

# Ubiquitous Systems and the Family: Thoughts about the Networked Home

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## ABSTRACT

Developments in ubiquitous and pervasive computing herald a future in which computation is embedded into our daily lives. Such a vision raises important questions about how people, especially families, will be able to engage with and trust such systems whilst maintaining privacy and individual boundaries. To begin to address such issues, we have recently conducted a wide reaching study eliciting trust, privacy and identity concerns about pervasive computing. Over three hundred UK citizens participated in 38 focus groups. The groups were shown Videotaped Activity Scenarios [11] depicting pervasive or ubiquitous computing applications in a number of contexts including shopping. The data raises a number of important issues from a family perspective in terms of access, control, responsibility, benefit and complexity. Also findings highlight the conflict between increased functionality and the subtle social interactions that sustain family bonds. We present a Pre-Concept Evaluation Tool (PRECET) for use in design and implementation of ubicomp systems.

## Categories and Subject Descriptors

J 4 psychology, K 4.1 privacy

## General Terms

Design, Human factors

## Keywords

Ubiquitous computing, the family, trust, privacy, social interaction

## 1. INTRODUCTION

The vision of ubiquitous computing (ubicomp) embraces always-on communication and seamless access to information. Systems that act, not simply to store information about health or finances, for example, but to continuously monitor and communicate status, coupled with intelligent environments that can respond immediately to this information: Restaurants that can screen the food on offer, homes that adjust temperature and lighting in accordance with known conditions, hospitals that are primed with up-to-date information the moment the patient arrives. However, the majority of these applications focus on functionality and often ignore the non-functional aspects e.g. human values [13].

There is a growing interest in how technologies will affect

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informal communication between family members, close intimates and friends [9]. As family life becomes more hectic, some researchers have asked how ubiquitous systems can enhance and improve family communication [5] whereas others have asked important questions about who controls access to sensitive information within and outside of the family.

The findings presented in this paper are part of a wider project which aims to develop a better understanding of how people will control and manage the exchange of information in a ubiquitous society. This article will focus on user concerns about the mundane exchanges of information that might underpin an ordinary family task – the weekly trip to the supermarket.

### 1.1 Ubicomp scenarios

The study we describe here is based upon a shopping scenario that illustrates one of the potential advantages of the networked home. This was one of four ubicomp scenarios that we developed in order to capture elements of a future in which health, finance, voting and shopping activities could potentially be enhanced by seamless data exchange. Near-future scenarios have been used by a number of researchers to explore the implications of new technologies, but these have typically focussed upon the interaction of handheld or implanted devices with intelligent networks and buildings [10, 6].

Often, futuristic shopping scenarios highlight ways in which a network of computers are able to determine the items a consumer needs by intelligently surveying food stocks and other goods in the individuals home [4]. However, as Friedewald and colleagues note, such scenarios tend to take an individualistic approach, ignoring the ways in which the various interests within a family may converge or conflict within a shopping expedition. In many families, shopping is considered a social activity where all family members might take part in the process. Younger members of a family (seldom seen in the ubicomp world) are typically active participants in the weekly shopping task, and are given their own responsibilities or activities.

### 1.2 Families

For over 50 years social scientists have investigated the nature and structure of family interaction and functioning [7]. An individual's well-being is crucially dependent upon the nature and quality of these family relationships and the quality of family relationships in general and parent-child communication in particular can have a major impact on the development of the child [14]. The ubicomp model of life in a fully networked, hyper-communicative home raises some interesting dilemmas for both

parent and child. Imagine this scenario: ‘A mother is in her local supermarket getting the family groceries. Her home is networked and everything in the cupboards and dustbins is monitored which helps build a personalised shopping list. She accesses the list and wanders up and down the aisles placing the groceries in to the shopping trolley. The list contains a few items that she or her partner does not use (cigarettes, condoms, vodka). The items have been discarded in the dustbin at home by her 18 year old son who is sexually active, smokes and is a regular consumer of alcohol’. This might seem a little extreme but how will the parent react? Does the mother confront her son? Does being monitored have an impact upon the son’s behaviour? Is monitoring all aspects of children’s behaviour acceptable or will this eventually impact upon socialisation processes and lead to dysfunctional families? Hess & Handel [7] argue strong family relationships evolve through an awareness of boundaries between family members. Will ubicomp erode or reinforce these boundaries?

Clearly, in the process of developing and maintaining positive family relationships some form of self-disclosure must take place. Yet information disclosure, whether deliberate or unintentional can have a profound impact on a relationship [3]. There is a need to be sensitive and responsive to what information is disclosed and this is central in building trust and reducing risk. However, the majority of current research into communication via technology between family members tends to focus on convenience, safety and awareness issues [9], with relatively little work on communal intrusion and family privacy. The extent to which a fully networked home will be deemed acceptable to the family is likely to depend upon issues of information access and control: Is it useful? Is it usable? Who has access? How is information shared? Who has control of this process? Is he or she credible and sensitive? Where is the information displayed? In what contexts is information collected? Does each family member have choice and control? Such issues were the focus of a series of discussions held as part of a two-year investigation into trust, privacy and identity permissions for ubiquitous computing [10].

## 2. METHOD

The first requirement of the project was to find a means to communicate the concept of ubiquitous computing to the ordinary citizen. There are many potential visions of the future and so we engaged with a number of key stakeholders in order to generate specific scenarios capable of communicating something about agent technologies and the trust, privacy and identity issues they evoke. The stakeholders included relevant user groups, researchers, developers, businesses and government departments with an interest in ubiquitous computing development. Working in conjunction with relevant stakeholders, scenarios were produced that were realistic and had high face validity.

### 2.1 Development of videotaped scenarios

Four scenarios were developed, relating to health, e-voting, shopping and finance that included facts about the device, context of use, type of service and category of information transmitted. The results in this paper focus on the shopping example (see 11 for a review of the other scenarios).

The elicited scenarios were then professionally scripted and used to create a Videotaped Activity Scenario (VASc). The VASc method is an exciting new tool for generating richly detailed and tightly focussed group discussion and has been shown to be very

effective in the elicitation of social rules [10]. VAScs are developed from either in-depth interviews or scenarios; these are then acted out in context and videotaped. The VASc method allows individuals to discuss their own experiences, express their beliefs and expectations. A professional media company was employed to recruit actors and videotape all scenarios. The production was overseen by both the producer and the research team to ensure that the essence of the scenario was being captured appropriately. British Sign Language (BSL) and subtitles were also added to a master copy of the VAScs for use with participants who had auditory impairments. However due to technical constraints BSL was not added to the finance VASc. All scenarios were approximately three minutes in length. An illustration of the shopping scenario is described below.

*Shopping scenario: Anita arrives at the local supermarket grabs a trolley and slips her PDA into the holding device. A message appears on screen and asks her to place her finger in the biometric verification device attached to the supermarket trolley. Anita places her finger in the scanner and a personalised message appears welcoming her to the shop. She has used the system before and knows her personalised shopping list will appear next on the PDA screen. Anita’s home is networked and radio frequency identification tags are installed everywhere. Her fridge, waste bin and cupboards monitor and communicate seamlessly with her PDA creating a shopping list of items needed. The supermarket network is set so that alerts Anita of special offers and works alongside her calendar agent to remind her of any important dates. As she wanders around the supermarket the screen shows her which items she needs in that particular aisle and their exact location. The device automatically records the price and ingredients of every item she puts into trolley and deletes the information if any item is removed. When Anita is finished she presses a button on the PDA and the total cost of her shopping is calculated. Anita pays for the goods by placing her finger on the biometric device and her account is automatically debited, no need to unpack the trolley or wait in a queue. The trolley is then cleared to leave the supermarket. Anita leaves the supermarket, walks to her car and places her shopping in the boot.*

FOOD FOR THOUGHT

FADE IN:

EXT. OUTSIDE STORE - DAY

A shopper drives into a supermarket car park

NARRATOR  
‘Intelligent trolleys and fridges’ isn’t a phrase you hear every day. But thanks to wireless technology the idea of your shopping trolley communicating with you and your fridge isn’t confined to the world of science fiction

The shopper collects a trolley with a biometric device attached. They place their finger on the reader

NARRATOR  
With just a fingerprint you can download your personalised shopping list and confirm your registered payment details

INT. INSIDE STORE - DAY

The shopper starts to move down aisles, checking the list and filling her trolley with shopping

NARRATOR  
As all items will be fitted with a Radio Frequency Identity tag your shopping list can be updated automatically when you throw things away at home into a bin or recycling box for instance. Or you can run a scan at any time to check what items remain at home in your fridge or cupboard so you don’t overstock

The shopper continues to move through the aisles

**Figure 1: Example of a VASc script**

## 2.2 Participants

The VASc was shown to thirty-eight focus groups, the number of participants in each group ranged from four to twelve people. The total number of participants was three-hundred and twenty-five. Participants were drawn from all sectors of society in the Newcastle upon Tyne area of the UK, including representative groups from the elderly, the disabled and from different ethnic sectors. Prior to attending one of the group sessions participants were informed about the aims and objectives of the study.

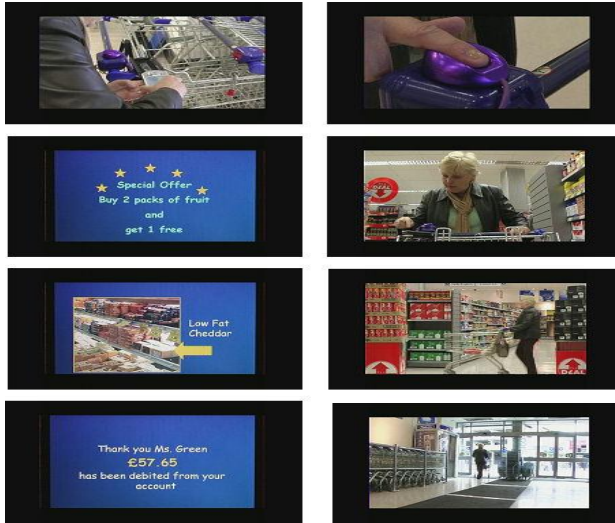


Figure 2: Screen shots taken from a VASc

Demographic characteristics of all participants were recorded related to: age, gender, disability (if any), level of educational achievement, ethnicity, and technical stance. A decision was made to allocate participants to groups based on: age, gender, level of education and technical stance as this was seen as the best way possible for participants to feel at ease and increase discussions. As this study was related to future technology it was considered important to classify participants as either technical or non-technical. This was used to investigate any differences that might occur due to existing knowledge of technological systems and that heterogeneity of groups might have a negative impact on the

**Table 1: Demographic characteristics, categorization and number of participants in each focus group: Young (Y) – 16-25 years; Middle (M) – 26-64 years; Old (O) – 65 -89 years**

Technical, High Education, Male [THM]			Technical, High Education, Female [THF]			Technical, Low Education, Male [TLM]			Technical, Low Education, Female [TLF]		
Young (y)	Middle (m)	Old (o)	Young (y)	Middle (m)	Old (o)	Young (y)	Middle (m)	Old (o)	Young (y)	Middle (m)	Old (o)
14	17	14	11	14	15	15	14	13	11	13	14
Non- technical, High Education, Male [NTHM]			Non- technical, High Education, Female [NTHF]			Non-technical, Low Education, Male [NTLM]			Non-technical, Low Education, Female [NTLF]		
Young (y)	Middle (m)	Old (o)	Young (y)	Middle (m)	Old (o)	Young (y)	Middle (m)	Old (o)	Young (y)	Middle (m)	Old (o)
12	15	14	10	11	16	9	10	12	11	14	12

social environment and impact upon group discussion due to incompatibility [2]. Therefore participants were allocated to groups initially by technical classification i.e. technical/non-technical, followed by gender, then level of educational achievement (high = university education or above versus low = college education or below), and finally age (young, middle, old). Overall this categorization process culminated in 24 main groups. Due to poor attendance at some group sessions 38 were run in total. 180 male and 145 female participants took part with an age range of 16 – 89 years. For ethical and practical reasons only adults aged 16 or above took part in the study. Although several participants with physical disabilities attended the main group sessions two group sessions for people with visual and auditory impairments were carried out at the Disability Forum in Newcastle. The forum was considered to have easier access and dedicated facilities for people with such disabilities.

### Technical classification

To classify participants into technical or non-technical six questions based on a categorization process by Maguire [12] were used. Participants answer the questions using a yes/no response. Responding yes to questions 1, 3, 5 and 6, no to questions 2 and 4 would give a high technical score of 6. If the opposite occurred this would give a low technical score of 0. Participants in this study who scored 0-3 were classified as non-technical while participants who scored 4-5 as technical. The questions were:

*If your personal devices e.g. mobile telephone or computer were taken away from you tomorrow, would it bother you?*

*Do you think that we rely too much on technology?*

*Do you enjoy exploring the possibilities of new technology?*

*Do you think technologies create more problems than they solve?*

*Is Internet access important to you?*

*Do you like to use innovative technology as opposed to tried and tested technology?*

## 2.3 Procedure

On recruitment all participants received an information sheet that explained the study and very briefly introduced the concept of ubicomp in very general terms. Participants were invited to attend Northumbria University, UK to take part in a group session. Groups were held during daytime and evening time-slots over a three-month period to accommodate participant preferences. Participants were told they would be asked to watch four short videotaped scenarios (NB: this paper focuses only on the shopping scenario) showing people using a ubicomp system and contribute to informal discussions on privacy and trust permissions for this type of technology. They were told all participants in their particular group would be of approximately the same age and gender and informed the discussion groups would be recorded for further analysis. Participants were not informed about the technical/non-technical or the level of educational achievement classification that was used. An informal interview guide was used to help the moderator if the discussion deviated from the proposed topic.

After the initial introduction, the videotaped scenario was shown (the moderator briefly gave a definition of ubicomp to avoid influencing participants opinions). Immediately after this each group was asked for their initial thoughts concerning the system and to envisage what they would like or dislike about using a system like that. The same procedure was used for the other three-videotaped scenarios (described elsewhere in [10]). Once all the videos had been viewed an overall discussion took place related to any advantage/disadvantages, issues or problems participants considered relevant to information exchange in a ubicomp society. No rigid interview protocol was used. The

moderator only interjected when the discussion deviated from the topic of ubicomp or when they wanted participants to expand and explain their ideas further. Participants' attitudes in general towards ubicomp systems were also noted. Discussions were audio-taped via a Sony MZ-B10 digital recorder. The duration of the sessions was approximately ninety minutes.

## 3. RESULTS

The group discussions were transcribed then read; a sentence-by-sentence analysis was employed using the Atlas.ti™ qualitative software programme. Then at least one other research team member read the transcripts and considered the codes. Constant comparison was used in the analysis to ensure that the thematic analysis represented all perspectives. Discrepancies between coders were resolved through discussion and mutual agreement before analysis. The data was open coded using qualitative techniques and then grouped into categories using sentences and phrases from the transcripts. None of the categories that emerged were predetermined. The thematic analysis produced a number of key themes including control, complexity, responsibility, transparency and information sharing. These are discussed below and summarized in Table 2.

In this section we unpack the key issues surrounding the impact of the networked home with regard to the individual and family relationships. We present the emergent themes in terms of a Pre-Concept Evaluation Tool (PRECET) containing five key questions: *Is it usable? Who controls? Who sees? Who benefits? and Who takes responsibility?* The quotes given illustrate themes which were common amongst the majority of groups.

**Table 2: Pre-concept Evaluation Tool (PRECET) that include important Themes, Contexts, Constructs that need considered in the design of ubiquitous systems**

Theme	Context	Construct	Question
<b>Is it usable?</b>	Within the family	Complexity	Will the system be easy to use?
		Accessibility	Will the system be accessible to all?
	Beyond the family	Compatibility	Will the system be compatible with others?
		Type of system	Will the system be centralized or decentralized?
<b>Who controls?</b>	Within the family	Power	Will the system affect the balance of power within the family?
		Identity	Will the system change family roles?
	Outside the family	Trust	Can the system be trusted to reflect and support family needs?
		Guidance	Will the system make decision-making easier?
		Autonomy	Will the system enhance or reduce personal freedom to choose?
<b>Who sees?</b>	Within the family	Individual privacy	Will the system protect the privacy of individual family members and facilitate management of personal privacy settings?
		Visibility	Will the system lead to improved collective or individual monitoring of consumption, resulting in savings?

	Outside of the family	Collective privacy	Will the system protect the privacy of the collective family and facilitate management of public privacy settings?
		Transparency	Will the system provide information about who has access to what information?
<b>Who benefits?</b>	Within the family	Personal Value	Will the system support individual and family goals (convenient shopping, doing things together)?
	Outside of the family	Persuasion	Will the system lead to the promotion of commerce – sometimes at the individual’s expense?
		Social Value	Will the system support societal values?
<b>Who takes responsibility?</b>	Within the family	Protection	Will the system empower the role of parent as caregiver and protector?
	Outside of the family	Risk management	Who takes responsibility for system malfunction or poor quality information?

### 3.1 Is it Usable?

Participants discussed concern over the complexity of ubicomp systems. Comments related to the fact existing technologies are often difficult to use and widespread exclusion would occur if people had to adopt ubicomp systems. Exclusion would occur due to age, anxiety, ability, disability and socio-economic status.

#### *Within the family*

Participants commented setting preferences for who has access to information complicated. As human behavior is dynamic, complex and not always predictable discussion focused on the need to continually change settings on the system as unacceptable. Comments also reflected the different abilities that exist between family members.

*‘I think that is good but new technology for older people is always difficult to comprehend.’ [NTLF(m)]*

*‘I think that is brilliant. To the younger generation they have been brought up with that technology. What about the minority groups, disabled, etc?’ [TLM(o)]*

*‘The thought of my Dad using that would cause more cognitive problems rather than solve them. It all depends on your technical ability to start off with.’ [THM(m)]*

#### *Beyond the family*

Participants questioned whether all systems would be compatible. Comments referred to problems arising through different service providers and centralized or decentralized systems. Ubicomp systems were considered an excellent way for companies to track goods and stock.

*‘I know that like you said they are knowing exactly what you are doing, but on the other hand, any information that the shop keepers have, would make sure that they have got the right stocks in and the right amount of stock and that sort of thing and it would all make that a bit easier.’ [NTLM(o)]*

### 3.2 Who Controls?

Participants expressed concerns about whether the key players in ubicomp systems could be trusted to control and contain the exchange of information. The ability of individuals to legitimately interrogate the system or influence and change the release of personal data was a key issue. Within the overarching theme of control, lay issues of control within the family, control beyond the family and the important issue of overall responsiveness to changing circumstances.

#### *Within the family*

Participants were keen to discuss the extent to which different systems could respond to or could influence family dynamics. They were particularly concerned that ubicomp systems might build conflict and tension between family members. Families interact and socialize in shared private spaces. Within these shared spaces family members have different views, opinions, activities and goals – and these were all seen as important issues for ubicomp. A number of key discussions focused on the extent to which one individual’s preferences and ideals might come to dominate – with some of the mothers expressing the need to retain control and voicing concern that children may be able to exploit the system for their own ends.

*‘That is to me food and providing for my family is integral to my home that is part of my care giver to my family and I want to do that. I want to decide that and I have enough problems, I do my shopping on-line and I have it delivered to the house, I have enough problems with Tesco and all with what my preferences are and how old I am and what my income is but that’s taking it that step too far.’ [TLF(m)]*

*‘It could get completely out of hand and I don’t know where you would get, who would take control in the house? I mean your kids could take control. Of course at the moment Telecom I know on your telephone bill telephone numbers appear that you get an itemised bill of numbers dialled and kids dial out, sometimes quite like big calls and they get shown up, they show up because it is assumed that the householder is the only one paying the bill, well again that is something that they might have wanted to keep confidential, but again it is divulged. We are really starting to be there, aren’t we? It can get very frightening I think.’ [THM(m)]*

### *Beyond the family*

The issue of *who controls* was also discussed in relation to the wider context of relationships with the supermarket and the system in general. In such discussions key issues of reliability, trust and exploitation emerged, particularly when participants realized the extent to which the system would have access to highly personal and sensitive data.

*'This little machine thinks things for you, tells you where to go, when to do it, reminds you of everything. I think technology is still too prone to glitches and things like that, that it might send the wrong information without realising. I would be a bit wary of saying I actually trust it.'* [NTHM(m)]

*'Well I quite like the idea of the electronic shopping list, it knows my shopping list and can direct me to where it is. I don't want to trawl round the aisles looking for something. I'd rather be told that's where that item is'* [NTLM(m)]

More worryingly, a number of participants expressed resignation over the fact that such systems, once implemented, would lead inevitably to a kind of 'big brother' society in which the individual had little autonomy or control over their own lives. They anticipated a future in which 'forced choice' would become the 'norm.' and where individuals would lose the right not to reveal information about themselves or fear facing exclusion.

*'And if your groceries have got RFID tags in them and also your car's being tracked by satellite to bill you by the mile then essentially you have no privacy, people know where you are, what you are eating, what you are doing, that really bothers me, that really bothers me. I sense it's inevitable but it bothers me.'* [THM(o)]

In addition, participants also wondered to what extent their physical lives would come to be dominated by the demands of the system – anticipating a future in which they may get no peace.

*'What I wouldn't like would be if you stepped inside the door and it started greeting before you even as much as blinked.'* [NTLF(y)]

### *System responsiveness*

Participants queried the extent to which systems could be trusted to faithfully reflect unpredictable day-to-day changes in human behaviour and family life. In other words, participants felt that the human capacity for capriciousness should be honoured, but worried that it may be threatened by rigid computational systems. Having to set individual profiles and permissions may become too time-consuming, reducing the utility of such systems.

*'And how would the system, how would you tell it in the first place what your normal diet is? Would it accrue information? What happens if you go on the Atkins Diet, you know, would it pick that up? You know, as the gentleman pointed out, it doesn't seem a huge step forward and again how hard is shopping?'* [THF(y)]

## **3.3 Who Sees?**

The issue of who might have access to sensitive data generated a great deal of discussion – once again reflecting concerns about communication within the family and beyond and also reflecting concerns about the transparency of the information flow. In

various wide-ranging discussions of privacy, participants agreed that the type of information shared normally depends on who, what, where, when and why, but crucially is informed by the type of relationship they have with the other person. If their relationship is close as, for example, with family then the majority of information is shared quite freely. However, sharing even with a close family member depends on situation and context.

### *Within the family*

Participants were interested in the idea of a means of monitoring consumption within the home, but were particularly intrigued and in some cases alarmed by the implications of information displays that might reflect who was consuming what within the home:

*'There would be untold rows. You'd be wondering who is eating the biscuits, using your Tampax or using your condoms or whatever, yes. That would have massive impact I think on family life I suppose.'* [NTLF(m)]

### *Beyond the family*

Of much greater concern was the possibility that personal information would be leaked to others outside of the family. Participants expressed concern over stakeholders sharing personal information with third parties, creating profiles, making inferences from personal information.

*'Oh I think they would be mortified. Nobody wants everybody to know all about them. They don't mind them knowing some things but for instance you wouldn't mind telling someone your taste in XXXXXX but you wouldn't want them knowing how much credit or debt you've got, the fact that you go gambling three times a week. You don't want people to know all of that.'* [THM(o)]

In many cases participants talked about a need to defend the privacy of their children – alerted, by facebook and other social networking sites – to the possibility of children being relatively poor guardians of their own personal data.

*'Like invading the privacy of your children. But then it's being able to have this tag over your children over what they buy.'* [THF(m)]

*'Suppose something they had bought appeared that would definitely be wrong, invading their privacy and you know sixteen plus, they are allowed privacy, confidentiality.'* [NTLF(o)]

Also, in this context it was interesting that while people were unconcerned that friends and acquaintances might have the opportunity to see inside the kitchen cupboard, it was rather different if some unseen force was monitoring provisions. In this respect a line might be drawn between those individuals who had been explicitly 'invited' into the family home and those who had not.

*'Although I don't really care if people know what's in my shopping cupboards or my fridge, it seems quite scary to think that somebody can have a log of everything that is in my fridge.'* [NTLM(m)]

Finally, people were aware of the potential for abuse if key information was passed on to third parties. Concerns were raised over the probability that stakeholders would collect personal information in an ad hoc manner without informing the

individual concerned. Data gathering and data mining by stakeholders could create profiles about an individual and his or her family that might contain false information. There was a feeling that such profiling could lead to unforeseen consequences. For example, an individual might be refused health insurance if their family profile suggested that they regularly purchase unhealthy food.

*'It's (information) where it can lead. That's the key to a lot of personal information about you, it's telling you where you live, they (3<sup>rd</sup> parties) can get details from there and there's companies buying and selling that information'. [THF(o)]*

#### Transparency

Transparency discussions covered data storage, mining, exchange and access by third parties. Participants agreed that systems needed to be transparent and accessible so that information could be verified and changed. Concerns were raised over what level of transparency would be required to support positive family relationships, although participants generally acknowledged that families should have choice over what information was shared within their own private space. Participants recognised that stakeholders already hold sensitive personal information and felt that this should be made more transparent. In relation to the overall question of 'who sees' the issue of transparency was crucial.

*'I mean they don't really know where the information is going and what individuals are actually accessing it or is it just completely churned up by computers? I don't even know but the information is going somewhere and the customer, the consumer should actually have, be allowed to know where that information is going and it should be an open process, open to the consumer, if the consumer wants to know of course, some people might not want to know, but if the consumer wants to know how all that information is processed it should be open.' [THM(o)]*

*'I don't know who has got what information. If I asked anyone are they going to tell me if they didn't want to and how would I know that they were telling me? So it goes into this kind of vacuum, but they are only going to tell me the information they want me to know and they miss the bit that they really don't want me to know, that they do know or not know, I have no way of finding out.' [TLM(m)]*

### 3.4 Who benefits?

In a series of wide-ranging discussion of the costs and benefits of ubiquitous computing, participants were aware of the increased convenience for the individual, while acknowledging that systems might encourage laziness. More pressingly, participants were concerned about monopolization by key stakeholders such as supermarkets and felt that in many ways they would be the major beneficiaries.

#### Within the family

Participants also reflected upon their own motivation to use ubicomp, acknowledging that they may come to trust systems if the benefits were tangible or convenient. Some recognized that future developments may be driven by certain user groups but that the benefits may not extend to all.

*'Its quick and easy; its more convenient for some people; not having to actually get out of the car, not having to actually go to*

*a cash point. It's more for business people. Technology these days is for people on the go' [THM(o)]*

#### Beyond the family

Participants raised concerns over stakeholders using ubicomp systems to pressure people in buying goods. They acknowledged the constant pressure of advertising and expressed fears that more detailed user profiles and sophisticated household monitoring systems might arm supermarkets and other suppliers with the capacity to apply undue pressure – giving them the ammunition of personal need. The issue of trust transfer (from a trusted to an unknown third party) was also seen to be threatening.

*'Sometimes I go out with a shopping list. I could see them putting 'special offers' on my shopping list, which would annoy me.' [NTLF(m)]*

*'They (supermarket) will become a monopoly so you do want to keep a number of people in the and especially with supermarkets, I wouldn't want to have Tesco everything even though I am a massive Tesco fan, but you can see the dangers, they've still got Asda snapping at their heels and if Asda went under, they would put all of their prices up. They've absolutely got you then.' [TLF(m)]*

Finally, participants discussed longer-term societal costs and benefits, perceiving ubicomp systems as capable of both fostering social isolation while stripping away privacy. There was an awareness of the ways in which we are increasingly interacting with each other from a distance, emailing rather than speaking, ordering online rather than face-to-face.

*'Unseen by a human, did not speak to a human, you don't need any human beings in a place like that, oh crumbs! Gosh!' [NTHF(o)]*

Coupled with this was a strong sense of there being something disturbing about privacy violations that take place in an unseen space as opposed to the simple and easily regulated violation of someone snooping in your supermarket trolley as you push it down the aisle.

### 3.5 Who takes responsibility?

Participants discussed issues of risk and responsibility in relation to self-reliance and the reliability of systems – acknowledging that both self and system might fail. For example in the shopping scenario the user was given an alert about a food allergy. Participants discussed liability and litigation - who would be liable if this information was wrong especially if they were buying food for a family member with a certain allergy. Some participants commented that, as parents, one of their roles is that of care-giver. They feared that this caring role may be taken from them and that ubicomp systems might lead individuals to act in a sterile way.

*'Now if I'm relying on a gadget like that in the store to say this is safe for my daughter who is on a gluten free diet and it's not, what happens, who is liable then, me or the gadget?' [NTLF(m)]*

Also, if the machine malfunctioned and the user was unaware of this what would the consequences be? Participants commented systems could not be truly aware of certain facts or always in control. They agreed ubicomp systems reduce cognitive load but questioned whether this was advantageous to humans in the long term.

'I want to rely on myself and a network of human beings, not a network of communications and little chips'. [THF(y)]

'The other thing is if you actually hand over all responsibility to automated systems you know if they make a mistake in your calculation and you are not actually paying any attention, you are just trusting this, you are not actually sitting down doing your sums at the end of each month, you know it is essentially dis-empowering you.' [NTLM(o)]

## 4. DISCUSSION

The findings from this study raise some interesting and pertinent issues. The design and implementation of ubiquitous systems cannot be solely based on traditional HCI issues of functionality, usability and accessibility. In a shopping context at least ubicomp systems need to incorporate a better understanding of family interactions and need to show some sensitivities to the natural information sharing boundaries that occur within the family. Such an approach will resonate with developments in other technologies, where the focus on 'user-experience' as opposed to 'usability' has seen a shift towards an understanding of the wider social impacts of HCI.

PRECET provides a tool to help understand the complex way in which families manage their trust and privacy exchanges, their boundaries and disclosure patterns. These concepts are vital if ubicomp systems are to work for these groups. This tool could be used to evaluate different user groups as well as current and future technologies. Key stakeholders and designers of ubiquitous systems need to acknowledge the fact humans are inherently social beings and their actions are always directly or indirectly linked to other people. This is important as family members need to have choice and control over what, when and to whom information is disclosed even within the home.

Hong et al., [8] suggest designers of ubicomp systems need to deploy a privacy risk analysis considering social and organisational content. This type of analysis considers: Who are the users? What kind of personal information is being shared? How is personal information collected? Hong, et al., suggest after the initial privacy risk analysis designers need to prioritise the findings and develop a privacy risk management record. The privacy risk management considers: What are the default settings? How does unwanted disclosure take place? [See 8 for a complete review]. Our findings generally support this perspective, providing the PRECET framework for understanding where the tensions may lie – and we have tried to represent this by pulling together the emergent themes of our work into a table of key questions. This could be used to prompt further work about how different systems might support or hinder the work of the family defined in more social terms.

A key question asked by researchers [e.g. 4] is how ubicomp systems can enhance and improve family communication. The majority of participants in this study viewed ubiquitous systems as convenient and efficient tools that could augment everyday mundane tasks. The vision of a future filled with smart and interacting everyday objects offers a whole range of possibilities, but our participants invite us to pause and ask whether the transformation that will take place will be socially acceptable. In the views of many of our participants, this will never be an issue of individual choice. Market forces, peer pressure or fear-fuelled state policies will bring the change about – and new tools and toys, sometimes delightful and sometimes

sinister, will proliferate – few of them judged on the basis of social value. The vision of a comprehensive network of agents capable of monitoring our private and public life [1] is not entirely welcomed by our own participants who worry that non-adoption will be penalised by stakeholders.

### 4.1 Limitations and future work

Friedewald et al., [3] state ubicomp scenarios tend to take an individualistic approach ignoring conflicting interests within a family. In hindsight the scenarios used in this research project might have been more explicit in portraying the underlying family dynamics rather than focus on an interaction with one member of the family. However, the filmed scenario was effective in prompting discussion of wider social and family issues. Future scenarios may benefit from representation of family interaction more explicitly, particularly with regard to disclosure, privacy managements and social processes. We need to acknowledge that all families are not functional solitary units where all information is freely disclosed between members. Ubicomp systems need to be designed to support and maintain trust and privacy for each family member, their interaction with other members, and their wider social network. When trying to understand family processes we should replace user with 'us'er.

The data generated from this research project is immense. In this paper we have only reported findings from the shopping scenario and from a family perspective. Further in-depth analysis will provide understanding of the advantages and disadvantages using ubicomp will bring to a host of different samples of the population e.g. age, disability and technical stance.

### 4.2. Conclusions

It is possible that the ubiquitous vision we have portrayed in our scenarios will not ever be fully realised, but we would welcome a research agenda that encourages the development of explicit tools and techniques designed to place human values at the heart of technological development.

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