

A new way to design buses: A methodological framework for the front end of design

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Abstract

The bus operation and manufacturing domains of the public transport field are traditionally dominated by quantitative methodologies. The methodologies are used to elicit quantifiable information about the public on a broad scale, helping to create services and vehicle designs. However, this approach often lacks when qualitative insights are needed, such as understanding in-depth user behaviour and experiences, which is necessary if true user-centred services and vehicles are to be designed. Secondly, there is currently a gap within the bus procurement process. Manufacturers and users have no direct contact, making the operators the centre of communication between the two groups. This can lead to less informed vehicle designs and it is suggested that operators need to develop a clearer way to understand and communicate qualitative customer insights to the manufacturers.

This paper proposes a design ethnography (DE) methodology as a solution. Design methods allow user-centred research to be conducted with a focus on product and service redesigns, and even though underdeveloped within this area, they have shown to be successful in other fields. To test the suitability of this methodology, a study was conducted and will be presented. Firstly, DE methods of observations and cultural probes will show how operators can conduct DE fieldwork with a focus on producing design outcomes, and secondly a transitioning stage from data gathered into a product design specification (PDS) which the operators can communicate to the manufacturers to design from. Undertaking these studies found that conducting DE research, compared to other methods, can lead to more holistic, user based research to be discovered, eliciting information that can be designed for. This information could then be easily transferred into a PDS, allowing a way for qualitative data to be designed for and assessed, leading to a more user centric design process.

1.Introduction

Public transport (PT) literature and studies tend to sway towards traditional quantitative focused methodologies. The field has a strong civil engineering background and quantitative methods allow quantifiable and non-subjective data on a mass scale to be understood and used. However, these methods are lacking when true user behaviour understandings are required, for example in service design. Qualitative research methods are suitable at gaining in-depth insights, allowing understandings about travel behaviour and users to be formed (Patton 1990). Understanding this information is key to producing new and improved services, with the shift in approaches being necessary for innovation and ideas such as

mobility as a service to be effective. Design methods are proposed as the next shift with design methodologies currently highlighted as being underdeveloped within the PT field (Roberts et al. 2017). This trend is beginning to change with design thinking principles and co-design workshops becoming more popular within the user focused departments of transport organisations. However, qualitative user-centred design research is still lacking within quantitative dominated areas such as vehicle manufacturing and service operation, which is the focus for this paper.

Understanding users is often created by forming an in-depth knowledge basis as to how individuals use the transport system, this knowledge then gives agencies the opportunity to innovate and improve service quality. This type of thinking is a central theme in design research, with design utilising methods that are suitable for understanding the users, leading to changes and improvements within the services and or the products. This process and thinking is made difficult within the current bus procurement and manufacturing process as there is a disconnection between the users and the manufacturers, with the operators being the centre of communication. This paper therefore offers a design methodological approach centred around design ethnography (DE) as a way to conduct qualitative research within these organisations, helping to expand and supplement the quantitative data that is currently being used. This methodological approach allows a clear way of understanding and communicating customer needs and journey experiences into designed bus solutions, helping to bridge the gaps between users, operators and manufacturers.

As a way to test the suitability of this methodology a study was undertaken by the authors, using DE methods within the Melbourne bus context. The methodology will be reviewed in relation to their suitability in understanding bus users and transitioning the insights into designed solutions. It is hypothesised that this approach will give operators a new way to understand their users and a means to help communicate these findings to the manufacturers.

2. Literature review

2.1 Users, operators and manufacturers

To perform their duties effectively, operators are tasked with vehicle procurement, requiring vehicles that can provide for the Australian standards, governmental contracts and the users. The manufacturers, being the seller in this situation, work hard to fulfil the specified operator's requirements, which can be difficult to achieve based on the nature of the design/manufacturing process. During this process if user requirements are not specified by the operators and communicated effectively they may not be considered. This is due to manufacturers having no direct link to the users, and not knowing exactly what the users want within a bus vehicle, relying on the operators to understand and specify their needs. This process is made more difficult when concerning subjective qualitative information, resulting in manufacturers making educated guesses, which may produce adverse bus design outcomes (Napper 2007). Similarly, Rochefort (1981), Schmitt (2015), and Hutchinson (2009) argue that operator and user perceptions of the service can often be different, playing a role in negative customer experience to the detriment of the system. Therefore, operators need a way to understand and incorporate customer thoughts within their vehicle specifications.

2.2 Design and design ethnography

The goal of design research is the development, articulation and communication of design knowledge (Cross 2007). Due to the versatile nature and lack of definition within the field, design can help respond to complex problems (Buchanan 2001), with methodologies being adaptable to suit certain project requirements. This project's framework has been adapted to suit the problem earlier specified and consists of three main stages; the front end using DE, the analysis and transitioning from data to design using PDS

2.2.1 *Design ethnography (DE)*

DE gives design teams a set of methods and techniques, encouraging the use of field based research to help understand routines and experiences in regards to particular products. This fieldwork creates an empathic understanding of the user to be formed, allowing designers to design from user perspectives (Stickdorn et al. 2011) and to create products that address particular needs (Norman 2013). DE methods allow the researcher to gain empathy and primary experiences regarding the current Melbourne bus users. This research creates knowledge about the service holistically, resulting in understanding underlying service issues and experiences at specific touch points. This type of knowledge when translated gives the designer areas to design for, but also the understanding of what not to redesign, or what to incorporate to create an improved design. Within DE there is currently an unclear translation process from raw data to usable information, often resulting in a heavily described and difficult to understand reports (Jones 2006), product design specifications are therefore proposed as a more succinct way of translating the data.

2.2.2 *Transitioning using Product Design Specification (PDS)*

DE is designed to produce rich qualitative, user-centred, data sets, that are often regarded as being subjective. Subjective information is ideal at developing and highlighting user based problem areas within a service or product. However, it often provides little guidance for designers and engineers during the design stages, whereas quantifiable attributes provide design scope and measurable results. A PDS is a tool that designers use for transitioning qualitative and quantitative data into quantifiable outputs. Acting as a "precise description of what the product has to do", leaving it up to the design teams to develop a suitable design solution (Ulrich & Eppinger 2012, p.92). Transferring subjective qualitative data into a PDS format can be difficult, but is necessary if true user-centred solutions are to be achieved. To do so, Ulrich and Eppinger (2012) suggest that user insights should be discussed in measurable terms, or that measurable proxies can be used for immeasurable topics, for example quality level. If information is important and non-measurable (subjective), it is suggested to specify the need and measure it via usability testing. This is important to note as the majority of the DE data collected falls within this category.

A PDS could potentially be used as a way to bridge the gap between operator's user-centred data to the manufacturers design process. Fitting a PDS to the design ethnography process not only allows a way to transition the information to design, it also allows the researchers the opportunity to analyse the data with design outcomes in mind and to target the outcomes towards both product and service interventions. This is not commonly done, but could create a more connected and holistic design outcome. The next section will go into depth on the specific methods that will be used for data collection and creation of the design outputs.

3. Methods: field research

3.1 Observational fieldwork

Having a DE focus when conducting observations helps to focus the research on specific user and product interactions, helping to track “different contextual data such as work flows, sequences of actions, the physical environment, ergonomic and usability issues as well as interactions between persons and products” (Mattelmaki 2006, p.164). The observations are qualitatively driven looking at how the users interact with the system and vehicle, how the system responds, discovering problems, and creating actionable insights. This is not purely a data collection method but a generative ideation process of discovering actionable insights that can be solved through design interventions and solutions (Lindley et al. 2014).

The observations were conducted by a single observer approach (similar to the Hirsch and Thompson (2011) study). The type of observation conducted was participatory based, focused on observing user experiences and the interactions the users have with the bus and or service. This research also allowed the researcher the opportunity to “go native” (Denscombe 2010) and observe their own bus experiences, allowing a further level of empathy and understanding to be observed as well as inform understandings and preceding research methods (travel diaries). To perform the observations successfully it was important for the researcher to retain “certain detachment”, allowing the researchers to walk a fine line between observing the experience and the passengers (ibid). As a means of doing this, the researcher used systematic based field-notes, in the form of a checklist of particular themes to be observed. The checklist included:

- Generic service information: route, time of day, external and internal factors (e.g. weather), new or regular journey and if any abnormalities occurred.
- Observational themes centred around user interaction and touch points: touching on, driver interactions, sitting compared to standing, catchment zones, what multitasking activity passengers performed and how driving styles affected these to name a few.

The observational fieldwork took place throughout 2017, in which the researcher used the bus as their dominant mode of transport. This allowed an empathic relationship to start to form between the bus and the researcher, turning the researcher into an expert bus user. 40 journeys, including the Monash university intercampus shuttle bus and Melbourne public bus routes, were observed with both generic service information and observational themes being noted down. Small sample sizes for this type of research are suitable, with Hutchinson (2009) suggesting that 25-200 trips may only be necessary before diminishing returns are seen.

The following is an abbreviated example of one of the abnormal bus trips taken:

“Shuttle bus Clayton to Caulfield, 5.15pm-6pm, dark outside. Due to a crash further in the route, the bus had to take a different route. This was done with no acknowledgment by the bus driver and it was observed that the longer the bus went off route the more concerned passengers became, resulting in transit wayfinding on their phones and irritable behaviour (speaking harshly to the bus driver).”

These findings helped to form an understanding and background knowledge of how passengers interact with buses in Melbourne. The themes generated from this study were then turned into a set of questions, making up the basis of a travel diaries study. Observational data is great at understanding how people are using buses, whilst the travel diaries are useful at confirming and asking further questions as to why.

3.2 Cultural probe (travel diaries)

Within user-centred design processes, observations and cultural probes can be classified as complementary techniques. When combined, they help to reveal user experience that can be seen and the aspects that cannot (Mattelmäki 2006). A cultural probe is a design led approach, that uses guided, evocative tasks such as travel diaries to encourage participants to perform self-documentation tasks and elicit “clues about their lives and thoughts” (Mattelmäki 2006, Hanington & Martin 2012, Gaver et al. 2004). This type of research, particularly travel diaries, are “ideal for collecting information from participants across time, sampling their thoughts, feelings, or behaviours at key moments” (Hanington & Martin 2012, p.66). This method, therefore, allows user oriented and observational research to be conducted in the early stages of the design process, helping designers gain contextual understanding and empathy, leading to new design solutions and ideas (Visser et al. 2005).

A small sample size of 14 travel diaries were returned from both regular and irregular buses users within Melbourne, 64% of participants were women, with an average age of 35 years, ranging between 18-66 years. 14 diaries is considered suitable for such a study with Mattelmäki (2006) suggesting that 5-10 participants from the target group is all that is required, due to the deep qualitative nature of travel diary studies.

Qualitative travel diary data gives designers deep insight as to how and why users perform “activities and the environmental factors that come into play” (Norman 2013, p.224). To achieve more in-depth qualitative results, the diaries covered a total span of seven days, and included multiple activities focused on understanding people’s current opinions and interactions with the bus. Evocative tasks were utilised to encourage participants to think and discuss their opinions and observations in a more open, creative and expressive manner, a tool not generally used within the PT field.

The tasks within the travel diaries included two main sections, firstly a daily travel information section, acting as the diary component of the probe, consisting of a set of questions to be filled out daily. This set of questions focuses on keeping track of trip types performed and experiences, thoughts and annoyances had. The second included tasks which changed daily, getting participants to talk about how they perceive the bus and its various attributes, rating experiences, issues and mode comparisons.

4. Analysis, transition and findings

During the data cleaning and transitioning stages useful nuggets of qualitative information which designers use to understand and design with can be lost or not articulated correctly. Similarly, ethnographic information is often translated into an extensive report, that does not endeavour to guide design solutions, making it difficult to translate (Jones 2006). A PDS is suggested as the clearest way to communicate the necessary information across to the designing stage, giving the designer and engineers a tangible list of interactions and experiences to design from and to quantify their outcomes against. This stage allows a succinct way of transferring the data collected to a third-party organisation.

4.1 Analysis

Initially an analysis stage needs to occur. The aim of the analysis is to “pick apart and interpret the data”, finding and relating the information to patterns, theories and frequencies,

resulting in new knowledge and understanding (Sanders & Stappers 2012, p.200). This was achieved by Nvivo coding and categorising of the data into an ordered data set. The DE data showed more holistic findings, highlighting the root causes of the customer issues and needs, whilst providing specific Melbourne information that can be directly designed for. The main discovery was the lack of control passengers felt when entering the mobility system, being one of the main hindrances to service use. Control can be classified as an overarching theme affecting the service holistically through safety, service perception, service wayfinding, layout and information provision.

4.2 Transition

The data was then transitioned into two PDS formats. Firstly, grouping all quantifiable needs into a short succinct PDS consisting of the following (examples shown in italics):

Number: 1, Subject: *layout*, Need: *multiple doors to transfer passenger*, Measure: *flow speed*, Unit: *time*

Secondly the data was transitioned into a longer PDS, including graphics and further details; 2,3) *Catchment areas. Around front wheel hubs. Once passengers start to stand within this catchment section it starts to falsely indicate that there are no seating spaces further on (free seats in the back area are visually harder to recognise).*

The longer PDS is less quantifiable but gives designers an in-depth understanding of all issues and touchpoints that could be redesigned to improve the service, whilst having a background knowledge as to why and how these needs exist. Both PDS' reference one another, giving the designers and engineers the ability to learn more about specific needs.

5. Discussion

This paper proposed that qualitative, user-centred design research should be undertaken alongside traditional transport planning methodologies. Focusing on this problem as a design issue as opposed to being transport centric, helps to inform vehicle and service redesigns through different means and methods. Secondly this paper proposes a DE framework to help undertake user based research and translate the knowledge gained into a PDS, giving bus manufacturers qualitative and user based data to design for. The evaluation of the methodology will be broken down into two stages, firstly the suitability of conducting DE research and secondly the suitability of translating the data.

5.1 Evaluation of conducting user based qualitative research

To improve user experiences and service designs, designers need rich data including holistic experiences of the overall system, an outcome that DE has shown to deliver. This paper, therefore, does suggest using DE methods as a suitable way of conduct user-based research as opposed to using the data generated from operating systems, however if operators possess user based holistic, in-depth data, this can be used in the transitioning stage instead.

5.2 Evaluation of transitioning design ethnography data for designing

Qualitative user-centred data is a key part of information required to design suitable user-centred products. Qualitative data, due to its subjective nature can be difficult to design for and transition into design information, which can lead to it being under represented within the

manufacturing process. Having a successful transitioning stage is an essential part in this framework if the data previously collected is expected to be useful and inform the design.

This research has proposed using both a synthesised PDS, suggesting quantifiable measures, coupled with a longer more detailed PDS, highlighting user opinions within these current scenarios. A PDS provides manufacturers a succinct overview and outputs of a study they were not present for. Operators have the ability to highlight specific sections of the specification, suggesting the main areas of focus and redesign, with the PDS informing the manufactures of user needs rather than actual design solutions.

5.4 Suitability

The main knowledge insights gained by applying a DE methodology and framework, as opposed to other traditional PT methods and frameworks is the creation of rich in-depth data, that can be designed for. Even though more testing needs to occur, this process has shown to develop holistic user based research outcomes, with the ability to analyse the data in a way that can transfer the raw data generated into information that can be designed for. This process can be considered suitable for bridging the gap between the operators, users and the manufacturers, allowing a succinct framework for understanding the users and designing for them. The next stages of research will be the analysis of the DE framework within the backend of design.

6. Conclusion

Currently there is a disconnection between the user, operators and manufacturers resulting in bus designs that are more quantitatively driven. This paper proposes the use of more qualitative user-centred data within the bus manufacturing process, and a DE framework as a way to do so. The DE framework solely looks at the front end of the design process and can be broken down into two distinct sections. Firstly, conducting ethnographic user based research, to understand how passengers are currently using the bus service within Melbourne. This was achieved by using both observational and travel diary methods to discover the complexities of bus users, creating a holistic view of user touch points, needs and issues. Secondly, this data was transitioned into dual PDS, allowing the information to be quantified and background knowledge to be understood and transferred to the manufacturers. This gives the manufacturers qualitative guidelines to design for and test against, helping to bring qualitative data to the forefront of bus manufacture and potentially resulting in more user-centred bus designs.

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