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Envisioning sustainable smartphone alternatives: A plurishop approach

Junge, Ines Petra*[a]; Culén, Alma Leora[a]

[a] University of Oslo, Oslo, Norway
*inespj@ifi.uio.no

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The urgent need to address the precarious possible futures necessitates a reassessment of our lifestyles, consumption patterns, and interventions for the benefit of humanity, coexisting species, and the planet. This reassessment includes envisioning radically different, desirable, and sustainable alternatives to everyday digital products, services, and systems. Generating such visions calls for creative new approaches and methods. This paper employs the 'plurishop', a workshop-based method that facilitates synthesis across multiple inquiries using gameful thinking and participatory visioning to explore sustainable smartphone alternatives and possible pathways toward a strongly sustainable smartphone industry. We describe the pre-plurishop activities conducted by five expert teams, each focusing on distinct inquiries. The plurishop helped to synthesise findings from these inquiries and gain new insights, including identifying opportunities to pursue further design explorations. Our findings demonstrate that this process enables a more holistic assessment of past, present, and future smartphone alternatives.

Keywords: sustainable smartphones; alternative designs; participatory visioning; plurishop

1 Introduction

Smartphones have transformed our lives, but with approximately 15 billion units in circulation according to the (Smartphone Subscriptions Worldwide 2027, 2022) and increase expected, they raise environmental concerns, such as the overuse of natural resources required for production, use of rare earth metals, precious metals, and plastics (Belkhir & Elmeligi, 2018), issues related to disposal behaviour (Ting et al., 2019), and waste management (Forti et al., 2020). These concerns underscore the environmental and social sustainability challenges associated with smartphones (Manzini, 2014; Silva & Schaltegger, 2019; Vezzoli & Manzini, 2008).

Envisioning sustainable smartphone alternatives is a wicked problem (Rittel & Webber, 1973), demanding a comprehensive approach. While efforts have been made to address certain sustainability challenges, such as adopting circular economy thinking and considering the entire smartphone lifecycle and its environmental and social impacts at each stage (Zufall et al., 2020), a need remains to

work toward strong sustainability. Transforming established systems requires a proactive stance in envisioning multiple sustainable alternatives and considering their long-term implications and consequences. Critical examination of existing systems and discerning use of critical-speculative thinking opens a range of possibilities for examining present and future alternatives. Complemented by designerly explorations, creative imagination, co-visioning, prototyping, and trans-disciplinary research, the approach has the potential to generate not only radically novel designs but also insights into their future desirability, possible social and environmental implications, and alignment with emerging values.

This article discusses how the 'plurishop' approach, detailed in (Culén et al., 2023) and outlined in Section 2.2 below, helped surface some sustainable smartphone alternatives and opened further designerly explorations of such alternatives. To handle the complexity of envisioning alternatives without oversimplifications, the plurishop relies on an extended pre-workshop phase for team-based explorations along multiple lines of inquiry. In this case, the pre-plurishop work was done by nine design researchers and practitioners divided into five teams, each pursuing a different line of inquiry toward sustainable smartphones. The plurishop itself served to synthesise across those inquiries, resulting in multiple opportunities to explore intersections and possibilities to strengthen desirable directions through further design and research.

Although this article focuses on sustainable smartphone alternatives, it contributes to the design work concerned with futuring sustainable, desirable alternatives to digital products and services more generally. For design situated at the junction of product-service systems, transition and interaction design, the plurishop approach supports meaningful discussions across these fields, drawing on each to envision sustainability transitions and consider values, responsibility, potential implications, and risks.

2 Background

We divide the background section into two parts. The first addresses design research approaches to radically novel, future-oriented, and holistic design thinking. The second one summarises the plurishop approach.

2.1 Radically novel thinking, imagination, and design

Looking for radically different approaches is not easy and can be compared to the Streetlight Effect1 parable, a commonly used metaphor for seeking solutions in the wrong places. The metaphor indicates that not everything can be found where the light is (known, visible, scientific, or in the present time), and to bring something new out of darkness (unknown, invisible, designerly, or in the future), one needs to engage with uncertainty, ambiguity, emergence. It also highlights the epistemic limitations of radically novel thinking and imagination. Yet, leaving such thinking and imagination to chance is not advisable. They require conscious and holistic reflection, supported by research and design knowledge, skills, ethics, social responsibility, and an appropriate mindset and posture (Candy

[1] A Sufi master searched for something under the streetlight. A passerby asked what was lost and, hearing that it was a key, helped search around the lamppost. Not finding anything, he asked where the key was lost. Hearing it was at home, he asked, *'Why search under the streetlight?'* The master answered*, 'That is where the light is!'*

& Dunagan, 2017; Gümüsay & Reinecke, 2022; Hopkins, 2019; Irwin, 2018; Scoblic, 2020) to arrive at possible and desirable trajectories to pursue through systemic design research. Moreover, Gümüsay and Reinecke (2022) suggest that moments of crises might serve as critical junctures for imagining alternatives to products, services, organisations, or systems. Currently, there is no shortage of moments of crises, thus, opportunities for exploring better and more sustainable alternatives.

Concerning smartphones, several industrial initiatives have demonstrated different ways of thinking about sustainable alternatives, e.g., Fairphone2, Shiftphone3, or Puzzlephone4 (Akemu et al., 2016; Schischke et al., 2016; Schomberg et al., 2023; Wernink & Strahl, 2014). Such start-ups might be considered pioneers of so-called strong sustainability within the smartphone industry. However, academic research has been less forthcoming with ways to explore or imagine sustainable smartphone alternatives. The critical-speculative design (Auger, 2013; Dunne & Raby, 2013; Mitrović et al., 2021) approach is gaining traction within the sustainability transitions research, also for smartphones. For example, inspired by the sustainability of single-use cameras and the 'borrowed for use' concept, Junge (2021) explored critical-speculative sustainable mobile phone practices and continued that line of inquiry into the plurishop.

2.2 Plurishops

In their article (Culén et al., 2023), the authors proposed the plurishop (the name inspired by Escobar's Designs for the Pluriverse (2018)), a workshop-based approach to address sustainability transitions more judiciously. The plurishop was described as a posthuman workshop that actively embraces pragmatism and methods designed to work in practice (Dalsgaard, 2014; Feilzer, 2010), emergent explorations (Gaver et al., 2022), and nomadic practices (Wakkary, 2021) to align it better with the demands of designing for complexity. It explores synchronicities and distinctions among multiple inquiries or perspectives through critical reflection, self-reflection, visioning, prototyping, value surfacing, and knowledge integration.

To generate more profound insights from diverse perspectives, plurishop participants must invest time in pre- and post-plurishop activities. Such activities could include understanding the design space, identifying manageable inquiries that might help untangle the complexity, considering the implications of pursuing specific design directions, and reflecting on the mindset, posture, values, knowledge, and skills needed to address tensions within the design domain. Like other complexity-oriented research and design, plurishop activities are most effective in transdisciplinary teams (Battistoni et al., 2019; Irwin, 2018; Sevaldson, 2022).

Plurishops are related to other familiar workshop formats. Notably, they relate to future workshops that Jungk and Müllert (1987) proposed to work with creative imagination toward desirable socio-technological futures. As a bridge between the present and future opportunities, the future workshop became one of the most frequently used methods to consider alternative and future designs. What

[2] https://www.fairphone.com/en/

[3] www.shiftphones.com/en/

[4] sustainabilityguide.eu/?guide=puzzlephone

distinguishes plurishops from future workshops is their purpose of synthesising pre-plurishop activities, thus engaging in a critical-speculative work rather than brainstorming alone.

Moreover, Dufva and Ahlqvist (2015) put forward an exploratory method for analysing discussions at foresight workshops, suggesting that futures knowledge is constructed through interaction between the workshop participants. Such co-construction is an integral aspect of participatory visioning that, along with gameful thinking, is the key strategy for making plurishops work in complex settings.

2.2.1 Participatory visioning

Participatory visioning approaches are often strongly advocated for, e.g., the evolutionary co-design (Vezzoli et al., 2008), participatory backcasting (Nikolakis, 2020), or transition design (Escobar, 2018; Irwin et al., 2020), where futures trajectories are created with the participation of stakeholders. The advocacy for participatory visioning processes builds on the availability of multiple voices and perspectives, yielding clearer visions that help determine and agree on trajectories with a high potential for leading toward sustainable and desirable future alternatives. For example, Gaziulusoy & Ryan (2017) discussed how participatory visioning was used in developing scenarios for low-carbon, resilient cities in Australia. Visioning methods like backcasting, forecasting, imaginaries (Lockton & Candy, 2018), experiential futures (Candy & Dunagan, 2017), scenario planning, fiction, role-playing, speculation, critique, and provocation are commonly used.

2.2.2 Gameful thinking

It is broadly accepted that gamification helps turn products, services, systems, activities, and even lifestyles (McGonigal, 2015) into positive experiences. As gamification lacks a consistent definition (Landers et al., 2019) and plurishops do not have to make gamification explicit (which the smartphone alternatives plurishop did), we opted for ‘gameful thinking’ to indicate that plurishops build on challenge, motivation, feedback, progression, and some form of competitiveness to boost engagement. Gameful thinking has been previously related to learning and complex problem-solving through real-life simulations (Miller & Cooper, 2021; Westera et al., 2008) and to sustainability and circular economy (Dufva et al., 2016).

3 Method

The first author drew inspiration from various sources, such as (Anastas & Zimmerman, 2003; Shedroff, 2019; Shedroff & Lovins, 2009), and collaborated with sustainability, transition, and interaction design experts to create alternative smartphone visions through the plurishop approach.

Details about the features of the plurishop method can be found in (Culén et al., 2023). The article used the smartphone example, along with a different one, to discuss design strategies and demonstrate a range of possible applications. The plurishop approach was refined through iterative reflections on its aims, design principles, formats, and processes (Figure 1 illustrates how such refinement changed the initial gameful thinking concept (Figure 1a), featuring individual work on tasks to teamwork (Figure 1b)).

The pre-plurishop phase required extensive preparations, including creating a website with references, inspirational examples, or suggestions for each inquiry (Figures 2a and 2b exemplify the website’s content). The nine participants were (self-)divided into five teams based on competencies and interests. Each team selected one of the following inquiries to explore, also through prototyping:

1. Borrowed for use: focused on circular smartphone practices to reduce waste (a one-person team comprising a sustainability design researcher with expertise in this area).
2. Radical matter: explored ways to minimise material diversity, especially for materials at risk or unethically sourced (comprising one creative technologist/maker and two transition/ interaction designers).
3. Biological: explored possibilities for using natural, renewable, and biodegradable materials (comprising one interaction designer and one sustainability design researcher).
4. Enrgy+: explored smartphone energy use (comprising two interaction design researchers).
5. Interaction-first: focused on interaction as a desired output of technology and sufficiency thinking (comprising one systemic/transition designer and one interaction design researcher).

ORACLE (the first author) facilitated the pre-plurishop phase, allowing teams to ask questions, receive feedback, and get help with their inquiries, but also to document the process, maintain the challenge, and help the teams regulate their progression. Along with a sense of competition between teams (no collaboration across teams took place), this helped to establish the properties of gameful thinking.

Figure 1. a) A snapshot from the website at an early phase of preparations shows that, initially, participants were to play alone. b) The five directions toward envisioning sustainable smartphone alternatives and an oracle (facilitator of the pre-plurishop phase), structured as a team-based board game. The integrative plurishop represented the final stage of the process.

Figure 2. Excerpts from the website informing and inspiring a) RADICAL MATTER and b) Interaction-FIRST.

From Figure 1b, it is evident that ORACLE was also the sole team member for the BORROWED FOR USE and a member of the BioLOGICAL team. The second author was part of the RADICAL MATTER

team. Thus, we have first-hand accounts of the pre-plurishop work for these three inquiries. However, no first-hand experiences were available for the remaining two tracks.

The pre-plurishop phase lasted approximately three months, allowing teams to choose their schedule and activities. In contrast, the synthesis at the plurishop itself took about three hours. The post-plurishop reflections and design research are still ongoing.

4 Findings and discussion

This section is divided into pre-plurishop, plurishop, and post-plurishop phases of the process.

4.1 Pre-workshop phase and prototypes

Each team exploring sustainable smartphone alternatives was free to interpret and align their inquiry with their values, identify entry points for addressing it, and gather the necessary knowledge to make progress. In what follows, we address the pre-plurishop work by each team, including prototypes and findings.

The BORROWED FOR USE team, led by a single researcher as mentioned in the previous section, drew inspiration from her previous research (Junge, 2021), building on the concept of no-waste from single-use cameras, where all parts were reusable and recyclable. This inquiry focused on the practice of cascaded reuse, refurbishment, and recycling (urban mining) of all smartphone components. Emphasising the significance of practice as a design unit (Kuijer, 2017), the team explored methods to encourage responsible practices. The Double Star Flexicube (Figure 3a) prototype demonstrated the vision of easy disassembly, parts-level modularity, and a segmented display on the outer shell.

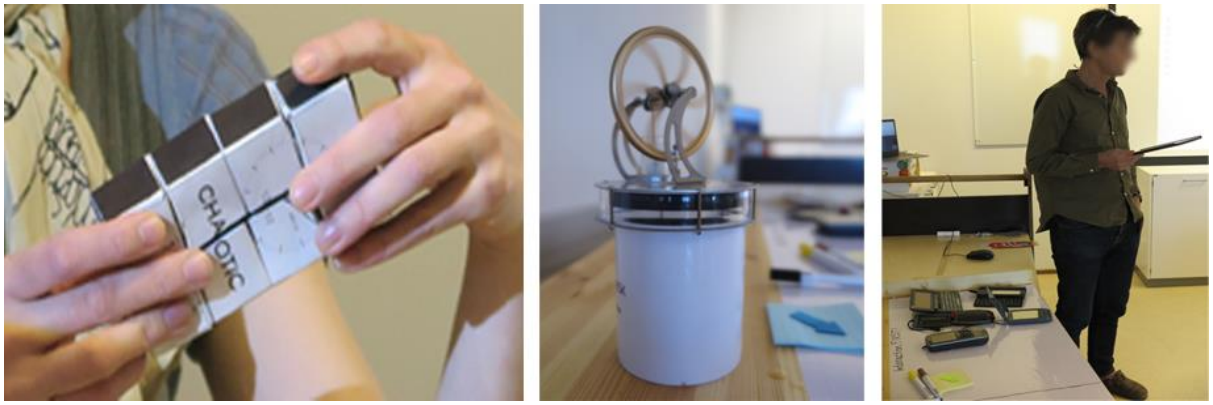

Figure 3. a) BORROWED for USE team illustrated circular practices, including the ease-of-phone disassembly, using a Flexicube paper prototype. b) The ENERGY+ team prototyped a kinetic charger for batteries. c) The Interaction-First team demonstrated a range of devices and interactional affordances. Source: Junge.

The RADICAL MATTER team was tasked with examining the potential for reducing material diversity in smartphones, particularly focusing on critical metals and conflict minerals. The team initially explored the idea of reducing material diversity by examining past design decisions that made the smartphone ‘smart’ and considered the alternatives to ‘smart’ today. However, the team abandoned this line of thinking, realising that it overlaps with the work of the Interaction-First team. Next, nano-printing and extreme mono-materials were considered, but this direction soon turned out to be beyond the team’s capabilities.

The team then looked into what industry giants, like Apple, were doing to reduce material diversity, continuing to discuss pathways for replacing dangerous, toxic, recycled, or rare materials with more sustainable and abundant alternatives. Using a periodic table of elements and transparent layering, the team identified a subset of non-toxic, abundant, or easily recyclable minerals, such as manganese (Figure 4a). Recognising the complexity of the material substitution (Graedel et al., 2013), the inquiry shifted towards developing an inventory app (Figure 4b) to help designers and engineers learn about the elements used in various digital components.

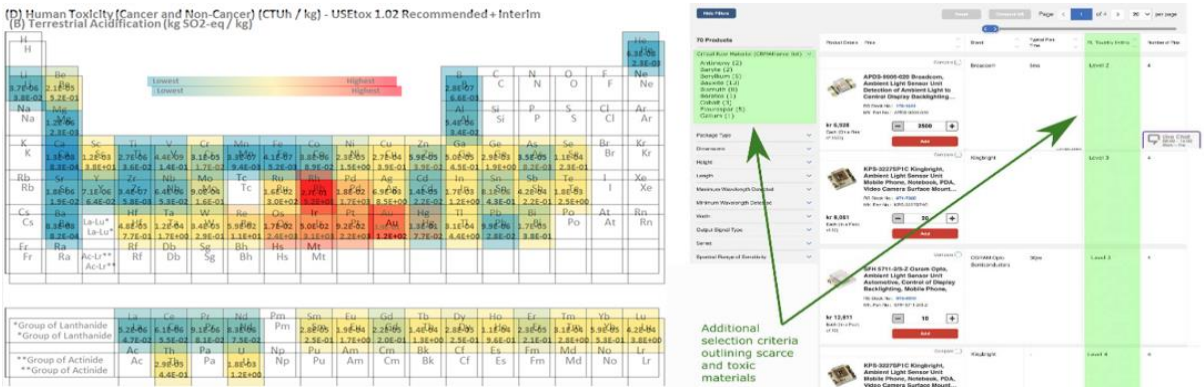

Figure 4. a) Superimposing the periodic table of elements to uncover opportunities for safer and more abundant materials – overlaying toxicity and terrestrial acidification. b) The mock-up of the app for designers and engineers.

The BioLOGICAL team was tasked with exploring organic, biodegradable, and biocompatible alternatives to smartphone materials while considering design trade-offs, such as aesthetics and user acceptance. They examined various material probes, including animal- and plant-based materials, wood-based bioplastics, and more, for potential use in electronic components beyond just structural parts. The team created a booklet showcasing eco-materials as layers (Figures 5a and 5b), featuring alternatives like Transparent Wood to replace glass, Opaque Liquid Wood for structural components, and Conductive Wood for printed circuits. They also explored organic electronics, passive e-ink displays, and wooden membranes for loudspeakers. Some limitations arose when organic materials couldn't meet electronic requirements, but the team discovered alternative technologies like muscle-like micro-structures for sound production. They also proposed ideas such as replacing Tungsten in smartphone vibration units with heavy organic material. These findings were presented at the plurishop for further discussion.

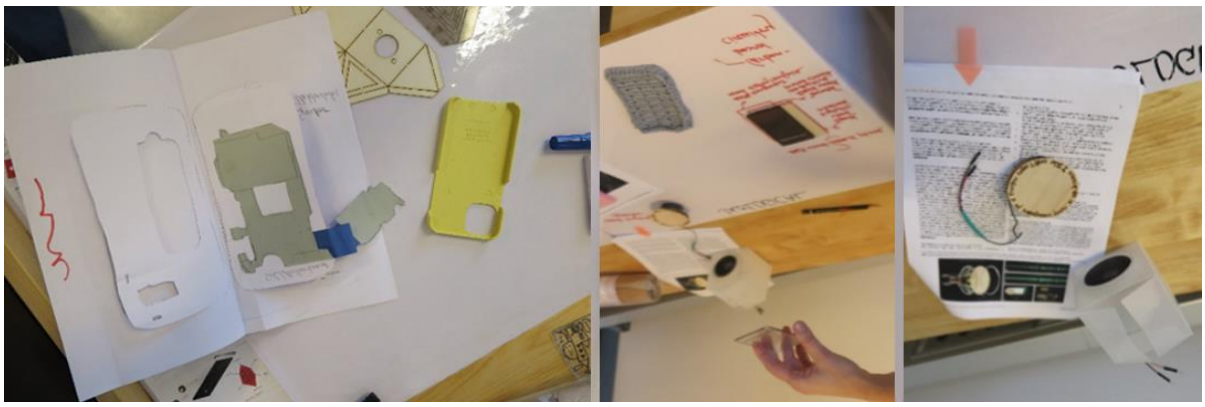

Figure 5. The BioLOGICAL team worked with a) smartphone layers, b) organic materials for layers, and c) conductive wood. Source: Junge.

The ENERGY+ team focused on exploring ways to harvest, produce, use, save, or store smartphone energy. They investigated renewable energy technology probes and experimental kits to create a net-positive smartphone device inspired by the principles used in ENERGY+ houses from architectural theory and practice. For instance, the team disassembled a radio with energy harvesting equipment to understand its components. They also exhibited a steam generator using heat and kinetic energy from hot water to produce electricity (Figure 3b). However, the team mainly focused on swappable smartphone batteries as an alternative charging method.

The Interaction-First inquiry prompted the team to examine smartphone use from an interactional perspective and its implications on sustainability. They applied an output-pull approach to determine the sufficiency of interactions and affordances regarding the technology and materials involved. The trade-offs were discussed, for example, low-energy attributes versus changed visual experiences using e-ink screens like Yotaphone (Грицаев et al., 2016). They investigated various early Nokia and Ericsson phone models, bringing them to the plurishop to discuss their interactional properties (Figure 3c).

4.2 The synthesis (plurishop)

During the plurishop, participants engaged in a combination of presentations and experiences with exhibits, learning about each other's inquiries and trying prototypes (Figures 3-5). This process led to the emergence of synergies between inquiries. Philosophical discussions about what defines a smartphone were sparked among RADICAL MATTER, BioLOGICAL, and Interaction-First teams, as narrowing down the definition could lead to using fewer or organic materials and how trade-offs in materials could affect the quality of experiences.

The ENERGY+ deliberations on swappable batteries showed a potential synergy with BioLOGICAL and new organic sodium-ion batteries (Torgersen, 2021).

However, some ideas were abandoned after discussions. For instance, the BioLOGICAL team's proposal to replace Tungsten in the vibrational component with a heavy organic material was found unfeasible due to the specific requirements of the vibrational components, which need the spark-hindering attribute of Tungsten. Another proposal from the BioLOGICAL team involved using muscle-like micro-structures for sound production. However, the suggestion of the silicon-based output raised concerns about harmful non-organic chemicals, highlighting the complexity of such alternatives.

Lastly, a fruitful line of discussion focused on using low-power displays. It was identified as one of the most realistic and promising directions to pursue post-plurishop.

4.3 Post-Plurishop

After the plurishop, the 2024 EU legislation concerning swappable batteries and practices related to reverse vending machines (Figure 6c) came out. It led to new discussions/confirmations concerning better services and practices along lines discussed by BORROWED FOR USE and ENERGY+. However, the work pursued by the first author took a slightly different turn, looking instead at the business perspective of making smartphone alternatives and resulting in a speculative, strongly sustainable venture (Junge, 2023).

Other synergies considered post-plurishop were related to batteries and materials. The first one was related to RADICAL MATTER and ENERGY+ inquiries and considered replacing Lithium-ion with organic sodium-ion batteries due to increased demand for lithium and its growing scarcity (Ding et al., 2019).

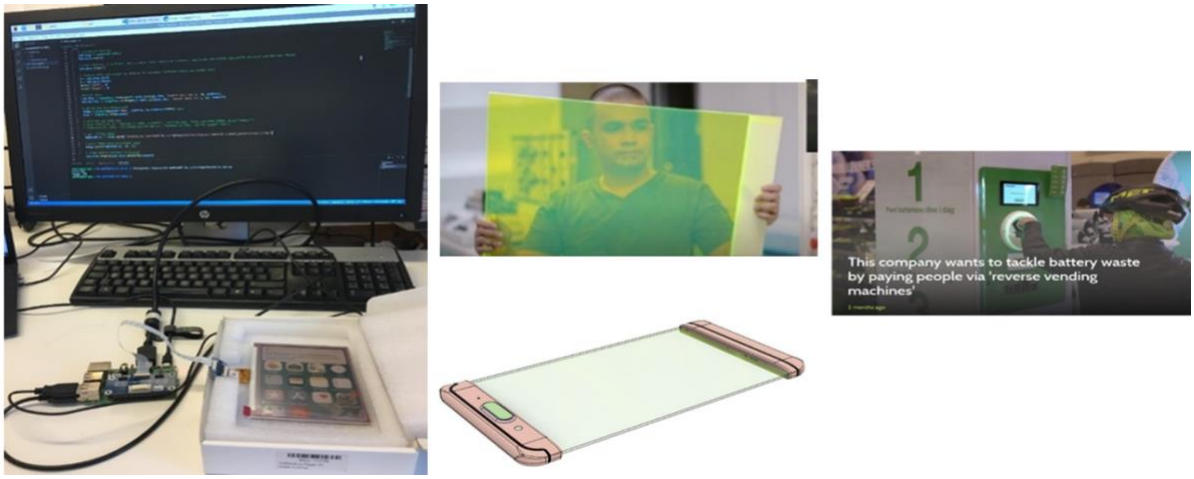

Figure 6: a) Successfully displaying a phone screen dummy on a 7-colour e-ink screen. Source: Junge. b) Translucent organic solar panel (credit: James Dyson Foundation) as display glass in an integrated phone concept. Source: Junge. c) A battery vending machine. Source: (Bailiwick Express, 2022).

The second one was related to the discussion around vibration as a smartphone interaction, sparking the idea of using sounds below the human hearing perception, with the muscle-like silicon chip technology to replace conventional loudspeakers – instead of the vibrational smartphone component. The third, furthest pursued and inspired by Yotaphone (Грицаев et al., 2016), used a 7-color e-ink display, a Raspberry Pi, and tweaked code to prototype with this low-energy display. The effort resulted in a proof-of-concept for e-ink displays and related image dithering techniques for smartphone use (Figure 6 a). A new, translucent solar cell technology made from food waste (Hahn, 2020) was explored through a tweaked and rendered CAD model and integrated with the e-ink display in one component (Figure 6 b).

Finally, through joint work with two other researchers, the authors pursued a methodological line of inquiry, defining plurishops and the best ways to design and implement them (Culén et al., 2023).

5 Conclusion

This article demonstrates how the plurishop approach paved the way to envisioning sustainable smartphone alternatives, using gameful thinking and participatory visioning as its main design strategies. It opened for collaborations within teams, knowledge sharing**,** and discussions across teams, successfully generating multiple trajectories to desirable alternatives. More generally, the work signals a novel approach to work with the complexity of sustainability of digital artefacts, shifting concerns from present systems to continued, dynamic design explorations of alternatives as real-world circumstances change.

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