Identifying Human Desires Relative to the Integration of Mobile Devices into Automobiles

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ABSTRACT
With advanced mobile device technology diversifying the role of the automobile, understanding what people desire in automobiles has become crucial to meet people's expectations. In order to better identify their desires, the human-centred design approach was used in conducting this research. 16 participants comprised from a group of professionals ranging from Baby Boomers to Generation Y and 16 participants from a Generation Z group were interviewed using optimised questions based on a combination of five qualitative research frameworks to probe people's expectations, desires, meanings and metaphors about possible automotive contexts. Nine design themes that refer to the most probable desires for automobiles were derived through thematic analysis and comparison between the two interview groups. The influence of the human-centred design approach on the results and the possible application of the results were discussed.

Author Keywords
Automobile; human-centred design; human desires; mobile device; thematic analysis; semi-structured interviews.

ACM Classification Keywords
H.5.2 [Information Interfaces and Presentation]-User Interfaces- *User-centred design, Theory and methods*.

INTRODUCTION
Rapid advances in mobile devices have transformed the role and perspective of automobiles from that of passive transport machines for moving from point A to B to that of "smart objects" [12]. These advances enhance mobility, adding multiple purposes such as communication, entertainment, leisure and business [39]. As a consequence, people's attitudes towards automobile ownership and travel behaviour have changed [38, 39]. As digital devices such as computers and mobile phones deeply pervade every aspect of life [17] and the frequent use these devices while in transit, automobiles are no longer perceived as a remote space in people's lives [14]. This is reflected by the deployment of mobile devices and the wide variety of applications in automobiles. In fact, mobile device integration systems which enable drivers to use apps running on their mobile devices in the automobile are expected to play a fundamental role in offering new experiences in the near future [19]. According to a recent survey [10], 77% of automobile owners with current mobile device integration systems considered apps to be very important.

Regardless of the form of integration between mobile device and automobile, the importance and benefits towards convenience and safety [23] have been highlighted. Little qualitative research however explores what people desire for their future automobiles with regard to using mobile devices. Technological and ergonomic research has largely been dominant [17]. Unfortunately however the technological approach may not fully capture the desires that are related to emotional, psychological and sociological aspects in the automotive context. A human centred design approach is thus useful for identifying and describing people's desires, meanings and metaphors [15, 44].

The study aimed to discover the aspects of mobile device integration and automobiles that might fulfil people's desires. To achieve this aim, the human centred design approach was applied, employing the multilateral semi-structured interviews. First stakeholder model was considered as a logical structure for recruitment of participants. Second the detailed research design is presented. Then data analysis and results are described. Lastly the proposed nine themes of desires are discussed from the perspective of well-noted sociological phenomenon of human needs and values.

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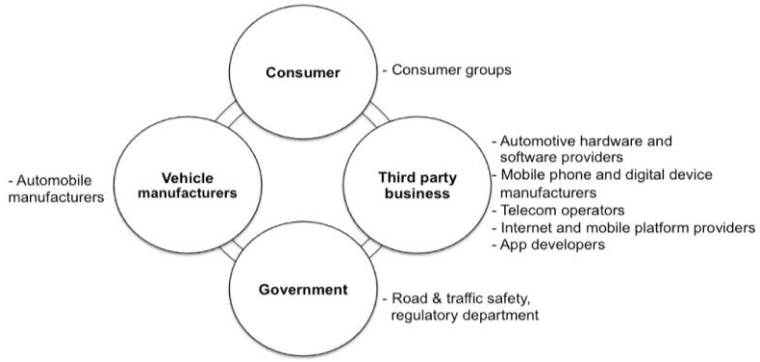

Figure 1. Stakeholder Groups

Stakeholder Model

A stakeholder model for the research was developed to identify stakeholder groups for research participation and to analyse each group's interests according to project objectives or goals [41]. Based on the most common and well-known definition of a stakeholder by Freeman [13], the definition that appeared to be most appropriate for the research was established as being something that "includes persons, groups or institutions with an interest in the project's performance and in the outcome of proposed actions" [32, 40, 41]. In order to achieve a logical structure for recruitment of professionals, the underlying structure of the stakeholder model was adapted from the Connected Car by the Groupe Speciale Mobile Association (GSMA) [20] (see Figure 1).

RESEARCH DESIGN

The research activities were conducted in two phases of interviews in order to gather a wide range of data across different age group (ranging from 10s to 60s) and to obtain meaningful data through a comparison of the results. In the first phase, based on the stakeholder groups, professional group was comprised of "Baby Boomers" born during 1946-1964, people from "Generation X" born between 1965-1977, and "Generation Y" individuals born during 1977-1994 [52]. Subsequently, Generation Z individuals, born after 1995 and defined as "digital natives" [51], were interviewed in order to compare their desires with those of the professional group, and to determine additional, new design themes that fill the gap between generations. Generation Z is the most recent one that has never lived without the Internet and has learnt via high mobile technology whilst experiencing a deluge of information [3, 52].

Purposeful Sampling Strategy

The purposeful sampling strategy, commonly employed in in-depth qualitative research [24, 34] was adopted. To obtain a wide range of insights from interviews in a relatively short period of time [34], the criteria of key informant selection [49] and qualities of key interpreters [50] were selectively applied to identify the characteristics of interview participants in the research.

- Willingness to share their knowledge
- Knowledge
- Seductive power to influence the emergence of new meanings
- Forward-looking and pioneering projects
- Hybridising the small local and big global companies

Following the criteria, 16 professionals were recruited as participants via social and professional networks. Six participants from automobile manufacturers, six participants from third party businesses, two participants from consumer groups and two participants from government organisations were recruited. In particular, they were recruited according to their level of seniority and domain. It helped to balance views of opinions by the degree of experience with different backgrounds and age (see Table 1).

Manager	Senior Manager	Head	Director
1 Marketing 2 Engineering & Design 1 Regulatory	2 Marketing 3 Engineering & Design	1 Marketing 2 Engineering & Design 1 Regulatory	1 Marketing 1 Engineering & Design 1 Regulatory

Table 1. 16 Participants in Professional Group

(Baby Boomers, Generation X and Y)

In the second phase, 16 Generation Z individuals were recruited as interview participants with the consent of their parents. Unlike interview participants in the professional group, they were randomly recruited by considering their age and gender and willingness to participate in the research (see Table 2). No payment was offered.

Secondary School Students (Born in 1996~2000)	Sixth Form Students (Born in 1995)
8 Female, 5 Male	1 Female, 2 Male

Table 2. 16 Participants in Generation Z Group

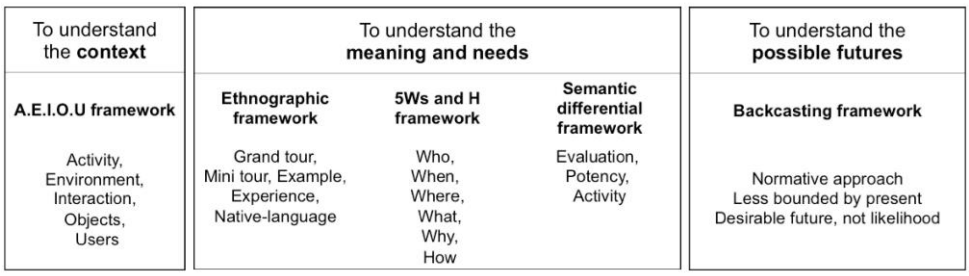

Figure 2. Criteria for Designing Interview Questions [35, 42, 46, 48]

Designing Interview Questions

To include questions encompassing a situation or context, the A.E.I.O.U framework (see Figure 2) was first applied when designing the format of the questions. Following this framework, the considerations were the elements of what people wanted to achieve, how they would use mobile devices in given future circumstances, how they would interact and communicate with other people and objects, what would be the things that they want to have or not to have [35]. In order to collect rich narratives and to interpret meanings appropriately, five types of descriptive ethnographic interview framework were applied [48]. These questions opened up unlimited possibilities to express more specific aspects of the events and to elicit more specific and differentiated desires from the interview participants. Further, a semantic differential framework, which is used to measure meaning [42] and the 5Ws and H framework were adopted to balance the composition of meaning in questions.

In particular, questions deploying a backcasting framework were designed to encourage interview participants to envision possible futures [46] regarding the integration of non-existing technology and automobiles. To uncover future views and requirements of technological innovations and future scenarios [11, 27], a trigger question was used allowing interview participants to become more immersed into situations from the near future to the far future. (e.g. *"Imagining that you are in the year 2030, how might you wish communicate with other people from within your car ?")*

Interview Procedure

All participants (n=32) were interviewed using the same semi-structured interview questions via phone or video call at the time and date agreed in advance so as to maximise the openness and to obtain unlimited opinions. A target interview time of approximately 45 minutes was chosen so as to minimize the bias that can occur due to learning or fatigue effects. Research and ethical approval had been granted prior to the study and informed consent to record the interviews was obtained.

DATA ANALYSIS

The aim of the analysis was to organise interview data into design themes of what people desire for automotive digital systems. Interview data was analysed using thematic analysis [5, 7, 9]. As many people's desires are not generally immediately apparent in interview data [43], thematic analysis method was employed to identify implicit ideas beyond explicit words or phrases and to categorise themes and issues addressed in the interviews. The actual analysis was conducted in accordance with well-described thematic analysis guidelines [7] and subject to a validity process [9]. In order to reduce bias and subjectivity [9, 48], three other researchers who are familiar with coding and theme generation were chosen as multiple reviewers. These coders were drawn from design (female aged 20s), business (male aged 30s) and engineering (male aged 30s), as people with different backgrounds and ages are helpful to obtain a range of viewpoints [2].

Thematic Analysis Procedure

1. Audio recordings of the interviews were transcribed in full and transcriptions were re-read after cross-checking to ensure accurate representation of the recordings.
2. The words, phrases, sentences and paragraphs were deductively analysed in accordance with research aim and coded from the transcriptions. They were given a distinctive colour in the transcriptions.
3. Coded words were again collated at a higher semantic level and were interpreted as intermediate themes beyond explicit words. Transcriptions were read again to search for other themes that were missed, and themes were identified when recurring in the data.
4. For bias reduction, three multiple reviewers independently generated their own coded data and intermediate themes from excerpts provided. Subsequently, they followed the comparison and matching their own themes with the themes provided. Some of the themes were discussed for consensus and reworded where few discrepancies emerged.
5. After reviewing process, the themes were regrouped, defined and named as final themes.

RESULTS

The first six themes were frequently and commonly indicated by both the professional and Generation Z groups, and the last three themes distinctively showed the difference between two interview groups (see Figure 3).

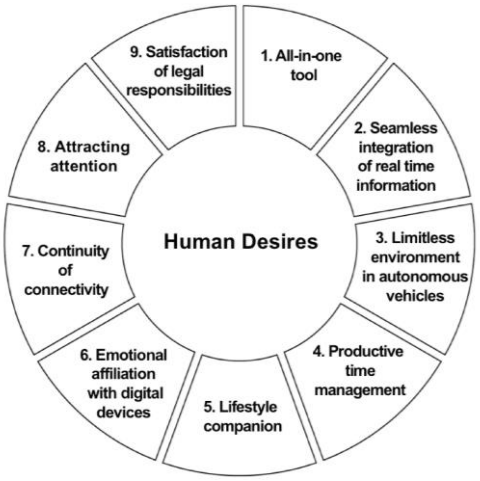

Figure 3. The Nine Themes of Human Desires in Integration of Mobile Devices into Automobiles

All-in-One Tool

The dominant concept was that integrating mobile devices and automobiles was perceived as a 'tool' with multi-functionality that allows easy and simple access to the individually desired functions. Among numerous activities that mobile devices support in everyday life, the need for multi-functional utilities appeared frequently when interview participants stayed in automobiles.

Typical function in current usage of mobile devices such as searching for destinations, directions and locations based on GPS, as well as entertainment systems including music players, games, videos, the Internet and social media, were still highly prioritised when considering the integration of mobile devices and automobiles.

…Listening to music, or read feeds on Facebook, Twitter… Professional

Through GPS, I could find out the location or directions. Generation Z

When contacting people or reaching certain information, the voice control utility was shown as a potential tool to enhance the driver's freedom in terms of in-car communication.

You can almost do anything by voice control or from controlling the phone…Professional

Based on these unsurprising multi-functionalities, however, was the need for a unifying feature that collects all the customised individual functions in one tool, which was identified as being important during the interviews. This suggested that an increasing number of multi-functions may not be an ideal way to integrate mobile devices and automobiles.

Like a Swiss army knife. […] I guess it is almost like a brain to people. Professional

Seamless Integration of Real-Time Information

Most interview participants imagined a daily future context in which they engaged in continuous activity through the integration of mobile devices and automobiles that would allow for seamless connectivity. Both interview groups highlighted that staying at the same level of connectivity regardless of the place or the device would be crucial in their future lives.

…when you get in the car, you can just continue reading that book […], car remembers the last chapter you were reading. Professional

In particular, the hybrid of real time information, including route finding, traffic, location-based reminder, fuel, travel, health status and tailored provision with personalised content were significant elements to boost the seamlessly connected experience.

If you are travelling with other people in a different car, […], the phone can detect where your friend's car is, so can tract back where they are and go to that place. Generation Z

As reflected in the current reliance on mobile devices inside automobiles, desires related to the automobile itself such as automobile security alerts, driving instructions and automobile maintenance alerts were mentioned frequently.

…the vehicle could have some sort of notification capability in case someone tries to get into it, start it or take it. Professional

This seamless experience implies that all information would automatically be synced and transmitted across the user's devices, which would make the user's life more convenient.

You just shouldn't touch your phone when you get into a car. It has to be absolutely synced. Professional

Limitless Environment in Autonomous Vehicles

Autonomous vehicles were referred to as one of the major phenomena that would create multi-purpose environments in which people could do whatever they want without restrictions.

One can be free to socialise and communicate. I can do whatever I do at home in my car as a personal space. […] It will bring about a rearrangement of the interior of the car. Generation Z

In accordance with numerous mentions, the limitless environment could give rise to endless possibilities for new avenues of communication that drivers would have the same freedom as passengers. This benefit may become a reality from an autonomous vehicle including flexibly designed vehicles with a living room, an office, or aircraft.

Work, watch films, sleep, work emails, or have meetings […] The driver becomes the passenger. Professional

The integration of voice and gesture communication technology, transparent windshields, holograms and the

use of Wi-Fi in automobiles commonly appeared as desirable technologies to further expand the limitless environment.

I can play 3D videos on the transparent windshield […] My car will be a theatre. Professional

Productive Time Management

Managing time productively within the automobile and while in transit was one of the required characteristics mentioned by both interview participants groups. Time saving was often exemplified in the description of benefit from getting information via remotely checking any status of automobile and managing schedules via real time journey calculation system.

…Things, which control its environment where you don't need to, go in person to go to certain places to double check if that is okay. Professional

Interview participants from both groups expected that integrating mobile devices and automobiles could enhance their productivity, regardless of the form of the integration. This theme implied that the intention to use mobile devices in automobiles aimed at the productive and effective use of time.

Rather than time-wasting by doing other things, I usually check over what I need to do in the day. Generation Z

Lifestyle Companion

Enthusiasm was expressed for an intelligent lifestyle companion that holistically manages both professional and social activities and relationships. It was a common theme for both interview groups, who both craved greater convenience in their lives.

Beverage in the morning […] Check for mails, juice, check for everything…it's endless. Professional

In addition to the typical role of a personal assistant, including managing schedules, participants expressed the need for an intelligent companion that is able to provide social tips in accordance with different cultures, and to read the other person's emotional status to improve personal relationships.

I would connect to apps on my child's phone to see if she is okay, I would want to know how she's feeling. Professional

Emotional Affiliation with Digital Devices

As mobile devices are perceived largely as tools, having an emotional aspect to them was paradoxically evident in the interviews. The professional group expressed an emotional engagement by associations with specific brands that they felt were part of their identity. The belief that brands can represent status appeared to contribute to an emotional affiliation with digital devices.

I currently don't have Land Rover anymore, it died. It was emotional painful. When you buy into the brands or buy their lifestyles… Professional

The Generation Z group frequently described their emotional engagement with the integration of mobile devices and automobiles as an essential bridge creating memories and to having a human-like relationship as one has with family and friends.

I think it is like a sibling in a sense that you see it every day. You do have an emotional connection with it […]. Without it, it's like losing a limb. Generation Z

Overall, this theme encompasses that the incorporation of symbolic identification through brands and the human-like characteristics of mobile devices would help to build interdependency between mobile devices in automobiles and people.

Continuity of Connectivity

Connectivity was a pivotal point of the integration of mobile devices and automobiles. This theme, however, revealed that the interview groups had quite obvious differences in terms of connectivity and disconnectivity. Disconnection from mobile devices always resulted in anxiousness, feeling disadvantaged, and discomfort caused by the restriction on communication, regardless of time and place, in both groups.

I would just feel kind of naked. It is something so important, I would feel big emptiness. Generation Z

Meanwhile, there were distinct mentions regarding the pursuit of intermittent disconnection in the professional group. Being disconnected from the network society was seen as beneficial in order to relax and pay attention to the physical situation and moment.

You are able to more easily focus on what's happening right now. Professional

Attracting Attention

This theme only appeared in the Generation Z group. A tendency to draw attention to the exclusiveness of their personal experiences connoted unique aspects for Generation Z.

I think buying attractive thing with new technology is to show off them in a way. Generation Z

Attracting Attention was also described as a sense of competition with others, and of sharing this with peers.

If they drive fast then they would like to post it on Facebook or Twitter, […] it could be competitive to go faster when you have additional feature for speed. Generation Z

Elements such as the exclusive experience, appearance, and power performance of the automobile were indicated to attract the targeted younger generation when designing better mobile devices integration into automobiles.

Satisfaction of Legal Responsibilities

The actions of the professionals were determined by their legal obligations and were justified by social responses surrounding the use of mobile devices whilst driving. This

theme only appeared in the professional group, and was defined as their legal responsibility. Although a few interview participants were aware that using mobile devices in driving situations was a serious distraction and very risky, they showed a tendency to justify the use of mobile devices while driving in unavoidable situations.

Have a look very quickly. I try to minimise the distraction. Professional

There's always a sense of urgency when there is an incoming call. Professional

From these quotes, the implication is that drivers need to be free from a sense of guilt when using mobile devices in a driving context, and this should be considered when integrating mobile devices and automobiles.

DISCUSSION

Influence of the Human Centred Design

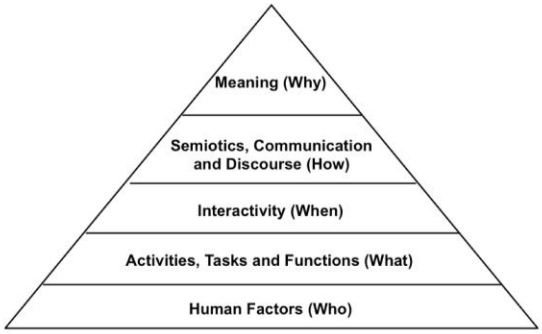

Figure 4. The Human Centred Design Pyramid [16]

As summarised in the hierarchy of the human-centred design pyramid [16] (see Figure 4), the essence of human centred design is in capturing the inherent meaning attributed by people beyond the physical actions and interactions with products, and between systems and services through a series of questions and answers [16]. In order to ultimately uncover meanings, this research was guided by, and designed according to, the human centred design principle; starting with the lower levels of the values in the pyramid [16] into a person's life related to the integration of mobile devices and automobiles.

Under the influence of human centred design, the proposed nine themes can be grouped into three categories of human desires: functional efficiency, emotional relationships and social values. This categorisation implies similar requirements to the well-noted sociological phenomenon of human needs and values [6, 36, 37, 47].

The first four themes (i.e., 1 to 4) appear to reflect human desires for the functional efficiency coupled with advanced technical support. As observed from the interviews, the technical demands for the multi-functionality and user expectations of *seamless integration of real time information* and *autonomous vehicles* have been increasing across industries to meet people's needs [28]. A seamless environment can assist drivers and passengers in planning their activities, enabling them to make a decision or change their schedules well in advance [25]. The first four themes thus appear to be expressions of the requirement for convenience and time efficiency while travelling [33].

The subsequent three themes (i.e., 5 to 7) appear to be expressions of people's desires for emotional relationships with machines. As people tend to treat machines such as computers in the same way they behave towards human being [45], people prefer to have a spiritual dimension [37, 47], even with machines [53], which ideally expected to play a role of beyond a functional helper. In terms of a sophisticated humanoid companion [8, 53], people desire that machines should care about human emotions, which may help to remove 'loneliness' and provide 'care' [30, 31, 53]. They seem to confirm the basic needs for love, belonging, affection and relationships, as described by the third level of Maslow's hierarchy [36].

The remaining two themes appear to reflect social satisfaction between driver and automobile. As people view themselves and their behaviour within a social context [18], drivers therefore monitor whether their behaviour obeys social rules and laws or attracts attention from others [26], which relates to satisfaction from ethics or moral obligations or duties [4]. Furthermore, the two themes appear to be a manifestation of self-esteem and responsibility as defined by Maslow's hierarchy [36], as well as the normative and comparative needs described by Bradshaw's classic social needs model [6].

The nine themes can ultimately serve as a design checklist. While previous automotive studies inherently focus on functional aspects of improved effectiveness, safety, and ease of performance [29], these nine themes outline complex human internal desires, which involve emotional and social aspects. Thus, it can be used to integrate design guidelines for the development of automotive products or service platforms. Furthermore, each major theme could be a focal point for a specific design concept. Technical specifications can be developed from the codes, and usability testing could be achieved by means of prototypes or para-functional simulators, in order to validate the concepts.

CONCLUSION AND FUTURE WORK

The in-depth interviews using human centred design approach was employed to discover the desires associated with the integration of mobile devices and automobiles.

32 participants from a professional stakeholder group and a Generation Z group were interviewed in order to propose nine themes that should be taken into consideration when designing the integration of mobile devices and automobiles. These are the *All-in-one tool*, *Seamless integration of real time information*, *Limitless*

environment in autonomous vehicles, Productive time management, Lifestyle companion, Emotional affiliation with digital devices, Continuity of connectivity, Attracting attention and Satisfaction of legal responsibilities. The research has identified nine key characteristics which people wish to see achieved by automotive digital systems, and which might be presumed to be beneficial in any future digital systems. Detailing activities are required to apply the findings to practical applications by developing specific design concepts and design specification based on each theme.

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