advanced speculative design probes that critique the limitations of today's R2R legislation, while at the same offer potential visions for more sustainable and equitable repair futures.

## Acknowledgments

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## References

Braun, V., & Clarke, V. (2006). Using Thematic Analysis in Psychology, Qualitative Research in Psychology, 3:2, 77-101, DOI: 10.1191/1478088706qp063oa

Ceschin, F., & Gaziulusoy, I. (2016). Design for Sustainability: An Evolutionary Review, in Lloyd, P.

and Bohemia, E. (eds.), Future Focused Thinking - DRS International Conference 2016, 27 - 30 June, Brighton, United Kingdom. https://doi.org/10.21606/drs.2016.59

Coldicutt, R., Williams, A., & Barron, D. (2021). A Constellation of Possible Futures: The Civil Society Observatory Discovery Report. London: Careful Industries http://careful.industries/foresight-observatory/discovery-report

Conway, L. (2021). The Right to Repair Regulations, Research Briefing Number 9302, House of Commons Library. https://researchbriefings.files.parliament.uk/documents/CBP9302/CBP-9302.pdf

Coulton, P., Lindley, J.G., Sturdee, M., & Stead, M. (2017). Design Fiction As World Building. In Proceedings of Research through Design Conference (RTD) 2017, Edinburgh, UK.

Design Council. (2021). Beyond Net Zero: A Systemic Design Approach. https://www.designcouncil.org.uk/fileadmin/uploads/dc/Documents/Beyond%2520Net%2520Zero%2520-%2520A%2520Systemic%2520Design%2520Approach.pdf

Ellen MacArthur Foundation. (2021). Universal Circular Economy Policy Goals: Enabling the Transition to Scale. https://ellenmacarthurfoundation.org/universal-policy-goals/overview

Elsden, C., Chatting, D., Durrant, A.C., Garbett, A, Nissen, B., Vines, J and Kirk, D.S. (2017). On Speculative Enactments,' in Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (CHI '17), New York, ACM, 5386-5399.

European Commission. (2020). Circular Economy Action Plan. https://ec.europa.eu/environment/circular-economy/pdf/new_circular_economy_action_plan.pdf

Fairphone. (2023). https://www.fairphone.com/en/

Forti, V., Bald, C.P., Kuehr, R., & Bel G. (2020). The Global E-waste Monitor 2020: Quantities, Flows & the Circular Economy Potential. United Nations University (UNU)/United Nations Institute for Training & Research (UNITAR) – co-hosted SCYCLE Programme, International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/Geneva/Rotterdam.

Global Climate Action. (2020). Climate Ambition Alliance: Net Zero 2050. https://climateaction.unfccc.int/views/cooperative-initiative-details.html?id=94

Gibbs, G. R. (2007). Analyzing qualitative data. Qualitative Research Kit. London: Sage.

Huusko, M., Wu, Y and Roto, V. (2018). 'Structuring and Engaging: The Roles of Design Fictions In A Co-design Workshop,' in Proceedings of the 30th Australian Conference on Computer-Human Interaction (OzCHI '18). New York, ACM, 234–241.

IPCC. (2021). AR6 Climate Change 2021: The Physical Science Basis: Sixth Assessment Report. https://www.ipcc.ch/report/ar6/wg1/

Jasanoff S. (2015). Future Imperfect: Science, Technology, and the Imaginations of Modernity. In: Jasanoff, S., & Kim, S. (eds) Dreamscapes of Modernity. Chicago: University of Chicago Press.

Knutz E., Markussen, T., and Christensen, P R. (2014). 'The Role of Fiction in Experiments within Design, Art & Architecture,' Artifact, 3, 2 (2014), 8-1.

Lyckvi, S., Roto, V., Buie, E., and Wu, Y. (2018). 'The Role Of Design Fiction In Participatory Design Processes,' in Proceedings of the 10th Nordic Conference on Human-Computer Interaction (NordiCHI '18), New York, ACM, 976–979.

Mattern, S. (2018). 'Maintenance & Care' https://doi.org/10.22269/181120

Nokia. (2023). https://www.nokia.com/phones/en_gb/self-repair

Rampino, L., & Colombo, S. (2012). Method, Strategy or Tool? A Semantic Clarification, in Rampino, L. (ed.) Design Research: Between Scientific Method and Project Praxis, Notes on Doctoral Research in Design, Milano: Franco-Angeli. pp 83-94

Sanders, E. B. N., & Stappers, P. J. (2014). Probes, Toolkits and Prototypes: Three Approaches to Making in Codesigning. CoDesign, 10(1), 5–14. https://doi.org/10.1080/15710882.2014.888183

Simonsen, J., Robertson, T. (2013). Routledge international handbook of participatory design. Routledge, New York

Speed, C., Nissen, B., Pschetz L., Murray-Rust, D., Mehrpouya, H., & Oosthuizen, S. (2019). Designing New Socio-Economic Imaginaries, The Design Journal, 22:sup1, 22572261, DOI: 10.1080/14606925.2019.1595023

Stead, M. (2016). A Toaster for Life: using design fiction to facilitate discussion on the creation of a sustainable Internet Of Things. In P. Lloyd, & E. Bohemia (Eds.), Proceedings of Design Research Society Conference 2016 (Vol. 8, pp. 3049-3068). (Proceedings of DRS 2016; Vol. 8). Design Research Society. https://doi.org/10.21606/drs.2016.455

Stead, M. R., Coulton, P., Lindley, J. G., & Coulton, C. (2019). The Little Book of Sustainability for the Internet of Things. Imagination Lancaster. https://eprints.lancs.ac.uk/id/eprint/131084/1/Stead_Coulton_Lindley_Coulton._2019._The_Little_Book_of_Sustainability_for_the_Internet_of_Things.pdf

Stead, M., and Coulton, P. (2022) A more-than-human right-to-repair, in Lockton, D., Lloyd, P., Lenzi, S. (eds.), DRS2022: Bilbao, 25 June - 3 July, Bilbao, Spain. https://doi.org/10.21606/drs.2022.718

Steen, M., Manschot, M., and De Koning, N. (2011). "Benefits Of Co-design In Service Design Projects,' International Journal of Design, 5(2), 53-60.

Tsekleves, E., Darby, A., Whicher, A., & Swiatek, P. (2017). Co-designing Design Fictions: A New Approach for Debating and Priming Future Healthcare Technologies and Services. Archives of Design Research, 30, 2: 5–21.

Vailshery, L. S. (2022). Number of Internet of Things (IoT) connected devices worldwide from 2019 to 2021, with forecasts from 2022 to 2030. https://www.statista.com/statistics/1183457/iot-connected-devices-worldwide