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Creating and Testing a Model-Driven Framework for Accessible User-Centric Design

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Abstract

Despite growing interest in user-centred design, there is limited discussion and critique of how to implement such an approach in a commercial design environment. This article examines the approach taken to gain knowledge of product use in order to evaluate a framework for user-research that draws on UCD theory through a number of commercial case studies. User-centric enquiry must fit into the design process where the aim is to create commercially viable output economically and efficiently, and where errors resulting from insufficient user consideration are mitigated cost-effectively; something that is rarely discussed in literature. This paper documents a practicing design team's efforts to guide user-led design practice and product insight acquisition with the implementation of a model-driven, user-centred, approach across numerous commercial projects.

Keywords - User Centred Design, Design Practice, User Centred Design Process.

Introduction

This paper presents four individual case studies that have been subject to a user-centred product development approach that involves strategically capturing user insight to ensure cost effective user-led product design output. The projects examined baby products, rehabilitation, and mobility aids, and varied distinctly in size and budget. These case studies provided a vehicle upon which to assess the effectiveness of the user-centred design process and the developed model. Further, it allowed the design team to understand and quantify the advantages of applying such an approach within a commercial design environment. This article highlights how the insights gained can be used as drivers for future product development and also investigates the processes that were undertaken in order to improve future design research. There is then, a twofold consideration of the insights gained within the individual studies, and also consideration of how the user-centric approach might be applied within wider design contexts. A framework for the management and delivery of user-centric design research services, and a physical space for observing, recording, and analysing user-product interaction, is therefore described and presented.

Background

Reviewing the state of design research, Sanders (2006) asserted that ‘The market driven era is finally giving way to the people-centred era’. Sanders argues such a change in focus is due to business recognition that products have to be useful to be successful. The issue of usefulness is further expanded by Utterback et al. (2006, p.154) who write of successful companies’ aspirations to ‘create an emotional link between the product and the consumer’ and Porter et al. (2007) who proposed that there is a reciprocal relationship between emotion and interaction. Almquist and Lupton (2010) further describe a transition in design research from a ‘study of things to a study of people.’ Despite much having been written about the need for User-Centred Design (UCD), and the various methods to capture user behaviour, there is little reporting of empirical enquiry into user-led design practice and the particular benefits user research brings to industrial application.

The purpose of a UCD approach to product development is to improve the applicability and acceptance of the end design. Therefore, from a management perspective, UCD has the potential to reduce development risk. UCD has been described as multidisciplinary (Mao et al., 2005), value adding (Boztepe, 2007), and inclusive (Steen et al., 2007). It is multidisciplinary as it requires experts from various disciplines to examine, analyse, interpret and synthesise user needs and behaviours and translate these into designed artefacts, often in an iterative process. It is potentially value-adding both in terms of improved design output (leading to greater commercial success) and in considering the overall experience of product interaction for the user.

Ideally, user interaction should be explored early in the development process, so that the usage habits of the user can be used to inform product development; to ensure that the most appropriate designs and solutions are identified. A difficulty in obtaining such data in a reliable fashion exists as many of the factors influencing the knowledge associated with a product, and many of the potential operating errors are heavily influenced by the environment in which the object is situated.

Despite the design community’s increasing awareness of the importance of UCD, a feasibility study undertaken by the authors in 2008 demonstrated that manufacturers typically lack the knowledge, expertise and resources to effectively implement such design principles. Additionally, there is a lacuna of research to assist user-centric design implementation by way of translation from theory to practice (Weng et al., 2007; Boztepe, 2007). In an attempt to begin to address this gap, this paper presents a conceptual framework that has been developed and applied within a number of commercial case studies to guide future user-research activity and consumer product design.

The Application of a Commercially Sensitive User-Centric Design Model

Although there exists design-industry wide recognition that UCD research can aid effective product development, a review of the literature has revealed relatively little information on how to translate user-centric theory directly to practice. Responding to the call for increased user-research, the commercial team within the product design research department of a university took the opportunity to explore user research-mechanisms. Although affiliated with a university, this team operates entirely as a product design consultancy, competing on the open market with a team of professional designers that have no teaching or wider university obligations. Operational since 1994, this unusual set-up provides the university with a highly regarded industry interface and generates data for the department's research staff to investigate the effectiveness of applied design research.

Having developed an in-house framework (Figure 1) for accessible user-centric design and research services and a physical space for observing, recording, and analysing user-product interaction, the commercial team used the framework across a number of case studies to determine the approach's effectiveness, commercial potential, accessibility and transferability.

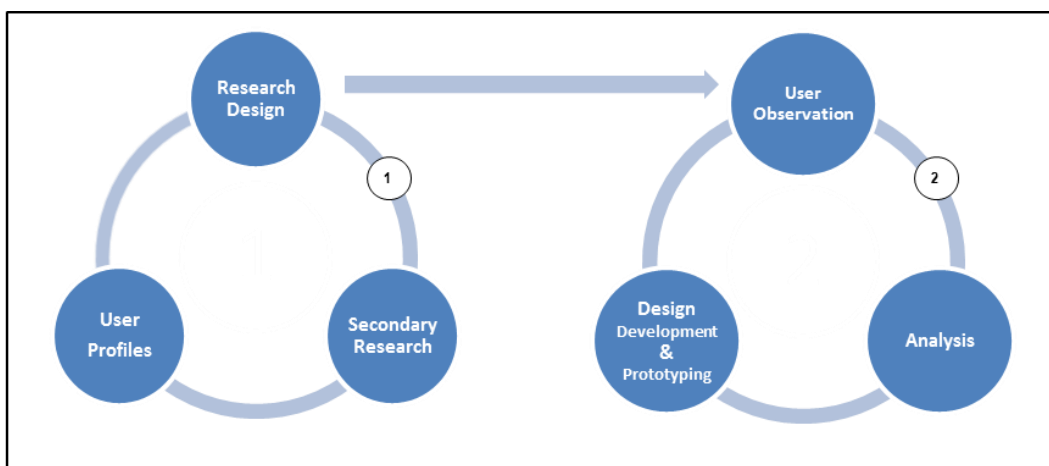


Figure 1: Framework for accessible user-centric design

The framework is designed to be implementable even in situations of limited resource, thus increasing its accessibility. It provides an approach for generating user knowledge at relatively low cost through access to specialist resources, tools and applied methods. However, it also aims to achieve rigor in the evaluation of potential product user behaviour in order to be an effective tool for improving the empathy of design teams when creating new products.

Individual elements of the accessible user-centric design model

The six-part framework follows a dual-iteration process; in the first iteration, the research design is further informed by secondary research and the development of user profiles, and provides material for output assessment. The second iteration is concerned with undertaking and analysing

observational research and contextualising results in terms of new concepts. Each of the individual elements will now be introduced in greater detail.

Research Design

The research design phase of iteration one initially covers exploration of project needs in discussion with stakeholders and builds towards a project plan for primary research based on the results of secondary research. As the research questions emerge this phase would also include internal pilot studies to confirm the appropriate research design.

Secondary Research

The secondary research phase is where research into related products, the perceived market, current and target users, etc. is undertaken. The actual investigations undertaken here were dependent on client and project needs, but it is intended to provide a basis to make decisions regarding the user-profiles for observational research and the most important instances of interaction to observe.

User Profiles

User profiles are determined based on the results of secondary research. As the phases are iterative, the results of the secondary research may impact on the requirements for the user profiles and the research design. Any changes to these may highlight a need for further secondary research.

User Observation and Observational Data Gathering

This phase of the second iteration essentially determines the situated observations and selected observational routines to be recorded.

Analysis

The analysis phase contains analysis of the observational research data and triangulates this against other participant data as directed by the research design. It is perceived that secondary research generated in the first iteration will provide further data by which to contextualise the results.

Design Development and Prototyping

A critique of early investigations proposed that the translation of the research results to product concept options was commercially valuable. As a result, a translation phase is built into the framework as an assessment of the impact of the findings on design and development. Additionally, the framework recognises that the perceived implications for product design can be tested through further observations of users interacting with prototypes.

User Focus

A unique component of the framework is the ethnography inspired user observation element with an emphasis on creating a structured and robust coding scheme for video analysis. There is a further stipulation of research trained individuals being involved in setting up the research questions, study design and video analysis. It could be argued that the insistence on the use of such researchers inhibits the intended accessibility aspect of the model, as a lack of available expertise has been cited as a barrier to design usage in the wider literature on product development (Larsen & Lewis, 2006).

However, this framework is intended to be used by design professionals that provide services to industry rather than for implementation within companies. Therefore, the accessibility (as in low entry costs) aspect is derived from the speed with which the study can be undertaken and the analysis fed back to designers. The application of the framework therefore considers:

- Situating Observations
- Selected Observational Routines
- Triangulation

Situating Observations

In order to create a practical mechanism in which to undertake user observation, consideration has been given to the environments in which user interaction is observed. The authors proffer that many product interactions do not require observation in their actual environments in order to provide accurate information on use. This might be a controversial issue, especially in terms of the tensions already shown to exist between anthropologists and designers regarding the way the design industry has modified ethnomethodology for its own purposes. However, if a simulated or quasi-contextual environment can provide an accurate notion of product interaction then such a strategy has the potential to reduce observation cost. Previous research has suggested that lower levels of fidelity in both the operating environment and prototype products still have the potential to provide accurate usage information (Woolley et al., 2010; Gill et al., 2008; Gordon & Wilgeroth, 2008). Because of the contentious nature of this proposition, the authors refer to such observation as ‘ethnography inspired’ to demonstrate that there is no claim of this model providing true ethnographic enquiry.

As mentioned, to provide a space for undertaking such user observation, the department created an observation laboratory. Essentially this is a white room equipped with multiple video cameras and audio recording hardware, linked to behavioural analysis software. This simple space provides a three dimensional canvas; a place where it is relatively easy to use props to simulate relevant environments (e.g. adding products, shelves and point of sale material to represent a retail space, or adding a hospital bed and medical equipment to represent a ward).

Selected Observational Routines

The central aspect of the framework is the observation of users interacting with products. With the situation to be observed simulated in the laboratory as a proxy for the real environment, the next barrier to overcome is concerned with the length of time of the observation. The implication of this is twofold: shorter observations are less expensive (a fundamental of the rationale behind the laboratory); and, using a laboratory means that only a limited set of environments can be observed over a fixed time period. This approach is based on the premise that useful information on product interaction can indeed be gained from careful selection of the observable tasks. The selection of these tasks is determined by secondary research into interaction with the relevant classification of product and the requirements of the individual design research project. In a commercial context, developing research questions in this manner provides a basis for providing limited and controlled buy-in from clients. That is, an ever increasing fidelity of understanding of product interaction can be obtained through the commissioning of further studies. In this way, risk can be managed by the client based on their perceptions of the usefulness of previous studies. Further, mock-ups or prototypes of new concepts, developed as a result of previous studies, can be used to repeat studies and refine the product solutions, thereby providing a mechanism to maintain user contact throughout development.

Triangulation

Early focus group style interactions proved to be an effective way of gaining insight into how the class of product fitted into the participants' daily routines. Further, using this approach to investigate daily usage behaviour also revealed how users and participants valued and developed uses for products beyond merely their core functionality. Given that the overall aim of this commercially sensitive framework is to produce the maximum user-derived design insight accessibly and cost-effectively, and that the framework relies on observations of selected routines, it is therefore important that mechanisms are employed to consider these observations in their wider context. Using focus groups, semi-structured interviews and questionnaires to delve into the product interactions of participants efficiently provides additional data for cross-examination, to contextualise user behaviour, and to compare the things that people say with the things that they do, and the things that they have done.

The Research Questions

This paper then, portrays the application of a commercially sensitive user-centric design approach and contributes toward the literature of relating user experience and user-centred design theory to practice. The overall research questions developed to validate the approach were:

- How effective was the user-centric design approach at yielding design insights?
- How can the experience be used to formalise and improve user-centric design research for commercial product development?
- How might such accessible UCD be deployed in industry?

Method

In order to address the research questions it was necessary to study the procedure that the consultancy took for gaining user knowledge and to understand how that knowledge related to the concepts presented to clients. Generated through a review of the project files and discussions with the Commercial Team Leader, a procedure was developed, aimed to better understand:

- What did each project intend to achieve?
- How was the research undertaken?
- Why was the particular approach chosen?
- What were the results of the exercise?

The study provided concise documentation of each project so that the results could be assessed against the benefits of various forms of user enquiry as reported in the available literature. This empirical research allows consideration of how each project influenced further commitment to design research from both the designers and the client; and subsequently of how design research theory can be applied to improve future performance in capturing user needs for product development. In addition, a physical space to facilitate user-research was created within the department in order to create a space for observing interaction; a user-centred design laboratory was developed that was equipped with multiple video cameras and audio recording hardware, linked to behavioural analysis software. This space provided a three dimensional canvas, where it was relatively easy to use props to simulate relevant environments (retail spaces, or hospital wards, for example). Each case study was performed within the interaction laboratory and contributed toward evaluating the framework and developing avenues for subsequent user research.

Case Study 1: Highchair Feature Appraisal

The commercial team at the research department were requested to generate new concepts for a range of baby products. With no preference on how this should be approached by the client and with the design team aware of the on-going dialogue in the design industry of the merit of UCD approaches, the framework for accessible user-centric design was followed. The majority of the design team were not parents, and an opportunity was thus recognised to explore the value of user-

centric investigation as a mechanism to demonstrate additional value to the client. However, as this was an initial exploration of needs, not directly bought into by the client, there was only a limited budget with which to resource the research.

The planning of the study was based on the materials provided by the client (a range of competing market products) and the identification by the client of typical user-groups. However, in this instance, there was little referencing of the literature on different approaches to gaining ‘user insight’. Rather, the Commercial Team Leader (a design, not research, professional) drew on his personal experience in ideation techniques and broad reading of professional design publications.

Recruitment for the study was undertaken through advertisements placed at a local mother and baby group. The respondents that replied and agreed to participate were considered a match to the typical purchaser profile as described by the client. It was perceived that participants with multiple children or practising as childcare professionals would have strong opinions based on increased experience with the classification of product and, as such, could almost be viewed as lead users (von Hippel, 1986). The sample consisted of 6 females and 1 male, ranging in age from 20 – 40 years of age.

The day was organised as a structured focus group, with the Commercial Team Leader inviting comments about how the products fitted into participants’ daily routines. Each of the products was then introduced to the group, where key features were discussed and critiqued by the participants.

The sessions were video-recorded and, additionally, one of the design team took notes on the comments and interactions of the participants with the products, whilst another designer made sketches of potential design options based on what he was observing. The analysis involved a simple review of all the material by the lead researcher, highlighting interesting observations that might guide product development. A long list of points was fed back to the conceptual designer, and the recording was used as evidence of these interesting points to help justify the resultant new concepts to the client.

Results

Participants were asked to rate specific product features on a 5-point scale, ranging from Not Important to Very important. Figure 2 highlights the instances where each of the features was considered *Very Important* by the participants. This approach provided an efficient, effective, and immediate, reflection of the individual features in terms of desirability, and also as potential drivers that might influence highchair purchasing decisions.

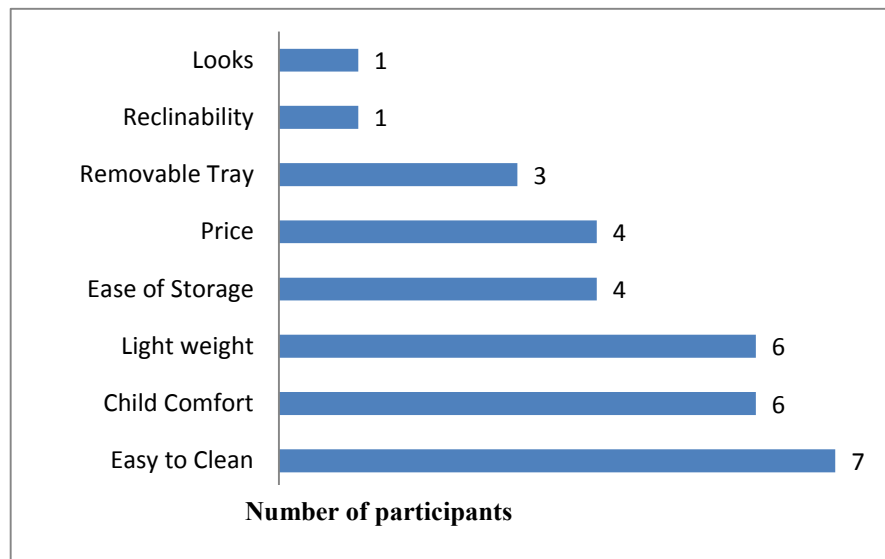


Figure 2: Highchair Features rated as Very Important (n = 7)

The main criteria that influenced the consideration of Highchair purchase drivers were the ease with which the product could be cleaned. This was followed closely by the categories of Child Comfort (considered very important by 6 out of 7 participants), and the overall weight of the product (again, considered very important by 6 out of 7 participants). Of note, is that the aesthetics of the product were not considered very important in this study and that similarly it was apparent that potential product purchasers were less influenced by price than the weight of the product, the perceived comfort of their child and the ease with which the highchair could be cleaned. The authors acknowledge there may be a gender bias present within the study due to the majority of participants being female, but are unable to comment on the extent to which males as a group may consider the individual features identified differently.

How did consumers justify their purchasing choice?

Child comfort and an ability to clean the product easily were clear purchase drivers and justifiers. Discussion revealed that product stability and inferred child security were key factors quantified on an aesthetic and physical level with additional interaction with the straps and tray feature.

How did consumers integrate the products into their everyday life?

The highchairs were integrated into the users' everyday life as a component of their daily routine used initially in the process of breakfast preparation, this activity taking place largely in the consumers' living room. This appeared to cause the highchairs to become an additional piece of home furniture with a frequent usage rate. It also performed a conditional learning function when parents used it as a tool to train their children to sit to the table at the parents' mealtimes even if the child had already eaten. The highchairs additional ability to function as a small chair or stackable table was also referenced.

Conclusion

Overall, the design team felt that the research had helped them to create better concepts, providing them with a better understanding of:

- How the participants tested and compared quality and desirability in the products
- How to assess the most important features based on the reaction of the participants
- How the parents justified their expenditure on such products
- The impact of particular aesthetic options
- How the product fits into family life

The client was also impressed with the knowledge gained and the impact that such research might have on product development programmes. This was evidenced by a further commitment to commission such research-based concept development with the design team, and in taking some of the concepts through to the next stage of development.

Case Study 2: Factors influencing Highchair Purchasing Decisions

In early 2011, the department was commissioned to undertake a second design research study to generate further new concepts for a range of baby products. The client was interested in understanding how consumers choose one product over another, and in how this knowledge could be used to create more desirable products. Achieving this aim required a combination of understanding how consumers assess the products at the point of purchase, how these decisions fit with their experiences of this class of product, and improving the empathy of the design team.

The commissioned research centred on purchase decision making and the selection of one product over another. The authors again followed the framework for accessible user-centric design and made use of the department's interaction lab. A key aspect of undertaking this research in a cost-effective manner was to be selective about the observable tasks; therefore, the laboratory was set up to represent a retail environment, and observations were made of participants (in this case the parents of young children) pretending they were in the market for the required classification of product. Participants were left alone to interact with eight products as they wished for 10-15 minutes, before a researcher returned to the room to ask predetermined questions on which product they would choose and why.

The fixed video cameras in the laboratory captured four video streams of each participant interacting with the products. The coding scheme employed to analyse the video footage was based on reducing interactions to a set of mutually exclusive events. Therefore, at any time the coding would identify which product, and which component of that product each participant was

interacting with. The video streams for each participant could be played back simultaneously or individually as required for the researcher to code interactions accurately.

By adopting this approach and analysing the behaviour of participants interacting with the products, the researchers were able to extract data, inter alia, on which products were inspected the most, which components demanded the most attention, and in what order the participants interacted with the products and components. To contextualise the behaviour of participants, structured interviews explored individual participants' current ownership and use of similar products. Additionally, a group cognitive walkthrough and feature exploration session provided further information into how these products fitted into everyday life and more detailed information regarding product features.

The sample consisted of 6 females, ranging in age from 20 – 40 years. Data gathering for this project was completed in one day, with the analysis and report generation completed in a further four days. The outputs provided a number of opportunities for new product options that had the potential to create more desirable products for little or no extra production cost. These outputs were communicated in the form of concept sketches that referenced the research data. It was perceived by the design team that the most valuable aspect of the research (to the client) was the presentation of the results in the form of new concept ideas supported by research evidence, rather than a text based report that simply highlighted observed behaviours. The value that the client found in this research was verified through further commissions to undertake such design research.

Results

Which product demanded or received the most attention and why?

In respect of the commissioning client's commercial interest, the products used have been anonymised. However, in terms of overall interaction, Figure 3 indicates on average how much time each participant spent interacting with each of the 8 products.

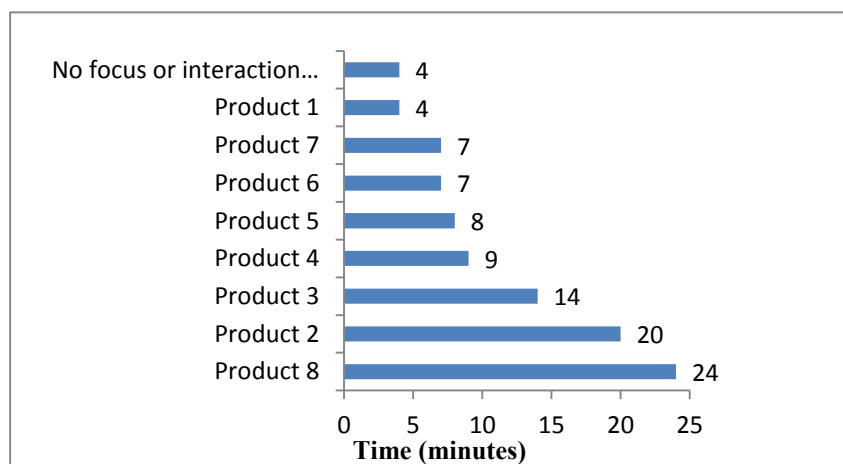


Figure 3: Average time spent engaging with specific products (n = 6)

Product 8 was manipulated by the group for almost a quarter of each trial and most participants interacted with it for the longest period of time. The variation of interaction in comparison with other products is apparent. However, it may be premature to conclude that the product the majority of consumers interact with the longest is superior, and this warrants closer investigation to determine if the behaviour observed is due to enjoyment and interest or interactional complexity [14]. Features that demand conscious attention are not *necessarily* the most rewarding; they may simply be the most misunderstood or difficult to understand.

In this study, however, participant feedback verified that the increased attention and inspection of particular products was indicative of a heightened interest in a desirable product or feature and an enthusiasm to interact, learn, and understand, more about it.

Which features demanded or received the most attention and why?

In terms of feature interaction, Figure 4 indicates on average how much time each participant spent interacting with specific features of the products.

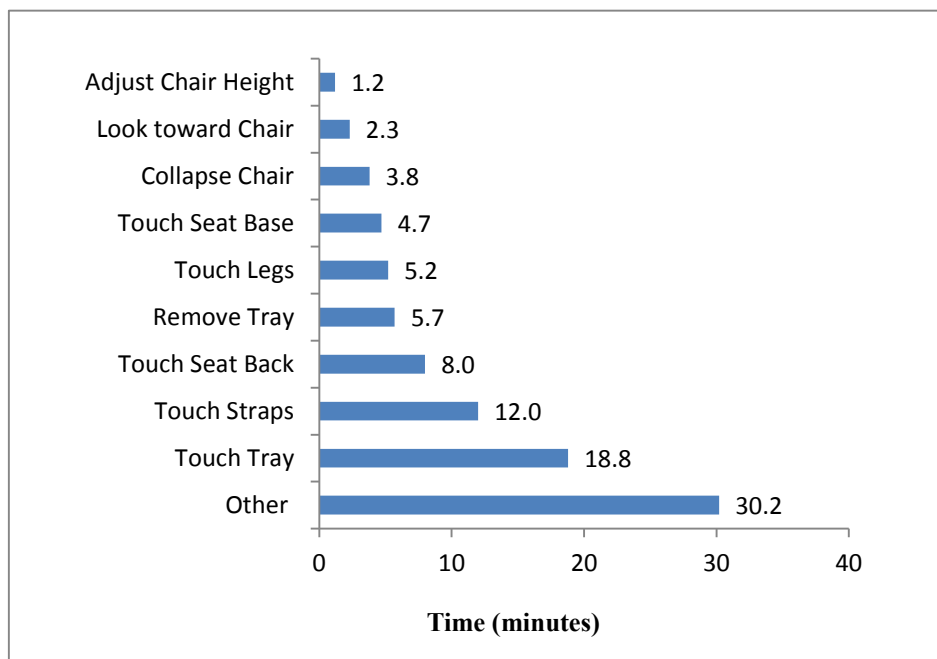


Figure 4: Average time spent engaging with specific product features (n = 6)

It is apparent from Figure 4 that the most frequently occurring behaviour fell into the category of ‘Other’. This was a category designed to cater for behaviours that didn’t specifically involve product interaction such as participants interacting with their accompanying child rather than the product. This analysis does, however, permit the identification of a number of key behavioural activities that participants were indulged in and the features with which they interacted.

As previously mentioned, the products ability to aesthetically convey notions of child security, comfort, and ‘easy-clean’ attributes, were important and appeared to be features that potential

consumers focussed upon. Through feature-interaction, these notions translated into key purchase drivers as parents were keen to ensure their offspring would be both safe and secure in the chosen product and comfortable. This also reinforced the findings that easy to clean products were considered highly desirable and preferable.

The adjustment of the chair height appeared to interest the participant sample the least, although as the experiment was performed in a simulated environment, it may have been a factor that users needed to make little adjustments for the chair to integrate effectively within that environment. Users spent the second least amount of time looking ‘holistically’ toward the chair, but focussed more on the individual features thereof.

Users spent increasing amounts of time collapsing the chair, interacting with the seat base and chair legs, removing the tray and touching the rear of the seat. Overall, interaction with both the Touch Straps and Touch Tray appear to be the features that users subsequently interacted with the most.

Conclusion

A general picture of consumer behaviour has emerged from this study, and key purchase decision factors have been recognised and validated through direct discourse with the consumer group. These revelations include but are not limited to:

1. Seeing and feeling a product makes a big difference when purchasing a product
2. When purchasing highchairs from Supermarket Retailers, consumers expect to receive little assistance. Conversely, they *do* expect help and guidance in purchasing the appropriate product from Independent Child Care Retailers, ascribing distinct value to such provision
3. Product safety is inferred through its stability and the buckles used to secure the child
4. Price, ‘foldability’, and ‘hideability’ are of interest as consumers acknowledge these products are unlikely to remain pristine; a highchair that can be easily stored is desirable

Case Study 3: Pushchair Feature Appraisal

A further opportunity to apply this approach presented itself in a study that examined pushchair features and their appraisal by potential consumers. The research was performed in the interaction lab and involved 22 female participants who were asked about the pushchairs they possessed. The intention of the initial focus group was to investigate what product features might be involved in pushchair product purchasing decisions. This was performed with a particular emphasis upon how importantly consumers considered universal features such as Build Quality, Manoeuvrability, and Comfort, at point of sale (POS). The user-centric approach helped to identify and reveal the features that were subsequently seen as potential drivers influencing child pushchair purchasing decisions.

Results

Participants were asked to rate specific product features on a 4-point scale, ranging from Not Important to Very important. Figure 5 (below) highlights the instances where each of the features was considered *Very Important* by the participants. This approach again provided an immediate reflection of the individual features in terms of desirability, and as potential drivers that might influence pushchair purchasing decisions.

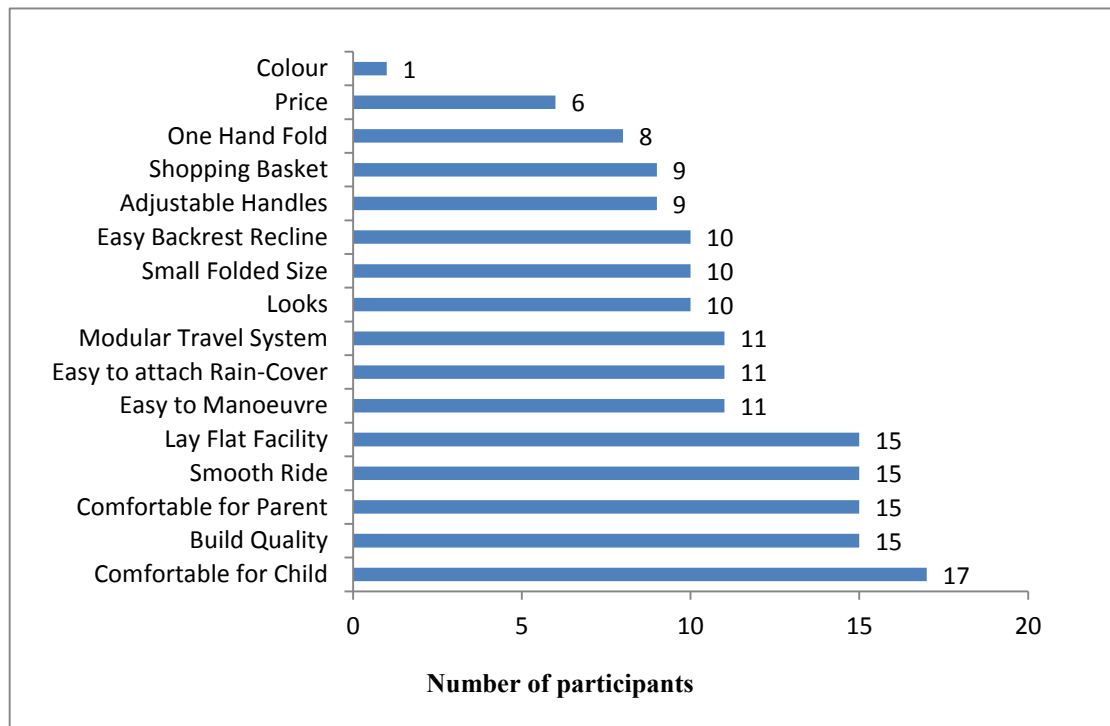


Figure 5: Number of Participants rating Pushchair Features as Very Important at POS (n = 22)

The results indicate that in this study the feature of ultimate importance when consumers consider their purchasing choice was how comfortable the buggy was for their child. The colour of the product was deemed the least important aspect. Build quality, user (parent) comfort, the ability of the product to provide a smooth ride, and its ability to lie flat, were features rated very important by 15 out of 22 participants. Ease of manoeuvrability, the ease with which a rain-cover could be attached to the product, and its ability to form part of a modular travel system, were considered very important features by just over half the focus group. The aesthetic appearance, reclining backrest and small folded size were considered very important features by 10 individuals. Handle adjustment, the possession of a shopping basket, the ability to dismantle the product with one hand, and the price, were comparatively less important factors that might influence purchasing decisions.

Conclusion

Similar trends are visible in this study to the trends apparent in the study of highchair features and their desirability or ability to influence purchasing decisions at point of sale. Child security and

comfort, build quality and ‘pusher’ comfort appeared to be significant purchase decision factors. The authors acknowledge that there may, again, be a gender bias present in this study due to the predominantly female sample and are similarly unable to suggest the extent to which males as a group may consider the individual features identified differently.

Case Study 4: Rehabilitation Product Market Drivers

Despite the generic commercial drivers for pursuing a UCD approach, the rehabilitation market within the UK has been slow to adopt such development processes. Perhaps the drivers of increased end-user satisfaction have been less important to rehabilitation product developers, as the end user is rarely a direct customer of the producer. Rather, clinicians, local authorities and health service trusts specify and purchase products, removing much opportunity for choice or comment from the end-user. However, the authors, through collaboration with rehabilitation product producers, notice a growth in the private market stimulated by local authority budget cuts. Such private market growth provides both opportunities and challenges for product producers. This case study documents the endeavour to understand these opportunities by addressing the challenge of understanding user needs and desires, focussing on the generation of ideas for new product opportunities in the active wheelchair user market. In order to effectively and quickly gain insights into the needs of such wheelchair use, a lead user approach was taken (von Hippel, 1986). In such an approach, potential new product users are consulted early in the development process, as their use and demands from a product are seen to be ahead of the market. Further, these users are adept at envisioning the particular benefits that new products will create for themselves. Therefore, in the development of products for active users, the extreme of this group, and therefore the lead users, would be professional or international sports persons. The authors’ recruited a user group of four participants that included two paralympians and two aspiring paralympians.

The purpose of the investigation was to understand both current use (and abuse) of products, and future potential use. Use was investigated in three ways:

- A survey of participants perceived needs from products;
- A semi-structured interview focussing on daily tasks (cognitive walkthrough) conducted by a clinician and a disability counsellor, and discussion of ‘future product use’;
- Observational research in a controlled environment.

Again, the authors utilised the observation laboratory to observe participants’ interactional behaviour as the desire was to capture natural interaction between wheelchair users and others over a couple of hours. Additionally, the participants were given the opportunity to interact with objects as they would in their everyday lives. Therefore, the laboratory was equipped with soft furnishings,

a television running news programmes, a conference table where food and beverages were stored, and an office desk with a PC which the participants used to enter their survey responses. The authors recognise that although the study was performed in a simulated environment, this approach did permit the examination of user-chair interaction in a more ecological, controlled setting, and thus maximised the potential for design insight acquisition.

All four participants met in the observation lab and were filmed interacting with each other, the authors, and objects, while waiting to be individually interviewed in a different room. In all, four hours of footage from four cameras was captured. The analysis of these multiple datasets was intended to provide the authors with rich insights into current and potential product use.

Each data set captured observations of behaviour and examples of statements from individual participants. The analysis was performed by initially categorising the observed instances of behaviour and the individual verbalisations in terms of four higher-level themes: *Positive Statements, Wants and Needs; Negative Statements and Dislikes; Participant Ideas; and Instances of Behaviours*. These themed observations were then classified in relation to a five-part, lower-level, coding scheme extracted from further analysis. Strict definitions for the application of the lower-level coding scheme were developed and adhered to (Table 1).

Table 1: Lower-level Codes used to interpret observational material

<i>Term</i>	<i>Definition</i>
Independence	Statements or behaviour relating to current or future products that either assist or impede the independence of the user
Reliance	Instances where the user relies on the product (usually a negative indication of a particular product or product attribute)
Empowerment	Instances where a product either provides, or has the potential to provide, greater empowerment of the user
Aesthetics	Instances where users indicate the importance of aesthetics
Functionality	Instances relating to the actual or potential functionality of a product

Results

Table 2 presents the four higher-level themes and, for each theme, the frequency of occurrence of behaviour or dialogue that correspond directly to the five-part, lower-level, coding scheme developed. Due to the commercial sensitivities involved it is necessary to present these results at a level of abstraction, although the individual references were thoroughly documented and pursued.

Table 2: Occurrence of observed instances of behaviour or dialogue

	<i>Positive Statements/Wants/Needs</i>	<i>Negative Statements/Dislikes</i>	<i>Participant Ideas</i>	<i>Behaviours and Observations</i>
Code	Occurrence	Occurrence	Occurrence	Occurrence
Independence	3	4	0	4
Reliance	2	0	0	4
Empowerment	4	8	1	10
Aesthetics	11	1	2	6
Functionality	5	2	9	11

Within the theme of Positive Statements, Needs and Wants, product aesthetics were observed to be the most frequently referred to factor. Participants demonstrated that aesthetics took precedence over almost all other considerations, even over functionality. Further, participants were reluctant to use functions that addressed their clinical needs if they felt they either detracted from the overall aesthetic, or made them look “more disabled”. Many of the empowerment issues referred to in the Negative Statements/Dislikes theme indicated that the product in its current iteration could do considerably more to empower the user and increase personal independence.

In terms of Participants Ideas, users were quick to suggest that new product developments should focus on improved functionality, often with the caveat that any new features must also look good as well as being functional. In terms of Behaviours and Observations, the main observations focussed on issues of Functionality, Empowerment and Aesthetics. Here, the workarounds that the users employed in place of using correct equipment (from a clinical perspective) included using an undersized chair as it was thought it was more aesthetically pleasing, or not using ‘anti-tips’ as they were felt to give the impression of stabilisers.

Conclusion

The importance and significance of product aesthetics to users is an undeniably key finding of this research. One author involved in an Italian study found that for user engagement and adoption in a similar market, it was imperative to promote features as value-added aspects of design often incorporating technology. Real users felt stigmatised by features that identified them as less-able, and this also had implications for mental health and self-esteem. To overcome these issues, finalised features had to be capable of making the product appear *trendy and desirable* to the widest possible demographic, including those with or without impairment.

The move towards the creation of products to meet the needs of a privately funded market provides an interesting challenge for rehabilitation product producers. It requires a step change in opportunity identification based on understanding the values and experiences of product users. That this is novel in the rehabilitation industry is highlighted by a quote from one of the participants: “In 40 years of wheelchair use, nobody has ever asked what I think.”

The results of the exploration presented in this case study indicate that valuable insights into user needs can be gained that have the potential to inform product development. These insights come in the form of a much greater understanding of the potential relationship between prescription and self-esteem. It is easy to think that a design that meets a clinical need will be appreciated in the marketplace. However, such designs do not necessarily consider how the user perceives that the product communicates their disability to the world around them. These results indicate that whilst the participants expressed a subconscious need for function, they also possessed a conscious want or desire for aesthetically pleasing products. In driving a product design brief, such knowledge will lead designers to create products that better empower users by ensuring that functional apparatus do not present negative connotations. Examples of these negative connotations provided by the participants included anti-tip devices being thought of as stabilisers, high and functional backrests making the user look more disabled, and an inability to match a wheelchair to social events (in the same way as you might wish to change your clothing to be appropriate for a particular function).

This exploration of the capture of user needs has been highly successful for the company in driving ideas for new products. However, there are limitations that must be acknowledged. This study observed a small sample in a bespoke environment, and care must be taken in generalising the insights gained. Despite this, the authors found a mechanism to improve their empathy with product users that will directly impact future development work; future research is planned that will examine user needs in different demographics and different environments.

Discussion

It is prudent at this stage to return to and reiterate the initial Research Questions to determine how well the model performs in terms of the original research aims and intentions.

The original research questions were:

- How effective was the user-centric design approach at yielding design insights?
- How can the experience be used to formalise and improve user-centric design research for commercial product development?
- How might such accessible UCD be deployed in industry?

How effective was the user-centric design approach at yielding design insights?

As a professional investigation to gain material for ideation and new concepts, it is clear that the framework was seen to yield significant results, and as an approach has proved to be very effective in terms of maximising the potential for design insight acquisition. This was demonstrated in the number of new concept ideas generated and in their perceived value to commercial stakeholders. The structured observation and recording of participants interacting with products provides strong evidence for the design decisions that were made. Further, the data output from the coding of user behaviour makes patterns of behaviour across groups more apparent than sequentially viewing video streams. This data output is important in assessing the relative importance of different behaviours and in providing evidence for clients' decision making processes.

How can the experience be used to formalise and improve user-centric design research for commercial product development?

Although performed in a commercial environment, it should be acknowledged that the research aspect of each of these studies had a limited budget. This resource limitation was deemed to increase the validity of the studies as similar resource constraints are likely to form part of any contract with smaller companies (Larsen & Lewis, 2006). One of the features of this model is that it provides an accessible framework for user-research in product development. That is, to create an approach to user-centric design research that is suitable for use with resource constrained smaller enterprises. Whilst efforts were made to match the participants to the target demographic and to group the participants based on their experience with the products, the use of recruitment agencies was not considered due to the budgetary constraints. Such a compromise, which necessarily removes sophisticated filtering, e.g. geographic or socio-economic filtering, is also likely to be a feature of any user-study conducted on a limited budget. This, in turn, is also a recurring factor in smaller-scale commercial ventures, and so maintains an important aspect of ecological validity.

The way in which the projects involved both the functionality of the products, and how they fit into the lives of consumers, does present an exploration of use, usefulness and value. Functionality is explored both in terms of the features of presented products and in the dialogue of what users want and get from this class of product. The focus group interaction with users generates a retrospective dialogue, and so fits with Boztepe's (2007) notion of value based on reflective evaluation.

The research process undertaken is similar to the Empathic Design approach; in so much as it is a move to get closer to the end-user to find inspiration (Steen et al., 2007). The incorporation of an ethnomethodological approach into the commercial and experimental case studies does liken the methodology used to more of a Participatory Design Model, where users are observed interacting with existing products and influence the design process accordingly. It is recognised that the needs

and resources in professional practice are not always an exact match to the ideals of the theoretical underpinnings. Regardless, these observations and interpretations of behavioural interaction and direct discussion with users and consumers have shown how this approach can lead to breakthrough designs and certainly provided a wealth of user insights into the products under investigation.

How might such accessible UCD be deployed in industry?

Walters & Evans (2011) recognised that there were historical challenges for the application of User-Centred Design approaches within commercial spheres that continued to centre upon the commitment and investment of resources: “Any research that relies on professional observation in the field for an extended period is likely to be costly, and therein lays the barrier to many firms’ engagement with user research” (p.126). This remaining challenge was the driver behind the further development of this commercially sensitive and accessible user-centric model as a framework by which to micro-manage resource investment. By employing a range of research tools and methods, as and when appropriate, and monitoring the research output accordingly, resource investors can decide to opt-in and out whilst still profiting from the benefits user research offers in commercial terms. Walters & Evans (2011) were advocates of such an approach, stating: “...to control the costs of such research, knowledgeable firms can deploy a portfolio of research tools to gain a broad understanding of user needs.” (p.126)

User-centric enquiry has to fit into a design process where the aim is to create commercially viable output and where errors of insufficient user consideration are mitigated cost-effectively. Ultimately a satisfactory compromise must be attained that maximises the insights derived from research based on the resource and resource-investment available. As a commercially sensitive approach, the framework presented has the potential to add value in terms of providing design insights that can enhance commercial success, and, almost as a natural by-product, this also has the effect of improving the overall experience of product interaction for individual users. Ideally, user interaction should be explored early in the development process, so that the usage habits of the user can be used to inform product development, and ensure that the most appropriate designs and solutions are identified at the earliest opportunity.

Overall then, the framework presented has been designed to be equally applicable to scenarios of copious and limited resource, and this approach has shown how User-Centric Design has the potential to not only reduce development risk, but also glean insights that can be used as drivers for future design research and product development.

Future Research

The approach presented was applied to typical product development contracts, often where existing products on the market are perceived to be addressing current user needs. This is not always the case and sometimes more exploratory investigations are needed to define product opportunities. It is the authors opinion that the approach is applicable to new and existing products alike, and that the framework is equally capable of catering for more exploratory activities, and see this as a likely avenue of future research. Future projects might also incorporate different design aims, and benefit from a different research process, perhaps including an even greater participatory dimension.

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