HawkEye – Deploying a Design Fiction Probe

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ABSTRACT

This paper explores how a design fiction can be designed to be used as a pragmatic user-centred design method to generate insights on future technology use. We built HawkEye, a design fiction probe that embodies a future fiction of dementia care. To learn how participants respond to the probe, we employed it with eight participants for three weeks in their own homes as well as evaluating it with six HCI experts in sessions of 1.5h. In addition to presenting the probe in detail, we share insights into the process of building it and discuss the utility of design fiction as a tool to elicit empathetic and rich discussions about potential outcomes of future technologies.

CCS CONCEPTS

Human-centered computing~HCI theory, concepts and models

KEYWORDS

Design fiction; Dementia care; Informal caregiving; Future scenarios; Technology probes; Monitoring technologies.

1 INTRODUCTION

Design fiction employs fiction as a means to reflect on the potential outcomes of future technologies and is becoming increasingly popular in HCI research to encourage discussion about the social and ethical implications of near future technologies, where it serves as a thinking tool to help envisage the mundane lived experiences of those who might use and be affected by such technologies, see e.g. [44,66].

A different approach to understand people's lived experiences of novel technologies is to deploy prototype technologies to understand how they might integrate with or perturb existing social practices, especially so-called technology probes [34].

Building on these methods, we developed an interactive experience of a smart home system designed for dementia care, called HawkEye. For three weeks, we deployed it in the homes of eight participants, followed up by interviews. Participants were placed in the role of informal caregivers to a fictional woman living with dementia, and were given remote control over the fictional smart home in which she lived. We further evaluated this probe with six HCI experts to discuss the utility of our approach for HCI research. In this paper we present a case study of a *design fiction probe.* The term has been introduced by Schulte et al. [53] to describe a design fiction that is employed as a practical method to elicit participants' data, but this is the first evaluation of building and deploying such a probe. In addition to an overview of the insights gained through the probe, we share a range of reflections of how a design fiction probe can be built for deployment.

2 BACKGROUND

In this section, we describe how the use of HawkEye differs from other design fictions or other speculative methods before presenting the context of our case study and projects that inspired the work.

2.1 Design Fiction & Probes

Design fiction is an approach to envision the use of novel designs and technologies that uses world building or narrative [12] as a strategy to position them within a fictional context (see e.g. [19]). While it has historically been debated whether design fiction is one or the other, increasingly, design fiction combines these approaches (see

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e.g. [38]) and it is in this realm that we position our approach to design fiction. The term 'design fiction' was coined by Julian Bleecker in 2009 [9], and was later described by Bruce Sterling as "a creative act that puts the viewer into a different conceptual space — for a while" [57]. The main aim of design fiction is to foreground issues to allow for an open debate about a subject [10]. Design fictions can take on many forms, such as text [53], images [11], audio fragments [62], video [58,59], objects [60] or experiential prototypes [11,23]. However, while design fictions have often been used to encourage discussion or critique, their particular audience or the form of the discussion they aim to encourage has often been (deliberately) unspecified. In addition, while design fiction has been shown to make such complex issues debatable, these debates often occur through presentation of the work in exhibitions or academic papers, removed from the concerns of everyday end users.

More recently, work has started to focus more on the types of discussion elicited by design fictions for defined audiences. For example, Fuchsberger et al. [28] used fictional job adverts as prompts for discussions by both stakeholders and members of the public. Elsden et al. [25] developed the method of "Speculative Enactments" that enabled participants to experience fictional services and reflect on their values. Design fiction thereby moves into the realm of probes, especially technology probes. For example, Hutchinson et al. [34] deployed prototype family communication tools as technology probes to understand end users' experience and to provide insights that might drive design. Similarly, Brown et al. [16] discuss how a field deployment of a prototype called Whereabouts Clock to families made manifest how the meaning of a location emerges in social interaction and how awareness of others' activities contributes to identity work.

Our *design fiction probe* HawkEye combines these approaches by developing a probe that has the look and feel of a professional product that could plausibly fit into participants' lives. In addition, the design has an elaborate back story to help participants to suspend disbelief and immerse themselves in our fiction. Furthermore, in contrast to some other speculative or critical work that has involved deployment of prototype technologies, such as Wakkary et al.'s *Material Speculation* [63], the HawkEye deployment has been used as a pragmatic mechanism to collect data, which has been qualitatively analysed to understand how users engaged with the deployment. In this paper we build on the work by Schulte et al. [53], describing a case study of building and deploying a *design fiction probe*. This method combines three elements: a design fiction that builds elements of a near future world for our participants to enact; a technology probe that supports their interactive engagement; and empirical analysis of their concrete, empathetic and rich discussions that were elicited by living with the *design fiction probe*.

2.2 Context HawkEye: Dementia care technologies

Dementia is a collective term for progressive brain diseases whose symptoms can differ vastly between cases [31]. Symptoms include memory loss and change in personality [31], difficulty performing simple everyday tasks [31], getting lost [30,31] and insomnia [55]. A significant research focus is on personalised care at home, to allow people with dementia to maintain their autonomy for as long as possible [13,30,40,47,49,52], enabling them to remain in their own home for longer [46]. Technologies address the stress of caregiving, which increases as symptoms become more severe [1] but is also unpredictable as symptoms fluctuate and needs change [4]. Additionally, the decreasing decisional capacity of someone with dementia poses an ethical concern [50]. When using the HawkEye *design fiction probe* participants are only involved in remote caregiving. Therefore, we do not touch on the physicality of caregiving, but included other elements: we simulate fluctuation of symptoms and ask the participant to make ethical decisions.

Many smart home care technologies are currently in development and we took inspiration from those prototypes by extrapolating how it might play out if they were deployed within a commercial project for our *design fiction probe*. Some technologies are intended to be used by people with dementia directly as a means to gain access or participate in social or civic activities (e.g. [13,51]) or take part in leisure activities (e.g. [2,3,6,36]). However, most are intended to be used by caregivers to support everyday tasks, such as dressing or cooking [33,39,65] or to keep the person with dementia safe (e.g. [24,29,41]). In this situation, the caregiver is tasked with setting up and maintaining the technology, while the person with dementia is a passive user of the technology. In our *design fiction probe*, we mirror this paradigm as the smart home technologies support and augment the human caregiver, while the fictional character is mainly presented as a receiver of care.

As research with people living with dementia is challenging, caregivers are often involved as proxies, which might prioritise their perspective over that of those who receive care. While guidelines [32] and practical reports [64] about involving people with dementia in research and

design are starting to emerge, this approach is still under-represented and alternative approaches are needed. Most previous research has used focus groups and interviews with caregivers [48] to elicit views on potential future technologies, such as smart homes. This has led to a debate focusing mainly on decontextualised principles of privacy and autonomy. As this debate is quite high level, with few concrete insights to inform new solutions, researchers turn to creative methods, such as participatory design fiction [61] or provocative speculative design [22].

3 HAWKEYE

HawkEye, our *design fiction probe* (see Figure 1), puts participants in the role of an informal caregiver caring for a fictional woman with dementia, called Annie, living in a healthcare smart home. HawkEye combines the world-building element of design fiction with the exploratory deployment of technology probes. It was based on a design fiction on dementia care by Schulte et al. [53]. In addition to incorporating elements of current research technologies, HawkEye also explores the attempts that corporations might take to circumvent legislation designed to ensure human involvement in care decisions. As customary in design fiction [9], the technologies are deliberately taken beyond those that are already known, into extremes, to spark debate. While probes are often about ambiguity and letting participants fill in the gaps of a story [21], design fiction relies heavily on details in the fiction [7]. A challenge in the design of HawkEye was therefore to find a balance between providing enough details without being too leading. During the design process of HawkEye we paid close attention to offering enough details such that the participants could get a clear idea of what the envisioned future would be like without defining the entire experience

Figure 1. HawkEye control panel, volunteer information brochure (left) and resident file (front)

for them. Annie's character was given specific traits, but was also open enough for participants to build an individual relationship with Annie.

We intended to make HawkEye as close to a real experience as possible. However, as we could not make it entirely plausible that the experience was real and the ethical concerns around not informing participants about the fictitious nature of the study were too high (see [18] for a debate about deception in design fiction), we chose not to offer the participants the opportunity to seek contact with Annie. We expected that the absence of social contact between the participants and Annie would raise questions for the participants, but that it would not prevent gathering rich insights. While it would have been possible to adapt the system to get the user in touch with a fictional character – bot, Wizard of Oz, etc. – we decided against this, as we thought it beneficial to break the suspension of disbelief, as a means to enable participants to step back and reflect on their experience of what they could or would like to do.

Our aim was to enable participants to experience technologies "that do not currently exist" [37] so as to foreground personal aspects of interaction with the technology. This *design fiction probe* can be thought of as a 'breaching experiment' [21] that created practices where none occurred before. By deploying the probe in homes, we hoped to evaluate how participants experienced the probe in their everyday lives and what types of insights it might lead to.

3.1 Fiction
The probe was not given to participants on its own, e.g. like a technology probe [34], but instead we carefully crafted a fiction that would make living with it believable and support suspension of disbelief. The HawkEye system placed participants in the role of volunteers caring remotely for Annie, a woman living with dementia. Annie lived alone in a smart home (see Figure 2) developed by the fictional company 'HawkEye Technologies'. Annie's home was located at a distance from the participant's home so they could not visit and take care of her in person. Instead they were given control over several functions of Annie's smart home remotely.

When entering this fictional programme, participants received the *design fiction probe* in a box that contained a welcome letter, the HawkEye control panel (Figure 1), the volunteer information brochure (Figures 1 and 3) and the resident file (Figures 1 and 3). The welcome letter explained the volunteer's role, and that they were selected to care for Annie because the HawkEye Technologies database found
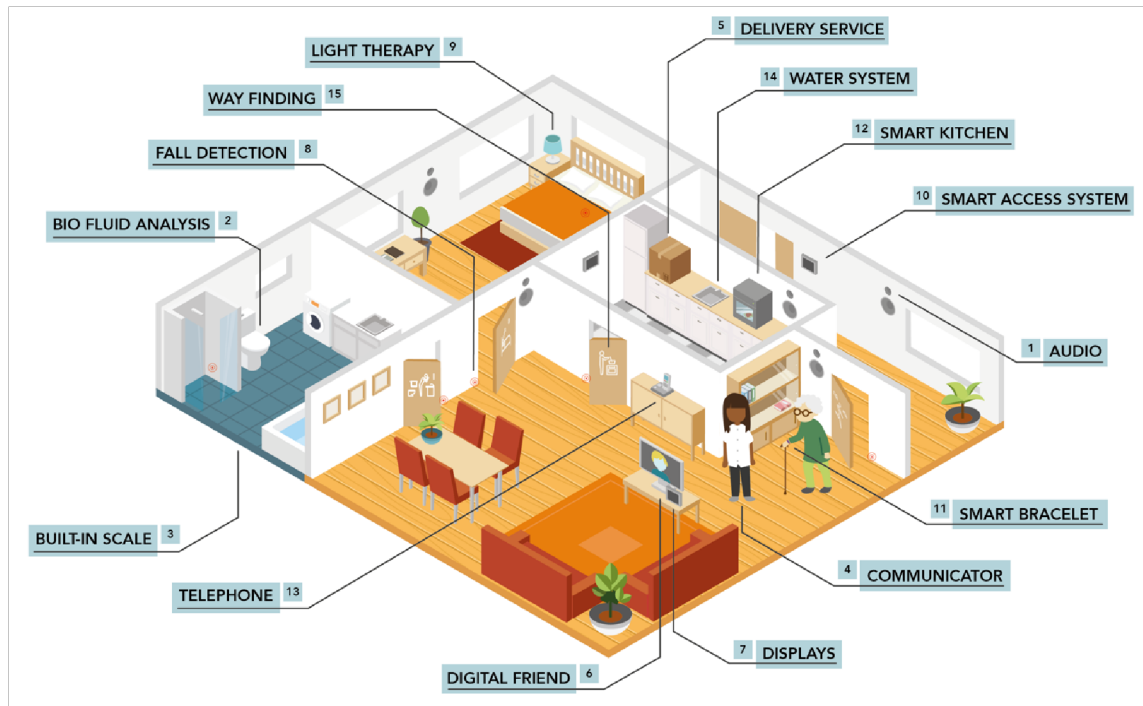
Figure 2. HawkEye Smart Home technologies overview, as presented to participants of the study

that Annie used to be a close friend of their family. It said that the participant used to go on holidays with Annie and that they had enjoyed her home-baked cookies in the past. The participants were told that they were part of a three-week trial, after which an evaluation would take place. They were then asked to install the HawkEye control panel and follow the instructions in the volunteer brochure.

3.2 HawkEye Technologies

The fiction embodied by our probe involves the company 'HawkEye Technologies', which produces and maintains smart care homes for people with dementia. Based on the three core domains of economic, legal and ethical responsibilities of the Corporate Social Responsibility model [54], we created a backstory for this company. The economic, legal and ethical values of the company were conveyed in the welcome letter and information brochure, as well as embedded in the design of the HawkEye system. The main economic motivation for Hawkeye lies in the projected increase in the number of people living with dementia [4]. In order to reduce the cost of care, Hawkeye replaced many functions currently performed by human caregivers, such as giving reminders or monitoring the wellbeing of the person living with dementia with smart technologies. The fiction considers how the corporation might aim to minimise the cost of future legal requirements to include human decision making in any care decisions, by

recruiting crowd workers and providing them with a quite minimal crowdsourcing interface that leaves much of the detailed decision making and delivery of care to the smart-home system.

3.3 HawkEye control panel

Participants were able to control functions of Annie's fictional smart home through a physical control panel. Once a day, they received a report in the form of a printed receipt (Figure 4) that would inform them about Annie's wellbeing. Based on these data, they could influence five different modules, which were elaborately explained in the brochure, by rotating the five corresponding knobs on the control panel (Figure 5). The settings of the knobs then defined which data would be printed on the next day. All data was pre-defined in a csv file, where different settings of the modules were considered. This meant that all participants experienced the same narrative with subtle differences in how it was delivered.

3.3.1 Care modules. During the study, participants were free to make decisions on activating and adjusting the five different care modules in Annie's smart home: Medication, Identification, Nutrition, Communication and Location. Each module could be set to a level between 1 and 4, where 1 meant there was no assistance in the specific area and 4 meant that the smart home would completely take over specific tasks of the care recipient. The modules were based

on current research technologies (e.g. night-time monitoring [49], wayfinding [30] and health smart homes [47] technologies) and on possible solutions for issues that cause institutionalisation (see e.g. [1]). Figure 2 shows an overview of the modules that were installed in the HawkEye smart home, which was also provided to participants in the information brochure.

The modules were specified as follows:

Medication focussed on remembering to take the right pills. Increasing the module to level 2 initiated reminders in the house, at level 3 a smart bracelet measured the amount of effective substances in the resident's blood and adjusted reminders to those measurements and at level 4 the system could add medication to the house's water system (cf. Schulte et al.'s *Homes for Life* fiction [53]).

Identification kept track of visitors to the house and people who call on the phone, as individuals living with dementia can have difficulty recognising people or judging their intentions [7]. Increasing this module to level 2 enabled caller/visitor identification for the resident, at level 3 it kept track of these visitors and callers and also sent this information to the informal caregiver, setting it to level 4 kept out unwanted callers or visitors, based on the system's judgement.

Nutrition can be a problem for people with dementia as they forget whether they have eaten or cannot recall how to prepare certain dishes [17]. At level 2, this module tracked what and how much the resident of the house has eaten, influenced the grocery shopping based on this information and set reminders for the resident to have meals. At level 3 a kitchen interface was activated with a cooking assistant that could explain how to prepare certain dishes, at level 4 it prepared simple dishes by itself. This module was based on smart kitchen research [8].

Communication can become very difficult for people with dementia, often resulting in loneliness. Inspired by

developments as described in section 2.2, at level 2 this module enabled the resident to contact lonely residents of other smart homes through a smart telephone. At level 3, the system could register the resident's emotions and send over care personnel whenever the resident was lonely. At level 4, this module activated an artificially intelligent companion for the resident. The emotional recognition for this module was based on research into monitoring emotional wellbeing in dementia [43].

Location enabled wayfinding both inside and outside the house. Many current developments address the question of how to keep people with dementia safe (e.g. [24,29,41]). As wandering becomes a bigger problem, at level 2 this module used a bracelet to direct the resident home, much like de Jong and Brankaert's navigation device [13]. At level 3 it offered wayfinding equipment within the home, to indicate which room is where, and keeps track of wandering at night. At level 4 this module offered bright light therapy and a smart access system that did not allow the resident to go out after dark.

3.3.2 Daily printed reports. The HawkEye control panel printed a report every day in the form of a receipt (see Figure 4). The receipt comprised a summary of how the
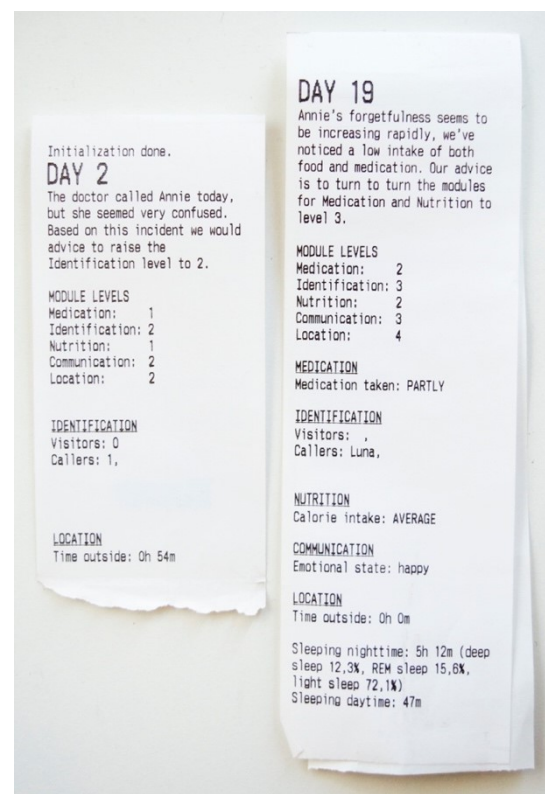

Figure 3. HawkEye resident file (left) and volunteer information brochure (right)

Figure 4. Examples of receipts printed by HawkEye control panel

Figure 5. Close-up of control panel with rotating knobs

smart system interpreted Annie's state, and then showed details for each different module. Information in these sections was activated when a module was set to level 2 or higher and showed more detailed information as the settings of the modules increased.

To give the participants feedback on the effect that they had on Annie's life, the data became more positive when the modules were set to higher levels. When the participant did not turn up the modules, the data gradually presented a more worrying progression of Annie's symptoms. Some days the system suggested turning up a module in response to Annie's data.

The HawkEye system worked entirely offline, but gave participants the impression of being online through a connection sequence being printed when first plugged in and by retrieving 'new' data each day. All data was pre-programmed but data was printed, depending on the positions of the individual knobs. See Figure 4 for an example of how information was presented based on the level that the modules are set to.

3.3.3 Resident file. Along with the control panel the participants received a resident file. There was space in this fil to note down the date and to store each day's receipt. Further free-text boxes were provided with prompting questions about the participant's thoughts on the resident's wellbeing, whether they changed the modules for that day and why, and a third text box for anything else that they would like to note down. Beyond this no instructions were given to participants on how to use the file.

3.3.4 Aesthetics and design rationale. We chose to design a physical system with analogue receipts rather than a smartphone application to act as a physical reminder for the participant caring for Annie. This was also expected to generate discussion between the participants and the

people they lived with or those who visited their home during the deployment. Furthermore, it contrasted with, and thus highlighted, the hi-tech nature of Annie's home.

The aesthetics of the whole HawkEye system (control panel, brochure, resident file, and welcoming letter) were carefully designed to make them as realistic and appealing as possible. They were inspired by the start-up project PillPack [45], which was designed by IDEO to deliberately break expectations of what health care technologies look like and looked like a designer item instead. To achieve this, materials like Perspex were combined with lacquered surfaces to develop a sleek appearance. Even the box in which the materials were shipped to participants was carefully designed to provide a satisfying 'unboxing experience' (see Figure 6).

4 DEPLOYMENT STUDY AND EXPERT SESSIONS

In this paper we present two studies in which HawkEye was used. We mainly deployed HawkEye in the homes of eight participants and undertook follow-up interviews to learn about their experience. In addition, and in parallel with the second week of the deployment study, we used it in 1.5-hour sessions in which six HCI experts simulated the experience to critically evaluate *design fiction probes* as a method. The studies were approved by the university's Ethics Committee prior to data collection: [8139/003].

4.1 Deployment study

4.1.1 Study Design. The study protocol included the deployment of the *design fiction probe* in eight participants' homes for three weeks, followed by interviews with participants.

Figure 6. Control panel in the box that was used to send it to participants.

4.1.2 Participants. Study participants were recruited through social networks, both online and offline. Participants were selected to have some knowledge about dementia, either because they had cared for or worked with someone with dementia, or studied the subject.

While nine participants originally agreed to take part in the study, one dropped out immediately after receiving the probe as they considered participation to be too stressful due to personal experiences with dementia. The demographics of the remaining participants can be found in Table 1. Four of the participants lived in the United Kingdom and four participants lived in The Netherlands. The materials they received were in their respective language and the interviews were in the same language. The interviews were audio-recorded and the Dutch interviews were directly translated to English. Participants were reimbursed with a voucher for their participation.

P#	Country	Connection to dementia research
P1	UK	Design/research work around dementia
P2	UK	HCI researcher with personal experience of caring for someone with dementia
P3	UK	Design/research work around dementia
P4	UK	Design/research work around dementia and personal experience of caring for someone with dementia
P5	NL	Personal experience of caring for someone with dementia and volunteer in dementia initiatives
P6	NL	Design/research work around dementia
P7	NL	Professional experience of caring for someone with dementia
P8	NL (living in Sweden)	Design/research work around dementia and personal experience of caring for someone with dementia

Table 1. Participant demographics

4.1.3 Procedure. Participants were fully informed about the study, and were told that the story presented to them in the study was fictional before signing a consent form. A couple of days later, they received a box with the HawkEye *design fiction probe*.

Participants were provided with an e-mail address and telephone number for urgent questions about possible technical issues with the system. Only one participant made contact by phone because the receipts were not being printed properly. This issue was resolved by giving instructions over the phone.

After the three-week deployment, the participants were interviewed about their experience with the HawkEye system and were asked to share their personal views on the future of dementia care. These interviews lasted between 17 and 40 minutes. All interviews were transcribed verbatim and thematically analysed [14]; in the analysis, recurring general themes were observed around feedback on the presented technologies, implications for technology in dementia care and the effects that were specific to the *design fiction probe* method. Data were then iteratively coded until sub-themes were defined.

4.2 Expert sessions

4.2.1 Study Design. The study protocol included pairs of participants interacting with the *design fiction probe*, followed by interviews. The studies ran in parallel with the deployment of the probes, but before the interviews. Even though the focus of the sessions was more on the suitability of *design fiction probe*s as a method in HCI, the sessions provided rich data that influenced our understanding of the probes. These sessions had the additional benefit that the first authors could sit in and follow participants through the sense-making process surrounding the artefact. The insights gained from these sessions helped to strengthen and guide the interview questions.

4.2.2 Participants. Six participants took part in the expert sessions, who were recruited at the University College London Interaction Centre through internal messaging tools. Participants all had experience in HCI research and were recruited independent of their understanding of and experience with dementia. Participants were not reimbursed for their participation.

4.2.3 Procedure. This study used the same *design fiction probe* as the deployment study, but had a different set-up. The expert sessions took about 1.5 hours each, during which the first authors were present at all times. The sessions were video and audio recorded. Instead of receiving a report each day, the experts received a report every 3 minutes. This allowed for discussion in between the reports, and gave them the possibility to change the modules accordingly. Each pair of experts went through 10 to 14 days' worth of reports.

After using the *design fiction probe* for a total of 60 minutes, the experts were interviewed in pairs about their experience with HawkEye and the design research implications of using design fiction as a research method, using a semi-structured protocol. The interviews varied in length between 24 and 42 minutes. The expert interviews

and use sessions were transcribed verbatim and then coded along with the deployment study interviews.

5 FINDINGS

The findings of the expert sessions, as well as the insights from the deployment study - the participant interviews and comments in Annie's files - are discussed together to avoid repetition. Experts are referred to as E1 to E6 with pairings of E1 & E2, E3 & E4, E5 & E6. Participants who lived with the *design fiction probe* for the three weeks are referred to as P1 to P8, while the participant who left the study is referred to as P9. Below we present four themes: Making the future accessible, Empathising with the future, Detail & Ambiguity in encouraging discussions, and Interactivity of fictional tools. Sub-themes are included where applicable.

5.1 Making the future accessible

HawkEye was designed as a means to bring the future to the present through an interactive *design fiction probe*. In the interviews, participants were asked to comment on whether the technologies used in the fiction felt realistic to them. Participants evaluated the technologies based on their own experiences and often provided a time frame in which they imagined the technology becoming real, such as "*not super, super in the future [...]. Maybe in 10 years that could be, a reality I guess.*" (P3) or by specifying that "*It stays in the realms of fiction but [...] it's a near future, you can visualise it. [...]*" (E5).

Other participants struggled more to imagine parts of the fiction: "*In some cases, it was very futuristic. Especially the story of taking in medicine through the water. I can't really imagine that*" (P5). Overall, the *design fiction probe* made it easy for participants to voice their expectations about what technology could potentially do, but also showed the limitations of what participants were willing to imagine.

Having the tangible probe helped participants to feel connected to and focus on the experience rather than the study: "*Although I knew I was taking part in a study there were moments when I almost forgot I was or I very much engaged with it and immersed myself in the experience*" (P2).

Having a story that progressed and was "*unfolding in front of you*" (E5) proved to be helpful for the participants. They could familiarise themselves with the modules and the technologies when they came into play and did not have to take everything in at once. While participants did not necessarily find the whole experience plausible, it did help them to consider the future experientially rather than abstractly.

5.2 Empathising with the future

5.2.1 The future of caregiving. The participants generally took their role as a fictional caregiver seriously, because they seemed to empathise with Annie. Participants frequently considered how Annie might be feeling or what her needs might be, based on the limited information that they had on her behaviour. These considerations influenced how they interacted with the system: "*Yesterday I turned communication to four, because she was lonely. I felt so sorry for her*" (P7).

Although most participants thought a lot about Annie's situation and her wellbeing, not all of them felt that they could play an active enough role in her care, when stating that they "*did not feel like a caregiver*", but instead "*I was just pushing a few dials every now and then*" (P1). Participants had to navigate their role and their relationship with the technology: "*I don't think I played an actual role. All the suggestions that are made here [on the receipt] could have been implemented automatically*" (P5).

This indicates that even though the tools might be helpful in some situations, they might have unintended consequences in the way caregivers evaluated their role and relationships.

The extent to which participants were willing to imagine parts of the story to make it more realistic for them varied. In some cases, filling in information missing on the reports helped them to relate to Annie. In the expert sessions this happened frequently during the discussions:

> E2: "*Maybe she got some groceries.*"
> E1: "*For the visitors?*"
> E2: "*Yeah, exactly. Maybe she's going to make chili sauce and she forgot to buy beans or something.*" (use session)

In the deployment study, this occurred less frequently as participants often underwent the experience on their own. But when using the resident file, some participants interpreted the data in their own way: "*Stefan called today, visited yesterday, loyal relative?*" (P5).

The probe helped participants to evaluate and reflect on different types of technologies, as well as look at them from a new perspective, e.g. not thinking about technologies in care homes anymore, but instead stating that "*you can also turn it around and create a technological house that provides an increasing amount of care*" (P6). In the interviews, participants expressed having changed opinions about the future of care for dementia, such as thinking about "*...the ideas of how artificial intelligence might come into play in terms of dementia care...*" which led them to conclude that:

"*personal touch is a lot more important than just a box that can say 'oh, you can change the dials'*" (P1).

Overall, the *design fiction probe* has been a useful tool to reveal participants' opinions about the role of technology in caregiving. Understanding participants' opinions and concerns can be useful to make designs that fit within the emotions and values of participants.

5.2.2 Role. Many participants expressed discomfort with their role during the study. They explained that they felt they had too much control over someone they did not know and that the relationship with Annie felt distant: "*It's almost [...] like a bit of a game sort of thing, or something you're just monitoring. [...] It does feel kind of closed and kind of cold. [...] I don't really get to know this person as I'm doing it as I don't really know anything more about Annie other than the name. [...] You do feel more, just like an instrument really, of the care*" (P3).

Nonetheless, most participants felt a high responsibility towards Annie and tried to act in her best interest: "*She was very confused and so I said 'I think Annie can use some more social interaction that might help her feel less confused' so I put communication up to two*" (P2).

Within the study, some elements of the fiction were interpreted differently based on participants' preferences. Participants had varying strategies of how they rationalised their decision making, e.g. by wanting more information or by distancing themselves from the fiction: "*I can imagine if you get even more feedback and even more details the person would [...] feel more responsibility to turn the right module the right way*" (P4) and "*I don't think it's something that you would actually physically be able to do, at least in terms of you have a tiny little paragraph about Annie's day and then you have to influence her entire life from that*" (P1).

The degree to which participants had personal experience of dementia also significantly influenced their experience of the system. Generally, it was easier for people who were familiar with someone living with dementia to relate to the probe and to fill in the gaps. P4 confirmed that Annie met their expectations of how a person with dementia might behave: "*I think she was- first of all she was believable I think with everything that was mentioned and the feedback she was believable that she was a real person. I think also seeing someone with dementia as well, you kind of- you can see a lot of similar characteristics in their behaviours and what they're doing*" (P4).

Some of the participants had been involved in the care of a loved one with dementia, and therefore were more emotional about their connection with Annie. P9 decided

after reading through the introductory letter and brochure, that having the *design fiction probe* in the house might become too emotional. Researchers offered contacts at support groups and to discuss any questions or concerns P9 had, but they denied offers of further contact and support as they had family support available. Participants who had no such experience looked at the fiction with more emotional distance. Similarly, participants who were highly tech-literate had a better understanding of the design elements and the possible consequences.

Overall, the *design fiction probe* was a useful tool not only to highlight potential benefits of the technologies, but also participants' concerns. Participants felt confident to critique the suggested system, which indicates that it could play a useful role in a co-design process.

5.3 Detail & Ambiguity in encouraging discussions

A frequent topic of discussion was the ambiguity of the messages on the receipt. Sometimes participants felt information was lacking, which made them question how to evaluate the situation:

> E5: "*Day twelve. 'Two of Annie's friends called her today, which made her happy.' But still no information.*"
> E6: "*I think it's worrying that the system is taking over. There's like, nothing to see here.*" (use session)

In other instances, participants interpreted the information in different ways than the system had: "*I mean there's a lot of times when I started thinking, like 'is the system trying to contradict what the paragraphs are saying?' So sometimes it'd say the module needs to be like level 3, but it really didn't, it didn't need to be influenced because I knew that she was taking [...] her medication*" (P1).

Having participants use the HawkEye system was an effective means to let them reflect on the specific technologies that were described, as well as the system as a whole. The system offered detail on technological specifications and participants commented on it at the same level of detail. When discussing the guidance offered in the kitchen for example, E2 (use session) wondered whether "*the person really needs guidance step by step*" as "*cooking is a routine based activity*", while P6 was positive about this technology in general, but questioned others: "*I expect that a smart kitchen interface will exist and that that could make a lot happen. But wayfinding symbols in the house for instance, I don't know how well that would work*".

But it also enabled participants to look beyond the technological opportunities and consider their own values towards the technologies and what they felt comfortable with: "*I think that if at some point I would have to decide like*

'Yes, put the medication in the water system so it comes from the tap', then I would think that's a step too far" (P7).

Discussions went far beyond the question whether technology in care was suitable, but also led participants to consider which ones were particularly (un)suitable and why, enabling participants to reflect on their values in regards to the technology.

While a written story might also be ambiguous, participants argued that the tangible probe had a stronger impact: "*I think it did really well to [...] put in that level of ambiguity that you would feel, so in a lot of cases where you are given scenarios I think [...] that ambiguity really helps. I think it deepened the sense of discomfort if I'm honest*" (E5).

In summary, participants in both sessions questioned the information they received, which was emphasised when information was not as they expected. This led to in-depth discussions about what was needed and wanted from the technologies. It further led participants to reflect on their values.

5.4 Interactivity of fictional tools

5.4.1 Feedback. The interactive nature of the HawkEye probe meant that participants could influence the story they experienced through their own actions. Getting feedback on these actions through the probe could help with immersion: "*... and then the next day she got a call and she was happy, and so I thought 'Oh, that worked'*" (P2).

However, due to the participants making some unexpected decisions, there were times when the feedback was different from what they expected, inconsistent or completely missing. These moments led to confusion and occasional frustration: "*I didn't feel like there was much I could do, except turn up the knob and sometimes I got the idea that it wasn't working or didn't respond right away*" (P8).

A technical issue occurred for P1 to P4, as well as the expert sessions. This meant that the module data was not printed on days 10 and 11 and in some cases day 12. While unintentional, this glitch serendipitously encouraged participants to evaluate how dependent they were on the system and how much they trusted it: "*Because of the technical glitches, I only think that made me think 'maybe this is on purpose, to make me think what happens when the technology breaks'. [...] I'm only relying on this one daily report but if it doesn't give me the information, [...], how am I going to make sure that Annie is okay? And it made me realise how dependent I was on HawkEye to make this work*" (P2). Participants did not gain direct feedback on their actions but had to interpret and analyse the data to make

sense of their input, which helped to trigger reflections on their role and responsibilities.

5.4.2 Detail & Engagement. Overall, participants were strongly engaged throughout the study which could be seen through the lively discussions of the experts or the notes in the resident file and button logs of the deployment. The interviews indicate that the appealing nature of the probe as well as the interactivity had a strong effect on this.

Setting up a design fiction that could be employed in participant's homes required a lot of believable detail in the story, which meant that the fiction became very expansive. This was not only a challenge for the researchers, but this also meant that it was difficult for participants to get a grip on the whole story and which responses were adequate: "[To E3] *Oh you were asking how we can get more information from the sensor data, I think just by increasing all these levels here*" (E4).

While participants got a delayed feedback to their action through the receipts, the system was lacking in one important detail. Participants imagined coming in contact with Annie, e.g. by calling to get more information: "*Maybe we should call her and ask her if she wants more entertainment*" (E4). In the deployment study, participants made notes in their resident files to call or visit Annie: "*She's sad :(I don't know what to do. Can I call her?*" (P2). This was not possible due to the setup of the probe, so when participants were missing specific information or more context, they often filled in some of the gaps according to their own imagination: "*It could also be a day that she doesn't feel like eating lunch. Maybe the last visitors left a chocolate*" (E5).

Therefore, we could observe that some elements of the fiction had opposite effects on some participants. E1 and E2 reacted very enthusiastically to the information given on the introductory letter and happily said that they recalled these moments, while E4 thought it was slightly creepy: "*That's odd... [...] How do they know that I like her cookies?*" (E4).

Even though participants had different experiences with the HawkEye system, many of them discussed that they found the experience valuable. They mentioned several reasons, including that they gained some food for thought, as well as an enjoyable, well-designed experience: "*I really, really enjoyed [the study]. It was very interactive, [...] I was super-engaged at every single point*" (E1).

This was also true for participants in the deployment study. P3 for example finished the interview by stating: "*I*

don't have any questions but I really enjoyed it, it was really good. I love the machine, it looks really nice and you've done a really good job on that. It's great. It's cool" (P3).

In general, the experts were very positive about the experience, emphasising that they felt more immersed in the fiction than through other types of scenario e.g. written stories or video: "*What I quite liked about this method is that you were an active participant. So there are also some studies where you are shown a video or [...] you have to read a scenario and I can still be like 'oh yeah I can imagine that might happen in the future' but I wasn't as engaged as I was now because now I actually have to make actions and based on your actions the story changes and I thought that was quite effective*" (E6).

The physicality of the probe also helped to start discussions. Multiple participants suggested that while it might not be realistic to have a physical machine to remotely control a smart home, it did make it easier for them to discuss the issues at hand: "*I like the fact that the output is more tangible so I like that it's not an interactive display*" (E2).

For the deployment study participants, the physical presence of the probe triggered discussions with friends and family as it was part of their life for three weeks. P2 mentioned regularly discussing with her partner, who did not dare interfere with the system but would indicate that the receipt had printed once P2 arrived home: "*Oh, check Annie's report, it came out! Oh, what have you done! Is she going to be okay? Did she die?*" (P2). P6 even took the probe with her on a holiday with friends, where she discussed Annie's wellbeing at length and took advice from her friends on whether or not to change the modules. Both in the expert sessions, in which participants were in pairs, and in the deployments, the artefacts encouraged reflection that often translated into discussions with other people about sensitive topics.

Overall, the interactivity and aesthetics of the probe helped to make discussing a serious topic engaging for participants. Nonetheless, the interactivity of the HawkEye system occasionally led to confusion, especially when participants felt that information was missing or that their actions did not have an immediate effect. However, this led participants to evaluate the technologies and engage with them on a more personal level than a printed story or video might have done.

6   DISCUSSION

This study aimed to gather insights on the use of *design fiction probes* to evaluate technology-based future

scenarios. This was done through a case study in the context of dementia care. HawkEye, a *design fiction probe*, was created and deployed in eight participants' homes over the course of three weeks, as well as experienced by six HCI experts. Both studies provided valuable insights into the specific context and practical insights into the development and use of the method. Here, we reflect on how these decisions influenced the results and offer suggestions for future work in the area of *design fiction probes*.

6.1   Participants' lived experiences around dementia care

Building and deploying a probe enabled us to learn about participants' views on dementia care beyond the high-level and decontextualized debates in current academic discourse. Design fiction has already been used to move beyond the discussions about technological capabilities of DIY medical devices, towards a discussion about the regulatory implications of such devices [56] and to address sensitive topics, such as urinary tract infection [44]. The discussion themes triggered by HawkEye were grounded in everyday experience. This method therefore supports a more situated and negotiated view of ethics as called for by Frauenberger et al. [26]. *Design fiction probes* might be a way to gain more situated insights from potential users. The dilemmas faced by participants question the limits of the system and the technologies that supported it. It disrupts the "solutionism" [42] of many technologies, as discussed also by Blythe et al. [11]. These considerations suggest novel angles for developing tools for dementia care that re-evaluate what information is shared and to what end.

6.2   Details and ambiguity in the design fiction

In this study, we used design fiction in an empirical way to elicit information from participants, in contrast to previous projects, such as [27] and [35] which present the artefact as a means to communicate their insights. The HawkEye system was not only a means to make previous research tangible and debatable, but we wanted to learn which type of insights it could lead to. We adapted technology probes [34] from a tool that enables free exploration, to a partly scripted experience. As with informational probes [20], we found that the probe was useful in producing practical data on a complex and sensitive topic.

When reflecting upon the balance between details and ambiguity in the design fiction, the details in the technology definitely helped participants to immerse in the story, which led to specific discussions of the technologies in the scenario. This detail and specificity can be valuable

not only for this case study, but beyond. Simultaneously, Annie's personality was deliberately left open to interpretation, which seems to have enabled participants to create their own personal image of her and therefore to make her more relatable. However, defining more about Annie's character could have made her more realistic to the participants which might have influenced their perceived closeness to this fictional character.

This level of detail is something that distinguishes *design fiction probes* from other design fiction methods, as people experience (un)pleasantness or (im)practicality first-hand, instead of reading or hearing about it. Increasingly, researchers turn to enactments and improvisation as means to explore participants' values and emotions [5,15,25]. By drawing on these methods and using a *design fiction probe* as a means for participants to step into a new role, we enabled them to explore technologies in their home and on their own time. In addition, as the probes were employed in participants' homes for a long period, participants encountered events we had not planned for which gave us insights into their decision making, e.g. around holidays and other people visiting. Participants' experiences over time also changed which enabled them to reflect on their values. We argue that these experiences led to rich and nuanced insights about complex and sensitive topics that would otherwise have been hard to gain.

6.3 Suspension of disbelief

In hindsight, the rich data we gained from the interviews indicates that the set-up without the opportunity for extra contact with Annie has been successful. Furthermore, when looking at the highly emotional responses of some of the participants to the study as it was, contact with Annie made the experience too personal and emotional for some. However, we believe that this was very specific to this use case as dementia care is a sensitive subject and there were ethical concerns about the emotional response of participants. In other, less sensitive debates incorporating elements that make the experience as close to real experience as possible might be desirable, to fully suspend disbelief. Although we still support our decision to leave out the social contact between Annie and the participants mainly in relation to the aforementioned ethical concerns, we do wonder what rich data this type of communication with a *design fiction probe* could elicit.

6.4 Considerations for designing design fiction probes

The elements of the 'perfect' *design fiction probe* are likely to differ between situations where they could be applied.

However, there are two general elements that should be carefully considered when crafting a design fiction: the balance between ambiguity and details and the suspension of disbelief. The level of detail in the fiction is likely to be mirrored in the level of detail in participants' responses. We would therefore advice researchers who are willing to use design fiction as a probing tool to consider the detail that they are looking for in study responses when crafting *design fiction probes*. Additionally, we experienced that breaking the suspense of disbelief can be a powerful tool to stimulate debate and reflection. Even in instances in which the fiction "broke", e.g. through technological glitches, participants stayed within the fiction most of the time and reflected on its limitations. Encountering gaps in the fiction therefore could be considered an opportunity rather than an issue. More so, it might offer the possibility for participants to look at the probe from up close while also taking a more abstract perspective from time to time.

6.5 Limitations

Although both studies have provided valuable insights, there are some limitations that need to be considered while looking at the results. First of all, there might be a slight bias because of the personal and professional interests of the participants. While we were mainly interested in recruiting people with a background in dementia care, without other constraints, the method of recruitment through our social networks meant that many of the participants, not only in the expert sessions, but also in the deployment study, were researchers themselves. This could mean that the participants are thus likely to have had an above-average interest in this new method and that they probably perceived the method differently to non-researchers.

While we gained rich data from the observations in the expert sessions, the interviews and resident files, we missed the opportunity to ask participants closer questions about the way they employed the probe, i.e. where they placed it and whether that affected their interaction with it. We suggest this for future deployments as it could have given us useful insights to understand and evaluate their responses.

This research has only looked at one use case of design fiction probes, but shows interesting future directions to explore. These include ways to make design fictions more interactive, methods to quantify design fiction results and the amount of detail that design fictions ought to have to instigate the desired discussions.

7   CONCLUSION

In this paper we described the development of a *design fiction probe*. This novel method combines the exploratory nature of probes, such as technology probes or information probes with a strong narrative element that elicited and nuanced responses. By employing this probe, both over the long-term in participants houses and in the short-term deployment that we were able to observe, we learned how participants responded to the probe, which gave us useful insights into the application of this type of research tool. In this paper we present a wide range of insights about both the development and deployment of the probe that can be useful to other practitioners in the field.

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