More-than-Human Making:

Crafting Pedagogic Engagement Tools to Accelerate Sustainable Technology Transitions

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ABSTRACT

Re:Play is an educational toolkit designed to support citizen learning regards *Internet of Things* hardware/software repair and *Circular Economy* principles. Re:Play consists of a broken games console with several 'issues' that users' must fix via creative and ludic 'hands on' repair exercises. As the user completes fixes, the more games they can play and the more functional the device becomes. Using the frame of a *design conjecture*, this short position paper outlines the instructional practices and pedagogy that support users' engagement with Re:Play and the *More-than-Human* sustainability knowledges these interactions begin to engender.

CCS CONCEPTS

• Human-centered computing • Collaborative and social computing • Collaborative and social computing devices

KEYWORDS

Sustainable Technology Transitions, More-than-Human Design Pedagogy, Physical Computing, Circular Digital Craft

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1 Introduction

57.4M tonnes of electronic waste (e-waste) (Figure 1) were generated globally in 2021 alone – a figure expected to increase to 74.7M tonnes by 2030 [1]. This deluge is exacerbated by the rise in the unsustainable consumption of so-called 'smart' *Internet of Things* (IoT) devices [2]. It is estimated that by 2030, there will be over 30 billion active consumer IoT devices like phones, voice assistants and wearables (Figure 2) worldwide [3]. Whilst the UK's *Right-to-Repair* (R2R) legislation [4] is, to a degree, helping to stymie device obsolescence and e-waste, the legislation's efficacy is reliant on citizen end-users availing themselves of this right. Moreover, the current R2R does not support repair of IoT devices, ostensibly due to their complex combination of hardware/software.

To enable citizens/communities to increase IoT product repair, manufacturers must create devices that bake in hardware/software repairability [5]. It is also critical that people become empowered with the deeper knowledge, skills and tools required for completing such repair activities. Developed as part of a UK AHRC funded project called *Generation Fix*, Re:Play is an educational toolkit designed to support citizen learning regards IoT hardware/software repair and *Circular Economy* principles [6]. Re:Play consists of a broken games console with several 'issues' that users' must fix via creative and ludic 'hands on' repair exercises. As the user completes fixes, the more games they can play and the more functional the device becomes. Using the frame of a *design conjecture*, this short position paper outlines the instructional practices and pedagogy that support users' engagement with Re:Play and the *More-than-Human* sustainability knowledges these interactions begin to engender.

Figure 1: Electronic Waste (e-waste). © Damrong.

2 More-than-Human Design Pedagogy

A dearth of information regarding electronic device repair practices and citizens' repair rights is available to the UK public. Within the

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Figure 2: Everyday 'smart' IoT devices. © Various.

country's secondary education system, *Design & Technology* would have traditionally provided 14–16-year-olds with practical skills, knowledge and confidence needed to conduct repair practices during and beyond school age. However, the number of children taking *Design & Technology* at UK GCSE level have fallen 68% since 2014 [7]. Scholars also emphasise how a richer combination of ontological, epistemic and systemic thinking should also be fundamental to design-oriented sustainable pedagogy. For example, Escobar [8] urges design-led education to "transition from the hegemony of modernity's one-world ontology to a pluriverse of socio-natural configurations." Such a shift requires new design frameworks which can account for the deepening physical and meta-physical entanglements between "place, the environment, experience, politics, and the role of digital technologies in transforming design contexts" [8].

As Figure 3 illustrates, through consideration of More-than-Human-Centred Design, educators can acknowledge that humans must become decentred in design practice and its outputs [9] – our existence is interdependent with a host of non-human actants which are emotionally, economically, ecologically, and morally independent of each other [10]. Importantly, the More-than-Human-Centred lens affords the opportunity to explore the growing impact of technological non-human actants – e.g., data, algorithms, Artificial Intelligence, smart devices and robotics – upon the other ecological non-human and human actants that exist within the same design assemblages [10]. In this way, More-than-Human-Centred Design pedagogy challenges theoretical and practice orthodoxies. As Micklethwaite [11] notes, where the creation of physical products was once preeminent in design pedagogy, it "can now be critiqued by an understanding that sustainability is an emergent property of systems, not a feature of products" and educators must now attend "more to the context of how and why products are made."

3 More-than-Human Making: A Design Conjecture

Embodying the More-than-Human-Centred Design considerations, Re:Play (Figure 4) physicalises key repair challenges which arise from contemporary unsustainable device design – yet it also provides tangible opportunities for sustainable problem-solving

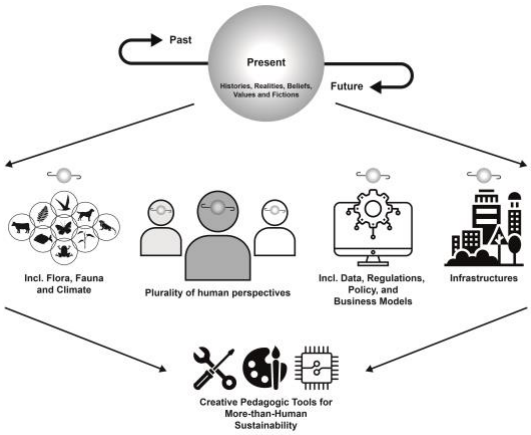

Figure 3: More-than-Human pedagogic considerations, after [5] and Gonzatto, van Amstel, Merkle, & Hartmann [12].

and decision-making. By offering users a practical pedagogic framework for repair, Re:Play supports users to engage in reflective More-than-Human exploration. This endeavour is increasingly seen as crucial for HCI discourse given the growing onset of climate change and the unsustainability of ubiquitous digital technologies including IoT devices [13]. The frame of a *design conjecture* [14] is used to outline the design process of Re:Play's creation, its material embodiment and its pedagogic intent.

Figure 4: The Re:Play educational toolkit.

3.1 Context

The *Generation Fix* project is a collaboration with *The Making Rooms*, a community makerspace based in Blackburn, a post-industrial town in the North-West of England (Figure 5). *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 6).

Given this inclusive and democratic context, *Co-Design* [15] was considered the most appropriate method to use to develop Re:Play directly in conjunction with *The Making Rooms* team. As Tskeleves et al [16] stress, it is crucial to include the community in the development phases of technologies, policies and infrastructure that will ultimately have a direct impact upon said community. The Co-Design procees was rooted upon a constructionist *Research through Design* (RtD) methodology which afforded the generation of new knowledge through design-led making, tacit material engagement and critical reflection [17].

Figure 5: The Making Rooms in Blackburn town centre, UK.

Figure 6: A vibrant, creative makerspace community.

3.2 Embodiment

To combat e-waste, particularly that caused by IoT 'smart' products, Re:Play aims to accelerate Circular Economy skills and know-how regards electronics/digital technology repair within local communities. To do so, the kit provides users with the opportunity to fix, upgrade and customise an initially non-functional handheld electronic gaming device. The kit contains all of the componentry, materials and tools required to diagnose and fix Re:Play, e.g., callipers, Multimeter and 3D print pen. (Figure 7).

Safety reasons notwithstanding, most electronic devices are difficult to dis-assemble and repair for manufacturer-controlled economic reasons, e.g., planned obsolescence and iterative release cycles [18]. As a result, end-users, particularly children, have limited opportunities to explore and learn how devices are made, how they operate and what they are composed of. This strips them of their right to tackle even the simplest of repair activities independently – such as changing a fuse (Figure 8).

Figure 7: Re:Play's parts, components, tools and materials.

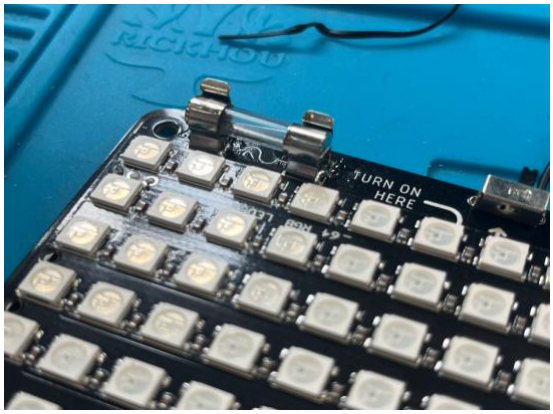

Figure 8: Fixing begins with simple steps like installing a fuse.

3.3 Mediating Processes

The kit helps to 'open up the hood' of unsustainable electronic device design and makes technology repair and circularity processes more visible, safe and fun. Through structured yet independent play, Re:Play aims to empower users by improving their knowledge and confidence and engendering sustainable, more-than-human literacy through interactive creative exploration. To make Re:Play fully functional, users must follow a set of instructions to diagnose and address repair issues with the device. Further, by incrementally fixing the problems, users are rewarded with enhanced gameplay, that is, more game functionality is unlocked as more fixes are completed.

The repair activities range from very simple linear problems, e.g., installing a fuse (Figure 8) or charging flat batteries, to more complex repairs, e.g., soldering a trace (Figure 9). This scaffolding of tasks [19] also encourages reflection, problem-solving and decision-making. Many of the non-functioning components can be repaired in different ways and users must personally decide what works best functionally but also aesthetically (Figure 10).

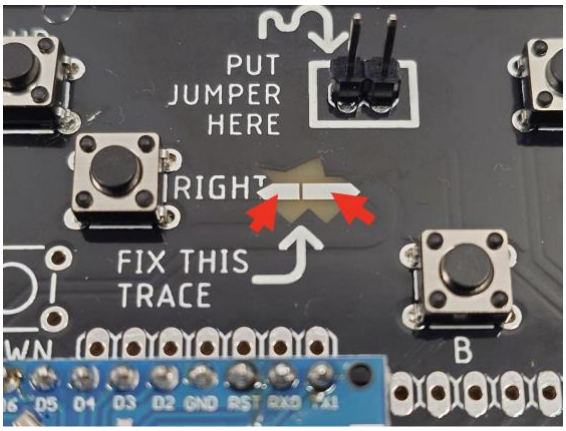

Figure 9: More intricate tasks e.g. 'bridging' a trace with solder.

Figure 10: Kintsugi via 3D printer pen.

3.4 Outcomes

Re:Play aims inspire learning regards how to fix things through interactive engagement that is both educational and fun (Figure 11). This duality is important to engage the broadest audience in dialogue and reflection on repair and Circular Economy thinking, particularly children. Empowering younger generations with knowledge, skills and tools they need to act more sustainably has recently been highlighted by the UK Government as a key pedagogic priority [20]. By imbuing these skills early on, children will hopefully continue to apply them into adulthood.

The toolkit is designed to be used even after the user has finished fixing their game device. They can leverage the knowledge they have developed to reconfigure the device and reuse the components for another prototype or within other electronics. A series of Co-Design workshops (Figure 12) with key stakeholders including repairers/makers, civic leaders, manufacturing representatives and citizen device end-users are play testing this first iteration of Re:Play. The insights will inform its second-generation design.

Figure 11: Empowering citizens/communities

Figure 12: Testing and evaluating Re:Play during a workshop.

4 Conclusion

UK citizens are increasingly beginning to understand the environmental and social value of repairing their IoT devices and exhibit a deep enthusiasm for conducting repairs themselves. Nevertheless, there exists a fundamental 'repair skills gap' across local communities [5]. Using a *design conjecture* framing, this paper has outlined how the Re:Play educational toolkit aims to help close this gap through creative, More-than-Human pedagogic engagement.

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