What users know about the design process:
a report on two exploratory studies

Natasha Aruk
Department of Psychology
Anglia Ruskin University
Cambridge CB1 1PT
+44 (0)1223 363271

natasha.aruk@student.anglia.ac.uk

Cathrine V. Jansson-Boyd
Department of Psychology
Anglia Ruskin University
Cambridge CB1 1PT
+44 (0)1223 363271

cathrine.jansson@anglia.ac.uk

Nathan Crilly*
Department of Engineering
University of Cambridge
Cambridge CB2 1PZ
+44 1223 332600

nc266@cam.ac.uk

ABSTRACT

This paper reports on two exploratory studies aimed at understanding the extent to which people's responses to products are influenced by their ideas about the processes from which those products result. The first study involved analysing 400 comments from online discussions of two mobile phone handsets. The second study involved conducting and analysing interviews with 29 members of the public about their own mobile phone handsets. The results indicate that some (but not all) people are prone to view products not just as things that exist, but as the work of agents such as designers, manufacturers or brands. These agents were thought to hold certain beliefs about users and to shape products in the light of those beliefs. The products were also understood to result from motivations that the agents held (e.g. to make a profit) or constraints that acted upon them (e.g. manufacturing costs). Although only exploratory, the studies reveal some phenomena of product experience that are not discussed in the existing literature and they suggest ways in which those phenomena might be further studied.

Categories and Subject Descriptors

A.0 [GENERAL]: Conference Proceedings
H.5.2: User interfaces, User-centered design.
J.7: Consumer products.

General Terms

Design, Human Factors, Theory.

Keywords

Consumer Response, Design Literacy, Inference of Intent, Interaction, Mental Models, Persuasive Technology, Product Experience, User Experience.

1. INTRODUCTION

As people go about their daily activities, their efficiency, safety and satisfaction are often determined by the experiences that they have with designed products (whether those be objects, spaces, software, systems or services). These experiences are, in turn, often determined by how well designers are able to devise products that encourage, facilitate or permit the experiences that are intended. The better understanding that designers have of how people might experience designed products, the more efficient, safe and satisfying those products will be for those people. Consequently, if we could increase our understanding of how products are experienced then we might (for example) be able to achieve greater sales volumes, increase customer satisfaction, reduce instances of user error, or promote more responsible re-use and recycling behaviour. With this in mind, the objective of this paper is to increase our understanding of how people experience products.

Because understanding how people experience products has important commercial, ethical, social and environmental implications, there have been many attempts to describe the nature of those experiences [26]. These approaches take many different forms, but for convenience we will here distinguish between those that focus on users' *perceptions* of products, and those that focus on users' *interactions* with products. We offer only a very brief comment on those two approaches in this introduction, but hope to illustrate how both have neglected what users know about the design processes from which products result. In contrast, our contention is that users possess knowledge of design, and that this influences their perceptions of products and their interactions with them. This contention is supported by the results of two exploratory studies that are reported on in this paper.

1.1 Users' perceptions

Those who study users' perceptions of products have sought to establish the qualities that users attribute to those products. For example, users might consider a chair to be elegant, a clothes iron to be happy or a telephone to be rebellious. In the theoretical and practice-oriented literature this is often referred to as product semantics, product character or product meaning [1,12,14,15,18].

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* Corresponding author.

A great deal of experimental work has also been done in this area, and consequently we now have a better understanding of the qualities that people assign to products [2,5,16,19], the different assignments that different people might make [11], the relationship between the assignments made and the products' attributes [5,10], and the relationship between those assignments and the assignments that were intended [8].

Whilst users attributing qualities to products is plausible, interesting and useful to know about, there is a related kind of response that has not received the same attention from researchers. Rather than studying the qualities that users assign to products, we might instead focus on the qualities that people imagine those products were intended to posses or evoke. Returning to the examples mentioned above, people might recognise that a chair is elegant *on purpose*, that a clothes iron *was supposed* to look happy or that a telephone *was meant* to be perceived as rebellious. Recognition of such design intentions would require that users be aware of the processes from which products result.

1.2 Users' interactions

In an effort to understand users' interactions with products, cognitive studies have traditionally emphasised the idea that users construct a 'mental model' of how a product works, and that they use that model to interact with the product [e.g. 24,25,29]. This perspective is often used to emphasise three key things: first, that designers have an image of how a product will work and how users will interact with it; second, that the product presents the user with certain opportunities for actions and offers feedback in response to those actions; and third, that the user forms an image of how the product works based on their interactions with it [21,22]. This perspective emphasises that users interact with products independently of designers, and that designers communicate with users through the products they design [3,4].

The concept of mental models has proven to be very popular as a description of how designers should think about users, and they are often accepted as a truth of person-product interaction. However, in the traditional mental models approach, the user's understanding of the product seemingly develops without the user being aware that the product *has been designed*. The approach does not explicitly credit the user with the capacity to recognise *that they are a user*, and that their use of the system *will have been anticipated*. As such, although the designer is viewed as having an image of the product, and of the user's interaction with it, the user is viewed simply as having an image of the product. What is not considered is that through interaction with the product the user might also form an image of the designer, and also an image of the designer's image of the user. To account for this, we would need to consider that the user may possess something like a mental model of the design process from which the product results.

1.3 Users' design knowledge

Whether considered from the perspective of perception or interaction, the discussion above raises questions about what knowledge of design people possess, what factors influence the development and use of that knowledge, what kinds of effects that knowledge has on product experience, and what designers might do to promote or discourage the formation and use of that knowledge. All of these questions focus on what might be called

users' *design knowledge,* their awareness of the processes from which products result [3]. We presently do not know much about design knowledge, and we lack the conceptual frameworks that would accommodate it or the design tools that could respond to it.

This paper aims to make a modest start to a research programme into users' design knowledge by reporting on two exploratory studies. These studies are exploratory in two senses: first, they aim to explore what kinds of research methods might be effective in accessing design knowledge; and second, they aim to explore what the content and structure of people's design knowledge is. Because we are seeking to conduct research into questions for which we find no close precedent, we do not simply report on our methods and findings, but also on the rationale for the methods used and the means by which our interpretations were arrived at. In so doing, it is hoped that this paper will encourage and facilitate the investigation of users' design knowledge so that users' experiences with products might be more fully understood.

2. TWO EXPLORATORY STUDIES

Two studies are reported here: the first study involved analysing online discussions of recently announced mobile phone handsets; the second study involved conducting and analysing interviews with members of the public about their own mobile phone handsets. In both studies, the focus was on users offering verbal accounts of their responses to mobile phones. These accounts were analysed with a view to identifying, classifying and relating the utterances that revealed some form of design knowledge. Mobile phones were chosen as the product category to focus on for a number of reasons: i) they are an important device upon which many technologies are converging; ii) they are a socially significant technology that many people have some investment or interest in; iii) they exhibit visual, tactile and auditory qualities to which people might respond; and iv) they permit or demand interaction rather than just inspection. This all meant that a broad range of possible user comments were possible. One further (methodological) reason for selecting mobile phones was that they are a product that many people regularly carry on their person. This was important because one of the methods that we wanted to trial was short interviews conducted with people in a public setting (local recreation areas).

2.1 Study 1: Online Comments

To increase the likelihood that we could elicit evidence of design knowledge in verbal appraisals of products, we surveyed leading mobile phone discussion and review websites. *GSMArena* [9] was chosen to sample comments from because of the high volume of comments posted to the site. Two recent smartphone handsets from prominent brands (here referred to as 'Alpha' and 'Beta') were chosen for the study. The choice of website forum and the choice of handsets made it likely that highly motivated, interested and knowledgeable people would provide comments. It was hoped that this would, in turn, increase the likelihood that evidence of design knowledge would be found in the appraisals. Comments were only collected between the time of product announcement and the time of product launch. Because this was expected to have prevented those posting comments from having used the handsets, analysis could be restricted to comments on design features (the specification and product photographs) rather than more complicated user experiences with the product. These

more complicated aspects of experience were to be addressed in the second study.

2.1.1 Sample

Following product announcements in early 2010, the first 200 comments for each handset were extracted from the website. The average (mean) length of each comment was 15 words for the Alpha product and 25 words for the Beta product. The comments were generally of an informal nature and the spelling and grammar indicated that they had been generated in a casual or rushed manner. Although this posed some difficulties in interpreting the literal meaning of some comments, the apparent carelessness was considered to be indicative of relatively uncensored response.

2.1.2 Method

With the notion of design knowledge in mind, the researchers read and re-read the comments, seeking to identify those comments that made some reference to the agents responsible for the product (e.g. the designers, manufacturers or brands), or some other reference to the processes from which the product results. Using this approach, a subset of comments was indentified for further analysis and these were categorised into a set of emerging themes. This process was initially driven by our research interests but new themes also emerged from the data itself [27].

2.1.3 Results

The majority of comments did not contain any phrases that demonstrated design knowledge. That is, about 80% of comments simply related to the product as an entity that exists and has certain qualities. Stereotypical examples of such comments might be "*it* is good" or "I like *it*" (where "it" refers to the product). However, a minority of comments (36 for Alpha; 44 for Beta) did demonstrate design knowledge by indicating some awareness of the agents responsible for the product and an awareness of the intentions, decisions and actions of those agents. Stereotypical examples of such comments might be "*they've* done this…" or "I wish *they'd* done that…" (where "*they*" refers to the agent). It was comments of this sort that were analysed further with the intention of exploring the nature of design knowledge and its possible influence on product experience.

The results of our analysis are presented below with the categories of response illustrated by example comments. All comments were originally posted in plain text; italics have been added here to indicate the phrasings that we thought were related to our research interests. Comments are preceded by the letter of the brand of handset to which they are referring (α for 'Alpha' and β for 'Beta'). In the analysis below, any proportional references like "some" or "few" are made relative to the subset of the original comments that revealed design knowledge.

In the majority of cases, the agent responsible for the product was referred to by the brand name although occasionally the more ambiguous "they" or the more specific "designers" was used. These agents were assigned certain cognitive capabilities, in that they were taken to have understandings, preferences, attitudes and intentions.

> α: "Woow flash for the camera good for you [Alpha], now *your learning*"; "please [Alpha] *think* about [the

handset] size its so big why you not *think* to out mini [handset]"

> β: "I hope [Beta] *understands* then phones needs to work smoothly and gracefully…"; "I hate [Beta] cause they put bugs in their phones *intentionally*. Suddenly showing low battery, slow processor…"

Beyond cognitive capabilities, the agents were described as taking certain actions. For example, the agents were thought to do things, work on things, make things, change things and copy things.

> α: "what the hell are *they selling* ! a square version of the [earlier handset]"; "why dont *they* put more *work and sweat* in to the [handset] and not the crap [other product offering]"

> β: "At last *[Beta] is making* a real smartphone…"; "looks like [Beta] *copying* the [competitor] design at [the] front [of the handset]."

Taking cognition and action together, the agents' were sometimes seen as being oriented towards serving themselves (e.g. by increasing sales). In contrast, we found no clear comments that revealed that the agents were thought to be oriented towards serving users (e.g. by making things easy to use).

> α: This looks better than [the earlier handset]. But *no much changes* in design. Again [Alpha] *looking for huge business profit*."; "[Alpha] just upgraded stuffs *a little again*. And, I think, *the look is better* than the older versions."

> β: "finally its here '*the [Beta's] warrior*'…" [we take this to be an indication that the product is seen to do battle on behalf of the agent.]

In many cases those offering comments interpreted the product and its design in light of their prior experience with the brand. Because of these experiences, those posting comments had expectations of what the agents' capabilities were, of what their motivations would be and of what constraints they would be operating under.

> α: "*it would be typical of [Alpha]* to release a 'new' phone which has a few minor improvements on previous releases*"; "*The design *doesn't reflect [Alpha]'s skill*."

> β: "Amazing design. *we hadnt expect to [Beta]* to design like this"; "*[Beta] known* for the image of 40 -50 years old out of shape lady out side and a CAT bulldozer inside ."

Those posting comments sometimes demonstrated that they possessed a quite sophisticated understanding of the broader context within which agents operate. This included an awareness of how competing agents (e.g. other brands) would behave and of the business functions that are involved (e.g. design, R&D, manufacturing, marketing, retail).

> α: "I find the design quite disappointing. Nothing special and quite ugly. *Looks like* the [competitor handset] IMHO."; "Now *[Alpha] has totally ripped* [competitor handset] *design* :) Earlier *they stole* the idea of touch phone, *now design*."

β: "If *[Beta] copied* [a competing model], i hope they copy the thickness of [it] too. cause all [Beta] phones have a thickness of a brick."; "They are *way behind* in the race. Good for them is to manufacture the same old low cost phones with limited technology."

Despite the negativity of many of the comments, there were also many comments offered that demonstrated an active interest in the agent's wellbeing and success. This was often revealed through recommendations or prescriptions that those posting comments thought that the agent should follow.

α: "*bravooo [Alpha]*"; "*Keep it up [Alpha]…*"

β: "*Good to have [Beta]* b[a]ck top of the list again"; "*Hope [Beta] changes the Display to Super AMOLED and video recording to Full HD supported with a really Good Battery. This is what I hope for. […] Come on [Beta] you can do it.*"

The comments collected from the forum can be interpreted as demonstrating design knowledge in a variety of ways. Despite ostensibly responding to the handset design and specification, many of the comments refer to agents, and the cognitive and active behaviour of those agents. Prior experience with the agent is demonstrated through expectations, disappointments and cynicism, but still there are comments that demonstrate support for the agent and some investment in the success of the product.

2.1.4 Comments on study 1

The study of the online forum had the benefit that the comments were produced independently of our research questions and therefore were not biased by them. However, the disadvantage of this approach was that we were not able to clarify ambiguous statements or elicit further comments through directed prompting. We also had no way to characterise the sample although we expect that those who submitted comments would be biased towards those interested in the product category and the brands concerned. Many of the comments were attributed to anonymous users and therefore we do not know whether individual users were making repeated comments. In summary, these archives of online comments gave convenient access to a large number of product appraisals; this permitted the rapid development of initial analytic categories of design knowledge and its influence, but the exact nature of the data is not easy to verify. Having developed a preliminary characterisation of design knowledge from the online comments, we planned a second study.

2.2 Study 2: Interviews

To gain more control over the form of the verbal appraisals offered, and to have some better understanding of our sample, we conducted a set of structured interviews with users. These interviews were intended to gain some appreciation of what questions might effectively elicit design knowledge. We were interested in recruiting a wide variety of participants, and chose to take our sample from people in open recreation areas in Cambridge city centre (UK). Compared to the highly motivated users represented in the online forums, we expected some of our interview participants to exhibit less design knowledge. However, because we were able to issue particular prompts, we hoped to have some influence over the type of comments that the participants would make. We hoped, in turn, that this would enable us to direct the participants towards reflecting on the processes from which products result.

2.2.1 Sample

In July and August 2010, we conducted 28 interviews with 29 participants; one interview was conducted with a pair of participants, all others were conducted on a one-to-one basis. The interviews lasted about five minutes each. The average age of the participants was 33; the standard deviation was 14; the youngest participant was 19; the oldest was 71; there were 14 women and 15 men. As might be expected from a city that is a 'technology hub', a relatively high proportion of this Cambridge sample worked in the science and technology space (6 people), but many other occupations were represented, including finance, healthcare, administration, music, design; students and retirees. All of the participants possessed mobile phones, ranging from sophisticated smartphones that were only a few months old to inexpensive handsets that they had been using for several years. Because the analysis of the interview data was expected to hinge on relatively subtle verbal cues, the decision was taken to discount any interviews with participants who were not fluent speakers of English (the language in which the interviews were conducted).

2.2.2 Method

In considering a questioning strategy suitable for the interviews, a number of potential problems were considered. We didn't want to ask about design knowledge directly, because we believed that once the idea had been suggested, people would be inclined to say that they possessed and used such knowledge. On the other hand, if we didn't prompt users in such a way that evidence of design knowledge was offered then we would not be able to access the phenomenon in which we were interested. The phrasing and ordering of the research questions was therefore thought to be a sensitive matter, and we planned to interview participants in a way that became increasingly explicit in the prompts used. This was intended to just give the participants the opportunity to reveal design knowledge with the early questions, but strongly encouraging (if not enforcing) it towards the end.

People were approached and asked if they were prepared to participate in a study about their mobile phone. With the participants' consent the session was recorded for later analysis. The first key question was divided into two parts: "*what do you like about your mobile phone?*" and "*what do you dislike about your mobile phone?*". In asking this, the bias is slightly towards the phone itself (the thing) rather than the processes from which the phone results (the designing of the thing). The second question was "*why do you think your phone is the way it is?*". If clarification was required, we used a prompt of the form: "*earlier you said that you {liked} that your phone is {angular}, why do you think that your phone is {angular}?*". By asking users "*why*", we expected to encourage a search for reasons, and suspected that those reasons might potentially be attributed to some sentient or intentional agent who had control over the phone in some way (e.g. manufacturers, designers, brands). The third question was "*when you are looking at, or using, products such as mobile phones, how aware are you that those products have been designed?*" This final question was intended to encourage reflection on intentional processes by promoting consideration of the agents responsible for the product. Following the three key questions we collected some basic information on each participant

and their handset to help us characterise our sample and interpret their responses. This information included details of i) the participants' handset model; ii) how long the participant had owned (or been using) their handset; iii) the participants' age; and iv) whether the participants had any occupations, hobbies or interests that they thought might be relevant to how they perceive technology or design.

2.2.3 Results

The first question posed was "*what do you like/dislike about your mobile phone?*" In response to this, a broad range of responses were offered, primarily focussing on technical features (capabilities and performance), personal benefits (connectedness and style) and objective attributes (colour, texture and cost). However, even with this relatively neutral question, two of the participants did reveal knowledge of design (the gender and age of the participants' precede each quotation; again, italics indicate an emphasis in the researchers' analysis not the participants' utterances).

> M19 (when prompted about appearance): "It's got a leather back, that's quite nice. Fake leather back. *It's supposed* to look high quality when it's quite clearly not..."

> F30: "I'm just waiting for *them to design* a handset that I like".

For the remainder (and majority) of the participants, responses to the first question did not reveal design knowledge. Instead, those responses simply referred to the features of the handset and the benefits that those features bestowed upon the user.

> F38: "Size. *It's small*. I like it coz *it fits* in my pocket. I quite like the chocolate brown colour."

> M31: "*I can* check the internet, *I can* do things that I couldn't do with my previous phone."

The second question was "*why do you think your phone is the way it is?*" Responses to this question more clearly revealed design knowledge, with about half of the participants making some implicit or explicit reference to an agent responsible for design decisions. Typically these responses included terms such as "they", "the designers", "the people", "the company" or some reference to the brand name. Participants often interpreted these agents as being aware of the user, and striving to offer something that the user wants or needs.

> F27: "Because the people who make [these phones] are incredibly clever; *they know what people need* in a mobile phone"

> M22: "I'm guessing *the company have looked at what people want* from their phone and designed in retrospect of that"

The participants thought that the agents responsible for the phone were not necessarily considered to be acting freely, but to be working within certain constraints. For example, the form of the handset was understood to be the result of compromises, with the size, shape, colour and texture of the handset influenced by limitations on what could be made, used and sold.

> F39: "Everything seems to be standard black. You don't get a lot of choice with things like this, so I don't know. I imagine *that's a production issue*"

> M38: "It's like the screen is about as big as they could make it. But if the whole thing were *any bigger, it wouldn't fit* in your pocket"

A number of participants interpreted the agent as producing a range of products with similar features. These responses reveal knowledge of how brands operate, with intentions to produce products that are consistent with those released previously. Other participants offered more basic references to "design" in an effort to express why an agent may have included certain features.

> M20: "Probably because they've, *the designers*, have put a lot of time into it. It's based on the look of, like, [other products from the same brand] as well."

> M43: "I guess it's [the shiny face of the handset is] just a *design statement* really"

The third question was "*when you are looking at, or using, products such as mobile phones, how aware are you that those products have been designed?*" In response, a few participants indicated with confidence that this was often something that they reflected on, a normal part of their product experience.

> M24: "Well, it's always an obvious consideration that any item on a shop floor has been through a *design process* anyway." [Note that this individual did not offer any indication of design knowledge prior to this question]

> F27: "I'm very aware they've *been designed*, they're sort of designed to look nice, to appeal to people."

A few more participants seemed to be processing the idea of design for the first time, perhaps recognising the explanatory power of that idea but acknowledging that it was not something that they had considered.

> M25: "Don't know really, probably not that aware of it. I guess they probably do design it to a purpose or budget…"

> F38: "Yeah I suppose you do think that, because they differ so much don't they. I don't suppose I really gave it much thought to be honest."

The comments above represent the minority of our sample, and many of the responses to the third question were short and negative. These participants claimed not to use design knowledge and did not demonstrate any interest in the idea. Some participants required further explanation of what the question meant and still answered in the negative.

> F40: "Not at all. Haven't any idea how it works or what happens."; F53: "Haven't really thought about it that much"; M68: "I don't suppose I ever really thought about that"; F21: "Not really that much to be honest."; M28: "I've no idea, I just buy it."; F71: "No idea..."

The three blocks of quotations above represent different categories of answers to the third question and seem to divide the sample into three groups: those who claimed to use design

knowledge habitually, those who didn't but recognised the idea, and those who seemed not to recognise the idea and were not interested in it either. This last group contains the three oldest participants in our study, but it is not easy to characterise the first two groups either by age or activity. It could be that a general disinterest in mobile phones [17] led the older users to be less aware of the factors that shape them. Looking back across the interviews, clearly some of our participants were more design aware than others, and also more aware of that awareness. Questions remain about how active these forms of awareness are outside of an interview context, and about what influence this has on product experiences.

2.2.4 Comments on Study 2

The purpose of the interviews was to permit the exploration of design knowledge and to assess the potential for interviews to elicit that knowledge without excessive prompting. The sample studied was not intended to be representative of any population, but it is still worth noting that it was restricted to residents of and visitors to Cambridge city centre, a population known to be skewed towards high levels of education [23]. Although the interviews asked relatively simple questions, and efforts were made to put participants at ease, the effect of the interview context cannot be discounted. The participants all knew that they were taking part in academic research, and we planned our approach so as not to indicate that there was any corporate involvement. Nevertheless, the research interaction risked looking like a market research study and therefore might have triggered associations with those who have a commercial interest in mobile phones. This potential supposed association may have promoted the formation, use and demonstration of design knowledge.

2.3 Discussion of Both Studies

The two exploratory studies reported here demonstrate that evidence of design knowledge can be identified in users' verbal accounts of products. In the first study, online comments posted on review forums were found to provide a useful and convenient corpus of data from which to extract large numbers of user appraisals of products. Some contributors actively decoded the products and attributed a range of cognitive and active behaviours to the agents responsible for those products. In the second study, short structured interviews with members of the public were found to permit insight into design knowledge through the use of carefully considered prompts. The interactive nature of the interviews permitted clarification of ambiguous utterances and encouraged response to the explicit revelation of the research objectives. Some interviewees were quick to refer to the product by referring to the intentions of the agents responsible for them, whilst others were not and were not receptive to the idea of design knowledge.

In both studies, the main means of distinguishing between utterances that revealed design knowledge and those that didn't was by discriminating between those referring to agents (e.g. "*they*") and those only referring to the product (e.g. "*it*"). Consequently, the analysis often hinged on determining what these key pronouns might refer to according to the context within which they were used. Although we are generally very confident in the fidelity of the analysis presented here there is certainly room for other interpretations of some of the responses. Given the small sample sizes and the exploratory nature of the studies, no

formal inter-coder reliability scores were calculated, but two researchers initially derived and agreed the coding structure together and then reviewed each other's coded transcripts in their entirety. This process revealed very good agreement on the results of the analysis but many quotations are offered in this paper so that readers might see the relationship between the fragments of data and our interpretations of them.

It is not necessarily the case that those who use design knowledge will reveal it in verbal utterances. For example, it is possible that someone extremely aware of design may choose to discuss products entirely in terms of the object (rather than the process from which it results). Conversely, it is possible for someone who is not typically very aware of design to be prompted to express design knowledge by some contextual factor. For example, people might form, use and reveal design knowledge if comments by others refer to the agents responsible for products, or if the research methods used prompt them to consider such agents. This poses one of the most difficult challenges to studying design knowledge: if the participants offer evidence of design knowledge, we can't be sure that we didn't (inadvertently but unreasonably) prompt them to do so; if they don't offer evidence of design knowledge, we can't be sure that they don't possess and use design knowledge in their everyday engagement with products. Overcoming this challenge will be a goal of future research.

3. FUTURE RESEARCH

As discussed in the introduction to this paper, people's experiences with designed products are often considered with a focus on perception or interaction. The two studies reported here were not intended to privilege either of these perspectives, but the data collected only revealed aspects of perception but not interaction. In the first study, the participants were not expected to have interacted with the handsets, but their comments did not directly relate to prior interactive experiences, or to those that they anticipated. In the second study, although all of the participants had previously interacted with their handsets, none did so during the interviews, and their comments, again, did not directly relate to their interactive experiences. Therefore, although the research methods used could plausibly have led to insights about the role of design knowledge in interaction, they would not appear to be methods that are best suited to that objective. A more complete understanding of design knowledge – one that accounts for both perception and interaction – will require a broader set of methods to be employed. Before considering those methods, we first consider the questions to which they might be addressed.

Attending to users' knowledge of the design process is a departure from normal lines of research, and many potential lines of enquiry present themselves. In particular, were we to seek a full understanding of design knowledge, there would be at least five key questions that might usefully be addressed:

1. What knowledge do people have of design processes?

2. How actively is that knowledge used during people's engagement with products?

3. What factors influence the formation and use of that knowledge?

4. What effect does that knowledge have on people's perception of products and their interaction with them?

5. What design guidance can be offered so that people's knowledge of design is properly accounted for?

If the use of design knowledge is taken as the phenomenon of interest, then the first question relates to the *substance* of that phenomenon ('what is it based on?'), the second to its *occurrence* (how does it happen?'), the third to its *prevalence* ('when does it happen and to whom?'), the fourth to its *influence* ('what does it do?') and the fifth to its *relevance* ('what can we do about it?'). Answering these questions would give us a better understanding of how people experience and interact with products, and the opportunity to design products that promote better experiences and interactions. 'Products' in this sense need not just include something like a device, but also a complex of related artefacts, including the device's packaging, its instruction materials, the promotional campaign that surrounds it and the training that supports its use.

If answering the questions posed above would increase our understanding of users' design knowledge then it is productive to think about how those questions might best be answered. The two exploratory studies reported on here primarily addressed the first question, but give some hints about what challenges might be faced in addressing the others. In particular, it is clear that studying design knowledge is difficult because that knowledge is often unobservable unless articulated. Furthermore, people often do not know what they think [20], and asking them about design processes could make them aware of those processes and thereby change what they think about them. So, on the one hand, we might not be able to access design knowledge unless we elicit verbal accounts of it, but on the other hand, efforts to elicit those accounts might actually influence the design knowledge that people have and use.

Despite expected difficulties in investigating users' design knowledge, there are three particular research streams that describe useful research methods that might be employed. These are Human-Computer Interaction (HCI) research into mental models, marketing research into persuasion knowledge, and psychological research into intent attribution. The focus of these research streams and the methods they use are outlined here so that their potential contribution to future research into design knowledge might be appreciated:

- *HCI research* into mental models is useful because it has focussed on people's conceptualisations of technical systems and has sought to reveal the implications of users adopting different conceptions. The methods used include interviews, questionnaires, think-aloud protocols, teach-back sessions and experiments of varying formality [see review in 28]. However, as discussed in the introduction, these methods have not been directed towards the users' mental model of the designer or the design process.

- *Marketing research* into persuasion knowledge is useful because it has empirically investigated the way in which consumers respond to their inferences about what advertisers intend their adverts to mean. Persuasion knowledge researchers have employed similar methods

to those in HCI, whilst adapting them specifically for the purpose of accessing the consumers' understanding of the agent responsible for the artefact [see review in 13]. However, the focus of such work is on an explicitly manipulative medium (advertisements) rather than on objects that serve a practical function.

- *Psychological research* into intent attribution is useful because it has focussed on how people attribute intentions to an artefact's creator. Such studies employ controlled experiments to study the effect that these attributions have on artefact naming, categorisation and interpretation. However, the focus is normally on the creator's intentions for what a thing should be, rather than what qualities that thing should have or how it should be used [6,7].

Drawing methods from specific research streams in HCI, marketing and psychology holds great promise for studying design knowledge. Methods from these disciplines might usefully be modified and combined in new ways as they are focussed on addressing issues that are particular to design knowledge. Of course, beyond those approaches that have already been used elsewhere, many other approaches might also prove to be productive. Other opportunities may open up as researchers creatively develop and refine novel methods that are uniquely suited to eliciting, recording and analysing users' design knowledge.

4. CONCLUSION

The exploratory studies reported here suggest that people sometimes approach products by thinking about where those products come from, who is responsible for them, what decisions have been made about them and what drove those decisions. This is not something that is typically discussed in the product experience literature, and it is consequently difficult to fit these ideas into existing models of product interaction or categories of product perception. Instead, the concept of users' design knowledge describes a new phenomenon to look for, account for and design for. There remains much work to be done to discover what the true nature of that knowledge is and what effect it has. However, we hope that this present paper has been helpful in exploring what it is that might be discovered, and by what means those discoveries might be made.

At present, we don't know much about users' design knowledge, and many questions remain about its substance, occurrence, prevalence, influence and relevance. However, it may well be important to understand these things because design knowledge could fundamentally influence how users perceive products and interact with them, and therefore how those products should be designed. If we wish to explore these issues thoroughly, then we can draw on the research methods that are used in other related disciplines, but these methods will need to be adapted and deployed in new ways. Although this would be a significant undertaking, such work seems warranted because it has the potential to tell us something new about how people experience products, and thereby encourage the design of products that are safer, more efficient and more satisfying.

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