

# Designing *with* older car drivers: seeking out aspirations and needs

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## ABSTRACT

Older adults are increasingly being recognised as an important and growing consumer market, however they appear reticent in adopting new technologies. One factor contributing to this is that their needs are poorly understood and products are thus poorly specified. Within the context of driving as a socially valuable skilled behaviour we applied a participatory design approach to engage with older people as valued design partners.

This paper examines different strategies for involving older people as experts in their own domain, developing a better understanding of their needs and aspirations and empowering them within the design process. This research took account of new developments in car design and opportunities for intelligent driver assistance systems to support driver safety. The findings indicate that older car drivers responded well to the opportunity to identify their needs and to evaluate prototypes and novel technologies. The use of novel technologies particularly supported improved understanding of skilled behaviours and mismatches with the technology. These evaluative activities when framed as part of the early stages of the design process offer important opportunities to enhance understanding of latent and implicit needs of older adults which can inform and refine design requirements.

## KEYWORDS

ageing well participatory design digital inclusion usability

## INTRODUCTION

Many studies of ageing have responded to changing demographics that show rapid growth in the numbers and proportions of older people in the UK, for example:

“The population of the UK is ageing. Over the last 25 years the percentage of the population aged 65 and over increased from 15 per cent in 1983 to 16 per cent in 2008, an increase of 1.5 million people in this age group. By 2033, 23 per cent of the population will be aged 65 (ONS 2009)

Typically, studies of ageing in relation to design and use of technology have focussed on the impact of physiological, sensory and cognitive changes of ageing. These have led to the development of design guidelines and recommendations to compensate for these functional changes (Fisk et al 2004). These studies which analyse the incidence of failing eyesight, hearing and cognition implicitly define a view of ageing that represents a negative view of loss and a medical model of age related decline. Studies of older car drivers have also shown concern for the adverse effects of ageing on driving performance and safety, and the increasing numbers of older car drivers. In an extensive review of the literature on the older driver (Hakamies-Blomqvist et al 2004) identified a changing focus from the physical, sensory and cognitive issues of declining capacity and associated increased risk of accidents to a more social focus on the broader issues of mobility, strategies for maintaining mobility and changes to transport planning. This strand of research has taken account of the benefits of continuing

to drive in order to support social interaction with others and continuing independence, and has investigated technological solutions to support older drivers.

For example, the EDDIT (Elderly and disabled drivers information telematics) project evaluated the acceptability of a variety of devices including collision avoidance, route guidance, emergency alerts and reversing aids during the mid 1990's finding that these were of interest to older drivers. This has led to the suggestion that advanced technology devices have the potential to give a disproportionately greater benefit to an increasingly ageing population (Meyer and Coughlin, 2001).

Holland (2001) comments on the potential of these advanced car technologies to benefit or hinder older drivers: "Various European programmes in particular have examined the potential impact of new in-car information technologies (known as Road Transport Informatics (RTIs) or Advanced Transport Telematics (ATTs) on older drivers, with particular regard to the question of whether they do actually help or hinder driving capabilities and their potential effect on safety."

The current generation of new cars are rapidly moving towards digital display interfaces which add innovative features - performance data on hybrid electronic cars, satellite navigation systems, environmental controls, communications and entertainment systems all with computer interface style touch screen displays and complex menu structures to access control options. As these new functionalities become part of the normal specification of new cars the question of help or hindrance remains, and there is a strong risk of alienating older people as familiar artefacts disappear and are replaced by unfamiliar and novel devices.

In 2007, the proportion of older driving license holders over the age of 70 had increased to 52% of (DfT 2008). However in a measurement of computer use by those over 65 only 30% reported using the internet in the previous three months (ONS 2009). Computer usage by older people is changing rapidly but these latest figures suggest that older people continue to have a low level of familiarity with computer style interactions.

Gregor et al (2002) argued that older people are more likely to value new technologies that meet their real needs and that researchers need to actively seek out diversity of those needs and abilities. Early participation in the design process is particularly important in meeting the real needs of older people, providing an understanding of the context of use and functional requirements. Eisma et al (2004) explored a number of techniques and approaches to facilitating early involvement of older people in the design, and the need to adapt and modify traditional methods of requirements elicitation such as questionnaires and focus groups, and use of prototypes.

In our study, we wanted to facilitate older people to identify the issues that they have in a significant activity - driving - to take account of diversity of driving experiences and to explore the potential opportunities and barriers of in-car driving assistance systems. In particular we wanted to explore methodologies which emphasised the role of the user as a design partner - designed *with* the user rather than *for* the user. One group of methods that particularly stress the importance of the users role in the early design process is Participatory Design. It is an approach that was founded in the workplace with organised groups of labour but has since been adapted for use in other contexts.

Our research question addressed both the characterisation and refinement of user needs, their aspirations in relation to driving and the context of the driving activity. We identified three explicit methodological challenges to applying a Participatory Design approach with older drivers in the design of driver assistance systems:

- How to define a sample of older car drivers that represents their diversity of experience
- How best to engage with older drivers as partners in the design process?

- How to enrich our understanding of older people' needs and aspirations in relation to the design requirements for desirable functionality and technologies

## **PARTICIPATORY DESIGN**

Participatory Design (Namioka and Rao 1996) is an approach to design which is characterised by a concern for improving the relationship between those involved in the design process. It was founded on a political framework of democracy and was initially applied to the introduction of new technology in the work place in Scandinavia. Key principles are that the designer's role becomes one of facilitator and the user role is elevated to that of expert within their own domain and that technology should be applied to enhancing existing skills.

Over time Participatory Design has become:

“ a set of theories, practices, and studies related to end users as full participants in activities leading to software and hardware computer products and computer-based activities” (Muller 2002).

The Participatory Design approach originated within the workplace and organisations and Muller (2002) identified this as a key concern in trying to apply this approaches to non-work, non-organised labour, where the users are not necessarily beneficiaries of the design innovation. The first documented use of participatory design with older adults was to make improvements to an online information system (Ellis and Kurniawan 2000). Working with only a small user group they worked iteratively with prototypes to refine requirements and develop guidelines supplemented by a literature search. The results gave rise to improvements in the interface design. The keys to success in this project were to create an environment where the users felt empowered to express their opinions, likes and dislikes in particular they defines three rules to working with older people as design partners:

- “ (a) invest in the relationship to develop trust,
- (b) communicate the importance and relevance of the project to the participants
- (c) engender a culture of partnership and mutual respect.”

There are many tools and techniques that have been developed by researchers to support the principles of Participatory Design with a particular emphasis given to observation and interviewing of end-users in context or the natural environment. However Participatory Design practitioners have recognised the difficulties of relating to novel contexts and have developed many strategies to help elicit shared understanding between the users and developers including low fidelity prototypes, drama, games, story telling, play acting and video.

The two case studies describe different approaches to sharing information and enhancing communication between the research team and the older car drivers. The first Case Study made use of low fidelity prototypes which evolved through a series of iterations, by way of contrast the second case study gave the older people the chance to evaluate two commercially available systems to assist in reverse parking.

## **CASE STUDY 1: LOW FIDELITY PROTOTYPES**

This Case Study consisted of four phases that supported the engagement and participation of the older car drivers, over a period of eighteen months through a series of increasingly sophisticated prototypes. The study began with a survey to support the development of a user panel that represented some of the diversity of experiences of the older driver.

## Methodology

The initial survey set out to build a large user panel in order to characterise the older car drivers and to enable us to select smaller, but representative samples to take part in the focus groups and individual sessions.

The survey tool included questions on driving experience, car buying practices and health as well as open questions on likes and dislikes of driving. It was distributed to car drivers over the age of 50 by making direct contact with the organisers of local social clubs and organisations. Further contacts were made to other locations thus extending the group from the suburbs of North London and the Home counties to include the more urban and semi-rural settings between Nottingham and Lincoln.

The participants in the focus groups and individual sessions were chosen from those in the North London area, and balanced to give a spread of age and gender. The seven focus groups had between 2 and four participants ranging in age from their 50s to 80s. The initial concept developments for the speed monitoring study passed through three stages of increasingly sophisticated visualisation, and each of the three trial activities were undertaken by one participant as a pilot trial and a further three to six individual trials.

## Characterisation of older car drivers

The self-completed questionnaire was returned by over 200 drivers over the age of 50. Careful analysis of the data gathered from the questionnaire revealed the importance of car driving to maintaining social contacts and activities of everyday living as well as identifying diversity including high and low frequency driving, high and low frequency use of other technologies by which to characterise these drivers. (Keith et al 2007).

## Identification Of Design Opportunities

A series of seven small focus groups was held with small groups of older drivers who were aged between 50 and 80. The general discussions of driving experiences in the initial sessions revealed a lack of knowledge of the latest technological developments. Subsequent focus groups were supplemented with a video material which demonstrated the results of research in driver assistance systems. These provided a stimulus for further discussion about the usefulness and appropriateness of these systems. Detailed analysis of these discussions revealed additional frustrations and anxieties when driving and enabled us to identify a number of opportunities for design innovation.

Two issues raised by the drivers which were identified by the design team as design opportunities were related to parking (see Case Study 2) and speeding. Both in the questionnaires and the focus groups a number of the drivers expressed concern and anxiety over unintentional speeding, the extensive use of speed safety cameras, high risk of incurring fines and potential loss of their driving licence:

“Motoring used to be a pleasure...but now the pleasure has gone out of it because of the roads, speed cameras and volume of traffic” (Male, 60-69)

“I would be mortified if I got points on my licence” (Female, 70-79)

Some drivers made a point of driving more slowly:

“I haven’t been caught by any speed cameras in recent years because I am lucky that I am now retired and can drive when I want to and don’t need to hurry” (Male, 60-69)

One driver reported being caught twice by cameras twice in the same day – on the outward and return journey using an unfamiliar route, thus incurring two sets of points on his licence.

## Design Concept Development

The first issue to be investigated related to speeding and speed monitoring. The initial design activity included a review of previous related research and design solutions, which was found to include a trial of a fully automated control systems which would restrict the driver from speeding. This solution was rejected because it did not meet the basic principles of participatory design to enhancing existing skills and maintain autonomy. The initial concepts focussed on enhancing information to the driver using auditory, tactile or visual feedback, and using the potential of global satellite positioning and a European mapping project to track the speed, location and current speed restrictions.

## Repeated Concept Iteration

The initial concepts passed through three stages of increasingly sophisticated visualisation and evaluation. The participants were selected to represent a spread of age and driving experiences and balanced for gender. All interactions were video recorded for subsequent analysis

- Static review of visual display and haptic warning – each participant was invited to view a simple animated representation of a car speedometer with four different enhancements to show current speed limit and relationship to the current speed of the vehicle. They also took part in a demonstration of two types of haptic feedback through the accelerator pedal to warn the driver that they were speeding. The participants were invited to chose which configurations were preferred and to discuss why.
- Dynamic presentation of visual display - using the initial comments from the static test, four of the visual display concepts were refined and animated as dynamic displays to show changing speeds and different configurations of information and warning states. Each participant was able to watch how th display changed in response to different speed limits and different conditions of excessive speeding. The demonstration was support by one of the researchers reading a short scripted story about the driving activity. The participants were asked to compare different elements of the displays and to justify their overall preferences or dislikes.
- Interactive games presentation – the four displays were further refined and integrated into the software for an interactive driving game which acted as a low-cost simulator. The display for the speedometer and enhanced warning states was installed into the dashboard of a static car, and the race track was displayed on a screen in front of the car. The participant was able to sit in the car, operate the steering, brakes and accelerator and monitor their speed while ‘driving’ round a track. This simulation enable them to be interactive, and to see how the speed warnings changed in response to their actions and the speed limits that were added to the racing game. Each driver was allowed to have a number of practice sessions to get used to how the game car handled, and once confident was able to try out the four variants of the speed warning system presented in a randomised order.

## Findings for Case Study 1

Each of the evaluative activities provided an opportunity for the participants to comment on the design and for these comments to be acted on in subsequent design iterations. Preparation for the next round of evaluations also facilitated the design team in discussion different options and configurations and how best to engage with the participants. Each of the sessions provided an opportunity for focussed discussions with the participants about driving practices, attitudes to speeding and to changing technologies.

## CASE STUDY 2: PRODUCT EVALUATION AS ELICITATION OF SKILL

In the earlier phase of Case Study 1, the theme of parking had also emerged as an issue. Initial reviews of technology identified a number of innovative products beginning to emerge from the motor industry including reverse parking sensors with audio warning, rear facing camera with a dashboard mounted viewing screen and a fully automated reverse parking system. These relatively novel technologies enabled us to explore the issues of reverse parking and the use of these novel technologies as experienced by older people.

### Methodology

The participants in this study of parking were selected according to a number of criteria, including those with older cars who were less familiar with novel in car technologies, high and low mileage, age and gender. Eight older car drivers took part, the first of these acted as a pilot study for the subsequent activities. Three participants were female, five (including the pilot) were male, and were selected to represent people in different age groups from 50s, 60s, 70s and 80s. The overall plan of this study was an evaluation exercise which explored the context of reverse parking activities. The various tasks were intended to build confidence and to facilitate communication between the participant and researcher while evaluating the novel technology. Each participant took part in all four phases of exploring the context of the driving activity and evaluating the test cars. The participants were offered the opportunity to attend two different sessions in order to limit session duration to approximately two hours.

The laboratory location was video recorded, while for the external sessions a video camera recorded the movement of the car and an audio recording was made of the discussions inside the car.

### Identification of research opportunity

The earlier focus groups had revealed a number of problems with the everyday task of reverse parking, some due to the inherent challenges of this task:

“I need lots of space, find it difficult to judge space to the curb” (Female, 60-69)

“Reverse parking is the most hairy thing about driving – I find it difficult to judge where I am”. (Female, 60-69)

And age related changes:

“I’m not as good at parking as when I was younger, is more difficult to judge smaller spaces” (Female, 50-59)

“As you get older you can’t turn round, your shoulders stiffen up.” (Female, 70-79)

Parking affects every journey and support for reverse parking has begun to become commonplace with new cars – reverse parking sensors, cameras and more recently self-parking systems. The focus group discussions revealed a lack of awareness, or personal experience of these latest technologies. This suggested that there was an opportunity to provide the older drivers with a realistic experience while evaluating these technologies and to explore how far they met their stated needs.

## Supporting Discussions With Static Props

The preliminary session held within our research laboratories and made use of toy cars and pre-printed road layouts as static props to assist in descriptions of recent journeys and parking activities at home and at the distant end of the journey. Spare paper and pens were provided to draw out alternative local parking schemes.

## Familiar Contexts

The second session was held in the familiar context of the drivers' own car. The participants were invited to park in a quiet corner of the university car park and to talk through their parking strategies and any difficulties. The parking activities were limited to examples of bay parking as typically provided in supermarket car parks and parallel parking typical of on-street parking.

## Familiar Patterns In A New Context

In the third session the participants were introduced to one of two new cars and was a familiarisation activity. All participants were asked to perform the same reverse parking activities as before but in the new car. Seven of the drivers used a car that was automatic with a hybrid engine. As a result the car had some unfamiliar characteristics - the handbrake was replaced with what was described as an emergency foot pedal, and the car was silent when running in the electronic mode. One driver used a different car which offered a more complex in-car interface which accessed many new features.

## Introducing Novel Technologies

In the final session the participants evaluated the new technologies to support the familiar reverse parking tasks. Both cars offered a display from a rear facing camera with additional on-screen graphics to support lining the car up. The hybrid car additionally had an automatic self parking system. The other car additionally offered front and rear audio proximity alerts. These technologies were novel to the participants, and the researcher briefly described the functionality. The participants were encouraged to work out the best strategies for using them, and discuss uncertainties and problems as they arose.

## Findings for Case Study 2

This series of activities revealed the complexities of the everyday parking task and strategies adopted to simplify the task. These acted as criteria for evaluating the parking assistance systems. The participants reported on many changes in the years that they had been driving, for example:

- Parking was not part of the driving test when they learned to drive
- It was easier to find somewhere to park because there were less cars on the street
- Early cars did not have wing mirrors
- Early cars did not have power steering

The participants also reported on their strategies for making the task easier:

- One person admitted bump the kerb deliberately to find where it was, but another tried to avoid this in order to protect the alloy wheels
- One person reported adjusting their electric mirrors in order to see kerb
- One person reported driving into car park spaces forward in order to get out of the way of other people but another reported reversing in because that gave better control – quicker, reverse out very slowly and stop to get better line of sight.

The participants all appreciated the reverse camera view on the new cars which enhanced the view behind but found the automated parking system was too slow and too limited. The participant found that the car had to be in the optimum position for the system to detect the space, otherwise the on-screen representation had to be adjusted manually or the driver had to reposition the car. As a consequence several minutes elapsed trying to get the car correctly positioned and to avoid errors of hitting the kerb or the barriers we used to represent adjacent cars. This made the activity much slower than when the participants performed the task manually:

“... in the real world you just do not have that much time to muck about getting the thing right. If that’s how long it would take me to set it up I wouldn’t use it. I would just park myself, using the camera of course. (Male, 60-69)

Another person also preferred to remain in control of the activity, and did not want to pass responsibility to the automatic system:

“ So ultimately the responsibility is mine and I’m not sure that I want to give it up to ... I mean it’s like having somebody else taking the steering wheel and you’re at the wheel, no thank you. I wouldn’t want to do it. So I think there is almost a moral issue (Female, 60-69).

## DISCUSSION

In both case studies the use of artifacts – either as prototypes or commercially available driver assistance systems effectively helped to bridge discussion between the participants and the research team.

### Grounding discussion in the real world context

Within the design of the study we chose to create safe opportunities to observe experience and gather data by finding ways to represent real world experiences. In both case studies, discussions were grounded in a real context in which the older drivers were highly skilled. In some cases they had been driving for over 40 years and had seen many changes in design of cars, road layouts and traffic density. In the first study we amplified the static and dynamic display with stories which helped to establish realistic settings for the discussions. In the second case study, our older drivers were able to describe a variety of complex parking scenarios encountered on a day to day basis – difficult access to driveways at their homes with hazards that included trees and parked vans that obstructed views, small children running to a nearby school, busy traffic and impatient drivers.

### Problems with low fidelity prototypes

In Case Study 1, the participants initially demonstrated difficulties in evaluating the proposed concepts within the static lab setting which was felt to be too far removed from the dynamic interaction of driving. All subsequent design development activity was directed towards creating increasingly greater realism and providing alternative concepts to support comparative assessments of the design details. Each review phase provided the design team with an opportunity to learn more about the driving context and changing experiences of the older driver and to refine small details of the design implementation.

### Grounding end user work practices in familiar tasks

The parking study enabled us to study the real-world task in a controlled environment. The drivers showed considerable skill doing simple parking tasks into a bay or parallel to the footpath with their own car and the new car. The drivers were self-critical about how neatly they had parked in the space, whether they were centred in the bay or sufficiently close to the curb. They adapted quickly to the



new cars once the more obvious difficulties were resolved such where was the reverse gear for this car located.

## Understanding how technologies support existing skills

The drivers made use of all possible sources of visual information while reversing – rear view and side mirrors and looking over their shoulders in order to control and position the car in the parking space. The dashboard mounted display from the rear facing camera enhanced this skill by improving rear visibility. Reading the 3D image seemed to cause some difficulty and one driver described how she initially wanted to believe that the point nearest to the car was at the top of the screen and not the bottom. The benefits of some of the directional guidelines superimposed on the display remained a mystery to most of the drivers. The increasingly common feature of an audio proximity alert was not available on the hybrid car which used an audio alert at all times to indicate that reverse gear was selected. The other car offered front and rear proximity alerts that were found useful when manoeuvring in a small space.

## Understanding constraints and limitations

Success with the automatic self-parking system varied – one driver got it right first time but had difficulty repeating this success in subsequent attempts, and one driver struggled through most of the allotted hour to line the car up successfully. Over several sessions it was discovered that the car self-parked successfully only when certain preconditions were met which included lining the car up within a narrow zone of tolerance. The permanent reversing audio alert on the hybrid car was distracting, while the need to agree to a statement on-screen warning that the driver should exercise care and vigilance interrupted the flow of the activity.

## CONCLUSIONS

Establishing trust between the participants and the researchers is an important part of participatory design. In this study, role of the participant as expert and valued partner was given an early impetus by allowing the design brief to emerge from the initial focus groups. It also established that the project had relevance to the participants who were keen to support devices that would help them remain confident and capable drivers.

The prototypes and parking system evaluation provided concrete experiences of new technology that helped to ground discussion in that experience, capturing both prior experience and future needs. In the parking study the participants were able to establish their expertise prior to the test task by parking using their own cars. When the self-parking system revealed itself to be inflexible and far less efficient than our older drivers, it was clear to both the researcher and participants that the problem with the automated system was attributable to the design and not some kind of failure on the part of the older person to understand new technology.

The participants using the low fidelity proto-types continued to express reservations about the lack of relationship to the complexities of driving on busy main roads, and their ability to make informed judgement. However, in the process of participation they revealed much about their attitudes and experiences of driving, how these had changed and co-incidentally what they thought generally about new technologies.

This study did not lead to the design of new artifacts but did indicate that older people can make a valuable contribution to the design of complex technologies when given the right opportunities, including revealing opportunities for possible innovations and adaptations.

Participatory design methods have an important part to play in enhancing understanding of the needs and aspirations of older people in relation to the design of information systems and services. It is important to continue to seek out opportunities whereby older people feel empowered to take part in the design process and to communicate their essential criteria for successful adaptive solutions and innovation. Designers need to actively seek out opportunities for engagement that build trust and a common basis for understanding – whether by the traditional route of using prototypes or the more unconventional route of taking advantage of the plethora of high-tech gadgets and gizmos.

### Implications for practice

- Older people can make a valuable contribution to the design and the development of novel or leading edge technologies
- Researchers and designers need to create safe and meaningful environments that can help elicit experiences and insights, and bridge knowledge gaps.
- Low fidelity prototypes have some limitations when representing a skilled, dynamic interaction like driving. However, having first identified common areas of interest these prototypes provide an opportunity to compare alternative versions and in doing so to elicit further understanding of attitudes and experiences at the earliest stages of the design process.
- Using current leading edge technologies can facilitate insights on usefulness and usability which are grounded in real experiences – and this has the potential to help refine next generation products that better match the needs and aspirations of older people

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