Design Futures, Ecological Citizenship & Public Interest Technologies = HCI Regenerative Interaction Opportunities …?

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Design practice(s) improve circumstances applying foresight, instigating creative *Human Computer Interaction* (HCI) proposals within systems. HCI physically and digitally embodies technologies through human touchpoints. We refer to HCI points as *Public-Interest Technology* (PITs), a growing field comprising expertise working to ensure technology is created, deployed, and used responsibly. This article reports on design-led opportunities combining *Design Futures* (Domain 1) and *Ecological Citizenship* (Domain 2), questioning *Public-Interest Technologies* (Domain 3).

Design Futures navigates 'preferable futures' based on real-world, tangible situations within the context of climate futures and stewardship of environment(s) we rely upon for 'all life'. *Ecological Citizen(s)* catalyzes empowered agents, informing *Public-Interest Technologies* as (at this point in history) the people of the UK have never been so excluded, disconnected, and deprived from our natural world(s). Interested parties do both actions; calling out where technologies improve the public good, and questioning whether certain technologies should be created. Insights are appropriate to the HCI community as they cultivate design and community-led opportunities for technologies in the field, through design practice-led approaches.

We report on a *Regenerative Design Field Kit* with *Smithery* consultancy, deployment with Royal College of Art MDes Design Futures students. We highlight the toolkit's development, precedents, leading to a *Field Kit*. The parts: a viewing frame, (teaching tool) facilitating the examination of worlds and 40 core questions based on The Design Council's systemic design framework and the RSA's 10 core capabilities. Work yields valuable insights from Domains (1–3), mapping HCI opportunities for *Ecological Citizenship* within PITs.

Keywords: Ecological Citizenship, Design Principles, Regenerative Design.

1   Introduction

This article reports on a *Regenerative Design Field Kit* combining; design futures, ecological citizenship with the means for students to instigate, question and cultivate *Public-Interest Technologies* (PITs). We specifically report on the use of a bespoke *Regenerative Design Field Kit* (Field Kit) with Design Futures students, mapping HCI opportunities for Ecological Citizenship, within PITs. *Public-Interest Technology* comprises "technologists [and designers] working to ensure technology is created and used responsibly. [Parties] call out where technology can improve for the public good, question[ing] whether certain technologies should be created at all. PITs combine perspectives with a knowledge of the way technology works and an understanding of the ethical, legal, policy and societal concerns that shape our world" [1].

Modelled after public-interest law, PITs work to ensure technology is designed, deployed, and regulated, protect[ing] and improv[ing] the lives of people, centering values of equity, inclusion, and accountability where public interest is a priority. PITs are simultaneously a positive catalyst juxtaposed with serious (unseen) negative ramifications requiring review, not polarisation. A contemporary example, *'Hello Barbie'* (technological child's toy) "carried everywhere [children] and their parents go, could be the ultimate in audio surveillance device for miscreant hackers" [2]. In the early days of social media, particularly *Facebook*, security agencies advised publics against "post[ing] social media status update[s] indicating their vacations, as [you may as well] leave your home's front door open" [3].

Strava fitness geo-locating app, not only helps people "navigate air pollution whilst exercising" [4], but also required review as (historically) "its heatmap feature enable[d] stalkers and predators to track users to their home addresses and commit felonies" [5]. Even '*find my phone*', a useful smartphone feature, (historically) caused implications for domestic violence [6]. Finally, technologies, i.e., 3D printers (the championed 'make anything anywhere tech'), have been used to fabricate untraceable working firearms [7].

These well-intentioned technologies require contextualisation, care, inverse questioning, empathy, culture, deployment and unpicking for applications and continuously questioning activities post techno-solutionism [8]. It is not our desire to populate spaces with 'future' technologies, but to unpick potential pitfalls, benefits, and opportunities within this space to mitigate against unsustainable challenges. This article navigates three domains: *Design Futures (DF)* (Domain 1), *Ecological Citizenship (EC)* (Domain 2) and PITs (Domain 3). It shares the rationale, methodology and HCI opportunities, specifically identifying touchpoints for future interventions and proposals.

1.1   (D1) Design Futures

DF has many definitions, design fiction [9] or speculative design, but it is not a metaphorical crystal ball or science-fiction tool. We view DF alongside Hopkins [10] from *What Is to What If?* – navigating preferable futures. In a turbulent era for nature, planet, and people, how we navigate futures is paramount. DF (at the Royal College of Art) "is designed to enable work across all disciplines and beyond, build future-shaping knowledge and skills, address the challenges we face, envision and then navigate towards a preferred future through design-led interventions" [11]. Preferable as in "those we think 'should' or 'ought to' happen: normative value judgements as opposed to the mostly cognitive" and preferred futures encompass "what 'should' or 'ought to' happen – can take in any or all of the classes from preposterous to projected, because these futures must be at least imaginable" [12]. We see it as steps to progress, unpick and navigate unsustainable consequences of our global actions.

The 'craft' of DF is navigating; "inquisitiveness over predictability, bridging today and tomorrow, crafting future narratives, being champions for a better future and tackling long-term challenges" [13]. Futures are seen by businesses as foresight tools, bringing strategic resilience and means to navigate challenges and opportunities. Foresight "tools can use hard evidence or exploit creativity and imagination. They may be based on insights from an expert pool or collective thinking and promote participation" [14]. DF methods can include comprehensive qualitative or quantitative studies or lighter touch *Headlines from the Future* activities [15]. DF is not bound by one 'industry' or skill-set, but a craft, applying what is happening contextually, and identifying emergence in between the things that currently exist.

DF focuses on resilience and how that translates to sustainable practices, using design as a means to explore positive action within climate futures [16]– in a world where islands are taking countries to court [17], young people are advocating for change [18] and governments refuse to seek nature-based solutions [19]. At the moment our human existence (not technologies) are constant as technologies change – the difference is, in time we often think differently; for example the unknown health impacts of diets [20], that smoking tobacco was considered (historically) 'cool' [21], the need to keep 'plastics' on a tighter leash [22], questioning global travel [23] and the historical life of 'ultra-processed foods' [24].

1.2   (D2) Ecological Citizenship

EC is defined as accessible activities and skills establishing sustainable practice(s) and/or addressing ecological inequalities. This is encompassed in our approach — to our contextual surroundings, materials we use (and more) as an act of citizenship to-wards each other and the ecosystem. We "are (all) citizens of the world, with the natural environment sustaining all life on earth. Our human existence is intertwined with our environment; we live in, and are 'citizens' of, that environment. EC fosters positive, ecological behaviours involving and benefiting communities through individual and collective action(s)" [25]. The domain constantly questions 'what being a citizen means.' Unconcerned with place, or judicial waters, but with what it means to be

empowered in place(s) you live, work, and contribute to… yielding 'better' for all. Citizen is a contentious term, we frame it as an opportunity for interested parties to have agency, enabling new sustainable practices. Stepping into the "citizen story, we recognise that context not only cannot be ignored, but that context is all. As citizens we must develop a sense of belonging in community, cultivate relationships with one another, help heal each other, and collectively build the world" [26]. *The Royal Society for the Encouragement of Arts, Manufactures and Commerce* (RSA) believes we are in an "economic, social and environmental crisis that has placed our world in a fragile, unbalanced and degenerative state" [27]. Their strategic aims are moving from 'sustain' "to 'do less harm' to the planet" to regenerate "seek[ing] to learn from Earth's living systems and look to regenerative future[s]" [28]. Regenerative design "has the goal of producing [outputs] with a net-positive impact on surroundings – restoring or improving their locales rather than aiming for less harm" [29]. Regenerative futures [30] are both; 1) a way of seeing the world, long rooted in many cultures, religions, and wisdom traditions around the globe, which is less present in dominant economic and social systems today; 2) An emerging paradigm, which looks to deepen notions of sustainability by taking a holistic approach to address current challenges [31]. Regenerative approaches are interlinked with Ecological Citizen(s), as they foster long-term agency in post-sustainable futures [32]. Sustainable futures are organizationaly run and top-down, post sustainable futures enable autonomy and decision making to its intended audience.

1.3   (D3) Public-Interest Technologies

Public-Interest Technology "is a growing field of technologists who work to ensure technology is created and used responsibly. Technologists call out where technology can improve for the public good, and sometimes question whether certain technologies should be created at all" [33]. In a leading *Freedman* report PIT challenges "are real and numerous, they are surpassed by the tremendous opportunities for action" [34]. Beyond access, "the challenge of PITs is the urgent need to create a new level of literacy, one that empowers [learners] not only to have access, but to be more selective and more integrative in information they receive" [35]. PITs are defined as the "application of design, data, and delivery to advance the public interest and promote the public good in the digital age" [36]. A "common mistake people make when trying to improve or modernise something is believing that digital will always be better. Digitising a broken paper process does not make it better" [37]. We see PITs as a means for collaborative, ethical and democratised action, providing technologies that protect individual rights and improve people's lives.

1.4   Uniting Domains

These domains coalesce, creating more ecologically, environmentally, and sustainably preferable futures. A contemporary approach is citizen science, for example "proving the River Wye was polluted" [38], or volunteer anglers monitoring for water quality as there is "limited government funding" with citizens looking after spaces they occupy [39]. The concept of "regeneration is inherently layered, complex, and evolving. It can have spiritual, ecological, and even medical connotations. Regardless of context, however, regeneration evokes hopeful themes of renewal, revival, rebirth, and restoration" [40]. Prospective design is a means of 'futures' believing that "Prospective Design is, in itself, a relation that discovers new possible relations in alternative presents, here and

now" [41]. Fig. 1, maps (known) analogue and digital intervention exemplars. We do not believe that 'technology' or futures only uses 'high-tech', but is appropriate and contextual to its surroundings, as represented in the following examples:

1. Historic Analogue Technology: a *Crinkle Crankle Wall 1}* "a curved structure taking fewer bricks to build than straight ones, gaining structural support from its sinuous shape, whilst a straight wall needs to be strengthened using buttresses" [42]. A process and technological knowledge that crosses domains.

2. Analogue Technology, Facilitating Digital; *Coast Snap 2}* hosts camera mount points around the Southwest coastline. Public smartphones are (momentarily) placed in camera mounts. Captured photos (taken from the mount) are shared with scientists offering "insights to a changing coastal environment including; beach erosion/accretion events to weather conditions, seasonal fluctuations and extreme storm events" [43]. A design mechanism that is cost and contextually effective.

3. Digital Technology: *Smart Citizens Kit 3}* "comprises various sensors measuring environmental parameters like temperature, humidity, noise levels, and air quality. This versatile tool empowers citizens to monitor surroundings, generate valuable data, and actively participate in creating solutions for their communities" [44]. A great resource that creates 'informed citizens'.
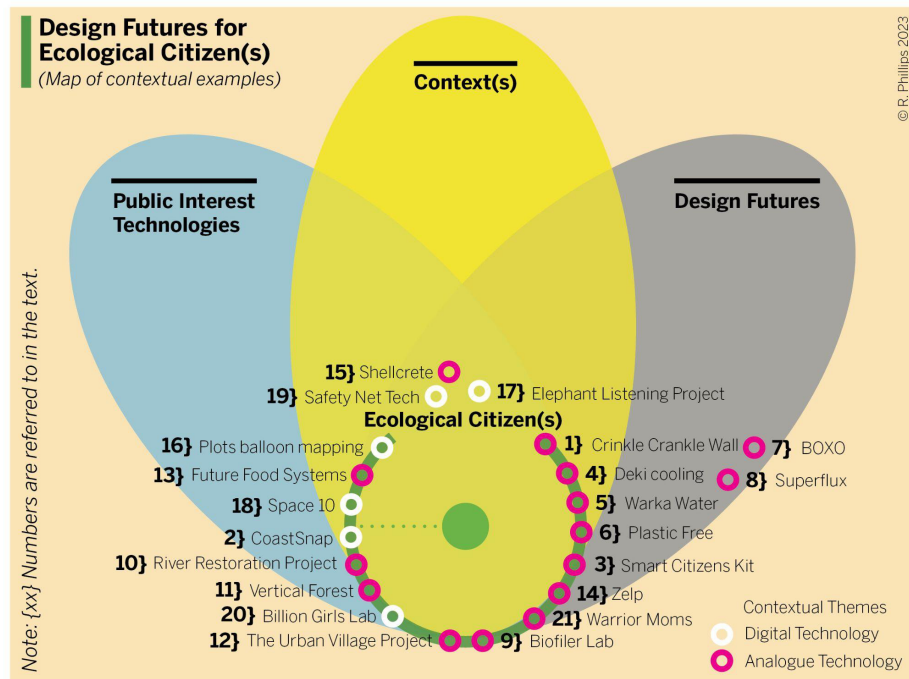

Fig. 1. Wider context of the design space. references and links within the map; **4}** Deki cooling [45], **5}** Warka Water [46], **6}** Plastic Free [47], **7}** BOXO [48], **8}** Superflux [49], **9}** Biofilter Lab [50], **10}** River Restoration Project [51], **11}** Vertical Forest [52], **12}** The Urban Village Project [53], **13}** Future Food Systems [54], **14}** Zelp [55], **15}** Shellcrete [56], **16}** Plots balloon

mapping [57], **17}** Elephant Listening Project [58], **18}** Space 10 [59], **19}** Safety Net Tech [60], **20}** Billion Girls Lab [61], **21}** Warrior Moms [62].

2   Method

Toolkit design | Design toolkits are means to help frame propositions, proposals, and prototypes. They are a set of parameters that operate as boundary objects [63]. Topics covered in our literature review included stewardship [64], play [65], circular design and more. We reviewed all and built on their processes, means and tools. Finally, we built on practitioner examples of a "resources audit", something that *Local Works Studio* do, navigating material mechanisms that are local to the building site [66]. Toolkits are "boundary tools" to help define and provide focus [67]. This article combines the domains (previously outlined) to show that they are accessible and provocative. It provides a framework for regenerative thinking, prototyping, and doing. The bespoke *Regenerative Design Field Kit (Field Kit)* offered *Design Futures* students mapping HCI opportunities for *Ecological Citizenship*, within PITs. The *Field Kit* was formed of three parts, created collaboratively and iteratively over time with: *Smithery, Thornton, A, & Shupak, L, and students*.

The first part, a viewing frame with core questions (What is this? What is it for? When is it used? etc.) was iteratively developed as a teaching tool. It is a prosthetic for thinking, for helping people to stand in the world and examine it more carefully *today*. The viewer is an *obliquiscope* [68]. It draws your focus to different layers of an object or situation, to see the world in new ways by asking *WHAT IS THIS?* The second part is the core challenge for people to hold on to as they step into the future. Reworking the Charles and Ray Eames motto (*'the best for the most for the least'*) for 21st Century regenerative design, it asks the holder to "design for the healthiest environment, for all of society, with the greatest economy" [69]. The third part of the field kit is a set of forty core questions, created from a matrix which combines the Design Council's "four roles from the systemic design framework" [70], and the *RSA's 10 C's*, "core capabilities for work in the 21st Century" [71].

Each question combines a role you could be playing, and a capability you want to develop. The four roles and ten capabilities give you direct questions you could ask of yourself, others, a team or indeed society, more broadly. They are meant to be questions which, depending on the context, are hard to answer. The challenges we face today are not insignificant. These questions, taken in combination, give us much to think about, but also a great deal for the collective imagination to tackle. For example, in the role of a *system thinker*, displaying *care* as a capability, the associated question becomes '*If you make the first change you think of, who won't benefit?*'. Participant demographic (MDes), was a mix of UK and international students, many of whom have have completed 2–3 years in industry in appropriate design industries from UX, service, product, industrial etc. The tensions around trying to hold all three of these ideas together in the same place is where people can start to find new points for intervention.

Participants were issued with a *Field Kit*, readings, and contexts to explore over three weeks. The main challenge, on the reverse of each card, is; 1) how do you design the

healthiest environment, 2) with the greatest economy, and 3) for all in society. Participants were trained in the use of the *Field Kit* and underwent an orientation exercise before they started to map 'opportunities for what [they] viewed (through the obliquiscope) and how it could inform ecological citizenship'. Students were given support and asked to catalogue six images per person, to restrict the scope, specifically explaining the image identifying the opportunity for *"what you viewed and how it could inform ecological citizenship".*

Over 55 participants contributed towards the gathered evidence. This was achieved through upload-able content, in the form of photographs and 100-word explanations of each image. Imagery was collected through an online portal over the course of one month. Thematic analysis was used by authors to map HCI opportunities for *Ecological Citizenship*, within PITs. The observations and notes through the DF students, were gathered on a digital platform, then mapped thematically against the following themes; *Embedded Interactions*, *Resource Access*, *Sustainable Alternatives*, and *Background System(s)*. Outlying data/images were removed or discounted from the thematic analysis if there was no description (provided by participants) or if it was repeated by another individual. These themes are specific with direct 'functionality' tangible for HCI communities/practitioners to scaffold off in multiple contexts.

3   Results

1) Embedded Interactions: are defined as "the technological and conceptual phenomena of seamlessly integrating the means for interaction into everyday artefacts. Technically, this requires embedding sensing, actuation, processing, and networking into common objects. Conceptually, it requires embedding interaction into users' everyday tasks" [72]. These are interactions that are built 'into' our environment, are accessible and not reliant on sole individuals, or siloed organisations. Examples of *Embedded Interactions* are train-ticket machines, public toilets, or supermarket self-checkouts.
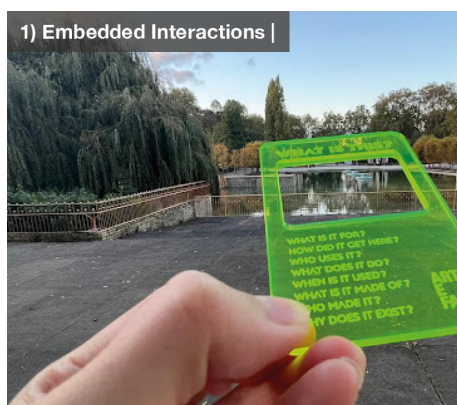
Public rainwater harvesting, that is used for irrigation. *Image Credit ©Qiqi 2023 |*

Self navigation within the context of efficient journeys, experiences. *Image Credit ©Trisha 2023 |*

Fig. 2. Examples of embedded interactions.

Participant insights included (Fig. 2); i) Rainwater harvesting in public / private buildings and how community resources can be shared. Scenarios included potential models of how you would rent your roof to organisations for rain harvesting, a parallel to solar power. ii) Food inventories (based on retail activity) and how that information can be stored, shared, or used to reduce waste. iii) Reviewing 'ticket machines' as financial assets. These are embedded systems holding other functions (i.e., charitable donation, or local payment where digital/physical finance is an issue). iv) Water use / consumption and how that can be beneficial to know / share local resources.

2) Resource Access: we define it as the access to resources within ethical and inclusive means, rather than hierarchical structures. Resources refer to useful or valuable possession or quality of a country, organisation, or person.

Perception of waste. *Credit ©Ibrahim 2023 |*

Open resources for wider situations. *Credit ©Trisha 2023 |*

Biodiversity resources for all. *Credit ©Maria 2023 |*

Fig. 3. Examples of resource access

Participant insights included (Fig. 3); i) Public communication points, e.g., public phone booths, charging stations and wayfinding. ii) Non-public/public resources e.g., sports clubs, wildlife properties, sports pitches, and libraries are public assets with amenities worthy of opening or consideration of how they can regenerate their environment. iii) Increasing biodiversity and how we can use digital means to perform transects, create accessible ecological records and positive parallel examples where we can all learn internationally from diverse cultures.

3) Regenerative Alternatives: defined as materials, sources and interventions that are proactively rejuvenating areas, means, materials or locations involved. To "regenerate" means to be formed or created again, restored to a better, higher, or more worthy state, to generate or produce anew, or to restore to original strength or properties" [73].
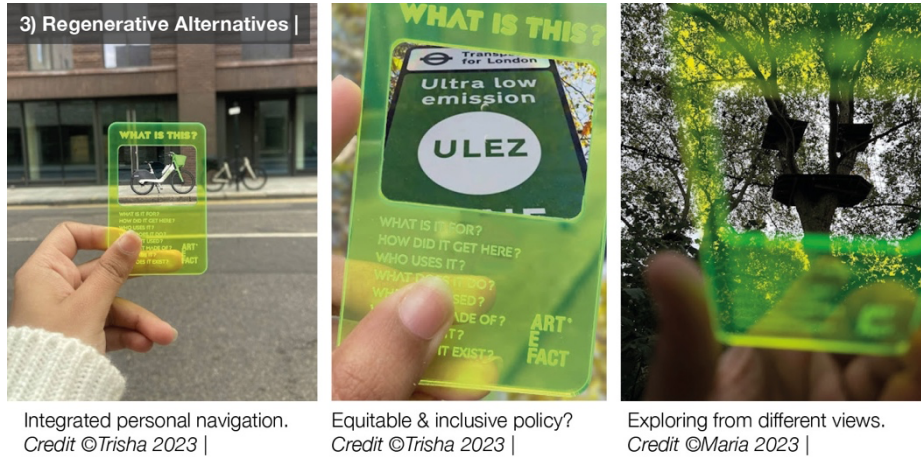
Integrated personal navigation.
Credit ©Trisha 2023 |

Equitable & inclusive policy?
Credit ©Trisha 2023 |

Exploring from different views.
Credit ©Maria 2023 |

Fig. 4. Examples of regenerative alternatives

Participant insights included (Fig. 4); i) Public Transportation, and optimisation of resources not from a cost-benefit, but from a journey or engine efficiency perspective. ii) Personal Navigation, looking at footfall and complimentary subsidiary services, for example community delivery services or similar. iii) Scenario Impact Mitigation, foreseeing and unpicking certain actions to find probable impacts on resources and how those could be benefitted, for example water use or ethical purchasing. iv) Parallel Growing Conditions, comprehending international food growing conditions so growers can benefit from prior knowledge in ever-changing emerging conditions. New Economies, alternate means of trading, earning based on non-conventional constructs. For example, time sharing, skills exchange, non-financial transactions or digital 'Saturday jobs'.

Background System(s): we define this as a process that runs behind the scenes (i.e., in the background) but can leverage other interventions for interested parties. More specifically clearly communicating how systems operate and their subsidiary interconnections. These things are imperative so that more ecological and sustainable choices can be made (where possible). It is a series of interactions and touchpoints that can bring agency to decision makers.

When is something truly waste?
Credit ©Shaivi 2023 |

Material passports and the depth of everything
'made'*Credit ©Shaivi 2023 |*

Fig. 5. Examples of background systems.

Participant insights included (Fig. 5); i) Ethical Material Passports, a means to comprehend all details of materiality, sustainability, and production even after its third or fourth owner, entering a material custody model for easy repair and more. ii) Ethical End of Life, how we (our bodies) and the goods we own transition into the next stage of life. iii) Public Food, the concept of using every space, location, and surface to grow accessible food within infrastructures. Something that is utopian, yet works with total logic. iv) Amenity Location & Distribution.

4   Discussion |

The researchers are aware of our biases and within design we often look for opportunities, and we are also aware of the desire for "techno-solutionism" within the discipline [74]. Within the domains (1–3) we identified and framed the responses in the analysed results. Authors perceive the following areas that are worthy of deeper research work as they are rich territories for HCI practices that can result in HCI opportunities for *Ecological Citizenship,* within *Public Interest Technologies*. The authors are also aware that the participants observed norms of "public to private", rather than private to public, meaning that participants explored how public systems benefit individuals.

4.1   Opportunities

HCI includes many technological means to make propositions. Within these we include; Augmented Reality, Virtual Reality, Data Repositories, Digital Sensing, Artificial Intelligence, Machine Learning, Mixed Reality, Embedded Technologies, Interconnectivity, and Internet of Things developments. We see these technologies as tools that can relay the following themes enabling Ecological Citizen PITs, although we are

also aware of the 'carbon divide' and the appropriateness of these technologies to certain contexts [75].

Based on the participants' insights, discussions, and reflections while using the Field Kit, we have identified key touchpoints where HCI can be used to develop themes from our analysis, and where HCI design propositions could be created to benefit this space. This includes HCI for more sustainable choice(s); from product specifications, deconstruction and spare-part repositories, to looking at more socially led propositions. Within the context of the three domains explained above, it is critical not to create "a culture of blame" [76] around decisions regarding sustainability; people are making choices about their family statuses, e.g., not having children [77], while other decisions should be made by governments rather than burdening individuals.

Including future generations: we need to include younger generations and children in choices about PITs, as they will inherit the impacts of these new technologies [78]. How do we/should we cultivate HCI systems for the bigger picture, for preferable futures? Or indeed how do we provide training or systems to onboard younger generations to the future systems we will need?

Decision making: more informed decision-making and diagnosis tools, for example AI decision-making that can help with everything from making journeys, supply chains, reducing food waste, to foreseeing the impacts of city construction and infrastructure change. The opportunity here is linking systems and improving communication between parties.

Inventory management: waste optimisation in all manner of systems, from domiciles to parts records on physical / digital systems etc.

Shared conditions: we are a connected world, somewhere in the world there are communities experiencing similar weather conditions to us/you. Digitally sharing those experiences; how they are growing food, how they live their lives, can be shared, and learnt from and are an amazing opportunity.

Interactive Material Passports: Repositories of items, washing instructions, identifying materials' compliance, artefacts that can talk to each other for easy replacement, repair / deconstruction, and key interactions. This could aid provenance tracing and encourage more locally based consumption.

Provenance: Burton (snowboards) are building material passports within high-end sports equipment [79]. Not only do these open-up cultures of repair and material provenance but they could also e.g., open up how buildings are recycled [80] and planning is co-opted with links to 'decision-making' applications. Fairphone has also set the bar in using ethically sourced materials that are dictating best practices for how materials should be sourced and communicated.

Sub-assemblies: products are built off common batteries and parts you will find in many items. There are digital opportunities for deconstruction, repair, reconstruction, and parts distribution.

Systems: the interconnection between things is vast, i.e., clothes labelling informing washing machines, to ensure optimum washing cycles etc.

Purchasing power; people are changing their purchasing choices informed by ethical sourcing and sustainable impacts, often badged (rightly so) as 'green washing', however sustainable practices are good for business.

Interactions that yield new economies & public regeneration; Saturday jobs, means of gathering data / citizen science that is validated and worthy of finance, new means of sharing tools, digitally mapping regenerative assets parks etc., interactive biodiversity corridor connectors, and connecting local skills bases.

Healthy world: there are so many opportunities now to create health-based interactions that can inform and protect citizens, for example detecting heart irregularities in shopping trolley handles [81] or via toilets monitoring our health [82]. The question at hand is: do we opt-in, and how is that ethically managed?

Citizen Science: opportunities are in full and existing operation, however the bigger opportunity for HCI is in ground truthing data, and enhancing how we protect the natural world through monitoring and data collection. Often this is built from dual motivations or across sectors, but building 'citizen-led' processes with rigorous data is a continuous interaction and HCI opportunity.

Cottage Data Industries: we are already in the domain of cottage makers and online selling, but akin to YouTube 'selling content' there is a model for selling your home's CO_2 footprint for optimisation, albeit a tiny market; a street-scale documentation of 'real-world' living could be shared and optimised.

Hubs: we see public resources as, eg. libraries, however, imagine if football clubs/venues could have regenerative effects on their surroundings. In peak Premier League season, 30,943 visitors go to Brighton & Hove Albion every week [83]. HCI interactions created for scenarios could yield scale. Knepp Estate (infamous rewilding site in Sussex, UK) was often thought of as unprofitable. Now, Knepp's nature tourism business – comprising 'wild safaris', camping, glamping, and a shop –has a turnover of around £800,000 per year, with a 22% profit margin (£190,000) [84]. It has cultivated; local volunteering, wellbeing, policy and social change, sustainable means, and species recovery and reintroduction (some of which have not been found in the UK since the Mediaeval period). This in turn connects communities to places, and provides opportunities for connection and creation of digital and physical interactions in the space.

4.2   Pitfalls

From our insights, the authors see spaces where more fundamental changes are required before the identified themes can be developed. Our current economic models are driven by capitalism [85] and this new typology of work requires the uptake of more distributed means. The ethical dimension and related security issues (e.g., of information) need to be unpicked and are only just being publically understood. The challenges of interested parties' motivation(s), outside of financial gain, are a further consideration. These models should be accessible to all, not just those that can afford the time. The kit did not identify economic means to support activities.

5 Conclusion

This field is new to design, but it is post-sustainability and requires deeper investigation, especially as our participants explored 'public to private' resources and not vice versa. This is an ongoing process, however we feel that learning how to look and unpick and identify HCI interactions/systems for regenerative opportunities can unite Product, Service, Systems. Whilst this requires refinement, it is an impactful process / tool for questioning how we can interlink HCI assets. Here we have identified several domains that can be explored for HCI purposes.

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