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OSKARRR: Data-driven Design Speculations For The Future of Domestic Waste

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Waste infrastructure is largely non-digital and resists mapping and datafication. Waste itself can be seen as material information, revealing of its creators, which is lost along with the material resources that are thrown away. Design and HCI can unlock this information.

Most people's engagement with waste begins and ends at the domestic dustbin, with minimal consideration of what is wasted and where it goes. When aggregated waste practices have significant sustainability impacts. Digital technologies designed to raise awareness of environmental issues compete for our finite cognitive capacity with the demands of everyday life.

To address this challenge, this paper uses speculative design of domestic waste devices. These speculative 'data objects' build on work in speculative design, sustainable HCI, and waste infrastructure mapping. The aim of this pictorial is to provoke debate on digital technology's ability to engage us with consumption and waste, resulting in behavior change and reduced environmental degradation.

Keywords: *Alternative design modes; Interaction design; Interaction design process and methods; Interface design prototyping*

THE FUTURE OF DOMESTIC WASTE

This work emerged from the lead author's engagement with their own waste data in a month long auto-ethnographic 'scavenger hunt' - gathering and exploring data with a view to create a design response. The laborious practice of recording waste through smartphone photography, weighing scales and a spreadsheet led to speculation on how this data could be gathered in an automated way. BinCam offers a solution to this, albeit with problems engaging people with their data once it is collected (Comber et al. 2013). This led us to investigate if a more tangible and physically co-located exploration of waste data can engage and provoke people in a way digital traces do not.

To address this challenge, this paper uses speculative design of domestic waste devices. There are only a few products currently available to households that make domestic waste visible and manageable through technology. Previous works in HCI design have struggled to engage people with their domestic

waste, and reflect: *'is recycling and food waste simply so uninteresting that we cannot get people to engage with it in the long term?'* (Comber et al. 2013, p.114). We do not believe this to be the case and propose the use of speculative data objects to engage people with the environmental consequences of their consumption. Section 1 of this paper provides the context and background for the speculative design work found in Section 2, whilst Section 3 discusses our contribution, its relevance and potential future work.

1.1 WASTE INFRASTRUCTURE

The realm of possibility for this work was opened up by the work of Dietmar Offenhuber and others at MIT in revealing the hidden infrastructures of waste through digital technology (Offenhuber and Ratti 2017). In the TrashTrack project, GPS trackers attached to objects placed into domestic waste collections revealed the sometimes unexpected routes and destinations of objects designated as waste. The authors highlight how little we know about the 'removal-chain' compared with the 'supply-chain'. This aligns with the amount of cognitive effort that is required to make a purchase versus that required to dispose of something. When faced with even the most basic of purchases we are frequently presented with a multitude of options, requiring us to make several decisions and trade-offs. The same can't be said for our (legitimate) disposal options.

The interface between household and waste disposal system is the humble 'dustbin'. Our work is situated in the context of the UK, where Chappells and Shove (1999) consider changes to dustbin design and collection as *'a mediator of changing waste practices'* (ibid. p.267). They trace the increasing levels of specialisation and collective (public sector) responsibility for waste disposal in the UK through changes to dustbins. Dustbin designs are seen as dictating household practices, actions and behaviors. It is this potential for dustbin as mediator that drives the speculation in this paper.

The design history of domestic bins for refuse collection is one of ever increasing capacity and volume. In the 19th century most household waste was burned in the home and the resulting ash collected for brick-making. As household waste composition changed, the first standardised metal dustbins came into use in the 1950s, which were then replaced by plastic versions in the 1960s. Higher volumes of packaging waste gradually replaced the ash content. Public health issues drove changes to collection frequencies, the use of plastic bin liners and designs for enclosed containers. The 1970s saw the introduction of wheelie bins, whose larger capacity led to increased volumes of waste sent to landfill as householders could include bulkier items they would otherwise have taken to a collection site (Chappells and Shove 1999).

Local recycling schemes emerged in response to increasing household waste volume and variety, introducing new types of bins and rules for collection. BBC analysis reveals 39 different sets of rules for plastic recycling across the UK (Stephenson 2018). This complex situation presents an opportunity for design and technology to highlight and respond to issues of waste and recycling. Design and supply of bins for waste collection is determined by local government, not households, so we look to the kitchen dustbin as a vehicle for speculation. The dustbin is positioned as mediator between household and collection system.

1.2 WASTE AND HCI

Previous works on waste and recycling in HCI design have looked to encourage behavior change by improving recycling compliance and reducing food waste. Thieme et al (2011) introduced *BinCam*, augmenting the kitchen bin in a sample of student households with a dedicated smartphone that captured images of users' waste. These images were then uploaded to a Facebook application that visualised the data, had elements of social interaction and gamification. A key point in the discussion of the project is the participants' *'feelings of guilt'* elicited by confronting their waste through the app but not having the agency to improve their behavior, for example due to the absence of any food waste collection or composting facilities. However they observed generally low levels of engagement with the app in the study, raising speculations that waste may be inherently uninteresting for most people until it becomes a visible crisis. The challenge for HCI and designers is to reconnect people with their

waste, in order for sustainable behaviors to emerge before environmental crises worsen.

The concepts we present can be termed speculative *'data objects'*. Sosa et al (2018) describe *data objects* as everyday objects at the intersection of data physicalisation and product design. They are *'usable, functional, and meaningful artifacts whose form and function encode data'* (ibid. p.1685). This bridging of everyday objects and data associated with them is an opportunity for engagement with the consequences of consumption. Sosa et al's (2018) design principles for data objects include *'design for access and (re)interpretation of the data'* with a focus on giving *agency* to users. Agency in domestic waste is a significant challenge as processes that govern it are largely outside of users' control. Revealing the data behind domestic waste through data objects, i.e. a smart dustbin, starts to create transparency and possibilities for challenging systemic issues.

1.3 SPECULATIVE DATA OBJECTS

This work deploys speculative design as a means to explore engagement with waste through near-future technologies and future social practices. Works of speculative design for sustainability and behavior change commonly create product designs that aren't intended to be commercially produced but challenge unsustainability in mainstream design and consumption. Stead articulates speculative design and design fiction as *'not concerned with the commercialisation of product designs but the meaning of products and the futures they might bring'* (Stead 2016, p.17).

An example of speculative design for engaging people with waste is the '*Lyssna*' design fiction diegetic prototype (Oogjes et al. 2016). *Lyssna* is a hearing-aid type device that aims to engage users with the food in their refrigerator with the goal of reducing food waste. The refrigerator is seen as central - a mediator - in household food consumption and routines associated with food waste. Engagement is encouraged by changing the way we interact with food - instead of relying on use-by dates the device encourages the use of our senses in the way people did in the pre-supermarket era, but augmented with data and possibilities of technology. In this study, the kitchen dustbin takes the place of the refrigerator as the object of mediation, and the target is general waste - the residual element that goes to landfill or incineration.

The ability to track and identify objects and their components is a potential enabler to smarter domestic waste disposal. As such the work of Stead (2016) on the *Toaster for Life* informs this paper through its development of Sterling's *spime* concept. *Spimes* are infinitely recyclable, sustainable objects with a physical and digital instantiation, enabling the object's history and make-up to be revealed to users. This idea of designing objects that have their own *metahistory*, revealing their origins, journey through the world, constituent parts and materials informs the thinking in this paper. Objects that become waste continue to exist and technology offers ways to better track and understand what happens to them next. Stead also demonstrates the use of speculative design to explore how and why futures might be designed or developed. Stead's toaster is not intended as a potential new production model, but a *diegetic prototype* that opens up debate on the need for more sustainable consumer goods

Figure 1. Speculative design, sustainable HCI - design fictions exploring sustainability. Lyssna design fiction diegetic prototype addressing food waste, left, Oogjes et al. (2016).
Toaster for Life provocation examining unsustainable consumer electronics, centre, Stead (2016).
Wardrobe design fiction exploring clothing consumption, right, Maldini and Stappers (2019).

and systems of consumption. A definitive design solution is not the aim of this paper - inclusive and accessible debate with a broad audience is.

The wardrobe is a possible object of mediation in the case of clothing consumption. Maldini and Stappers (2019) look at the dynamics of clothing and explore how various wardrobe systems and services could address the sustainability issues of fast fashion and underutilised clothing. Six fictional promotional posters are presented for sustainable fashion services, including one for an IKEA wardrobe. The ideas are presented in a convincing graphical style that enables the viewer to suspend disbelief and enter the world where sustainable pay-as-you-wear clothing replaces buy-it-and-wear-it-once consumption. A key guiding principal for the creation of these fictional posters was a balance of clarity and ambiguity in the message. This principle has informed the development of the OSKARRR concepts here, where technical detail is set aside in order to focus on the provocation - engaging people with domestic waste.

IKEA designs and catalogue pages have been used in previous speculative works in direct collaboration with the company (Brown et al. 2016). The benefit of using IKEA's format for our work is to create an instantly recognisable and believable narrative, accessible to a wide audience beyond designers and technologists. These speculative works could be shared with householders as provocations to better understand attitudes to waste and behavior changing technology. The contribution of the paper is through a series of visual speculative IKEA catalogue style designs, which explore how to create a more considered connection between people and their waste.

2.1 THE OSKARRR SYSTEM

OSKARRR is the name of our speculative IKEA dustbin system, a mnemonic of Organise, Sort, Kollekt (Swedish for collection), Augment (with data) plus the three Rs of waste - Reduce, Reuse, Recycle. The existing, real-life IKEA GIGANTISK dustbin product is used as the foundation of the speculative concept designs presented. The existing IKEA design has no smart features. The product name and real-life online reviews highlight the large capacity of the bin (60 litres) as a selling point, suggesting a target market that produces large amounts of waste.

The base design was selected for being easily disassembled, allowing for the addition of new, smart components. IKEA's use of modular assembly and complementary systems of products enables their customers to design unique home interiors. This gives people a sense of individuality and choice over materials and functionality without the expense of truly bespoke products. It also provides fertile ground for speculative designs from the design community produced independently of IKEA, as this work was.

OSKARRR is a companion product to the GIGANTISK bin. It is a modular system of components that augment your kitchen dustbin with smart features that enable you to be more aware of the impact that your household waste has on the planet. Interchangeable lids offer a variety of styles in which to engage with your waste data. Components like the REDUCE base and the KOLLEKT indicator offer benefits for managing household waste more effectively through the use of data and connectivity. AUGMENT and TOPOGRAF are *data objects* revealing the geographies and volumes of domestic waste.

ORGANISE is the main container for the dustbin system, identical to the existing GIGANTISK bin.

SCREEN is the playful configuration of OSKARRR. A recycling assistant that uses a camera with built-in, artificial intelligence that signals a sorting mechanism to reject items that are incorrectly sorted. Rejected items are released to the floor. Accepted items are tipped into the bag.

KOLLEKT is a simple two light Internet of Things indicator that obtains collection schedules from the waste authority and reminds you to put your waste outside. A blue light signals that waste collection is due tomorrow. A blinking light is shown on collection day. Used in conjunction with the REDUCE base, the second light indicates how full the bin is to avoid overfilling, split bags and difficulty lifting.

AUGMENT is an integrated display designed for use with TRAG trackable bags. It keeps you in the

loop with the journey of your waste, meaning you can hold disposal authorities to account. New international waste transparency agreements enable the display to tell you where your waste is anywhere in the world.

REDUCE is a smart dustbin base that monitors the weight of the waste in your bin. You can choose whether to share this data with local authorities or use the system offline with the KOLLEKT indicator.

TOPOGRAF is a dynamic waste sculpture and a dustbin lid. It can display the current volume of waste in your dustbin using data from the REDUCE base, or cumulative volumes for the year or month, reminding you that everything that goes in your bin has a consequence.

TRAG is our trackable waste bag designed to fit the OSKARRR dustbin. Data is securely fed back to the AUGMENT screen or OSKARRR phone app, letting you check that your waste is being disposed of in a way you are happy with. RFID tags and scanners enable this functionality.

GIGANTISK BASE is the non-smart dustbin base, for those who don't need volume data.

Figure 2. Speculative IKEA catalogue page. Source: authors, background image IKEA (2020).

01 OSKARRR KOLLEKT Fill level and collection day indicator €19

02 OSKARRR AUGMENT Waste data and location display and lid €29

03 OSKARRR ORGANISE Dustbin body €9.99 Interchangeable with existing GIGANTISK body.

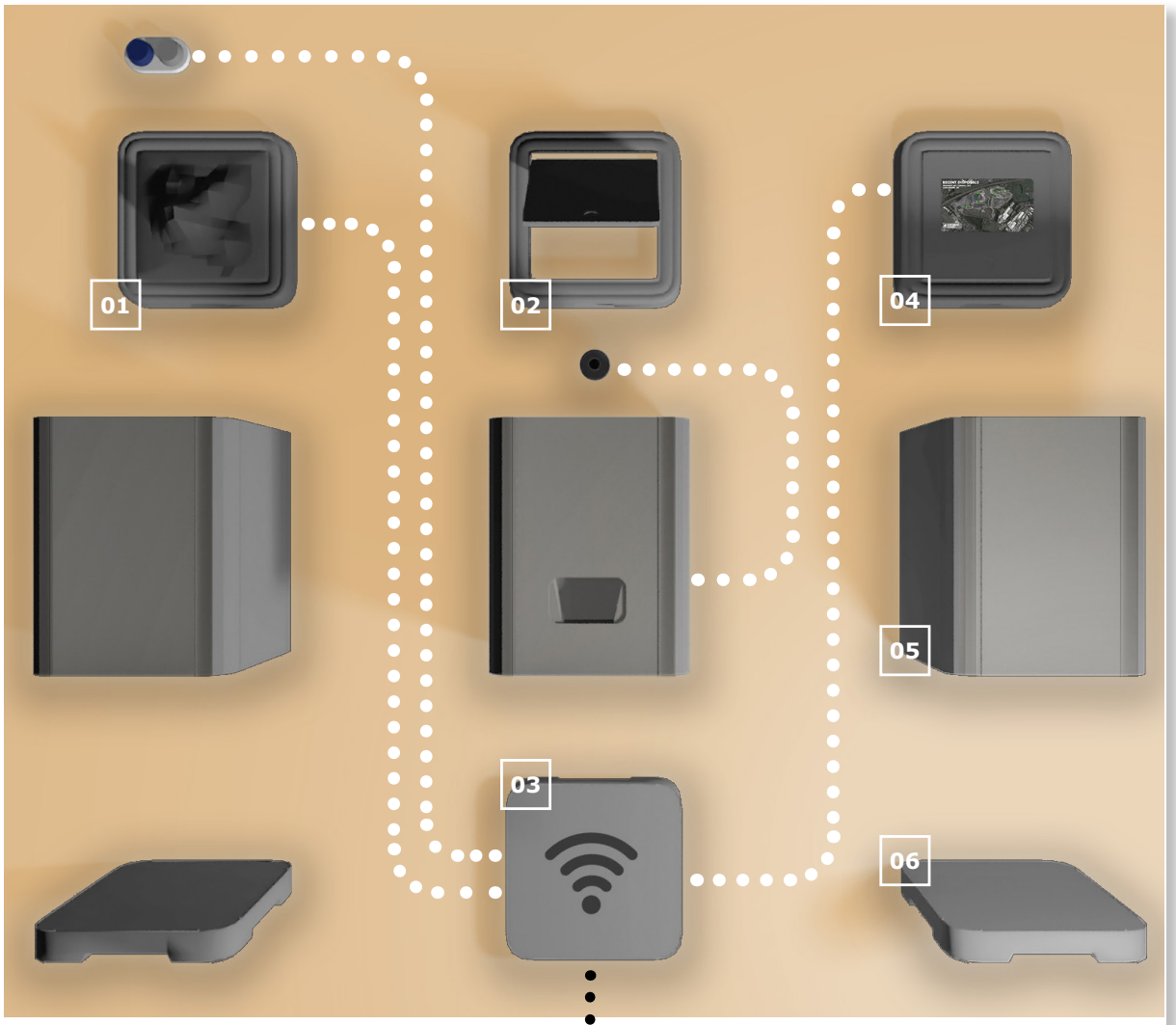
04 GIGANTISK dustbin base, basic model €9

Bursting the waste bubble

We all create waste, and think little more of an object once binned. Waste is part of everyday life and only becomes an obvious problem when the system fails. The OSKARRR range is our way of connecting you with the reality of what happens to things we consume when we're finished with them.

121 Smart waste

Figure 3. Speculative IKEA catalogue page. Source: authors.



OSKARRR TRAG
Waste tracking bags
€5/10pcs

01 OSKARRR TOPOGRAF Dynamic waste data sculpture lid €29

02 OSKARRR SCREEN Recycling assistant, includes dustbin body with rejection channel €39

03 OSKARRR REDUCE Smart dustbin base €19

04 OSKARRR
AUGMENT Waste data and location display and lid €29

05 OSKARRR ORGANISE Dustbin body €9.99 Interchangeable with existing GIGANTISK body.

06 GIGANTISK Dustbin base, basic model €9

07 OSKARRR TRAG Tracking waste bags €5/10pcs

122 Smart waste

Figure 4. Speculative IKEA catalogue page. Source: authors.

Revealing waste volumes

Figure 5. Revealing waste volumes. OSKARRR can be set to reveal cumulative waste volumes over a year or to represent the currently used capacity of the dustbin. Steeper peaks indicate larger volumes over time or the immediate need for the dustbin to be emptied.

Source: authors, background image IKEA (2020)

Playful behaviour change

Figure 6. Playful behaviour change. OSKARRR SCREEN is programmable to reject items that don't belong in your OSKARRR bin. Kids not recycling properly? SCREEN will nudge them in the right direction.

Source: authors, background image IKEA (2020), humans Emdén (n.d.)

Revealing waste geographies

Figure 7. Revealing waste geographies. OSKARRR AUGMENT reveals the final destinations of domestic waste disposed of using electronically tagged TRAG bags. The tags do not reveal the identity of the household but allow them to find out if their waste and recycling is being disposed of responsibly.

Source: authors.

Figure 8. Revealing waste geographies. OSKARRR AUGMENT screen grabs revealing the ultimate destination of your waste using data from TRAG waste bags. Using online geographic data the system returns the likely method of disposal - landfill, incineration, export etc.

Source: authors, aerial images Google Earth.

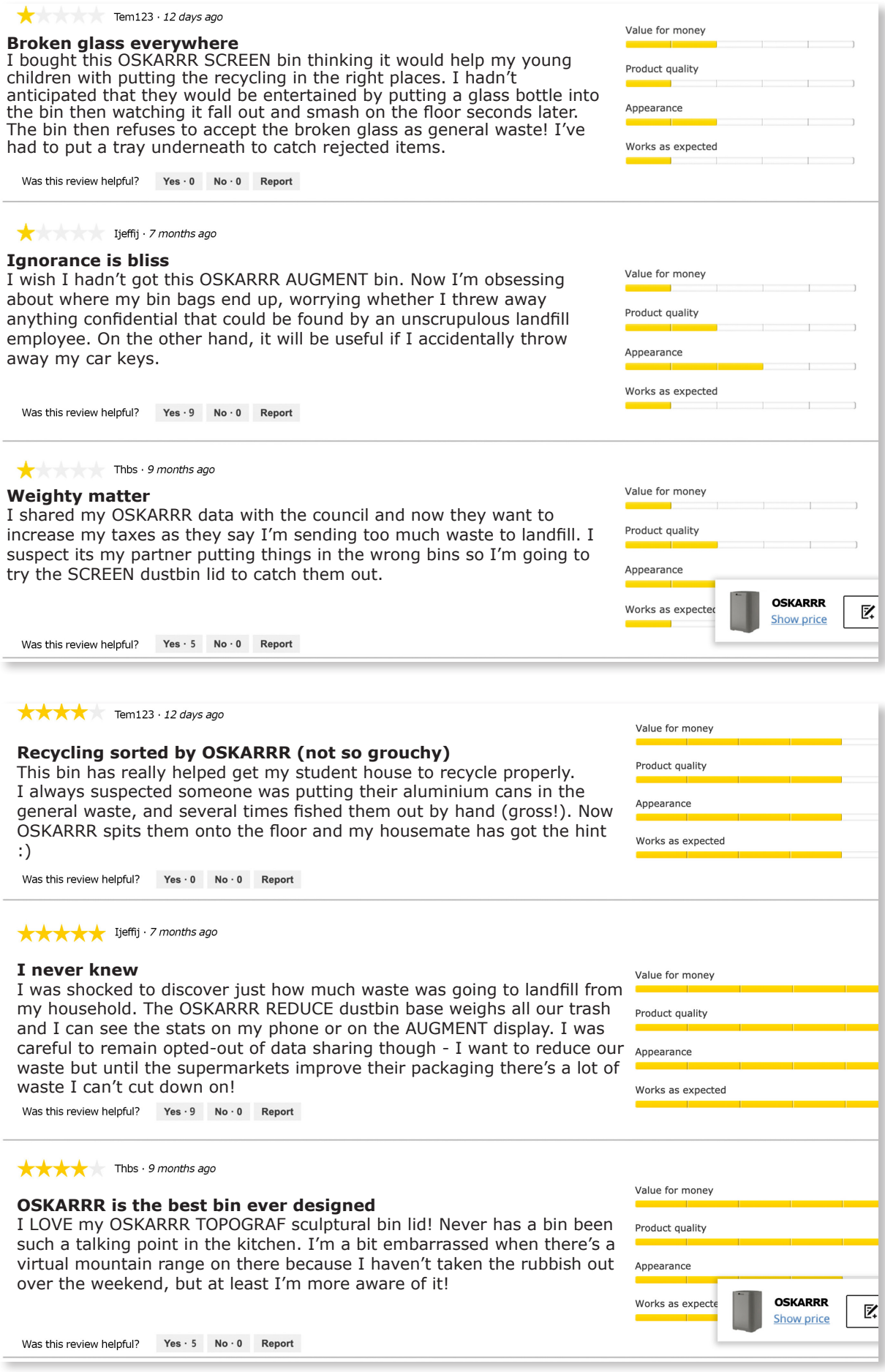


Figure 9. Negative and positive fictional product review webpages. Source: authors.

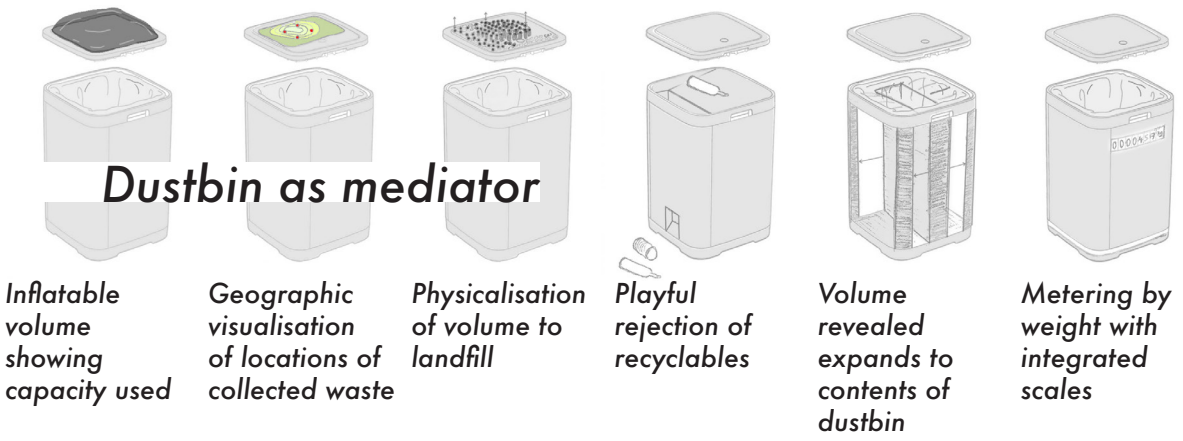


Figure 11. Dustbin as mediator. Sketching speculative design ideas to engage people with household waste. Source: authors.

2.2 DESIGNING A DATA-DRIVEN DUSTBIN

The provocations presented here are research products, exploring how technology and data can improve the environmental sustainability of our everyday lives. HCI literature demonstrates we have the technology to measure and quantify many aspects of our everyday life. Aside from the previously mentioned studies, waste has largely resisted datafication unlike energy consumption (e.g. the Google Nest thermostat), diet (e.g. Noom weight loss app), exercise (e.g. Strava), transport (e.g. CityMapper), environmental conditions (e.g. Physikit (Houben et al. 2016)) and shopping (e.g. Amazon). The Quantified Self movement, dedicated to *'self knowledge through numbers'* has a few examples of sustainability self-tracking projects but only one entry on domestic waste (Quantified Self 2020). Indhira Rojas undertook a similar waste tracking project as the previously mentioned autoethnography (Rojas 2010). She highlights the status of waste as information - *'discards tell stories about ourselves'*. Her *IndexR* idea is a database and interface for tracking consumption and enabling recycling behaviors.

Privacy concerns are heightened with the collection of data on domestic, personal waste. Our waste reveals much about our everyday lives and some waste is personally identifiable. The misinterpretation, perhaps deliberate, of BinCam (Comber et al. 2013, Daily Mail 2011, Hickman 2011) as a means for local authorities to spy on their citizens evidences the sensitivity in this area and this informs the concept designs for the OSKARRR system. Auger proposes that speculative designs should *'inspire an audience to think not only about what they do want for their future… but also what they do not want'* (Auger 2013, p.22). The adverse response to BinCam and the ability for speculative design to explore potentially undesirable futures without the ethical concerns of placing data-gathering bins in peoples' homes were key reasons for choosing a speculative design approach to this work.

The mainstream media reaction to BinCam suggests that the public in the UK is not ready for their waste to be photographed and uploaded to Facebook. They may be more amenable to closed 'black-box' type systems where data does not leave the household. Our playful concept (SCREEN) speculates on the potential for a dustbin with self-determination, rejecting items at the point of disposal, reducing the need for screening later on in the disposal process.

Figure 10. The real-life IKEA GIGANTISK bin, used as the jumping-off point for our speculative designs. Source: IKEA (2020)

Our designs seek to avoid the tendency for proposing apps as a solution for any problem - *there's an app for that* - the Apple iPhone/ App Store ethos. Inspired by the *Lyssna* (Oogjes et al. 2016) approach of enabling rather than undermining domestic practices, our concepts are designed for visibility without intrusion, revealing processes and infrastructure without adding complexity. Engagement with apps can be minimal as BinCam revealed, as they compete for attention with other apps and priorities (Comber et al. 2013). With this in mind the concept designs are standalone objects giving users an immediate visualisation or response.

3 A SUSTAINABLE HCI DESIGN FUTURE

Waste is a small but significant contributor to global greenhouse emissions, making up around 5% of the total (Bogner et al, 2008). This is mostly made up of methane generated by organic material decomposition in landfill sites. HCI and design could intervene here, diverting organic waste away from landfill through improved consumer behavior in waste separation, and in the prevention of waste in the first place, as beautifully demonstrated in the Lyssna design fiction for food waste (Oogjes et al. 2016). In this paper we address the entirety of the landfill element of waste as mediated by the kitchen dustbin. As landfill capacity decreases, more of this waste will be diverted to incineration, or exported, with their own environmental and social problems. One example of this is coastal landfill sites. In the UK, around 120 coastal landfill sites are predicted to start eroding into the coastal environment by 2055, some have already started, exacerbating the ocean plastic problem (Brand 2020). As a society we need to engage with what is being wasted and reversing increases in volume. We can no longer stop thinking about the objects we use and consume on a daily basis as soon as they enter a dustbin.

These speculative designs demonstrate that design has the capacity to assist people with understanding the complexity of waste disposal and engaging them with environmental consequences. The TrashTrack (Offenhuber and Ratti 2017, MIT n.d.) project revealed the complexities and geographies of a sample of objects through waste disposal mechanisms. As the complexity and cost of tracking waste reduces, it is possible to envisage a future where information on waste is as comprehensive as information on the supply-chain. Visions of the smart city tend towards making a more efficient and profitable version of business-as-usual. Smart waste bins that alert the management company when a bin is full and plan an optimal collection route (e.g. Wijaya et al. 2017) risk continuing the vicious circle of capacity and demand. The concepts in this paper aim to show that the technology offers us a greater range of futures than this.

A major concern in the design process for domestic waste is agency - the materials we dispose of are largely predetermined by organisations delivering products and services, the collection services determined by local government, the final processing by any number of parties, all around the world. In this context the major lever of agency for us as consumers is to buy less, but even the most basic essentials are delivered in non-recyclable packaging destined for landfill. By creating fictional product reviews, this uncomfortable position is explored. Our reviews were produced after analysis of real reviews of IKEA bins and smart home products. Even the real, mass-produced and tested products evoke a range of unexpected responses and user behaviors. This informed how our fictional reviewers might respond to the interactive dustbin elements, with their unconventional operations and abilities.

The use of an existing range of smart home products as a design language and context helps to embed the ideas in this paper in the everyday mundane. The use of an ordinary IKEA bin as the basis for the smart dustbin further grounds the work in its s*ubtle and uncertain absurdity* (Pierce 2016). The products look plausible and aren't too far from devices in existence like *Genican* and *Eugene* (Genican 2020, Uzer 2020), yet they remain *uncertain* and *ambiguous* in their operation and purpose. Could we live with a dustbin that stubbornly refuses to accept items? Are we open to having our waste scanned and weighed if the purpose is for more sustainable living? Exploring these questions through speculative design opens up the debate on what is preferable and helps focus future design research for the real-world.

This work aims to provoke further work on design for more sustainable household waste practices in the design research and HCI communities. We build on the foundational work of others with playful design concepts that examine a serious and vital issue for humanity to resolve. Speculative data objects are one approach to sustainable HCI design. We look forward to seeing further contributions from the community that challenge and extend this work.

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