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Invisible Design: Exploring Insights and Ideas through Ambiguous Film Scenarios

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ABSTRACT

Invisible Design is a technique for generating insights and ideas with workshop participants in the early stages of concept development. It involves the creation of ambiguous films in which characters discuss a technology that is not directly shown. The technique builds on previous work in HCI on scenarios, persona, theatre, film and ambiguity. The Invisible Design approach is illustrated with three examples from unrelated projects; Biometric Daemon, Panini and Smart Money. The paper presents a qualitative analysis of data from a series of workshops where these Invisible Designs were discussed. The analysis outlines responses to the films in terms of; existing problems, concerns with imagined technologies and design speculation. It is argued that Invisible Design can help to create a space for critical and creative dialogue during participatory concept development.

Author Keywords

Invisible Design, Film, Participatory Design, Older Adults.

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms

Design.

INTRODUCTION

Traditions of participatory design (PD) have long sought to include potential users of technology in the earliest stages of concept development [21]. However, engaging participants in design processes can be challenging. This is particularly the case for older people, who may be disinterested, mistrustful or hostile to new technology [13]. This paper considers Invisible Design as a technique for use in PD. Invisible Designs are depicted in film-based scenarios where characters discuss technologies that are never shown on screen. We argue that the technique opens up a space for critical and creative dialogue.

The technique builds on previous work in Human Computer Interaction (HCI) on scenarios, persona, theatre, film and ambiguity. In this paper we present three examples of Invisible Design films: Biometric Daemon, Panini and Smart Money. One of these films has previously been presented to the HCI community as a video showcase. The films were made to stimulate discussion in PD workshops across three separate projects. Transcripts from the workshops are analysed using a grounded theory approach [12]. Responses were predominantly; reflections on existing social and technological problems, concerns with the imagined technology and design speculation around the "invisible" technology.

This paper contributes to HCI in two ways. First, Invisible Design provides a documented example of how ambiguity can be leveraged and applied in a PD context. Second, we describe how the Invisible Design technique can generate useful design insights and transform the focus of development in a PD process.

INVISIBLE MONSTERS, BOSSES AND TECHNOLOGY

Although film is a visual medium some of its most powerful effects have been achieved by what it does not show. This is most obvious in early horror films where the monster is seldom if ever shown directly. The camera takes the creature's place as it stalks a victim or the scene cuts just before the thing is shown to someone screaming. Early film criticism was quick to point out that the camera's power is not "to reveal, but to suggest" [20]. Invisible monsters have survived successive decades of film and technological development and famous examples include *The Island of Lost Souls* (1933), *Night of the Demon* (1957) and *The Blair Witch Project* (1999).

Although digital technologies make it easier and cheaper to show any kind of spectacle, indirect techniques are still used to great effect as a standard trope in Science Fiction, Thrillers and Comedy genres (where, for example, George's boss in Seinfeld is heard but never seen). Literary and Film theorists have long argued that any "text" book, music or film, must be completed by its reader [16]. The experience of a movie is a "gestalt" made up of the film and what we bring to it. Our imaginations supply the gaps in the text to make something more powerful than what is simply shown on screen.

Ambiguity in HCI

Several years ago Gaver et al. argued that ambiguity could be considered as a resource for design [17]. This is, in many respects, a startling argument. Most of the papers returned in a search for "ambiguity" in the ACM digital library are concerned with eliminating it. Ambiguity is dangerous in safety critical systems and it prevents many others from functioning at all. Gaver et al. claimed that home-based systems not concerned with the completion of specific tasks might use ambiguity to create engagement. The paper argued for the value of ambiguity at informational, contextual and relational levels. Informational ambiguity is concerned with interpreting data, illustrated by Mona Lisa's enigmatic smile. Contextual ambiguity relates to when and how systems can be appropriated e.g. a Mother using a mobile phone ringtone to soothe a baby. Relational ambiguity addresses the relationship between the user and the device; the "telegotchi" virtual pet for instance has no buttons and the child can imagine their interaction with it as telepathic [ibid].

Aoki and Woodruff [1] demonstrated the importance of ambiguity in more prosaic design contexts, claiming that ambiguity was important in the design of personal communication systems like mobile phones. If a person does not return another's call, they argued, an overly specific and unambiguous system might convey that the call had been declined rather than just accidentally missed or not heard. Boehner and Hancock developed a number of guidelines for designing for ambiguity such as leaving space for over interpretation [5]. Sengers and Gaver went on to argue that design practices must change once we recognise that authoritative interpretations of systems are not necessarily desirable or possible [29].

This paper considers the role of ambiguity in the design process. In particular we explore its role in early ideation and participatory design. We describe a technique - "Invisible Design" - which encourages and uses ambiguity to develop new concepts and proposals. In the following section we overview the use of film related techniques in design processes prior to introducing our technique.

SCENARIOS, PERSONAS, DRAMA AND FILM

Scenarios

Scenarios have a long history in design. In the 1960s scenarios were commonly used in disaster planning [9] where they were favoured for their power as illustrative tools. The use of scenarios in HCI was made popular in the mid 1990s with the publication of John Carroll's early work [10] and the subsequent recognition of the usefulness of two kinds of scenarios: 'problem scenarios' that could illustrate the complexities and difficulties with known systems and 'activity scenarios' that facilitated reasoning about uncertainties and supported the creation of sets of alternative realities that could stimulate the design process [26]. In their summary of scenario-based design, Go and Caroll [18] argued that one of the principal contributions of scenarios was a *common language for design* across four different communities (strategic planning; requirements engineering; object-oriented design and human-computer interaction).

Persona and Characters

The 'users' in a system were also the subject of some elaboration in the form of persona development. Personas were first introduced by Cooper [15] as a means of creating abstract yet rich representations of users that could capture users' goals, attitudes and emotions rather than simply display their attributes. Rather like scenarios, personas aimed to promote an understanding of how particular sets of users, with particular motivations, may behave *in context*. Pruitt and Grudin [26] critiqued existing scenario approaches where characterless actors effectively render scenarios 'lifeless'. They emphasised the need for good persona development, based on rich contextual data such that the design team *'engages with them over a long enough time to absorb nuances, as we do with real people. This duration of engagement is critical. In a movie, heroes and villains may be stereotyped because of a need to describe them quickly, as with stand-alone scenarios. But in an ongoing television series or a novel, predictable stereotypes become boring, so more complex, realistic characters are more effective'* [26: 13]. Such comments anticipated a further development of scenarios and personas – the pastiche scenario.

Pastiche scenarios are the appropriation of well-known fictional characters from literature, television and film, to allow designers the opportunity to be more adventurous in their explorations of scenarios [3, 4]. For example characters from Anthony Burgess' A Clockwork Orange were used to explore the notion of a "Cambadge", a wearable form of CCTV which would relay images to authorities when alarmed users activated the device [3]. The use of fictional characters can open up the design space in order to provide a mutually understood common ground for designers and users and can place the discussion into a fantasy space where participants feel safe in offering criticism.

The introduction of film and theatre

The emergence of film and theatre as tools in the PD process can be seen as an almost inevitable step given the gradual coming together in recent years of scenarios (or scripts) on the one hand and personas (or characters) on the other. Mancini et al. [23], for example, created two short films to depict on-screen characters positive and negative experiences of a futuristic technology as a way of provoking a response from groups of participants. Raijmakers [27] described the advantages of film in response to a major design project, undertaken by Phillips, where a set of personas were initially displayed to designers in the form of posters which singularly failed to inspire the design team, who found the material limited and difficult to assimilate. In response, Raijmakers and colleagues used the poster material as a basis of a documentary film that captured the everyday lives of the users in a more compelling form. Designers were then able to engage with such material, noting that it was often the incidental details in the lives of the characters that were more compelling.

A key phenomenon associated with the use of theatre or film is *the foregrounding of people's experience of a design* over more familiar and literal accounts of design function and usability. Newell et al embraced the power of dramatisation in their use of 'forum theatre' in design, acknowledging that the *'emotional attitudes of the users can be as important as their physical and sensory abilities, and we need to explore ways in which this aspect of the users' characteristics can be highlighted'* [24: 1000]. Newell's pioneering work in bringing theatre to the design process was in large part derived from his experience in developing methods of designing for older adults [25]. Motivated by the desire to encourage audience participation, and inspired by Boal's 'forum theatre' (a form of street theatre from Brazil, where it was used to promote a voice for oppressed communities), Newell and colleagues developed a process in which script writers work with designers and older user-groups in order to create theatre or short scenarios that can then be professionally filmed and used to highlight important points for audience discussion [25]. Such film/theatre serves several purposes, including fostering more balanced discussions between designers and users, and creating a 'safe' and yet 'liberal' environment for the exchange of views.

INVISIBLE DESIGN

In our own work, we sought to use film as inspirational material for PD. A series of short films were created for a number of separate projects which each featured characters using and discussing a technology which was never shown directly. The early rationale for our *first* use of this 'invisible design' film technique (in support of an authentication device called the Biometric Daemon) was pragmatic: the film allowed us to convey the impression of a inexistant product at a very early concept stage, i.e. we were able to convey very novel device function and

outcome, but without the need to specify device design. This was useful as we had no prototype and creating a prop would be not only time consuming and expensive, but would also limit us to a particular instantiation of the design. Developing an ambiguous film also provided more scope to be reused in future work and development cycles, being less prone to becoming quickly 'dated' as a prototype might be.

We swiftly realised that the absence of any explicit design would also allow a space for participants to generate ideas about how the imagined object might be used and experienced in an unconstrained way. We believe Invisible Design is a response to the known, inherent danger of using an existing object (either a design or prop) as inspiration for a new product. Such dangers were well documented by Brereton and McGarry [6], who noted that design thinking has always been heavily dependent upon existing physical objects. They explored the ways in which student designers were quick to appropriate such objects when given a particular design challenge (e.g. design a kitchen weighing scale). Existing objects provided a useful input to the design process but also severely constrained the new design possibilities under consideration.

Removing such objects or artefacts and making them 'invisible' within a film is a means of 'seeding without leading' [22]. In other words it is a means of stimulating thinking around a design and giving particular focus to the desired user experience, without constraining thinking by anchoring on an existing design or prototype. In some ways it can be conceived as the cinematic equivalent of a design sketch. Sketches have been shown to facilitate idea generation in the design process, arguably because of their inherent ambiguity [19]. A sketch allows a designer to think about a single attribute within a design without having to envision the whole [6]. In addition, the ambiguity of the sketch gives different observers the capacity to each make their own unique inferences about the inferred object [32] – all of which stimulates idea generation and subsequent discussion. Our films are *explicitly non-committal* about the objects they describe. This is easily achieved in film where, for example, a device can be placed on a table out of shot, or obscured by a camera angle (see Figure 2).

Invisible Design films are particularly suited to development work with groups that struggle to engage in focused discussion around technology. For example, the technique of filming around a design without actually showing the design was adopted by Read et al. [28]. In this work Read et al. asked schoolchildren to produce obstructed theatre pieces that were then used in design workshops with other children. We discuss multiple occasions where we presented professionally produced Invisible Design films in PD workshops. Two of the three example films – Panini and Smart Money – were solely presented to older adults, a population known to be resistant to technology solutions and likely to take a critical

perspective if the technology is made explicit [13]. Here, our hope was that rendering the technology invisible would inhibit criticism of specific technological features and instead encourage discussion of the intangible, experiential aspects of design. As will be shown in later sections, the Invisible Design film acted as a starting point, an inexact vision of the concepts that acted as a springboard for speculation.

METHOD: FILM DEVELOPMENT

The films described here were created using a five-stage process that lasted one to three weeks and involved: (i) communication of the initial project goals and key concepts to the film-maker; (ii) an iterative process of script-development, (iii) film-making; (iv) presentation of the film to a group of users or stakeholders and (v) evaluation. These processes are each described here in more detail.

(i) Communication of project goals and key concepts.

A professional scriptwriter/director was hired to create a compelling story, displaying a rich inter-personal interaction for each of the films. However, the scriptwriter needed to understand the design challenge. For each project there existed a rich source of research material that reflected initial interviews or focus group discussions with user-groups or that summarised existing research describing known problems. Such interview material, coupled with descriptions of example technologies in this domain, enabled the scriptwriter to convey not only a sense of the relevant technologies, but, more importantly for us, a sense of the underlying concerns and fears that users might have.

(ii) An iterative process of script-development.

The scriptwriter presented researchers and designers with early drafts of the script and discussion took place as to whether the film script sufficiently captured the design problem of interest and also encompassed a critical assessment of the value of the script more generally – whether it was entertaining or whether it effectively conveyed the emotional content and experience of the user group. In this two-way communication phase, the researchers and designers were effectively educated about the ingredients of effective film and theatre, while the filmmakers were educated about the essential experiences they needed to convey.

(iii) Film-making

During this phase, actors were auditioned and cast in the roles, suitable locations were found, a rehearsal period was set aside and then the director worked with a professional cameraman to deliver the film. A first edit of the film was then shown to the research and design team whose comments informed the final edit of the film.

(iv) Film screening and discussion

In this phase, the film was created to do a job of prompting rich discussion around a particular design problem. Each film, then, was presented to one or more groups of users and a moderator led a subsequent group discussion in which users were asked to comment on the film itself, but were also asked to address the design challenge associated with each film, effectively using the film as a prompt to explore ideas (as in the scenario, persona and pastiche literatures). All discussion was either audio or video recorded and later transcribed. This process followed a structured UCD methodology [26] involving the following elements; briefing participants, gathering participant information and consent, film screening and subsequent discussion around scenarios prompted by the film, a claims analysis focusing on the user experience and finally, feature and future scenario envisionment.

(v) Evaluation

The transcriptions of user-group discussions were then presented back to the researchers and designers and assessed in terms of both the reaction to the film and also in terms of contribution to the PD process.

More detailed examples of stages (iv) and (v) are given below, for the three very different invisible design films: Biometric Daemon, Panini and Smart Money.

Biometric Daemon

The Biometric Daemon film [**Error! Reference source not found.**] was an accompaniment to a conceptual design for a lifelong personal identity management and authentication system called 'the Biometric Daemon' [**Error! Reference source not found.**] - a kind of electronic pet that metaphorically thrives only in the presences of its owner (being sustained by the biometric properties of the owner). The Biometric Daemon concept was inspired by Philip Pullman's His Dark Materials trilogy where each human is constantly accompanied by their "Daemon": a manifestation of an element of their soul or psyche which they cannot stand to be physically separated from. This was a highly futuristic concept, and while we were comfortable with the Daemon's essential function and purpose, we had no preconceptions as to its physical form. That said, we wished to test user reaction to the Daemon and so commissioned the first of our Invisible Design films in which, quite simply, one man happens upon another man's Daemon and tries to discover what it is and does.

Figure 1: Doug (left) and Dave (right) interact with the 'Biometric Daemon' off-screen.

The Daemon was never shown in the film which centred on a dialogue between two men sitting in what might be a waiting room (Figure 1). The characters were inspired by the Pete and Dud dialogues where the British comedians Peter Cook and Dudley Moore played two working class men from Dagenham. The characters were both idiots but the Pete character imagined himself to be more knowledgeable than the more subservient Dud [14].

The Biometric Daemon film drew on such comic traditions to present a dialogue around the imagined technology. Looking outside of the frame the character on the left, Doug, begins the exchange asking: *"What's that then?"*. Dave looks up briefly from his paper and asks: *"What?"*. Doug points off camera: *"That"*. Dave replies: *"That's my Biometric Daemon"*. The dialogue continues with Doug being curious and Dave more or less impatiently explaining that his Biometric Daemon is: "*a Daemon that's biometric*". When Doug touches it Dave becomes more animated and tells him not to:

DOUG: *"What's it doing?"*
DAVE: *"It's displeased! It's distressed. It's upset ... I've got to reassure it now.* [Moves out of shot to reassure the Daemon] *– it's not yours is it? You haven't nurtured it with your unique biometrical attributes like I have."*

The camera cuts to a close up of Doug looking mildly surprised. He asks – *"does it like that does it*?". "*Yeah*" says Dave. We do not see what he is doing but Doug reflects: *"I suppose it would."*

Panini
The second Invisible Design film, Panini, was part of a project on transport. The design sessions used in this project had a structure grounded in scenario-based work [e.g. 11] and so the resulting film, *Panini*, had a rich context, strong narrative and well-defined characters. One of the themes that the project explored was route-finding in the city. Panini was shot on location in Newcastle, creating a rich context of use for the device.

Figure 2: Alice (left) plays with the 'invisible device' as Bob (right) reads the manual and looks on dubiously.

The film opens on an older couple (Bob and Alice) sitting outside a shop on mobility scooters (Figure 2). Bob is attempting to coach Alice on how to use her scooter and notices that she has a new device (unseen) fitted to her scooter that helps her navigate and communicate with their friends. As with the other Invisible Design films humour and playfulness were important elements of the script, in part reflecting Bob's refusal to accept Alice's superior (device-dependent) knowledge of the best available route.

An argument ensues over the best way to take to the café ensues as Bob tells Alice: *"I don't want to go down there, I always go this way. I've walked down Northumberland Street thousands of times!"* The two take separate routes. While Alice is able to get there easily, Bob encounters a number of obstacles (dead ends, broken paving stones) along the way and becomes increasingly frustrated. Eventually Alice rescues him (as, unbeknown to him, she had stuck a small 'tracking device' on his mobility scooter) and they go off for tea together. Bob's growing frustration and Alice's growing confidence are played out through their dialogue.

Smart Money
The third Invisible Design film was for a project on the design of new banking technologies for people aged eighty and above. One of the themes that the project investigated was the problem some older people had with delegation. For instance, some 'eighty something's' with mobility problems would engage in insecure practices - giving their debit cards and pin numbers to carers. The idea behind 'Smart Money' was an intelligent banknote that only worked when in the hands of an authorised person, and could only be used at predetermined locations. The team had not yet committed to any design or technological platform details, hence this film suited a non-committal context very similar to that used in Biometric Daemon.

Figure 3: Doug (left) and Dave (right) interact with 'Smart Money' off-screen.

Smart Money opens with upper body shots of two workmen (Doug and Dave again – using the same actors) dressed in high-visibility reflective vests taking their tea break. Dave attempts to explain 'Smart Money' to Doug, but he struggles to communicate the concept to his workmate. In order to better explain, Dave puts his Smart Money on the table (unseen by the camera) in front of them and asks Doug to touch it (Figure 3), in order that Doug might understand that the money is only responsive to its 'owner'. Doug remains unconvinced and reflects that 'smart stamps' might be a better development.

RESPONSES

The Biometric Daemon film was shown to four groups of four participants each. The Panini film was shown to four care home residents aged between 65 and 85 and two carers. The Smart Money film was shown to ten participants over the age of eighty in three groups. All of the workshops were recorded and transcribed and these transcripts were analysed using a grounded theory approach [12]. Here the word "theory" is understood as a broad description of phenomena rather than a predictive model (ibid). Data were categorised into broad open codes which were then grouped together into the following themes: (i) existing problems, (ii) concerns with imagined technologies and (iii) design speculation. Quotations in italics are taken from transcripts.

For the most part responses to the films were positive and the participants enjoyed them. The participants laughed at Bob in particular: *"Typical man, he doesn't look at the instructions"*. They also told their own jokes during discussions:

"Can I just say you know how to, you know, if you've got private letters, and you want to hide them from a man, you know how to do it don't you? You put it in a file marked, you know, instructions [laughter]. *Men don't read instructions. So, you put it in a file marked, you know, instructions. So yeah, they don't..."*

When asked what might help Bob, Mary replied: *"Give him a new brain"*. There was then engagement with the characters and issues. The Biometric Daemon and Panini films were best received. Smart Money was less successful

(as later sections will show) but discussions though critical were playful and humorous. There were common themes across the discussions overall three films.

Existing Problems

All three films led to discussions about current problems with everyday living and current technology. Although the Smart Money film was not always well received all of the participants responded with reflections on current banking and security problems. There was much general discussion around trust and security following both the Smart Money and the Biometric Daemon films. For Biometric Daemon much of the discussion of contemporary problems revolved around the difficulties of keeping track of and remembering passwords.

The discussions around Panini were often specific to particular problems with sites in the town where the film was made. The disabled spaces in a particular area, for example, were too far away from the shops. There were also city wide comments on problems such as the difficulty of finding dropped curbs for scooter access: *"you think they're going to be all over, but they aren't"*. Unexpected obstacles such as roadworks were also discussed. Other transport problems identified included: bus drivers *"taking off"* before older people have found a seat; older people spending too long *"out and about"* and not getting home in time to take medication; and younger people missing the last bus home and being stranded.

Current problems were discussed in relation to specific technologies. References to already existing technology sometimes helped participants to imagine what the Invisible Design might look like. Jane, for instance whilst discussing the Biometric Daemon noted: "*You can get biometrics stuff in the airports now*". But comparisons were often critical: "*I remember when the electronic pets came out and for the first two weeks all kids wanted them and then after that they got bored and it was all "sad beep, sad beep" and then they were dead.*" (Linda). Jane followed this remark recollecting that she threw them in the bin when the started beeping because she "*couldn't stand the noise*". There is an implication here that the Biometric Daemon might be similarly annoying.

Even where the Invisible Designs were too opaque for the participants comfort they provoked reflection on the strangeness of current technologies. One of the Smart Money participants for instance directly associated the concept with her ongoing experiences with credit and debit cards: *"you don't always get proof of what you've spent, and how do you remember what you've spent it on?"*. Although Margaret thought Smart Money was a *"stupid idea"* she reflected that: "*People thought pin numbers were a stupid idea when they were first mooted, weren't they?*". She remarked that it is: "*amazing how we've gotten used to them*". The rather odd ideas of Biometric Daemons and Smart Money here served to remind us how strange some of

our past and present technologies can seem. Bardzell and Bardzell [2] have noted that criticism of existing technology can often become a resource for creating new designs. The critical atmosphere of discussions around the individual designs also led to creative design speculation. These often began as concerns or criticism of the imagined technologies.

Concerns With Imagined Technologies

Of each of the Invisible Designs, the most clearly described on a functional level was perhaps the Biometric Daemon. The concerns about this design were then quite specific. Participants were chiefly concerned the Daemons might mistakenly reject their owners. Though passwords could be reset it was felt that biometrics would be more difficult. There was also a concern that "reassuring" the Daemon might be time consuming. Jane, after pointing out that she had three children and three part time jobs, noted: *"I want something that's going to look after me. I don't want to have something that is going to be intense."* Many of the concerns across the three films related to security, maintenance and costs.

Security was a concern for Biometric Daemon participants because they felt a device, containing valuable information, would become a target for thieves. When asked whether children would be able to use them participants' worried that they might share secret information with friends. Security was also a concern for the Smart Money participants. Rita noted that many older people worry about being mugged. Dolores agreed: *"Oh yes we are targets"*. Smart Money was too vague a proposition to be considered *"risk free"* which was *"the aim"* for Dolores. Discussion of money that could only be spent in certain shops led Betty to warn: *"That's where the forgers step in"*, to which Anna replied *"Well said!"*. Though crime was not a strong feature of the Panini discussions safety was often returned to in terms of going out and getting home in one piece.

Maintenance was an issue across all three films. The Panini discussions often returned to battery charge times on scooters. The battery time of the Biometric Daemon was also a concern: *"what if it ran out at a crucial time? It's hard enough remembering to charge your phone and your iPod"* (Jeff). Conversations on maintenance encompassed issues of time. The Smart Money participants worried about keeping track of yet another payment system. *"With the faults you hear from the gas, the electricity, the phones, the internet banking, it's just going to multiply. I'm glad I'll not be here to use it!"* (Rita). Other Smart Money participants simply felt it was an ill thought out and silly idea. Two Smart Money participants returned to a later PD workshop with further notes on the film. Rita wrote: *"the Queen's head disappeared if handed to unauthorised payee. How do we know we are going to buy something e.g. a lady goes shopping for shoes and may visit 10 shops before she finds what she wants. How does she pay if not one of the authorised payees?"* The notion that people had very preset financial routines was an assumption that she wanted to challenge. Whether participants liked the ideas or not they were always concerned about potential social and economic costs.

Costs concerned all of the workshop participants. Panini participants were quick to point out that people who have retired are on a fixed income and *"think twice"* about whether they can afford any technology and its *"upkeep"*. One Panini participant instructed the researchers to *"make them affordable for starters."* Biometric Daemon participants feared that Daemons could become widely used and that then they would be forced to register for one despite not wanting to. Once they were in wide use it was also feared that there would be upgrade costs. Fears about who would make and profit from these imagined technologies spanned all three groups. One Biometric Daemon participant asked: *"Who would be in charge of it all?"* Jeff asked whether the Daemons would be made by: *"some dodgy company making lots of money off it"*. Another participant answered: *"Or would it be some sort of awfully ran government thing, you know where they just accidentally email your Daemon details to people and stuff"*. Similarly the Panini participants discussing costs noted ruefully: *"people have become like a second thought, making money has become the first thought"*.

The Smart Money participants were deeply suspicious of the motives and practices of the Banking industry: "*I don't trust the banks, I don't trust the finance institutions, because it's only one operator filling in one set of numbers, puts in the wrong number, the wrong initial on a name, and you're in hock*" (Edith). The context in which a technology is developed and used is crucial to its acceptability and indeed usability. Although these comments may seem more related to sociological concerns than technology development they offer crucial insights into the user experience of current and future technologies.

Design Speculation

Because the concept designs had not been directly shown, it was possible to ask participants what they might look like. Biometric Daemon participants came up with the most detailed accounts of how the device might work. For instance Jane summarised a breakout group discussion where the Daemon was imagined as a kind of stress ball: *"the way I would squidge it would be different to the way that somebody else squidges […]. So it might end up developing its shape based on how the owner looked after it"*. Other break out groups imagined devices that responded to the colour of their owner's irises. Kelly imagined something that would change shape: *"So it would have like legs that could, like your transformer, so it could transform into er a phone or an animal, whatever you want it to be and erm you can see its expressions so you know whether its happy or not. Erm and it would have to be fluffy if you wanted to stroke it otherwise you wouldn't want to really like take care of it if it looked ugly."* Tamogotchi and

iPod shuffles were also used as inspirations for making the Invisible Design more visible.

Such detailed imaginings were not a feature of the Panini or Smart Money discussions. This is partly because the facilitator of the Daemon sessions explicitly grouped the participants into break out groups and assigned a design task. This did not happen in the Panini or Smart Money sessions but it is unlikely that they would have resulted in such rich illustrations in any case for reasons that will be explained in the Discussion. Although they did not fill in the gaps as richly as the Daemon participants the other groups were also characterised by discussion of what the device "would" "could" or "should" do. For Smart Money: *"you would have to have some sort of equipment to validate the note"*. Similarly, Agnes suggested*: "It could be a card with the Queen's head on with some electronics attached to it."* There were sometimes general principles such as this usability formulae from a Panini participant: *"if you're looking at some kind of technology that would help with planning and reminding I think it would have to be quite an easy thing to use."* (Mary). Occasionally however they were quite specific. One comment from the Panini session is worth quoting at length:

MARY: *"is it not possible to have some sort of network that if… you know people, wheelchair users, not necessarily electric scooters or disabled people in general, if they go somewhere where they get good service or useful places that they can pass on, like a network of wheelchair friendly places to visit or shops to go to, that sort of thing? I know years and years and years ago, my great aunt had both legs amputated and it was before disabled toilets were common in places and, I mean, she was a very proud, she wouldn't shop in the town where she lived because she was well known in the town and she didn't want people's pity so her and my dad used to take her shopping elsewhere but it was always governed by where there was a disabled toilet or where there was disabled access and it became a, sort of, a network of all her friends and everybody she knew- Oh, I've been somewhere and there's a toilet there. And it became, sort of, a thing that, as soon as somebody found a disabled toilet, because they were starting to become well known, you know, popular, then they automatically used to tell my aunt. But is there not some sort of a network thing that maybe could be developed that somebody goes somewhere, passes it on and that way people can go to places quite easily."*

Mary's explanation is interesting because it is a very clear articulation of a developing design speculation. There are of course now apps available that locate and provide user ratings for public lavatories. But searches on the app store at the time of writing show no service for disability utilities as described. The quote is also a good example of the way innovative and creative thinking can be linked to reflection on the past. The thought about the disability service is deeply embedded in memories of the participant's Aunt, not only her disability (the loss of both legs) but her character, her pride (she didn't want people's pity) and independence. Neither is it a sentimental account of personal resilience. The Aunt's independence is embedded in the city and community (a network of all her friends and body she knew). The route she learns is regularly updated (I've been somewhere and there's a toilet). As Mary pursued the idea it became more explicit:

"A map, yeah, that shows useful places, wheelchair friendly places to visit; it doesn't necessarily have to be shops but you know that sort of thing where they can be guaranteed good service and people there to help people, you know, something like that would be good."

This is a very clear example of someone thoroughly engaged in a PD process. It is also sufficiently removed from the original idea expressed in the Panini film to show the advantages of Invisible Design. The film indicated a way-finding device but detail was minimal. It is developed here by the participant in the space or the gap left in the Panini text. This is the kind of moment that organizers of PD sessions hope for. There is clarity, insight and a new potential avenue of development to explore. While such concrete suggestions did not occur after the Smart Money films the moments at which the participants reflected most critically on the redundancy of the idea was one of the most useful for the team:

MARGARET: *"Well I visualise it as a blank note with no sum on."*
IRIS: *"Like a cheque in other words. You can…"*
ANNA: *"Fill it in yourself"*
IRIS: *"… fill it in and validate with whatever amount you want."*
MB: *"That's interesting isn't it. I hadn't thought of that before, it's like a cheque already is Smart Money, isn't it?"*
MARGARET: *"Because a cheque has all your details on."*
IRIS: *"It's only when it gets to the recipient that it's of any value."*

The Smart Money workshops took place at a time when the UK Payments Council were proposing the abolition of cheques and much of the workshop discussions had focused on the value of cheques in terms of their use in paying trades people and sending money to grandchildren in the post [34]. Framing cheques as Smart Money however indicated what sophisticated financial instruments they are and perhaps why they endure. This led the team to change direction and develop further work on digital cheque books [**Error! Reference source not found.**].

The responses to Biometric Daemon were also used in further development work which resulted in the creation of prototype "Daemons" which function as password reminders. Although more prosaic than the imaginings of the participants, concerns about maintenance and loss informed a design based on fingerprint and gait recognition.

It was not just the participants' creativity that was of value in the sessions but also their criticism.

DISCUSSION

Responses to ambiguity

Perhaps the first thing to note is that the participants responded differently to varying kinds of ambiguity. Whilst the rich context of Panini led naturally to discussion, the minimal context of Smart Money though well received by some provoked enormous frustration in others who simply felt that they were wasting their time in the absence of any explicit account of the device. Two Smart Money participants stated they: *"didn't really get the point of it".* Another completely dismissed the film: *"I don't know why you folks have bothered to buy something that didn't tell you anything".*

The Biometric Daemon film was most successful in terms of positive participant responses. The Daemon script was quite specific about functionality while silent as to appearance. The Smart Money film in contrast was rather vague about functionality but specific about appearances – the Queen's Head would fade. Smart Money was perhaps at once too vague and too specific, leading Edith to comment: *"if they'd shown us some of the money that was supposed to be there, and how it worked, it would be more helpful to me".*

Participants requesting explicit descriptions of the idea suggest a failure of the Invisible Design technique. It was not however a total failure as it led to critical insights and new directions with that particular project. A feature of the project Smart Money was created for was that the same participants returned on multiple occasions to meet with the project team to discuss and create new design ideas. The ambiguity of the Smart Money film enabled the participants to speculate on the day what the idea might be from their own experiences (i.e., a cheque is Smart Money). Meeting them repeatedly in the future enabled richer discussions of why they thought a cheque was Smart Money [34], which went on to seed an iterative PD process [**Error! Reference source not found.**]. The more ambiguous the function of an Invisible Design therefore emphasises the benefits of engaging in an ongoing dialogue with participants in the design process.

One of our goals with Invisible Design was to develop a method that allowed marginalised user groups (older adults in this case) a chance to explore future technologies. To simply provoke frustration in the older group was not the aim and many participants were willing to play with the ambiguity – to speculate about the invisible objects in a meaningful fashion. Indeed, some of those who were initially frustrated subsequently returned to the later workshops more positively having thought about the underlying ideas in the interim. Although it is not possible to generalise from so small a set of films and participants, it may be that Invisible Design is most successful not only when the device is not shown but also when it is not described in any detail. It may also be that the method requires a concept design that is well defined in terms of functionality. However, we would argue that the vagueness of the Smart Money film also provided useful results.

Why Use Invisible Design?

Invisible Design permits the audience to be critical of the impact of technology on the lives of 'others' – to be sceptical about new devices in the abstract, rather than to be critical of them in any particular instantiation. This allows both participants and designers to be more reflective of the ways in which these new technologies might be embraced by different people in different situations. Furthermore, our films are entertaining and humorous in their own right – which means they have a quality that can live in the memory and promote subsequent discussion. These carefully rendered and humorous films still retain something in common with "low fidelity prototypes" which have been found to promote greater user input (in part because users feel free to criticise very early prototypes). In our case it is the invisibility of the design that leaves this door open. However, despite the sketchiness of the design, both films function well as a form of experience prototyping. The films make a design commitment but this can be very conceptual, e.g. something you need to nurture, something that helps you eat in a healthier manner; as well as concrete (something that helps you navigate your mobility scooter around town). In this regard we consider it a success that both the films encouraged participants to critique the design with reference to their wider experiences.

CONCLUSION

This paper has argued that Invisible Design can create a useful space for creativity and dialogue with participants in PD workshops. It is important to note that the technique is advocated here for use in early concept development. As previously noted there is a great deal of work in the safety critical systems literature which is concerned with eliminating ambiguity. This is for good reasons; the need for precision and safety is of course paramount in areas like finance. The Biometric Daemon and Smart Money concepts were not intended to remain ambiguous. Prototypes resulting from this work such as the digital cheque book did not aim to be vague or undetermined [**Error! Reference source not found.**]. The uses of ambiguity here were in generating and developing initial ideas. The films did not aim to elicit a particular response in terms either of approval or disapproval but rather to generate a space for ideas, insights and dialogue.

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