Using Annotated Portfolios to Interrogate Speculative Designs: The Case of Emergent Personal Data Trails

Annotated Portfolios for Personal data

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We have reached a point where many users fully expect their technology to listen in on their casual conversations. Complete control of personal data is a distant memory. This paper explores users' future relationships with personal data, using six speculative design proposals concerning new and emergent personal data trails. Using an Annotated Portfolios approach, we map the relatedness and relationships between designs and highlight how this process generated new knowledge about the research space. Based on insights gathered in the processes of annotation, comparison and mapping portfolio constituents, this paper: (1) showcases speculative design responses to assist users in understanding and managing new and emergent sources of personal data, and (2) reflects on the Annotated Portfolio method as a reflective orientation tool that can help designers anticipate the implications of new technologies on users' data entanglements. We explore how an Annotated Portfolios approach can be helpful to interrogate speculative designs.

CCS CONCEPTS Human-centred computing → Interaction design → Interaction design theory, concepts and paradigms.

Additional Keywords and Phrases: Design, Annotated Portfolio, big data, privacy, consent, control, data trail, digital footprint

ACM Reference Format:

First Author's Name, Initials, and Last Name, Second Author's Name, Initials, and Last Name, and Third Author's Name, Initials, and Last Name. 2018. The Title of the Paper: ACM Conference Proceedings Manuscript Submission Template: This is the subtitle of the paper, this document both explains and embodies the submission format for authors using Word. In Woodstock '18: ACM Symposium on Neural Gaze Detection, June 03–05, 2018, Woodstock, NY. ACM, New York, NY, USA, 10 pages. NOTE: This block will be automatically generated when manuscripts are processed after acceptance.

1 INTRODUCTION

This paper is concerned with speculating new and emergent personal data trails, and how an Annotated Portfolio approach might help us understand how to support users' in this space. Keeping track of personal data is becoming increasingly complex as more parts of our existence become technologically mediated. Continually emergent sources of data capture and analysis mean users' data trails are appended and analysed in ways that cannot always be anticipated [33, 41, 58]. Technology designers, researchers, and practitioners play a vital role as advocates for user privacy and assisting users in managing their trails of personal data [59]. Designers support users through both: (a) improving users' awareness of -and options for controlling- *existing* sources of personal data capture (e.g. voice assistant logs) [59] and (b) *anticipatory* measures such as speculating about new and emergent sources of personal data capture [11] and managing consent in near-future exchanges of data [69, 72]. Designerly approaches such as speculative design create future-focused perspectives [4, 21, 23, 57], which, when coupled with more participatory, collaborative approaches, can help map out possible future trajectories of personal data [75].

Arguably the greatest concerns around personal data seldom stem not from a single source of data capture, but rather from the analysis or aggregation of multiple discrete sources together [56], drawing inferences which might be difficult to otherwise anticipate [69]. 'Mosaic analysis' relates to when disparate sources of information are aggregated or analysed together for greater inference, cumulatively forming a greater privacy risk than any of the sources separately [27]. Accordingly, in work anticipating and speculating about new data interactions or emergent sources of personal data, we need to closely consider their potential for mosaic analysis. The Annotated Portfolios method offers great potential in this regard, representing a means of exploring the relationality between designs to gather new knowledge about the portfolio as a whole [15, 29].

Annotated Portfolios are a method for documenting, generating, and communicating design research and praxis beyond traditional written formats [29]. They are *"...a way to articulate the new knowledge gained from research-oriented design practice"* [43], illustrative of how assemblages of designs and textual annotations can assist in understanding the relationality of designs. This format effectively makes the design socially interrogatable through the externalisation of design decisions; it creates transparency, inviting argumentation [61], critique, and reflexivity [63]. It generates "intermediate-level" knowledge by interrogating multiple design assemblages in a way that is not possible by reflection on single design artefacts or concepts; or through more orthodox, individual academic analyses [49]. The method has been extended to new contexts (e.g. auto-ethnographical documentation [28], human-robot interaction [36]) and has been adapted to support new means of reflection, e.g. the new mappings afforded by Culen et al.'s "ecosystems" approach which identifies how separate designs in a portfolio may work [15]. To our knowledge, however, Annotated Portfolios has not been applied to speculative designs, nor remote collaboration (e.g. designs curated across multiple and geographically disparate design teams). We suggest an Annotated Portfolios approach may be helpful to understand relatedness between both speculative and fully realised designs and may be a useful tool for exploring complex and heterogenous problems such as pre-empting and supporting future encounters and emerging challenges pertaining to personal data. Externalising, critiquing and understanding relationality is particularly important with data trails where the danger is not so much the number of data trails, but the overlap between them and their potential to be analysed together [27, 40].

This paper illustrates how an Annotated Portfolios approach might be useful to speculate upon new forms of personal data, and map these to better understand inherent opportunities and risks. We extend existing HCI work concerned with designing more positive and informed interactions with personal data [18, 18, 26, 31, 45]. We solicited and collaboratively mapped a portfolio of six speculative designs sourced from 17 institutions across three

continents, bringing together design researchers working on new forms of personal data trails and assistive technology that help users' navigate new interactions with personal data. The portfolio is analysed utilising an exploratory analysis, drawing from the *Annotated Portfolios* approach [29] to draw out the relationality between designs.

The paper seeks to answer two key research questions:

- *RQ1. How can annotated portfolios be used for interrogating speculative designs across multiple concepts?*
- *RQ2. What considerations and appropriations are required to make annotated portfolios suitable for collaborative speculation?*

In answering these questions, we additionally discuss the new knowledge generated around how to better support users in managing new and emergent data trails. The paper makes three contributions: (1) We present an appropriation of the Annotated Portfolios method to suit a crowd-sourced, cross-domain portfolio of speculative designs, reflecting on the suitability of the approach to speculative (as distinct from physical) designs and the adjustments necessary to support this new application. (2) We plot and analyse additional 'continua' of dimensions onto the portfolio constituents, to assist researchers in exploring the inter-relatedness of designs and how to operationalise them, building on Culén's "ecosystems" approach [15]. Finally, (3) we reflect on how this process can assist designers in pre-empting future interactions with personal data and how they might best support users in this regard.

2 BACKGROUND

2.1 Future interactions with personal data

The new norm of targeted marketing, bespoke and tailored services, and corporate surveillance provides a strong rationale for identifying new sources of data capture and new interactions with personal data [5, 11]. Human-Computer Interaction (HCI) literature contributes important perspectives to personal informatics [24, 47], quantified self [54, 60], 'intimate' data [45], interpersonal data [31], explainable/transparent AI [1, 66] and data entanglements in the home [18]. Safeguards to assist users in navigating new interactions with personal data include the design of more usable privacy and security [2, 20, 55], managing informed consent and consent fatigue [5, 50, 51] and mapping potential avenues for surveillance [10, 11, 62]. Risks of losing control of ones' personal data are categorised into: (1) Exposures or 'breaches' of personal information [35]; (2) Inconspicuous discrimination or exclusion from services through user profiling [68]; and (3) Re-analysis of personal data in ways which a user cannot anticipate. For example, the *Cambridge Analytica* scandal involved re-analysis of data in a way that users could not have reasonably expected when sharing the information years prior [38]. Supporting users to better understand their personal data and its sensitivities helps safeguard against losing control of data. In this space HCI contributes important design work towards increase literacy of existing sources of personal data through visualisation of voice assistant data capture [59], reclaiming solitude away from technology and its' data [57], usable privacy [2] and alternative and transparent approaches to consent [51, 74]. Equally important in this space is *anticipatory* work in this space. Namely, not only supporting users with their existing interactions with data, but anticipating new sources of data capture, future interactions with data [18, 58] and ideating how best to support users with new and emergent sources of personal data, where the data itself or implications of its analysis are unlikely to be anticipated by everyday users. This future-oriented focus lends itself to be explored through

speculative approaches, which are inherently valuable for enabling us to focus on possibilities beyond what is already known [21, 23].

2.2 (Speculative) Design responses toward reclaiming control

Speculative design presents visions of the future, with the aim of provoking discussion, critique, reflection and debate about our current practices [4, 21, 23, 57]. Exploring what the future might look like fosters debate about the implications of our current practices and allows us to engage with the mundane imaginatively [57, 58], and explore more nuanced possibilities of ordinary life, in turn, allowing us to work towards a more preferable future. Speculative approaches [23, 37] present provocative future-oriented scenarios, that build worlds [37, 48, 52] and explore future possibilities while being grounded in familiarity and relevance for the audience; making it easier to understand and imagine themselves in alternative futures [4]. Speculative design has a future-looking agenda which is well suited to forecasting potential future interactions with personal data and is a useful medium to engage users with technologies which could not easily be prototyped owing to ethical, legal or social concerns [6, 74].

Recent studies using speculative approaches have questioned 'who gets to imagine the future?' [9, 71, 73]; and given this present work looks at how to make the complexity of personal data more visible to both researchers and end users; it is imperative we also explore how the methods make design more accessible to all stakeholders. HCI research contributes speculative design responses toward reclaiming greater control over personal data and re-democratising technology through means of "camouflage" and "avoidance" [11]. The "CCD-me-not Umbrella" and CV Dazzle, are physical objects used as "camouflage" [11], i.e. to confuse facial recognition algorithms in CCTV [64] and represent metaphors for the need for physical shields against constant surveillance. Pierce's speculative Wireless De-Router creates digitally disconnected spaces, allowing users to experience digital detox [57]. Neighbourhood Wattch allows users to experience a world in which everyone's electricity consumption data is publicly available, allowing attribution of who is using power during peak demand [70]. Yet understandably, the focus for much of this work on personal data is on single data sources (rather than multiple or triangulated sources) and on extant sources of personal data, rather than future or emergent data trails, as is our focus here. The process of creating design materials is as valuable as using them [8, 42] and hence the value of creating speculative design artefacts and concepts around data trails, with or without the actual users, helps designers better understand and ask questions of the context they are envisioning.

Understanding relationality within multiple personal data trails is critical, underscored by the growing commonality of '*mosaic*' analysis, i.e., piecing together multiple data trails for greater inference [56, 58]. For example, co-analysis of loyalty card purchase history and demographic data [40], or comparing smart doorbell logs with IoT camera data in a home for greater personal inference and attribution [3]. Accordingly, it is important to develop methods for designers to better document, map, and understand the relationships between users' personal data trails, as trails become more complex and intersect with others, It is this need for perspective which leads us to explore relationality *between* design; to understand the implications of combinations of data trails, via Annotated Portfolios. We also draw on the increasing body of work that explores more participatory, and collaborative approaches towards speculative design [75].

Annotated Portfolios and intermediate knowledge

Annotated Portfolios [29] is a method for generating, documenting and communicating design research. The original method involves: "*..selecting a collection of artefacts, finding appropriate representations of artefacts and combining these representations with (typically) brief textual annotations that point out their salient qualities or the issues they address"* [15:1634]. Annotated Portfolios are recognised as a form of "intermediate-level" knowledge generation, i.e. the space between a given artefact, or what can be termed as an "ultimate particular", and generalisable theory, providing pragmatic insights that design practitioners use to support their practice [32, 49]. Annotations draw attention to aspects in the portfolio constituents which are not immediately apparent and enable comparison with other annotations and annotated objects. The presentation of an assemblage of artefacts with textual annotations can provide for designers richer ostensive and material representations than orthodox academic formats [29]. The original method has been extended in several ways, i.e. applied to business model creation [46], as a means of considering complementarity and ordering of deployment between designs; as an "ambiguity-compatible" feminist method, used in an auto-ethnographic pregnancy journey to document and reflect upon the interactions with technologies throughout pregnancy and childbirth [28]. However Marita et al. [17] highlight that the method is more commonly applied to ones' own work, rather than analysing the work of others, suggesting the method has promise in this regard. The method has been applied to discrete experiences [28] through to the critique of over 20 years of a studio's design practice [30]. Annotated portfolios offer not only a new way of appraising and critiquing designs, but extend the practice of HCI itself, providing an additional "methodological path to moving beyond foci of use, utility, interaction, and human-centeredness" [34:459].

Culén et al. [15], adapt the original Annotated Portfolio method, proposing two additional strategies towards abstracting new knowledge about the qualities of interaction and the design domain. These include: (1) development of a "chronological trajectory" that *"...shows the historical account of new domain explorations"* and (2) *"…a design ecosystem strategy that aims to show how artefacts can work together"* [15:1633]. The "eco-system strategy" assembles portfolio constituents as an eco-system, highlighting possible complementary relations between designs. This eco-system approach is of particular interest to our application area of wishing to understand the relationality between data trails and understanding how different combinations of data trails can be analysed together in a mosaic analysis to glean greater insights than may be possible than by analysing either data trail in isolation [3, 27].

In this paper we use an Annotated Portfolio approach to speculative design proposals concerned with future interactions with personal data. Ours approach adapts and builds on Culén's eco-system approach [15], where we intend to determine the suitability of an Annotated Portfolios approach to a portfolio comprised of diverse, crowd-sourced, and speculative proposals with a view to better understanding the data mosaics possible by overlaying designs within a portfolio. We contend that a portfolio approach to the growing body of work around near future interactions with personal data is warranted because of the sheer breadth of the problem space. Because our particular portfolio (described in the following section) maps out distinct speculative design proposals as elements, it also allows for the identification of possibilities to add to these trails and flesh out their emergent social consequences. Following, Culén et al. [15] we describe our portfolio of curated works, the annotation process, the eco-systems they exist in [15] and synergies between portfolio constituents that this method facilitated.

3 METHOD

The complete process of data collection, collation and analysis consisted of: (1) Solicitation of speculative design proposals through a workshop call. (2) Online collaborative annotation of the resultant portfolio of work from all contributors and workshop facilitators. (3) Subsequently, a smaller group of researchers mapped relationships and relatedness between portfolio constituents and from these, developed the continua described in Section 5.1.

3.1 Solicitation of speculative design proposals

A total of nine speculative proposals were received from HCI and design researchers, whose work focused on new and emergent personal data trails, as part of an open call to participate at a workshop hosted at a leading international HCI conference. The workshop call solicited speculative design proposals concerned with both new sources of personal data collection, as well as novel future interactions with personal data. The nine speculative proposals received from researchers across nine countries, were concerned with either: (a) defining an emergent personal data trail, presenting use cases, and/or (b) speculative technology concerned with assisting users in understanding or managing personal data trails. Authors of proposals were later contacted by workshop facilitators to have their works represented as part of a portfolio of design work and to contribute to this present paper. Of the nine proposals received, two represented theoretical position statements rather than designs and one author did not wish to participate further. The six included works provide a broad range of speculative future interactions with data including new data trail types and assistive technologies to manage personal data. All proposals were made available to workshop participants prior to the online workshop and each researcher delivered a 10-minute presentation to familiarise the team with their proposal and its context. A collective annotation activity was then run as part of the workshop which is detailed in the next section.

3.2 Annotation strategy

The process of annotation (conducted on the online collaborative whiteboarding tool *Miro*) ran as a workshop activity. The 14 workshop participants (including facilitators and creators of the design proposals) participated equally in annotating each design with virtual sticky notes using Miro, with users asked to use coloured sticky notes to denote: Pink: Most salient issues, Green: Opportunities and extensions (Figure 3.1). All papers attracted annotations and all workshop attendees participated in the annotation process. As per Culén et al. [15], the annotations represent an *"unordered and unfiltered record"* rather than deep or considered reflections. The collaborative nature of the annotation differs from previous applications of the Annotated Portfolio method, where multiple researchers separated by international borders annotated each other's designs (including their own) simultaneously within a restrictive timeframe. Figure 3.1 provides a screenshot of the annotation activity in a small section of the total Miro board. After the activity, it was realised the output of workshop closely resembled a format akin to the original intent of Annotated Portfolios [7, 15, 29];. documentation of the salient features of artefacts of interest, connecting these features to matters of further concern [7] and providing a useful platform for exploring relatedness [15].

Figure 3.1: Screenshot of annotations taking place during the workshop (author blurred)

3.2.1 Mapping relatedness and trajectories

Initial textual annotations were applied and discussed cumulatively as a workshop group including facilitators and participants. The process of annotating on Miro is depicted in Figure 3.1 (above), while a representative selection of annotations are provided in our description of each of the proposals below (Section 4). Following group discussion on each proposal and their annotations, the workshop facilitators (after the workshop) considered the ways in which the annotations gave rise to spatial and temporal considerations, leading the development a number of continua upon which to map the proposals to explore their relatedness, as per Culen et al. [15].

The process of creating the continua and the composite integrations involved the lead authors of this paper re-reading each of the six proposals alongside the textual annotations made during the workshop, transferring these annotations from the Miro board to a separate table alongside each paper, making further notes on each paper separate to the annotations and identifying relationalities between portfolio constituents. Emergent from this process were the three continua upon which each proposal is plotted (Section 5.1) and the idea to explore the new knowledge/perspectives available from integrating the proposals as a composite, according to specific attributes (Section 6). These continua were shared and refined with workshop participants for discussion in the development of this paper.

4 PORTFOLIO

Here we present the six proposals as abridged versions of the full designs submitted. Visuals from all portfolios are presented in turn, where annotations have been transposed from the Miro sticky notes to dot-points under each design proposal. During the annotation activity participants were directed to use pink sticky notes for the most salient issues and green sticky notes for opportunities and extensions. In presenting these designs, our purpose is not to determine or evaluate their quality as individual proposals or artefacts, but in the spirit of speculative design work — use these as provocations that open dialogue around these potential future personal data trails and their implications for users.

(1) Pathogens (PA)

Investigating Pathogen Trails As A Design Strategy to Combat Invisible Health Dangers in Everyday Environments

This proposal leverages the sharp increase in the availability of environmental microbiome information to non-expert users. Popular testing services produce data about the microbiome of people (e.g. skin or gut) and about their living environment (e.g. kitchen counter, bathroom surfaces). A solution is explored using "smart mirrors" utilising a corrective and augmented electronic display that makes visible these typically hidden data and can positively influence hygienic behaviour change (r*efer Figure 4.1).*

The design makes visible previously invisible environmental bacterial data (generated through periodic consumer microbiome testing) through augmented reality, or purpose-built mirror displays. These displays would be placed in areas known to attract high bacterial contamination and areas in which healthier hygiene behaviour change is possible, e.g. washroom sinks, kitchens. The design attempts to combat the knowledge-deficit of the ways in which pathogen spread, which currently limits healthier behaviour change. The mirror may heighten the perceived self-relevancy of the information and explores the role of self-observation in the process of self-regulation and the provision of more targeted and tangible information beyond generic public health hand-washing advice. Through making visible the transfer of pathogens in spaces of known transfer, allows us to embed a solution right in the middle of common pathogen trails while providing means to end them.

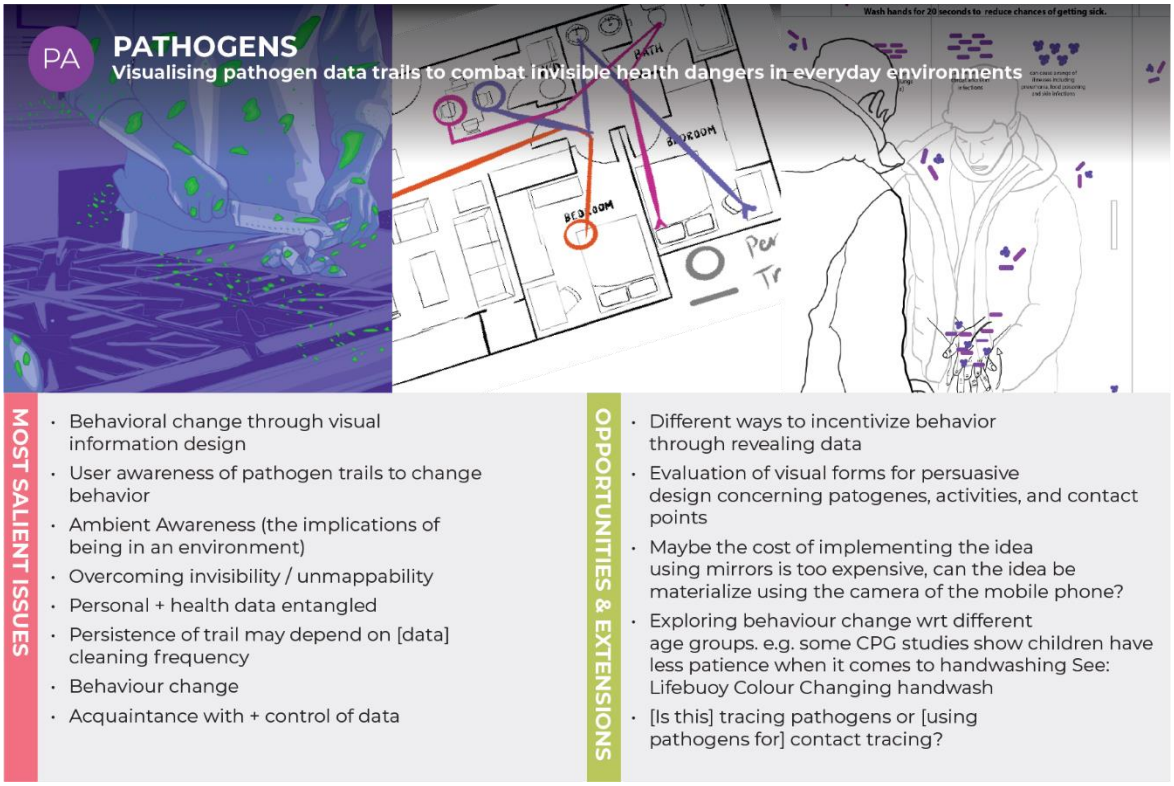

Figure 4.1 Speculative Proposal: Pathogens

(2) Artful obfuscation (AO)

Promoting agency in preserving anonymity in family photo streams

This proposal incorporates art when preserving anonymity in photo streams through means of obfuscation. The work is motivated by personal experiences of extended families spread across multiple countries utilising photo sharing platforms as a vital means of staying in touch. It can be endearing to watch a young niece or nephew comfort their sibling back to bed when you can't be with them personally, but it's also somewhat unnerving that all this is captured by a baby monitor and shared by family online. Motivated by the value to family of these shared photo streams coupled with concerns over their potential reach beyond the family, this work creates experimental films based on video footage from real family photo streams. Design responses focus on the artful obfuscation of identity, engaging fashion designers to create artful identity obfuscation methods, including experimenting with different levels of "dressing" participants in different levels of image transparency (refer *Figure 4.2*). The intent is to (a) bring attention to the privacy threats posed by large-scale photo sharing through online media, as well as (b) providing a means of preserving these practices of sharing by allowing personalisation of methods of anonymity, e.g. computer-aided masks, blurring effects; creating artful and beautiful forms of obfuscation.

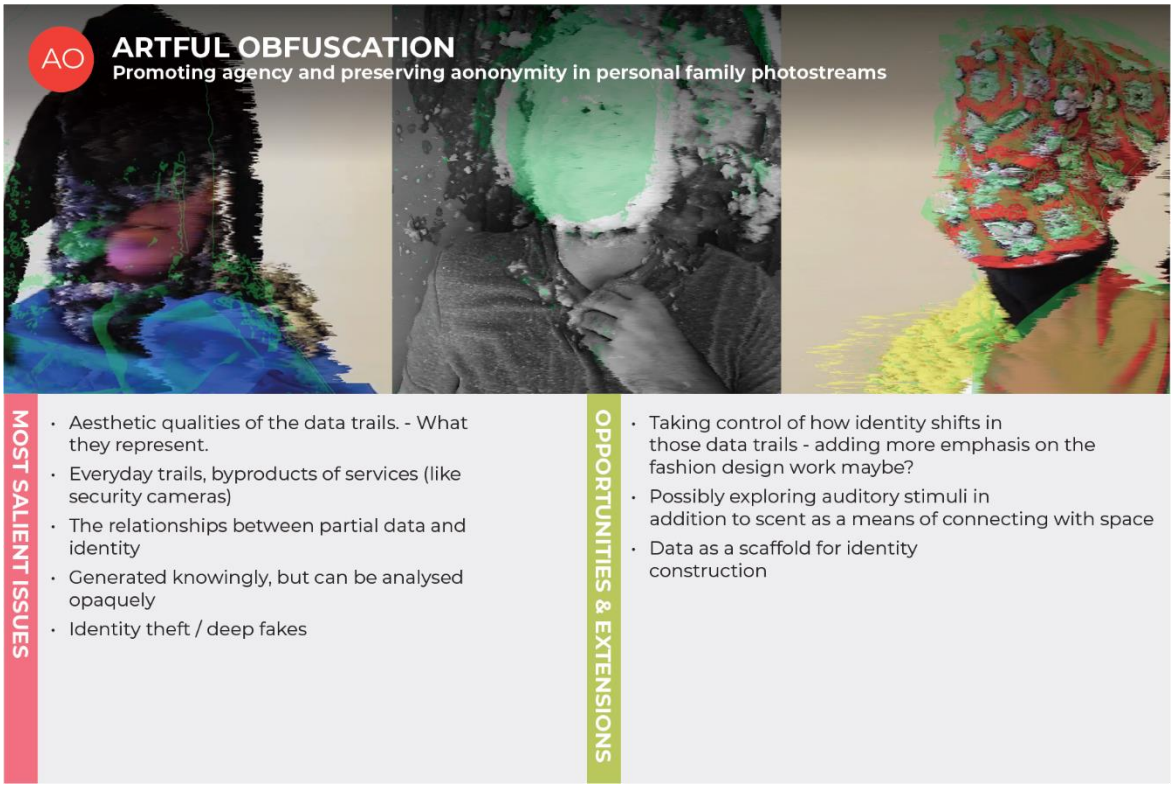

Figure 4.2 Speculative Proposal: Artful Obfuscation

(3) Driver performance data (D)

Emerging Multi-modal and Facial Video Data Streams for Adaptive, Personalised and Intelligent Human-Vehicle Interactions

The emerging trends of Autonomous Vehicles create opportunities for more adaptive, personalised and intelligent Human-Vehicle Interactions (HVI). BROOK is a new proposal for driver performance monitoring, which gathers data on multiple aspects of users' driving performance, drawing from streams including Facial Video, Vehicle Speed, Vehicle Acceleration, Vehicle Coordinate, Distance of Vehicle Ahead, Steering Wheel Coordinates, Throttle Status, Brake Status, Heart Rate, Skin Conductance and Eye Tracking. BROOK builds upon existing systems for driver performance monitoring through the monitoring of both physical, gaze and physiological metrics, additionally seeking to draw users' attention to the numerous mechanisms for monitoring an action as simple as driving a car. *Figure 4.3* visualises an example use-case of the BROOK database, where multi-modal statistics are projected to drivers during autonomous driving procedures.

The intention is to provide a higher quality and quantity of information to automotive and technology companies regarding vehicle and occupant safety and additionally provide feedback to occupants to allow for better reflection and critique of driving styles, safety concerns, unconscious biases and mistakes in operation. Yet equally, the quantity and granularity of information gathered on users may be considered sensitive, used for profiling and hence potentially valuable to third parties, including insurance companies.

Figure 4.3 Speculative Proposal: Driver Performance

(4) Metaphorical language (ML)

A Visual Metaphorical Language for Interfaces to Visualise Data Trails

This work presents mobile interface design concepts to make personal data trails visible and increase users' cognizance of data exposure. Motivated by the rapidly increasing difficulty in staying in control of ones' data trails, sources of data leakage and lack of awareness of the capability of data analysis techniques, this proposal introduces a smartphone plugin which to increases users' understanding of their personal data, using metaphors including: Frosted screen, Rainbow Heatmap, Hungry Zombie, and Data Current (*Figure 4.4*). This widget represents a critical reaction to our smartphone dependency and increased vulnerability to exploitation through the data that we produce intentionally and unintentionally. It focuses on the home screen as the medium to catch the users' attention. The intention is to delight the user by introducing unexpected visual forms and screen behaviours yet annoy the user eventually by disrupting the addictive experience of using our smartphones and their apps (r*efer Figure 4.4).*

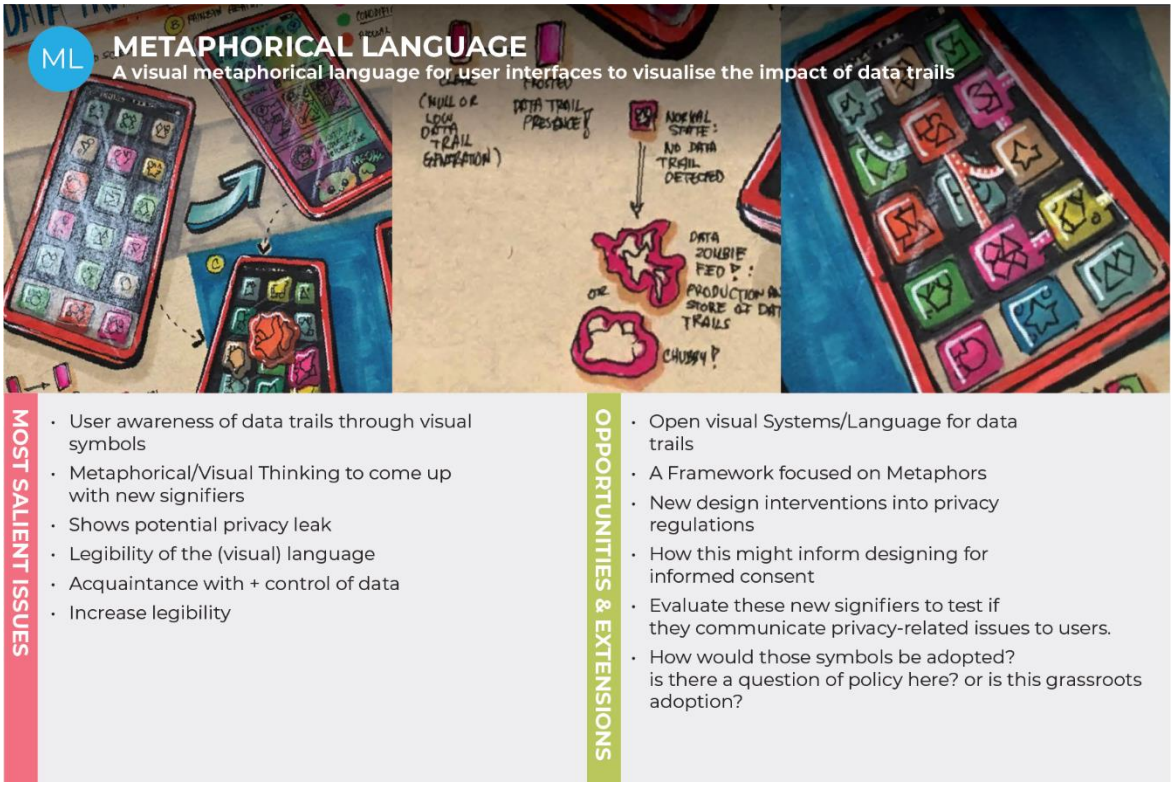

Figure 4.4 Speculative Proposal: Metaphorical Language

Frosted screen: The degree of frostiness indicates the amount of data in circulation and used by third parties. *Rainbow Plasma Cloud:* The plasma cloud visualises data produced and shared as a result of using different apps during the day, week, or month, mapped in colours. The cloud appears as a dynamic layer on the screen of the phone, where the extent of each colour indicates the amount of or significance of a particular data kind, such as identity, mobility, and commodification.

Data Zombies: Each zombie feeds on app data, increasing its size as a function of how much data it eats. The more data the app produces, the bigger and chubbier the app's icon becomes.

Data as Current: This visualisation regards each app as a creature, akin to a slug or octopus. The personal data produced by each app makes the icon develop tentacles which suction onto the icons of the apps that use and benefit from the data, to help the user understand their data flows.

(5) Energy use data (E)

Children-authored probes data of household energy use

Electricity monitoring produces a trail of household electricity data, which when analysed, can represent a source of sensitive information on householder habits, preferences and appliances. This study reflected on the sensitivity of the exposure of family energy use habits through probes-based research in the form of a game for children. The probe pack engaged children with missions, where they can choose to become a detective, electrician, or psychologist to gather data about the energy-related habits and knowledge of their families. The activities, while

fun for children, make visible the ways in which energy use constitutes a series of private actions within a family. Uncovering them through children for research raises questions over the fairness of this type of data elicitation method and highlights both the interpersonal nature of energy use data and the difficulty in obtaining informed consent for sharing this data *all* the household members implicated in the data trail. *Figure 4.5* provides an example of interaction with the "detective" mission where the child is tasked with finding the most power-hungry appliance in each room. A balance needs to be struck here between promoting energy literacy among children and ethical research which does not unintentionally compromise the privacy of other family members through energy data.

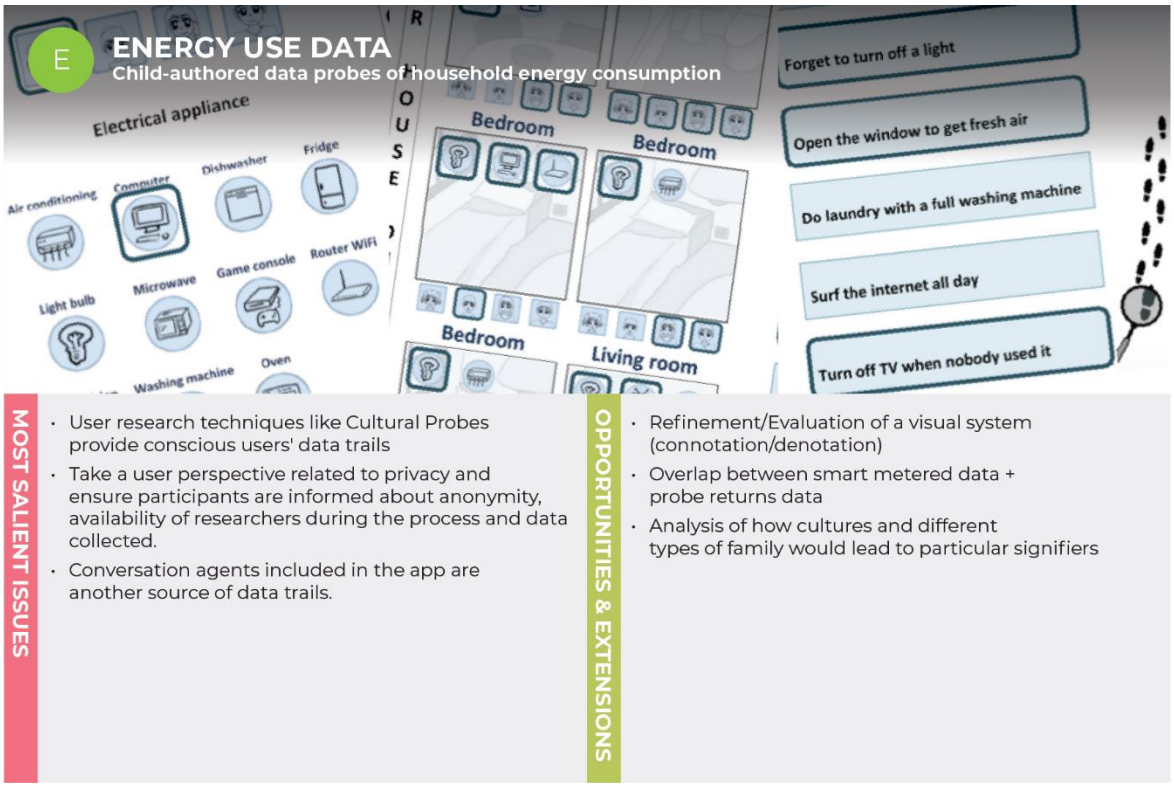

Figure 4.5 Speculative Proposal: Energy use data

(6) Physical data manifestations (PM)

Engaging through novel data representations

This proposal represents a series of speculative designs for physical objects created in response to users' reflections on patterns and habits on personal data in the home. These are visualised in *Figure 4.6.* The objects provide for new encounters with IoT data in the home and seek to understand how these encounters can acquaint users with previously unseen dimensions of their data and challenge existing perceptions of data as binary and two-dimensional. The physical representations include, amongst others: *Data Reality Glasses (a)*: Make the unseen accumulations of data piling up in a house visible. This gives a material, organic, and active quality to representations of data which allow interpretations to emerge between the physical space of the home and the smart objects of the home. *Data Dunes (b)*: Represents data as distinct layers of sand which display a stratification

of historical actions, allowing data to be seen through a log of interactions. A volumetric, stratified, and semi-solid layering of data which represent home dwellers' habits and interactions with the home. *Data Tarot Cards (c)*: A service where someone uses various interpreter cards to read through one's home data. The Alchemist card mixes data sets to find new meanings, the Explorer card follows one line of data as deep as possible and the Oracle card reveals futures as well as hidden pasts.

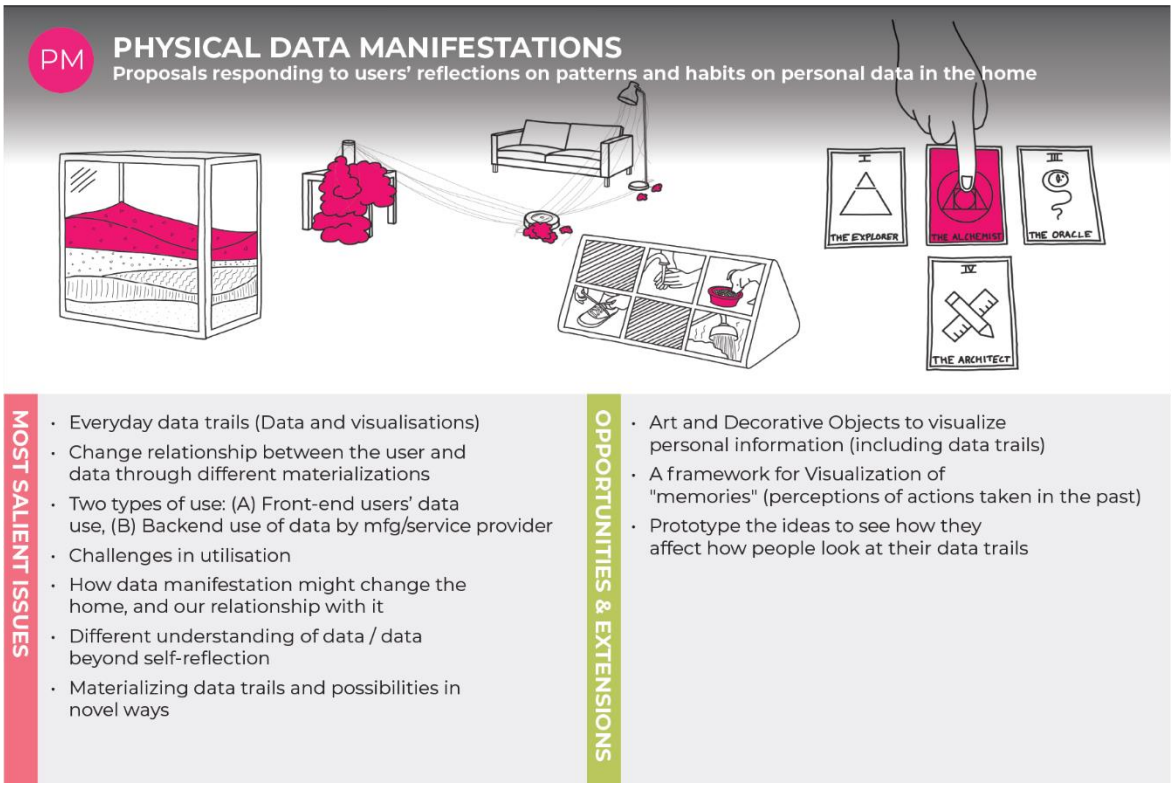

Figure 4.6 Speculative Proposal: Physical data manifestations

As detailed above (Section 3.2.1), a process of reflection and comparison of each of these proposals and the portfolio as a whole, gave rise to new understandings of the emergent personal data trail space and insights into their relatedness, complementarity and potential applications. The following section details the results of these processes of annotation, reflection, comparison and analysis.

5 PORTFOLIO EXPLORATION AND COMMENTARY

We refer to each proposal by its abbreviation (above). Each proposal introduces or defines a potential interaction with data, whether new form of data trail (E, D, PA), [and/or] a means of familiarising or empowering users in understanding or managing their personal data (PM, ML, AO). These proposals and the process of annotation illustrates the scope of possibilities for future data trail types, e.g. physiological and psychometric driver performance analytics (D), the traces of microbial matter we leave behind on objects we touch and the potential for

personal attribution of disease spread (PA), the potential sensitivity of energy use data both within a family and when shared beyond a family and the role of games to educate children of these aspects (E).

As an *"unordered and unfiltered record"* [15] of reflections on the proposals, the annotations were also a product of time constraints i.e., the annotation process being limited to the duration of the workshop. The annotations reflect immediate reflections from co-researchers on each of the designs, providing a catalogue of design considerations. For (PA), the annotation: *"persistence of data trail depends on frequency of cleaning"* highlights the ephemerality of pathogen trails as a personal data source, where the availability of digital information depends on physical actions, e.g. a users' hand hygiene or surface cleaning schedules. *"Overlap between smart metered data and probe returns"* (E) points to the difficulty in separating research data from smart meter data and the potential for overlap/leakage even through design research. Similar to Culén et al. [15], the process of textual annotations led to an understanding of researchers' initial or *"first-to-mind"* responses to each design, where some annotations act as notes made to assist the annotator's understanding of a design. The focus of many annotations was the ethical implications of each portfolio or considerations for user advocacy, e.g. *"what is drivers' experience of being monitored?"* (D), *"...ensure participants are informed about anonymity"* (E), *"potential for identity theft"* (AO). The annotations additionally point to potential data trail intersections beyond those immediately identified in the designs. These include incorporating knowledge of family type and culture to profile families according to their electricity data (E), identity constructions using partial representations through IoT cameras (AO), or whether the use case of identifying pathogens may in fact be appropriated to identify individuals by their pathogen traces (PA).

Cumulatively, the annotations point at the assistive aspects common to all proposals. The design probes around energy use (E) and the two-way mirror for visualising pathogens (PA) both aim to increase literacy of an unfamiliar data trail. (D) aims to enable more informed decisions through reflection on data and AO and ML both provide pragmatic tools for awareness of data capture and commodification (ML). AO juxtaposes the widespread practice of sharing photos online with the growing challenge of limiting the degree to which such photos are shared (or used) more widely than anticipated. Similarly, the transmission of pathogens is well understood, but visualising pathogens in-situ, and potentially attributing them to a time of contact or even individual people, is novel.

5.1 Continua

Based on Culén's "ecosystem strategy" to explore the relatedness of designs in a portfolio [15], the researchers reflected on common attributes between portfolio constituents, assisted by the annotations, to develop three exploratory continua upon which all proposals may be mapped (*Figure 5.1*). The intent of the continua was to explore how new knowledge may be generated *"...about the qualities of interaction and about the design domain"* [15:1633]. Also to better map the relatedness of portfolio constituents, and structure thinking around emergent and near future data trails.

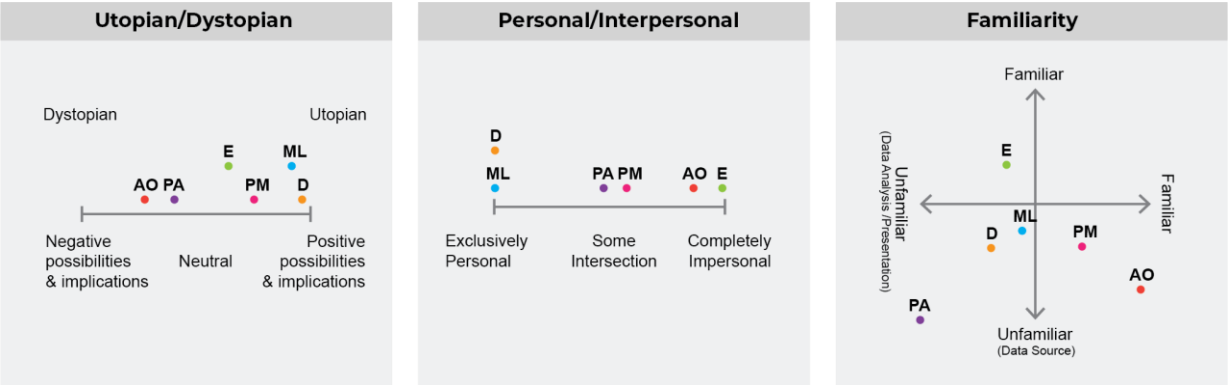

Figure 5.1 Continua – with Speculative Proposal Mapping

Figure 5.1 (above) shows the indicative placement of all design proposals on these three continua. The placement of the proposals on each continua are based on discussions between researchers and are subjective and exploratory in nature. The intent is not to segment or profile, but rather, to highlight the ways in which the proposals' attributes and annotations provide new ways of charting the relatedness of designs in a portfolio and how these alternative mappings may lead to new knowledge [15]. For example:

Utopian/Dystopian (Left): Utopian and dystopian framings are widely used in the development of design fictions [44]. We found the framing of proposals in the portfolio varied between more utopian and more dystopian. For example, (D) is framed as more utopian, where the use of driver performance data is outlined as a means of better understanding driver speed, fatigue and improving safety. Whereas (AO) and (PA) are framed by a more dystopian future where we need support to camouflage ourselves against surveillance and facial recognition and where the pathogens we leave behind may become new sources of identification and attribution. By mapping design responses according to their Dystopian/Utopian positioning we seek to avoid colouring our interpretation of the consequences of a proposal by its specific framing or orientation.

Personal/interpersonal (Centre): Reflection on proposals highlighted the personal/interpersonal differences in data source. Interpersonal data refers to data sources in which multiple users may be implicated in the one data stream, such as CCTV camera footage, or a family's energy use, where multiple people's actions contribute to a family's electricity use data [31, 69]. The continua maps (from left to right) the highly individual personal physiological data collected by (D) vs highly interpersonal data such as energy use data (E) and family photo albums (AO), in which multiple individuals are implicated in the same data trail. Understanding whether a given data trail is personal data or inter-personal data helps us consider issues like differences in gaining consent, e.g. how should consent and data sharing preferences be managed with interpersonal data?

Familiarity (Right): Annotations such as "generated knowingly but analysed opaquely" (AO) and "change relationship between user and data" (PM) caused us to consider how familiarity differs based on data source and method of analysis. E.g. users may be very familiar with a source/type of data but completely unfamiliar with the types of analysis which may be applied to it. Unfamiliarity with sources of data can lead to unsafe behaviours with

it (e.g. over-sharing) [53]. Accordingly, we expect doubly unfamiliar data sources (unfamiliar source and analysis potential) might be of highest priority to support users' in data literacy and understanding.

These continua assist reflection on the different *types* of relationality between the proposals. Mapping all the proposals in this manner also invites consideration of how best to support users, e.g. those implicated in interpersonal data who are not the data owner. Or how to increase data literacy in cases where users are unfamiliar with the trail itself and how the trail might be analysed.

5.2 Contours and boundaries

The method of mapping portfolio constituents on continua [15], allowed us to explore relatedness, scale, contours and boundaries within and between portfolio constituents. In particular, given forms of data capture already cross property boundaries (e.g. the field of vision of many home IoT cameras [58]) we were particularly interested in how the boundaries of data capture between designs interfaced with one another. As part of these explorations, we developed digital layers from our continua and portfolio constituents, to provide an illustrative depiction akin to showing or hiding layers in a Geographic Information Systems (GIS) model. Figure 5.2 (below) visualises a composite map of these overlays, where we experimented with transposing all portfolio constituents to a common setting- a family home. This exercise explores different aspects of boundaries within a design or context and relatedness between designs. Arranging speculative proposals in a common setting such as the home affords new possibilities to explore assemblages of trails and limits of data capture. The process is generative (in similar vein to de Bono's random-input method for creativity [16], and world building [14])– a core aspect of speculative design work. The result, Figure 5.2 provides a means of considering how the different properties of each data trail (e.g. familiarity, interpersonality etc, refer Figure 5.1) may play out when multiple data trails are co-located in a common space — visually depicting the mosaic.

Figure 5.2 Composite Integrated Data Trails: Small Multiple Mapping of Individual Discrete Data Trails and Composite Data Trail map: AO: Artful Obfuscation; E: Energy Use Data; D: Driver Performance; & PA: Pathogens.

Figure 5.2 first maps out the data trails individually (e.g. AO, E, D, PA), and then overlays them onto one frame. This created visual mosaic of the data trails highlights the relationality between the maps. The figure highlights the geographic and temporal boundaries of each data trail. For example, continuous data fields (IoT cameras (AO), pathogen movement (PA), electricity monitoring (E)), versus point-in-time surveillance e.g. only while driving (D). This type of visual mapping re-frames the data, leading to new insights and new questions, such what are the dangers of different combinations of data types? Unfamiliar, interpersonal data types with a high value for commodification may be a much higher concern than more familiar data types. The visual mapping underscores mosaic potential of these trails when they co-exist, posing questions such as can any of these trails be erased or removed? These types of aggregated views of data help generate new knowledge by identifying overlaps in certain data trails, and unique characteristics about others — providing a more holistic picture of data trails.

We note that these explorations are not simply results synthesised from a dataset. Rather, they are exploratory illustrations of how proposals collated and enriched via annotations can create new knowledge. They showcase where personal data intersections might exist, and where it might be captured and analysed in isolation.

6 DISCUSSION

An original intent of the Annotated Portfolios approach was to supplement the richness of design praxis; capturing value which was not appropriately represented in traditional written text [29]. Our adapted approach continues this tradition, presenting a creative appropriation of Annotated Portfolios that is consistent with the foundations of design i.e., externalisations [12, 19, 25, 39]. Applied to the complex problems associated with pre-empting and supporting users' future interactions with personal data, an adapted Annotated Portfolio approach [7, 15, 29] made it possible to plot and explore these concerns upon several continua (Figure 5.1), and better understand the mosaic analysis potential of the data trails depicted in the proposals (Figure 5.2). The process generated valuable insights for design, despite the differences in application context and process to the original Annotated Portfolio method [15, 29]. Like others who have experimented with Annotated Portfolios [15, 28, 46] we too advocate that even when appropriated to suit new contexts, it is useful in generating actionable knowledge from a collection of design responses beyond that which is possible from reflection on the designs individually. In our case, the Annotated Portfolios method enabled a more holistic picture of the landscape of emergent personal data trails, and avoided considering concepts in isolation. The resulting portfolio became a starting point interrogate the broader societal, ethical and potential legal implications of these near-future technologies. The mosaics generated (Figure 5.2) provide richer insight into the consequentiality of different intersections of personal data than the annotation activity alone, and it helped us reflect on what support users might need in respect of these emergent data sources.

In what follows, we synthesise our experiences towards answering the research questions posed in Section 1:

- *RQ1. How can annotated portfolios be used for interrogating 'mosaics' of speculative designs across multiple concepts?*
- *RQ2. What considerations and appropriations are required to make annotated portfolios suitable for collaborative speculation?*

To be clear, we do not suggest it is possible to provide definitive answers to these questions from the experiences of this one study; rather our responses represent a starting point to be built upon by others:

RQ1. How can annotated portfolios be used for interrogating speculative designs across multiple concepts?
The Annotated Portfolio method holds excellent potential for portfolios of speculative designs — particularly from the perspective of world building [14]. Speculative design is intended to invite critique [21]. Hence using the collaborative annotation process as a method to scaffold critique, we are serving speculative design's purpose; this is complimentary but distinct to the extant work done about collaborative and pluralistic approaches to speculative design [75]. The designs contained in the portfolio (PA), (AO), (D), (E), (ML) and (PM) by their speculative nature lack physical form, are not fully realised, implementable or immediately testable. Yet their speculative nature and the lack of finality to the elements also makes them more amenable to critique, and useful in a dialogic nature i.e., they can be built on further to explore different lines of inquiry. The speculative nature of our portfolio constituents has implications for the generation of intermediate-level knowledge [49]. Because the data trails detailed in the proposals are localised (i.e. situated within their own contexts) and emergent (i,e. there is no standardised approach to these new forms of data), the highest form of knowledge that can be created through this approach is

'intermediate-level' knowledge [17, 49], which is useful to the context of application and practical for those working within this field.

In particular, mapping of the relationality of the proposals within the portfolio, namely, the continua (Figure 5.1) and geo-spatially inspired overlays (Figure 5.2) resonate with Culén et al.'s [15] 'ecosystems' approach to better understand the relationality between deigns and how designs in a portfolio could be complementary or sequential in their deployment. The continua are scalable to a point, given further portfolio constituents could be easily placed upon each continua, allowing a portfolio to grow (or shrink) over time, which departs from previous notions of a portfolio as complete and static [15, 29]. The layering (Figure 5.2) represents a means of better mapping out a field of research, particularly useful with topics such as emergent personal data trails, providing a new analytic lens and insight into the consequentiality- of data mosaics (Figure 5.2) [56, 58]. They caused us to consider for example, what would be the implication of overlaying attributable data on disease transmission (PA) with security camera footage (AO) or driving data (D)? The purpose of the speculative approaches is to break down rules, suspend disbelief about change and encourage us to think beyond what we already know [21, 23]. Exploring these speculative works as a collective, helps preserves the original voice of the design; yet also enables us to collectively interrogate it as a constituent in a larger composite or mosaic. Future work appending these speculative proposals with other approaches (e.g., detailed scenarios and use cases) using the annotated portfolio structure, could in fact add greater depth to the discussions elicited.

RQ2. What considerations and appropriations are required to make annotated portfolios suitable for collaborative speculation? Our portfolio illustrates how adapting and extending Annotated Portfolios in accordance to the eco-system approach [15] is useful in creating value — underscoring its versatility and scalability in application. This versatility relates to its embodiment of a foundational characteristic that unifies all design, i.e., creating externalisations, analogous to drawings or sketches [1–4], open to scrutiny and critique. In this regard Annotated Portfolios are not just spaces to create these sketch-based appendages to concepts. Rather, when used across multiple concepts, as mosaics — in a collaborative setting, they enabled users to create a multitude of permutations, and variations of the concept sketches — opening new possibilities, ecologies, and trajectories for exploration (Section 6.1 below). The annotations also make individual stances taken on designs explicit to everyone engaged within the annotation process, creating transparent, explicit avenues to facilitate argumentation [4]. Conscious of other designers wishing to adapt the Annotated Portfolio to support remote work, we reflect on which aspects of our digital experience worked well:

- **Shared expertise:** While spread across domains, all participants in the collaborative annotation exercise were designers, were comfortable with speculative design, and wicked problems.
- **Familiarity with designs**: The nature of the workshop meant all participants reported having read their fellow participants' proposals, which meant little reiteration or explanation of designs was required in the annotation activity, allowing focus on the annotation activity itself.
- **Equal agency:** All designers participating in the annotation activity had equal control over the board and equal time to create and place sticky notes.
- **Generative:** The process of annotation was generative; did not involve refinement, which we suggest was helpful in creating an authentic first-to mind collection of annotations and as per Culen et al., [15]; an

"unfiltered record" of considerations, critiques, notes and statements on each design. Everyone had the same agency placing sticky notes on the board.

6.1 New knowledge on personal data trails through a 'mosaic' analysis using Annotated Portfolios

This paper illustrates that the mosaic analysis [27] for a given selection of data types can be valuable in expanding our understanding of emergent topics. For instance, the personal attribution of household energy use data (E) might be difficult to determine (e.g., [22, 70]). Yet when combined with IoT camera data (AO), knowledge of which family member is in -or is not in- a given room may paint a detailed picture of everyday life that a family may be largely unaware of (See: Figure 5.2). Through creating, analysing and reflecting on the portfolio as a whole, the actionable knowledge from this collection of design responses exceeds what may be possible through reflection on the designs individually i.e., the sum can be greater than the parts. We close with a summary of the new knowledge we discovered regarding future personal data trails through the method:

Identifying/prioritising threats: By mapping the portfolios in terms of their *familiarity*, *commodification* and *degree of interpersonality*, then integrating these continua, we were able to gain greater understanding and comparison- of the types of risks posed by data trails. For example, data trails which are highly unfamiliar to users, yet highly commodifiable and interpersonal pose a greater threat to users than trails which users may be more familiar with and hence are better able to manage (Figure 5.1).

*Planning design responses***:** Once threats have been identified, this method of mapping relationality between designs helps understand how designs may be deployed in a complementary order, e.g. which interventions may be suitable at different times. For instance, designs such as PA which acquaint users with a new data trail may usefully deployed first, followed by initiatives to better familiarise users with specific aspects of a trails, e.g. Proposals 4 or 6 (ML, PM). Once users are well familiarised with the trail and its risks and opportunities, it may be suitable to deploy designs to assist users in managing aspects of their data trails (e.g., AO).

Mapping a research area: The mapping of the portfolio demonstrates how these additions to the Annotated Portfolio approach holds promise for collaboratively scoping and defining boundaries for an evolving phenomenon such as emergent data trails — essentially a space for world building by collating different speculative design concepts, in a pluralistic, collaborative way. These types of dynamic approaches to mapping we explored with the Annotated Portfolios method (Figures 5.1, 5.2) are commonplace in other industry sectors, e.g. perceptual mapping of competitors' value offerings in business [67], however are not as common when it comes to exploring visions of the future within design.

7 CONCLUSIONS AND FUTURE WORK

In this paper we have demonstrated Annotated Portfolios as a valuable tool for understanding, mapping and abstracting knowledge about an emerging field of research. In particular, we have: (1) demonstrated how Annotated Portfolios can be used for interrogating speculative designs across multiple concepts, (2) detailed the considerations and appropriations of this method required to make it suitable for collaborative speculation and (3) discussed the valuable perspectives on personal data trails gained through a 'mosaic' analysis which is possible using Annotated Portfolios. We do not claim the portfolio studied here is representative of the complete range of possible future personal data trails, nor that have we critiqued the futures provided in each proposal. Rather, we have demonstrated the value of an Annotated Portfolio in eliciting new knowledge via the collaborative annotation

of speculative designs and how practitioners may use and benefit from this method. It should also be noted that while we have focused on the relationality between designs, each proposal is highly valuable in its own right. Each also raises important questions and challenges for future work beyond the scope of this paper. We hope this paper and the proposals contained within it inspire design avenues for how HCI research might advocate for users in a world in which sources of data capture are proliferating and in which personal data is becoming harder to trace, represent and control.

ACKNOWLEDGMENTS

Thank you to all workshop participants in the CHI 2020 workshop on Emergent Personal Data Trails and the conference organisers. We thank the anonymous reviewers for their feedback. This research was supported by the CSIRO, National Science Foundation Grants 1910218, 2142795, 2236822, SGR 00313, FairTransNLP-Language (PID2021-124361OB-C33, MICIU/AEI/10.13039/501100011033/FEDER,UE) and ACISUD (PID2022-136787NB-I00 funded by MICIU/AEI/10.13039/501100011033) and the Australian Research Council Centre of Excellence for Automated Decision-Making and Society (CE200100005).

REFERENCES

[1] Ashraf Abdul, Jo Vermeulen, Danding Wang, Brian Y. Lim, and Mohan Kankanhalli. 2018. Trends and Trajectories for Explainable, Accountable and Intelligible Systems: An HCI Research Agenda. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems - CHI '18*, 2018. ACM Press, Montreal QC, Canada, 1–18. https://doi.org/10.1145/3173574.3174156

[2] Hazim Almuhimedi, Florian Schaub, Norman Sadeh, Idris Adjerid, Alessandro Acquisti, Joshua Gluck, Lorrie Cranor, and Yuvraj Agarwal. 2015. Your location has been shared 5,398 times! A field study on mobile app privacy nudging. In *Conference on Human Factors in Computing Systems - Proceedings*, 2015. ACM, Seoul, Korea, 787–796. https://doi.org/10.1145/2702123.2702210

[3] Noah Apthorpe, Pardis Emami-Naeini, Arunesh Mathur, Marshini Chetty, and Nick Feamster. 2022. You, Me, and IoT: How Internet-connected Consumer Devices Affect Interpersonal Relationships. *ACM Trans. Internet Things* 3, 4 (November 2022), 1–29. https://doi.org/10.1145/3539737

[4] James Auger. 2013. Speculative design: Crafting the speculation. *Digital Creativity* 24, 1 (2013), 11–35. https://doi.org/10.1080/14626268.2013.767276

[5] Tim Baarslag, Helia Marreiros, Alper T. Alan, Enrico H. Gerding, Richard C. Gomer, M. C. Schraefel, and Ilaria Liccardi. 2016. Negotiation as an interaction mechanism for deciding app permissions. In *Conference on Human Factors in Computing Systems - Proceedings*, 2016. ACM, San Jose, CA, 2012–2019. https://doi.org/10.1145/2851581.2892340

[6] Eric P. S. Baumer, Mark Blythe, and Theresa Jean Tanenbaum. 2020. Evaluating Design Fiction: The Right Tool for the Job. In *Proceedings of the 2020 ACM Designing Interactive Systems Conference*, July 03, 2020. ACM, Eindhoven Netherlands, 1901–1913. https://doi.org/10.1145/3357236.3395464

[7] John Bowers. 2012. The logic of annotated portfolios: communicating the value of "research through design." In *Proceedings of the Designing Interactive Systems Conference on - DIS '12*, 2012. ACM Press, Newcastle Upon Tyne, United Kingdom, 68. https://doi.org/10.1145/2317956.2317968

[8] Eva Brandt. 2006. Designing exploratory design games: a framework for participation in Participatory Design? In *Proceedings of the ninth conference on Participatory design: Expanding boundaries in design - Volume 1*, August 2006. ACM, Trento Italy, 57–66. https://doi.org/10.1145/1147261.1147271

[9] Kirsten Bray and Christina Harrington. 2021. Speculative Blackness: Considering Afrofuturism in the Creation of Inclusive Speculative Design Probes. In *Designing Interactive Systems Conference 2021*, June 28, 2021. ACM, Virtual Event USA, 1793–1806. https://doi.org/10.1145/3461778.3462002

[10] P. Briggs, E. Churchill, M. Levine, J. Nicholson, G.W. Prochard, and P. Oliver. 2016. Everyday surveillance. In *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems (pp. 3566-3573). ACM.*, 2016. ACM, San Jose, CA, 3566–3573.
[11] Kieran Browne, Ben Swift, and Terhi Nurmikko-Fuller. 2020. Camera Adversaria. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, April 21, 2020. ACM, Honolulu HI USA, 1–9. https://doi.org/10.1145/3313831.3376434
[12] Bill Buxton. 2010. *Sketching user experiences: getting the design right and the right design*. Morgan Kaufmann.
[13] Eugene Y. Chan and Najam U. Saqib. 2021. Privacy concerns can explain unwillingness to download and use contact tracing apps when COVID-19 concerns are high. *Computers in Human Behavior* 119, (June 2021), 106718. https://doi.org/10.1016/j.chb.2021.106718
[14] Paul Coulton, Joseph Lindley, Miriam Sturdee, and Mike Stead. 2019. Design Fiction as World Building. *n Proceedings of the 3nd Biennial Research Through Design Conference* (2019), 1–16. https://doi.org/10.6084/M9.FIGSHARE.4746964
[15] Alma Leora Culén, Jorun Børsting, and William Gaver. 2020. Strategies for Annotating Portfolios: Mapping Designs for New Domains. In *Proceedings of the 2020 ACM Designing Interactive Systems Conference*, July 03, 2020. ACM, Eindhoven Netherlands, 1633–1645. https://doi.org/10.1145/3357236.3395490
[16] E deBono. 1992. *Serious creativity: Using the power of lateral thinking to create new ideas*. Harper Collins, New York.
[17] Delft University of Technology, Marita Sauerwein, Conny Bakker, and Ruud Balkenende. 2018. Annotated Portfolios as a Method to Analyse Interviews. June 28, 2018. . https://doi.org/10.21606/drs.2018.510
[18] Audrey Desjardins, Heidi R. Biggs, Cayla Key, and Jeremy E. Viny. 2020. IoT Data in the Home: Observing Entanglements and Drawing New Encounters. In *Proceedings of CHI 2020, Hawaii, USA*, 2020. ACM, 1551–1562. https://doi.org/10.1145/3313831.3376342
[19] Alan Dix and Layda Gongora. 2011. Externalisation and design. In *Proceedings of the second conference on creativity and innovation in design*, 2011. 31–42.
[20] Paul Dourish and Genevieve Bell. 2014. "Resistance is futile": reading science fiction alongside ubiquitous computing. *Pers Ubiquit Comput* 18, 4 (April 2014), 769–778. https://doi.org/10.1007/s00779-013-0678-7
[21] Anthony Dunne and Fiona Raby. 2013. *Speculative everything: Design, fiction, and social dreaming*. MIT Press, Boston.
[22] Gunther Eibl and Dominik Engel. 2015. Influence of Data Granularity on Smart Meter Privacy. *IEEE Trans. Smart Grid* 6, 2 (March 2015), 930–939. https://doi.org/10.1109/TSG.2014.2376613
[23] Chris Elsden, David Chatting, Abigail C Durrant, Andrew Garbett, Bettina Nissen, John Vines, and David S Kirk. 2017. On Speculative Enactments. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (*CHI '17*), 2017. ACM, New York, NY, USA, 5386–5399. https://doi.org/10.1145/3025453.3025503
[24] Daniel A. Epstein, An Ping, James Fogarty, and Sean A. Munson. 2015. A lived informatics model of personal informatics. In *Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing - UbiComp '15*, 2015. ACM Press, Osaka, Japan, 731–742. https://doi.org/10.1145/2750858.2804250
[25] Daniel Fallman. 2008. The interaction design research triangle of design practice, design studies, and design exploration. *Design Issues* 24, 3 (2008), 4–18.
[26] Martin Flintham, Murray Goulden, M Price, and D Urquhart. 2019. Domesticating data: socio-legal perspectives on smart homes and good data design. In *Good data*, Angela Daly, S. Kate Devitt and Monique Mann (eds.). Institute of Network Cultures, Amsterdam.
[27] P. Brooks Fuller. 2017. Mosaic Theory and Cyberharassment: Using Privacy Principles to Clarify the Law of Digital Harms and Free Speech. *Communication Law and Policy* 22, 3 (July 2017), 309–350. https://doi.org/10.1080/10811680.2017.1331637
[28] Mafalda Gamboa. 2023. My Body, My Baby, and Everything Else: An Autoethnographic Illustrated Portfolio of Intra-Actions in Pregnancy and Childbirth. In *Proceedings of the Seventeenth International Conference on Tangible, Embedded, and Embodied Interaction*, February 26, 2023. ACM, Warsaw Poland, 1–14. https://doi.org/10.1145/3569009.3572797

[29] Bill Gaver and John Bowers. 2012. Annotated portfolios. *interactions* 19, 4 (July 2012), 40–49. https://doi.org/10.1145/2212877.2212889
[30] William Gaver and Andy Boucher. 2024. Designing with Data: An Annotated Portfolio. *ACM Trans. Comput.-Hum. Interact.* (July 2024), 3685272. https://doi.org/10.1145/3685272
[31] Murray Goulden, Peter Tolmie, Richard Mortier, Tom Lodge, Anna-Kaisa Pietilainen, and Renata Teixeira. 2018. Living with interpersonal data: Observability and accountability in the age of pervasive ICT. *New Media & Society* 20, 4 (April 2018), 1580–1599. https://doi.org/10.1177/1461444817700154
[32] Colin M. Gray and Yubo Kou. 2017. UX Practitioners' Engagement with Intermediate-Level Knowledge. In *Proceedings of the 2017 ACM Conference Companion Publication on Designing Interactive Systems*, June 10, 2017. ACM, Edinburgh United Kingdom, 13–17. https://doi.org/10.1145/3064857.3079110
[33] Adam Greenfield. 2006. *Everyware: the dawning age of ubiquitous computing*. New Riders, Berkeley, CA.
[34] Sabrina Hauser, Doenja Oogjes, Ron Wakkary, and Peter-Paul Verbeek. 2018. An Annotated Portfolio on Doing Postphenomenology Through Research Products. In *Proceedings of the 2018 Designing Interactive Systems Conference*, June 08, 2018. ACM, Hong Kong China, 459–471. https://doi.org/10.1145/3196709.3196745
[35] Alex Hern. 2019. Largest collection ever of breached data found. *The Guardian*. Retrieved from https://www.theguardian.com/technology/2019/jan/17/breached-data-largest-collection-ever-seen-email-password-hacking
[36] Marius Hoggenmüller, Wen-Ying Lee, Luke Hespanhol, Malte Jung, and Martin Tomitsch. 2021. Eliciting New Perspectives in RtD Studies through Annotated Portfolios: A Case Study of Robotic Artefacts. In *Designing Interactive Systems Conference 2021*, June 28, 2021. ACM, Virtual Event USA, 1875–1886. https://doi.org/10.1145/3461778.3462134
[37] Maria Huusko, Yiying Wu, and Virpi Roto. 2018. Structuring and Engaging – The Roles of Design Fictions in a Co-design Workshop. In *Proceedings of the 30th Australian Conference on Computer-Human Interaction - OZCHI '18*, 2018. ACM Press, Melbourne, Victoria, Australia, 234–241. https://doi.org/10.1145/3292147.3292165
[38] Jim Isaak and Mina J. Hanna. 2018. User Data Privacy: Facebook, Cambridge Analytica, and Privacy Protection. *Computer* 51, 8 (August 2018), 56–59. https://doi.org/10.1109/MC.2018.3191268
[39] John Chris Jones. 1992. *Design Methods*. John Wiley & Sons.
[40] Kashmir Hill. 2012. How Target Figured Out A Teen Girl Was Pregnant Before Her Father Did. *Forbes Magazine*. Retrieved August 16, 2020 from https://www.forbes.com/sites/kashmirhill/2012/02/16/how-target-figured-out-a-teen-girl-was-pregnant-before-her-father-did/#717d20636668
[41] Awais Hameed Khan, Stephen Snow, Scott Heiner, and Ben Matthews. 2020. Disconnecting: Towards a Semiotic Framework for Personal Data Trails. In *Proceedings of the 2020 ACM Designing Interactive Systems Conference*, July 03, 2020. ACM, Eindhoven Netherlands, 327–340. https://doi.org/10.1145/3357236.3395580
[42] Awais Hameed Khan, Stephen Snow, and Ben Matthews. 2023. Participatory Design Tools: Leveraging Materiality and Familiarity to Adapt Unconventional Materials into Design Tools. In *Creativity and Cognition*, June 19, 2023. ACM, Virtual Event USA, 399–412. https://doi.org/10.1145/3591196.3593339
[43] Risa Kimura and Tatsuo Nakajima. 2023. Designing innovative digital platforms from both human and nonhuman perspectives. *Multimed Tools Appl* 82, 26 (November 2023), 39961–40008. https://doi.org/10.1007/s11042-023-15124-3
[44] Eva Knutz and Thomas Markussen. 2014. The Role of Fiction in Experiments within Design, Art & Architecture-Towards a New Typology of Design Fiction. *Artifact: Journal of Design Practice* 3, 2 (2014), 8–1.
[45] Hyosun Kwon, Joel E. Fischer, Martin Flintham, and James Colley. 2018. The Connected Shower: Studying Intimate Data in Everyday Life. *Proc. ACM Interact. Mob. Wearable Ubiquitous Technol.* 2, 4 (December 2018), 1–22. https://doi.org/10.1145/3287054
[46] Justin Larner. 2019. Reflective ethnographic design of collaborative economy models using annotated portfolios. In *Ethnographies of Collaborative Economies Conference Proceedings*, October 25, 2019. Edinburgh, 8–17.
[47] Ian Li, Anind Dey, Jodi Forlizzi, Kristina Höök, and Yevgeniy Medynskiy. 2011. Personal informatics and HCI: design, theory, and social implications. In *Proceedings of the 2011 annual conference extended abstracts*

on Human factors in computing systems - CHI EA '11, 2011. ACM Press, Vancouver, BC, Canada, 2417. https://doi.org/10.1145/1979742.1979573
[48] Joseph Lindley and Paul Coulton. 2015. Back to the future: 10 years of design fiction. In *Proceedings of the 2015 British HCI Conference*, 2015. ACM, 210–211.
[49] Jonas Löwgren. 2013. Annotated portfolios and other forms of intermediate-level knowledge. *interactions* 20, 1 (January 2013), 30–34. https://doi.org/10.1145/2405716.2405725
[50] E. Luger, T. Rodden, M. Jirotka, and L. Edwards. 2014. How do you solve a problem like consent?: the workshop. In *Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing: Adjunct Publication*, 2014. ACM, Seattle, 613–619. https://doi.org/10.1145/2638728.2641676
[51] Ewa Luger, Stuart Moran, and Tom Rodden. 2013. Consent for all: Revealing the hidden complexity of terms and conditions. In *Conference on Human Factors in Computing Systems - Proceedings*, 2013. 2687–2696. https://doi.org/10.1145/2470654.2481371
[52] Thomas Markussen and Eva Knutz. 2013. The poetics of design fiction. In *Proceedings of the 6th International Conference on Designing Pleasurable Products and Interfaces*, 2013. ACM, 231–240.
[53] Nora McDonald and Andrea Forte. 2020. The Politics of Privacy Theories: Moving from Norms to Vulnerabilities. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, April 21, 2020. ACM, Honolulu HI USA, 1–14. https://doi.org/10.1145/3313831.3376167
[54] Jochen Meyer, Steven Simske, Katie A. Siek, Cathal G. Gurrin, and Hermie Hermens. 2014. Beyond quantified self: data for wellbeing. In *Proceedings of the extended abstracts of the 32nd annual ACM conference on Human factors in computing systems - CHI EA '14*, 2014. ACM Press, Toronto, Ontario, Canada, 95–98. https://doi.org/10.1145/2559206.2560469
[55] Nicholas Micallef, Mike Just, Lynne Baillie, and Maher Alharby. 2017. Stop annoying me! an empirical investigation of the usability of app privacy notifications. In *Proceedings of the 29th Australian Conference on Computer-Human Interaction*, 2017. 371–375. https://doi.org/10.1145/3152771.3156139
[56] Office of the Assistant Secretary for Planning and Regulation. 2014. *MINIMIZING DISCLOSURE RISK IN HHS OPEN DATA INITIATIVES. 3. OPEN DATA POLICY—MANAGING INFORMATION AS AN ASSET*. U.S. Department of Health and Human Services. Retrieved from https://aspe.hhs.gov/report/minimizing-disclosure-risk-hhs-open-data-initiatives/3-open-data-policy%E2%80%94managing-information-asset
[57] J. Pierce. 2014. Design proposal for a wireless derouter: Speculatively engaging digitally disconnected space. In *Proceedings of ACM conference on Designing Information Systems (DIS'14)*, 2014. ACM, Brisbane, Australia, 388–403.
[58] James Pierce. 2019. Smart home security cameras and shifting lines of creepiness a design-led inquiry. In *Conference on Human Factors in Computing Systems - Proceedings*, 2019. ACM, Glasgow, 2347–2356. https://doi.org/10.1145/3290605.3300275
[59] Dominik Pins, Timo Jakobi, Alexander Boden, Fatemeh Alizadeh, and Volker Wulf. 2021. Alexa, We Need to Talk: A Data Literacy Approach on Voice Assistants. In *Designing Interactive Systems Conference 2021* (*DIS '21*), 2021. Association for Computing Machinery, New York, NY, USA, 495–507. https://doi.org/10.1145/3461778.3462001
[60] Amon Rapp, Federica Cena, Judy Kay, Bob Kummerfeld, Frank Hopfgartner, Till Plumbaum, Jakob Eg Larsen, Daniel A. Epstein, and Rúben Gouveia. 2016. New frontiers of quantified self 2: going beyond numbers. In *Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing: Adjunct*, September 12, 2016. ACM, Heidelberg Germany, 506–509. https://doi.org/10.1145/2968219.2968331
[61] Horst Rittel. 1984. Second-Generation Design Methods. In *Developments in Design Methodology*, Nigel Cross (ed.). John Wiley & Sons, 317–327.
[62] Pedro Sanches, Vasiliki Tsaknaki, Asreen Rostami, and Barry Brown. 2020. Under Surveillance: Technology Practices of those Monitored by the State. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, April 21, 2020. ACM, Honolulu HI USA, 1–13. https://doi.org/10.1145/3313831.3376889
[63] Donald A. Schön. 1983. *The Reflective Practitioner: How Professionals Think in Action*. Basic books.
[64] David Shepherd. 2011. Sentient City Survival Kit. Retrieved January 22, 2020 from http://survival.sentientcity.net/umbrella.html

[65] Irina Shklovski, Scott D. Mainwaring, Halla Hrund Skúladóttir, and Höskuldur Borgthorsson. 2014. Leakiness and creepiness in app space: Perceptions of privacy and mobile app use. In *Conference on Human Factors in Computing Systems - Proceedings*, 2014. ACM, 2347–2356. https://doi.org/10.1145/2556288.2557421

[66] Ben Shneiderman. 2020. Human-Centered Artificial Intelligence: Reliable, Safe & Trustworthy. *International Journal of Human–Computer Interaction* 36, 6 (April 2020), 495–504. https://doi.org/10.1080/10447318.2020.1741118

[67] Steven A. Sinclair and Edward C. Stalling. 1990. Perceptual Mapping: a Tool for Industrial Marketing: a Case study. *Jnl of Bus & Indus Marketing* 5, 1 (January 1990), 55–66. https://doi.org/10.1108/EUM0000000002738

[68] Karolina Snell. 2019. Health as the Moral Principle of Post-Genomic Society: Data-Driven Arguments Against Privacy and Autonomy. *Qambridge Quarterly of Healthcare Ethics* 28, 2 (2019), 201–214.

[69] Stephen Snow, Awais Hameed Khan, Kaleb Day, and Ben Matthews. 2024. Household Wattch: Exploring opportunities for surveillance and consent through families' household energy use data. *ACM Trans. Comput.-Hum. Interact.* (June 2024), 3673228. https://doi.org/10.1145/3673228

[70] Stephen Snow, Awais Hameed Khan, Mashhuda Glencross, and Neil Horrocks. 2021. Neighbourhood Wattch: Using Speculative Design to Explore Values Around Curtailment and Consent in Household Energy Interactions. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, May 06, 2021. ACM, Yokohama Japan, 1–12. https://doi.org/10.1145/3411764.3445095

[71] Matt Ward. 2019. Critical about Critical and Speculative Design. *SpeculativeEdu*. Retrieved April 22, 2021 from https://speculativeedu.eu/critical-about-critical-and-speculative-design/

[72] Lauren Wilcox, Robin Brewer, and Fernando Diaz. 2023. AI Consent Futures: A Case Study on Voice Data Collection with Clinicians. *Proc. ACM Hum.-Comput. Interact.* 7, CSCW2 (September 2023), 1–30. https://doi.org/10.1145/3610107

[73] Woodrow W. Winchester. 2018. Afrofuturism, inclusion, and the design imagination. *interactions* 25, 2 (February 2018), 41–45. https://doi.org/10.1145/3182655

[74] Richmond Y. Wong, Ellen Van Wyk, and James Pierce. 2017. Real-Fictional Entanglements: Using Science Fiction and Design Fiction to Interrogate Sensing Technologies. In *Proceedings of the 2017 Conference on Designing Interactive Systems*, June 10, 2017. ACM, Edinburgh United Kingdom, 567–579. https://doi.org/10.1145/3064663.3064682

[75] Yingfei Ye and Zhang, D. 2024. Co-creating pluralistic futures: A systematic literature review on participatory speculative design. June 23, 2024. . https://doi.org/10.21606/drs.2024.1316