HECTOR VR
DRIVING SIMULATOR

VIRTUAL REALITY DRIVING SIMULATOR FOR OLDER DRIVERS

Project Evaluation Report

harvest
community sector consulting

Report prepared for McLean Care | By Alicia Eugene, Harvest Community Sector Consultants | August 2019

This project was conducted by: McLean Care® DEAKIN UNIVERSITY With funding from: Australian Government Department of Health

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

This report was prepared with the contribution and cooperation of the following key stakeholders:

- Sue Thomson, CEO, McLean Care
- Nikole Fletcher, ICT Manager, McLean Care
- Dr Michael Mortimer, Deakin University
- Dr Ben Horan, Deakin University
- Alan Wild, ICT team member, McLean Care
- Heidi Manning, 2Creative Media, project media partner

This project would not have been possible without the support and participation of the older people from the Inverell and Tamworth communities, including members of the Kamilaroi nation. We thank them all for their willingness to try something new and for giving their permission to share their results, comments and images in this report.

The project was funded by the Department of Health through a Dementia and Aged Care grant.

ABBREVIATIONS AND ACRONYMS

ACRONYM	MEANING
CAD	Computer Aided Design
DUHREC	Deakin University Human Research Ethics Committee
GRP	Group
HCI	Human-computer Interaction
HMD	Head Mounted Display
MR	Mixed Reality
PEOU	Perceived Ease of Use
PU	Perceived Usefulness
TAM	Technology Acceptance Model
TAM-VR	Technology Acceptance Model – Virtual Reality
VR	Virtual Reality
UAT	User Acceptance Testing

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

Driving is key to independence for many older people and is considered essential for completing daily tasks such as shopping, attending medical appointments and engaging in social or community activities. This is especially true for those who reside in rural communities or other areas where public and private transport options are limited.

However, research consistently highlights that accident risk increases for the older driver population. Several factors are likely to contribute to this increased risk, including age-related changes in sensory and perceptual processing, attention, and cognitive ability.

Driving cessation is associated with a number of negative outcomes. These include marked declines in quality of life and general health, increases in clinically significant depression, reduced social networks (regardless of the ability to use public transport) and premature entry to residential aged care.

The question of how to support older people to maintain their driving competence; or to relinquish their drivers licence based on an objective assessment of their ability is therefore an increasingly pressing policy issue in many developed countries with ageing populations.

Through funding from the Australian Government's Department of Health, this project aimed to develop Australia's first driving simulator specifically with, and for, older drivers.

In partnership with Deakin University, McLean Care created a fit-for-purpose mixed reality driving simulator prototype that has been officially launched as "Hector VR". Hector VR is mobile, replicable and able to be accessed anywhere that is out of the weather and with access to power. It combines the cut-down shell of a physical vehicle with a VR headset. A number of controls in the physical car, including the steering wheel, brake, accelerator and indicators link to the controls in the virtual vehicle. Users can select from three different driving scenarios, including a town-driving scenario (modelled on the regional township of Inverell) and a country driving scenario complete with hazards such as stock on the road and a kangaroo crossing the driver's path unexpectedly. Drivers receive a results summary that shows reaction speeds, and adherence to common road rules (such as speed limits, giving way, and correct indicating).

The simulator was developed using an action research and co-design methodology in which feedback at each stage was used to inform the development and successive improvement of later iterations of the simulator across a three-phase model. A specially modified Technology Acceptance Model tool was developed to help capture user attitudes towards and perceptions of the simulator across the phases of its development.

More than 63 older people (aged 65+) were recruited to help develop the simulator. This exceeded the original participant target by approximately 26%, highlighting the broad support received from the local community throughout the development phases.

In addition to completing pre-and post- simulator driving questionnaires, participants also responded to questions about their current and future driving behavior. These results indicated that half of the older drivers in the research sample already place limits on their own driving, predominantly by no longer driving at night or by limiting where they drive (e.g. high traffic areas like Sydney).

Focus group sessions were also held for the final development phase of the simulator. The qualitative results were thematically analysed and used to supplement the quantitative data collected throughout the project.

Project outcomes indicate positive end-user feedback and acceptance with more than 75% of participants indicating they would use the driving simulator in the future if they wanted to know more about their driving competence, 81% indicating the driving simulator is easy to use, 97% indicating the results from the driving simulator are useful and 100% indicating the simulator driving test results are easy to understand.

The project has already received various national and international awards and a range of opportunities for future use of Hector VR are being explored.

CHAPTER 1:

INTRODUCTION

INTRODUCTION

As a specialist not-for-profit regional and rural aged care service provider, the team at McLean Care were acutely aware of the significant impact of having a drivers licence on the quality of life of older people in the geographically dispersed farming communities in which they operate in the regional areas of north western NSW and south western Queensland.

Conversely, they were also aware that having to relinquish a drivers licence made older people highly vulnerable, sometimes prompting otherwise unnecessary entry in to residential aged care. This was particularly marked in rural areas without access to alternative transport options such as buses, taxis or ubers.

The cost of undergoing mandatory driver training, and the stress experienced by many older drivers caused by pressure from well-meaning family members about the perceived age-related reduction in their driving competence was also recognized.

Having previously undertaken a successful small-scale trial using VR technology with a small group of their residents, McLean Care recognized the potential for emerging technologies such as VR to address some of the challenges of ageing in regional and rural communities.

The team put forward a concept of a VR driving simulator that could test older drivers against the same competencies as a "real-life" driving test. The idea was to provide older drivers in the community with access to objective information about their core driving abilities. In turn, it was hoped that this would aid dignified decision making by older drivers about whether (and when) to relinquish their licences; and help older people to maintain their independence in the community for as long as it is safe to do so.

The project was one of only eight projects that received funding in a 2017 national grant round through the federal Department of Health's Dementia and Aged Care grants scheme.

As the project clearly required very specific VR subject matter expertise and designers capable of building a driving simulator from the ground up, the McLean team examined a number of potential university partners from around Australia.

Ultimately, the team from the CADET VR Laboratory in the School of Engineering at Deakin University were selected as being the best fit. This research-industry partnership between the two organisations proved to be critical to the overall success of the project.

An experienced project manager was also appointed to oversee the project and collectively, key staff from McLean and Deakin established a Project Steering Committee to oversee the project. The Steering Committee met on a regular basis to check progress against milestones and to actively manage any emerging risks and issues.

Through the development and evaluation of the VR driving simulator, the project aimed to:

- Improve the driving competencies of elderly drivers in a low-risk and supported environment;
- Enable elderly drivers to safely and easily assess their driving competencies to help inform decisions surrounding the relinquishing of a driver's licence;
- Use the results of user evaluations to inform development refinements between successive development stages of the VR driving simulator;
- Evaluate the efficacy of the VR driving simulator in achieving its aims.

Within a co-design framework, over 65 older people were involved in helping to test and review the driving simulator across three development phases. Other stakeholders included local police and ambulance staff, the local Council, Chamber of Commerce and local politicians were engaged in the project. The project also received wide media coverage including print, online, radio and TV. Since the completion of the prototype simulator, the team has won various national and international awards for the project.

After the formation of the partnership between Deakin and McLean Care, the journey to create the first known mixed reality driving simulator designed specifically with, and for older drivers began. Hot Rod Inverell were contracted to cut down a Holden Captiva car purchased from a wrecker's yard. They were tasked with basically cutting the car in half, and preserving the front end of the vehicle so that it could house the VR technology and form the physical shell for the driving simulator. When this was completed, the shell was transported to Deakin University's Virtual Reality Laboratory in Geelong for the initial technology installation.

In June 2018, the Deakin and McLean Care teams jointly facilitated 'Experience VR Days' in Tamworth and Inverell. The sessions were advertised to community members aged over 65 and were planned as a soft-entry approach to recruitment. This proved to be highly successful, and in combination with various other recruitment strategies, the participant target was not only reached, but exceeded.

In July 2018, the first version of the simulator was released in Inverell. This was called the "Alpha" testing phase, and the core components of the planned simulator were approximately 30% complete. Older drivers tested the vehicle and gave feedback across a number of domains. The development team then returned to Geelong to continue to refine and update the prototype based on the feedback.

In September 2018, the second testing phase was undertaken with the Deakin VR team returning to Inverell with the product now at 60% completion. Participants from the first phase, as well as new participants assisted with the collection of additional data and feedback to enable further refinement of the simulator. This was termed the "Beta" testing phase.

In November 2018, final release testing took place in Inverell, with three groups of participants – those who had completed alpha and beta stages, those who had only completed the beta stage previously and completely new participants who tried the simulator for the very first time.

During this period, all participants were also offered the opportunity to take part in focus groups, which yielded rich qualitative information to supplement the data collected throughout the research process.

An official launch event was held on 21 November 2018, with broad community representation, including a number of the older people who had been involved in testing the simulator. The completed prototype was officially named "Hector VR" after the founder of McLean Care - Hector Neil McLean. Hector was a community minded citizen and was committed to the dream of establishing a Convalescent Hospital for the people of the local district. In 1932, McLean Care was founded at the bequest of Hector Neil McLean.

After the analysis of all the data and final adjustments based on feedback from the final release; the Hector VR simulator was officially handed over to McLean Care by Deakin University in May 2019.

It is currently housed in a custom-built room on-site in Inverell. A range of options are being explored to share Hector VR with a wider national and potentially international audience.

This report reviews the relevant literature which informed the project design and approach, the outcomes of the research conducted across the three development phases of the simulator, key findings and recommendations for the future.

Ultimately, the project highlights how a small organization with a strong understanding of their community can successfully design a solution and deliver an innovation of international significance.

Research Timeline

December 2017
McLean Care and Deakin University partnership established

February 2018
Acquisition of vehicle

February - April 2018
Ethics and Project Planning

June 2018
VR experience days and participant recruitment

July 2018
Alpha phase release and evaluation

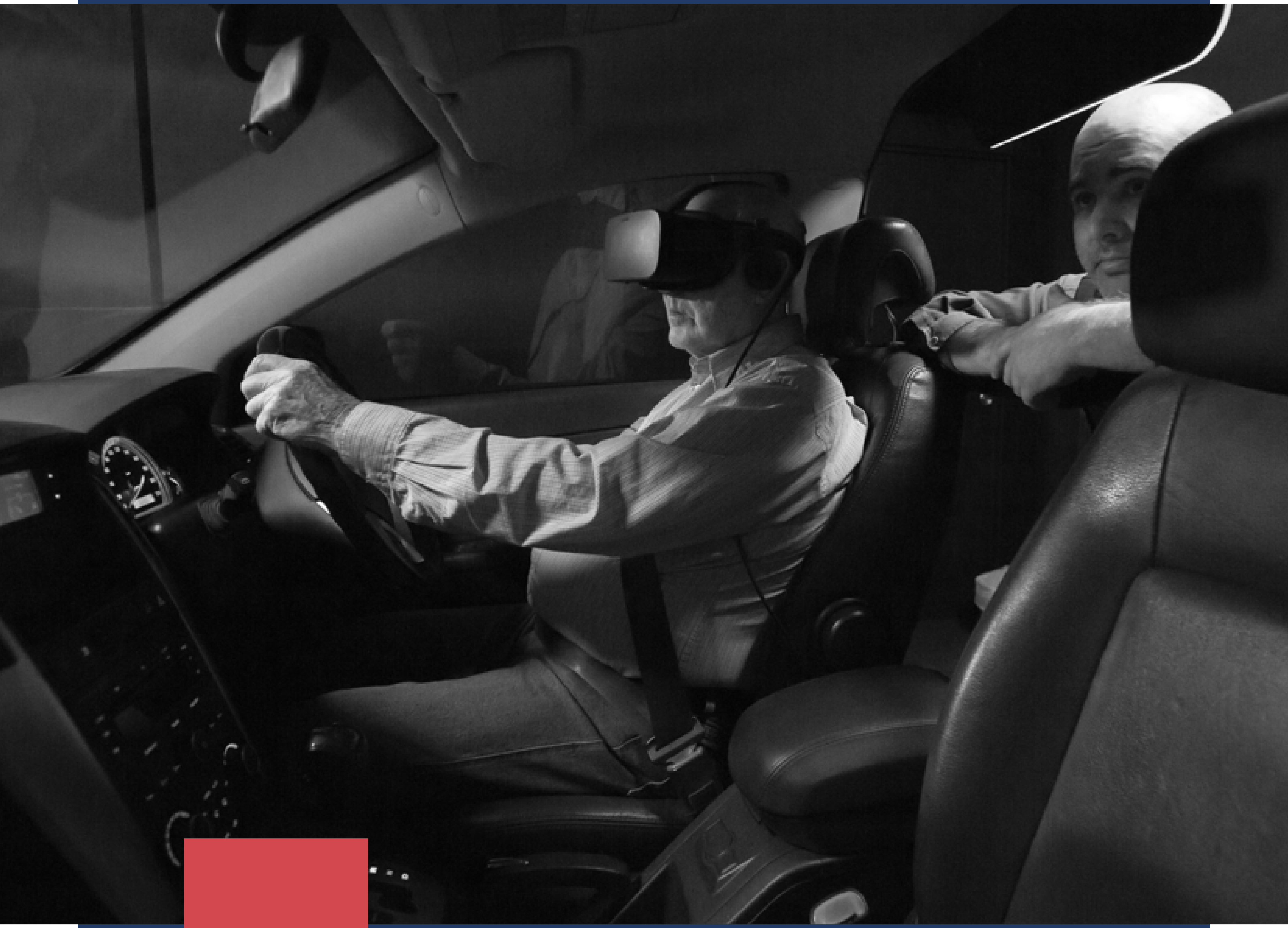
September 2018
Beta phase release and evaluation

November 2018
Final phase release and evaluation
Focus groups

21 November 2019
Official launch of Hector VR

December 2018 - March 2019
Final modifications to simulator by Deakin Uni

June 2019
Final delivery of simulator to custom built room at McLean Care
Process evaluation completed



CHAPTER 2:

LITERATURE REVIEW

Driving, Independence and Age-Related Changes in Driving Competence

To many older people, driving is not only their primary form of transport, but also a symbol of independence, freedom and self-reliance, enabling the exercise of choice and control (Whelan, Langford, Oxley, Koppel, and Charlton, 2006). Driving is key to independent mobility for many older people and is considered essential for completing daily tasks such as shopping, attending medical appointments and engaging in social or community activities. Webber, Porter and Menec (2010) conceptualise mobility amongst the elderly as "the ability to move within community environments that expand from one's home, to the neighbourhood and to regions beyond." They consider mobility for older people to be an essential attribute of quality of life. This need for independent mobility can be especially marked for older people who reside in rural communities or other areas where public and private transport options are limited.

Driving is a complex task which requires many interlinking cognitive, perceptual and physiological processes. Reductions in physical and cognitive abilities is a natural part of the ageing process, and can negatively affect safety of driving in different ways. There is therefore a need to strike a balance between continued independence of individual drivers and broader considerations of general road safety. Research consistently highlights that accident risk increases for the older driver population (Langford & Koppel, 2006). Several factors are likely to contribute to this increased risk, including age-related changes in sensory and perceptual processing, attention, and cognitive ability (Ni, Kang and Andersen, 2010).

Profile of Accidents Involving Older Drivers

According to the Victorian Transport Accident Commission, drivers older than 75 years have the highest risk of losing their lives in a motor vehicle crash in Victoria. Similarly, national data compiled by the Bureau of Transport, Infrastructure and Regional Economics (2014) found that each year in Australia, 250 people aged 65 and over die from road crashes and approximately 4,000 more are hospitalised. Many more near-misses or single vehicle accidents not resulting in hospitalisation go unreported. According to the Bureau, there is also evidence of recent increasing annual trends in the rates of fatalities and hospitalisations amongst this driver population, compared to a reduction in younger driver injury and death rates.

The types of fatal crashes involving older drivers also differ from fatal crashes involving other age groups. The aggregated data for the decade 2004 – 2014 analysed by the Bureau of Transport, Infrastructure and Regional Economics (2014), for instance, confirms earlier research findings that intersections are over-represented, as are multiple vehicle crashes. German researchers have also found that there are typical situations that are more difficult for older drivers and more likely to result in accidents. These are mainly giving right of way, turning, and driving backwards, particularly in difficult or unexpected situations such as complex crossroads (Karthaus and Falkenstein, 2016). According to the UK Department of Transport (2001), older drivers are involved in collisions that generally occur in daylight, at intersection and at low speeds. It is posited that older drivers in particular have difficulty in making critical decisions under time pressure and dealing with immense traffic conditions (Musselwhite and Haddad, 2010). Hence, many of their collisions occur when drivers become overloaded with information when performing manoeuvres (Brendemuhl et al. 1988), merging onto roads (Schlag 1993), and older drivers are over represented in at-fault collisions at junctions and intersections, especially those with no traffic control (e.g. traffic signals and lights) and those that involve right-hand turns (in the UK—i.e. across the oncoming traffic) (Hakamies-Blomqvist 1988; Preusser et al, 1998).

Similar trends regarding rates of older driver fatalities are noted across OECD countries (Bureau of Transport, Infrastructure and Regional Economics (2014).

Impact of Driving Cessation on Older People

Over the past fifty years, the number of Australians over the age of 65 has increased by 300% to 3.4 million, and those over 85 years by 900% to almost half a million people (Australian Institute of Health and Welfare). The Australian Bureau of Statistics (ABS) predicts that by 2064 there will be more than 9 million Australians aged over 65, and almost 2 million Australians aged 85 or older. According to the World Health Organisation (WHO), the world's population aged older than 60 years is estimated to grow to about two billion by the year 2050 (World Health Organisation and Alzheimer's Disease International 2012).

Forfeiture of driving privileges is considered a major loss by many older adults in terms of social identification, control and independence. For many, it can result in an increase in depressive symptoms including clinically significant depression (Marottoli, de Leon and Glass, 1997) and a decline in out of home activity levels, declining community access and connection and a range of other negative outcomes. These include marked declines in quality of life and general health (Edwards, Lunsman, Perkins, Rebok, & Roth, 2009), increases in clinically significant depression (Mezuk & Rebok, 2008), reduced social networks (regardless of the ability to use public transport) (ibid) and premature entry to residential aged care (Edwards, Perkins, Ross, & Reynolds, 2009).

The decision as to whether to retain or relinquish a driver's license has a direct impact on the quality of life of older people and, often, on their need to access aged care services, potentially resulting in premature access to residential aged care services with associated increases in public health and care costs. A study with more than 1500 subjects showed that older people who stopped driving a car for more than six months had a five-fold higher risk for permanent care than active drivers, independent of confounding factors such as health state (Freeman, Gange, Munoz, and West, 2006).

The question of how to support older people to maintain their driving competence; or to relinquish their drivers licence based on an objective assessment of their ability is therefore an increasingly pressing policy issue in many developed countries with ageing populations.

Older Drivers Adapting Their Driving Behaviour to Reflect Changing Abilities

There is some evidence that older drivers themselves adapt their driving behavior to reflect their changing abilities. A UK study found that 100% of the older driver sample they interviewed adjusted their driving to reflect changing abilities. They did this by either changing their behaviour (e.g. driving slower with increased gaps) or changing their travel behaviour (e.g. not going out at night and not driving at busy times) (Musselwhite and Haddad, 2010). An Australian study with a sample of 656 drivers aged 55 and older from urban areas, country towns and rural areas in the state of Victoria found that the highest avoidance levels were seen for busy traffic, night driving and driving at night when wet. About one-quarter of the participants reported avoiding these situations. More than half of drivers who avoided night driving or driving at night when wet reported doing so because of vision-related issues, especially adjusting to glare from lights (Charlton, Oxley, Fildes, Oxley & Newstead, 2003).

Effectiveness of Mandatory Testing of Older Drivers

A number of countries, including some jurisdictions in Australia, have introduced mandatory testing and / or screening for older drivers above a certain age. However, the effectiveness of this approach has been questioned by a number of researchers. Hakamies-Blomqvist, Johansson, and Lundberg (2016) compared the number of fatal accidents in Finland, which requires drivers aged 70 and above to undergo medical tests to renew their driving license, and in Sweden, a country without such tests. No advantage was found in the Finnish system concerning the reduction of accident rates.

Similarly, in another recent study, Siren and Meng (2012) compared the rate of fatal accidents in Denmark before and after the introduction of a medical plus a short cognitive screening test for elderly drivers. Again, no reduction of accidents was found in the period after test introduction. A study by Redelmeier, Yarnell, Deva Thiruchelva and Tibshirani (2012) showed that physicians' warnings to patients who are potentially unfit

to drive revealed a small reduction in hospital admissions for road accidents but also substantially increased the number of admissions for depression. In addition, stopping driving leads to a decrease in outdoor activities, social interactions and related cognitive simulation, which keep the elderly cognitively fit (Marottoli, de Leon, Glass, Williams, Cooney, and Berkman, 2000).

According to Karthaus and Falkenstein (2016), blanket restrictions on driving for the elderly is therefore not a good solution in terms of either traffic security or the health and wellbeing of older people. They propose that rather, measures should be taken that find a trade-off between security and mobility to preserve driving within the older driver group.

Whilst there is well established longitudinal research in relation to older road users and road safety issues, there is more limited research around measures that can be taken to increase, or at least maintain, older driver competency. The use of emerging Virtual Reality (VR) technology has been identified as one potential means of supporting older drivers to make an informed decision regarding their ongoing driving competence and potentially to practice driving in a virtual, low-risk and supported environment (Karthaus and Falkenstein, 2016).

Use of Driving Simulators for Research

Driving simulators have been used in research to determine older driver competency in specific road conditions and driving scenarios. For example, researchers Trick, Toxopeus and Wilson (2010) used driving simulators to investigate the driving performance of older drivers when exposed to lack of road visibility (e.g. fog), traffic density, and navigational tasks. Frittelli et al (2009) studied the effects of Alzheimer's disease and mild cognitive impairment on driving performance using a driving simulator.

The supportive advantages offered by the immersive interactive characteristics inherent to VR have been highlighted in the literature as making VR an important tool for potentially improving the quality and efficacy of health care and social support services needed by the world's growing elderly population (Garcia-Betances, Jiminez-Mixco, Arredondo and Cabrera-Umpierrez, 2014).

In recent years VR has gained from several technological advancements such as low-cost mobile computing, reduced latency in data communication, a significant improvement in graphical rendering and real-time tracking systems. This has seen an influx of low-cost commercially available VR hardware that is improving the level of user immersion over traditional methods such as fixed 2D displays, keyboard, mice, joysticks and gamepads.

Driving simulators can provide a much safer environment when conducting driving research, education, and training. The benefits of using a driving simulator include reproducible scenarios, a safe environment to explore hazardous situations, ease of data collection, unique feedback (e.g., replaying scenarios), and standardization of results. According to Michaels et al (2017) compared to on-road driving studies, the virtual environment of a driving simulator provides several advantages. Chief among these is that participants'

reactions to potentially life-threatening driving situations can be evaluated in perfect safety. Driving simulators allow researchers to reliably control, standardize and replicate specific driving events and conditions, such as route difficulty, traffic, weather, in ways that are simply not possible with on-road study designs that use open (i.e. public roads) or closed roads (specially designed closed circuits). Moreover, driving simulators allow researchers to collect and process a wealth of objective, performance-based data in a relatively short time.

Karthaus and Falkenstein (2016) highlight that driving simulators allow the simulation and repetition of complex traffic situations independent of daytime and weather. Moreover, they avoid risk to the drivers and other road users when encountering difficult situations in real traffic. The high control over driving situations and tasks and the exclusion of confounding variables enables a high degree of standardization between subjects and therefore allows for comparisons between subjects and groups. They suggest that driving simulators are therefore a good compromise between laboratory experiments, which are far from reality, and real driving, which is hard to control.

Several studies confirm the validity of driving simulator data to estimate driving behaviour in real traffic (Szlyk et al, 1995). In particular, coping with complex situations in the simulator is related well to real driving performance in older drivers (Casutt, Martin, Keller, and Jäncke, 2014).

Design Challenges of Driving Simulators: Simulator Sickness

Although driving simulators provide several advantages for research and for driver training purposes, they also have several design challenges, including user discomfort during operation such as simulator sickness (De Winter, Van Leuween and Happee, 2012). Older people in particular are more susceptible to simulator sickness than younger people (Brooks et al, 2010). Researchers have suggested this may be due to physiological reasons such as better eyesight amongst younger drivers, or due to younger people being more likely to have previous exposure to technology (Reed, Parkes, Peacock, Lang & Rehm, 2007). Others have suggested that symptoms related with older age, such as increased dizziness and problems with balance, could be an explanation for the fact that age is associated with simulator sickness. (Brooks et al., 2010) Some research has also indicated women are more susceptible than men (Matas, Nettelbeck, & Burns, 2015).

Simulator sickness has been described as a syndrome because of the breadth of its symptoms, including headache, sweating, dry mouth, drowsiness, disorientation, vertigo, nausea, dizziness and vomiting (Brooks et al, 2010). The most widely accepted theory explaining simulator sickness is the sensory conflict theory, which states that an incompatibility of different sensory information, such as visual, auditory, and motion, occurs at the same time, causing the various physiological symptoms (Jacobs et al, 2019). The symptoms are usually temporary and often decrease within one to two hours (Mullen, Weaver, Riendeau, Morrison, & Bédard, 2010).

In a large Scottish experiment with over 700 participants, rates of simulator sickness experienced by participants completing truck driving training using a driving simulator caused approximately 50% of participants to drop out of the study (Reed, Parkes, Peacock, Lang and Rehm, 2007). A 2015 study of 88 older drivers (average age 73) using a desktop driving simulator, reported that 59% of participants experienced simulator sickness that caused them to discontinue with the trial (Matas, Nettelbeck & Burns, 2015). They found that older adults, females, and those with a prior history of motion sickness may be especially at risk.

In a recent study by Jacobs et al (2019), 83 participants (including 84 with Huntington's disease), drove in a driving simulator that included urban and motorway scenarios. All participants were still active drivers. Thirty percent of their sample group

dropped out due to simulator sickness, which they found was positively correlated with older age and female gender but not associated with cognitive functioning.

To reduce the risk of dropout, the authors recommend starting the simulator assessment with scenarios that are less visually demanding (e.g., motorway scenarios and straight roads) before continuing to more complex and detailed scenarios with curves and sudden stops (e.g., urban scenarios). This way, participants can become better adapted to the simulated environment. They also suggested the configuration of detailed scenarios should be optimized, in particular the refresh rates of the visual information on the screen.

Other authors have suggested that adaptation to the simulator before the actual driving test could reduce the dropout due to simulator sickness. Such previous studies have shown that multiple exposures and more time between the practice session and the actual driving simulator test can decrease the occurrence of simulator sickness (Domeyer, Cassavaugh, & Backs, 2013).

Recent Advancements in VR Technology and Use in Driving Training

In recent years, advancements have been made in fully immersive stereoscopic systems, including VR, augmented reality (AR), and MR solutions. Each provide benefits including improved depth cues and updated visuals based on user movement (e.g., the natural viewing of an environment with head movements). These advancements are related to the increase in research on the possible benefits of using VR head-mount displays (HMDs), such as Oculus Rift and HTC Vive, to improve the level of immersion in existing driving simulators. VR Head Mounted Displays (HMDs) offer users the ability to view virtual environments using natural head rotations and user tracking systems allow more natural interactions using gesture-based controls such as simply pointing to areas of interest. The rapid introduction of VR hardware such as HMDs has seen a vast change to human-computer interaction (HCI) in a range of fields such as architectural and Computer Aided Design (CAD), education, entertainment and training.

Driving simulators are included in those applications reaping the benefits from the advances in VR hardware For example, Likitweerawong and Palee (2018) investigated the benefits of using an Oculus Rift VR HMD to allow younger drivers to practice driving skills before taking a driving test.   Ali, Elnaggarz, Reichardtz and Abdennadher (2016) shows promising results in using VR to help train users for good driving behaviors.

Several studies show positive effects of simulator training on driving competence in real traffic.

Roenker, Cissel, Ball, Wadley, and Edwards (2003) compared simulator training and functional training in older drivers. The authors assessed driving performance before, directly after, and 18 months after the training both in a simulator and in real traffic. The simulator training (but not the functional training) improved the behaviour of older drivers at left turns and traffic lights. Research by Lavallière, Simoneau, Tremblay, Laurendeau, and Teasdale (2012) found improvements in real-life driving when the simulator training was coupled with driving-specific feedback. In a recent study by Casutt, Theill, Martin, Keller and Jäncke, L. (2014 B), older drivers were assigned either to simulator training, attention training, or a no-training control group. Before the training phase, driving performance in real traffic and cognitive performance in traffic-related tests was assessed for all participants. After 10 training sessions, both tests were administered again. Both training groups improved their cognitive test performance compared to the control group, but only the group trained in the simulator showed an improvement in real driving performance. The authors assume that the advantage of the simulator training is due to its more realistic and dynamic structure, which facilitates transfer to real traffic situations, whereas functional training is more abstract and removed from reality.

Application to Hector VR project

The Hector VR project built on this body of research to build a Mixed Reality driving simulator that was successively improved over development phases, based on feedback from an older driver user group. A number of domains were examined in the project, including the efficacy of the simulator for its intended purpose, user perceptions, design features that enhanced the efficacy of the simulator, self-reported changes and adaptations in older driver behavior, rates of simulator sickness experienced by participants, and perceived efficacy of drivers results summary for simulator users.

CHAPTER 3:

EVALUATION METHODOLOGY

3.1 Ethics Approval

A full Human Research Ethics Application was submitted to the Deakin University Human Research Ethics Committee (DUHREC) on 11 January 2018 (ID: BH00028).

The DUHREC is registered with the National Health and Medical Research Council and therefore works within the guidelines of the National Statement on Ethical Conduct in Human Research 2007.

In the case of this project, Ethics Approval was required as the research examined a cohort of vulnerable people, specifically the elderly. Particular consideration was given to the issue of informed consent and ensuring any perception of a dependent relationship between aged care service recipients and staff from McLean Care was appropriately managed.

The project gained ethics approval at the scheduled committee meeting on 8 March 2018.

3.2 Research questions

The defined purpose of the research component of the Hector VR project was to understand:

- If participants find that using the simulator provides useful information about their driving competence;
- If participants find that this information about their driving competence is useful in informing future decisions about driver licencing and possible relinquishment of licences;
- The level of user acceptance of the technology;
- To what extent the final developed simulator delivers against the intended design outcomes and the feedback from users in the earlier release stages;
- Whether the process utilised to deliver the project is effective.

3.3 Methodological Approach

Overall, a multi-modal or mixed method design was used within a broader action research framework. In this model, the research process takes place gradually, with a cyclical or spiralling model in that the earlier cycles are used to help decide how to conduct and design the later stages or cycles as shown in the diagram below.

THE SPIRAL OF ACTION RESEARCH

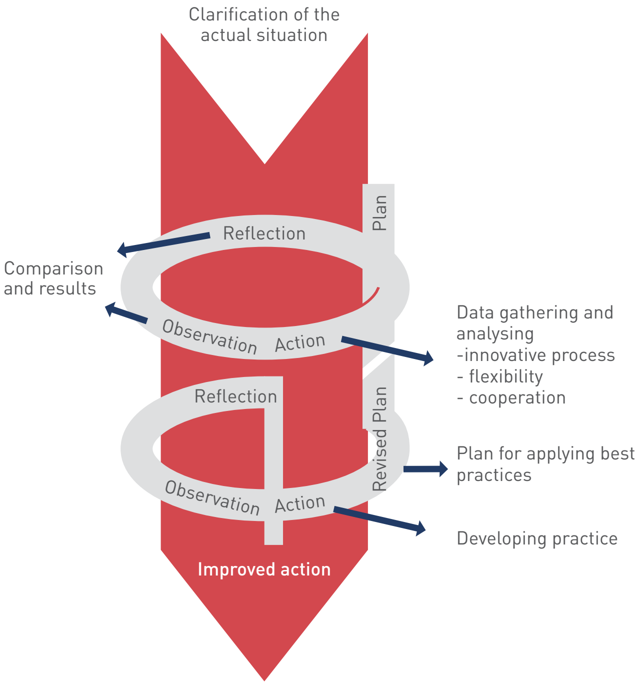


Figure 1. Action research framework articulated by Kemmis et al (Kyrö, P. 2004).

Based on critical reflection and review by relevant parties, the model is intended to yield a greater depth of understanding and refinement over time. The model is iterative with the main steps detailed as; plan, act, observe, reflect. These steps are then repeated incorporating observations and insights gained from reflections made in previous iterations.

A modified Technology Acceptance Model (TAM) scale was designed specifically for use within the project and termed TAM-VR. It examined a number of specific domains relating to attitudes to, and prior experience with technology, perceived usefulness of the simulator and behavioural intentions and attitudes relating the future use of the simulator.

The other key aspect of the research was the principle of co-design. Co-design is a participatory research approach that involves a partnership between researchers and stakeholders, with collaboration occurring from the outset to test designs and improve implementation and effective uptake.

3.4 Participant target group and recruitment strategies

A sample target of 50 older people was set for the project.

The inclusion criterion were:

- Adult men and women aged over 65;
- Who can give informed consent;
- Who have no physical or sensory impairment that would prevent them from accessing a non-modified vehicle independently; and
- Who have no health conditions that would preclude them from holding an Australian driver's license.

These criterion were designed to meet the requirements of the project and also to ensure that potential issues with informed consent were appropriately managed. In particular, the research team identified that it would be necessary to ensure that people with dementia or other cognitive impairments were not inadvertently involved in the trial without giving informed consent.

In addition to the criterion specifically relating to informed consent, a further criterion of having no health conditions that would preclude them from having an Australian drivers licence was also added. This was designed to be a secondary means of ruling out participants impacted by dementia or other impairments that would be screened through the Australian driver licencing system.

A range of targeted participant recruitment activities were undertaken, including advertising via:

- Local media (community radio and newspaper)
- McLean Care's social media (Facebook posts)
- Flyers and posters at McLean Care's residential aged care facility
- Invitations mailed to community care clients
- Liaison and invitations through local aged care networks to include other providers

A community "Try VR Morning for Older People" was hosted in Inverell and Tamworth and advertised through both paid advertising and free community radio. Staff from the team at Deakin University attended the event along with McLean Care staff and showcased different immersive VR experiences – such as virtual diving and whale encounter experiences. After trying the VR technology, attendees were then invited to sign up to participate in the research project. These community events were particularly effective in yielding high response rates from interested research participants.

A rolling recruitment model was utilised to fit in with the 3 phase approach to development. The diagram below summarises the planned recruitment numbers.

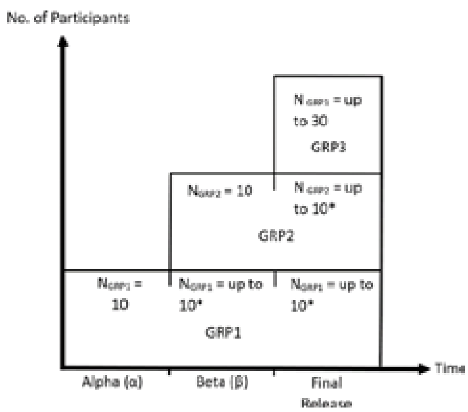


Figure 2. Plan of rolling participant recruitment model across alpha, beta and final release development phases.

3.5 Consent

Once a person expressed an interest in participating, they were provided with the Plain Language Statement (PLS) and consent form (Appendix B) for consideration. If requested, assistance was offered by a member of the research team to read through the document and/or to answer any questions. This was done by a member of the research team and not a staff member of McLean Care in order to manage any potential ethical issues relating to the perception of a "dependent relationship" between clients receiving services from McLean Care which may impact on their ability to freely give consent to participate.

Where recruitment took place in a group-based environment, such as the "Try VR days", the PLS was read aloud to the group of participants after each person had been provided with a copy of the PLS and consent form. An opportunity was then provided for participants to ask any questions or seek clarification on any aspect of the project or research process.

It was anticipated that some participants would want to see the VR headset that would be used with the simulator, so this was made available for potential participants to view and to handle prior to making their final decision as to whether to participate.

Provision was made in advance for use of translators if required; although none were requested.

As the evaluation activities took place in three phases that were a couple of months apart, one of the key researchers also verbally re-confirmed participant consent immediately prior to each use of the VR simulator by the individual participant.

Participants were offered another copy of the PLS for their information and reminded that they could withdraw from the project at any time without consequence or disadvantage.

3.6 Research Activities

Participants were invited to take part in evaluation activities relating to the simulator across three stages of evaluations - Alpha, Beta and Final Release phases, in accordance with the project's action research methodology which aimed to successively improve the simulator based on feedback at each stage.

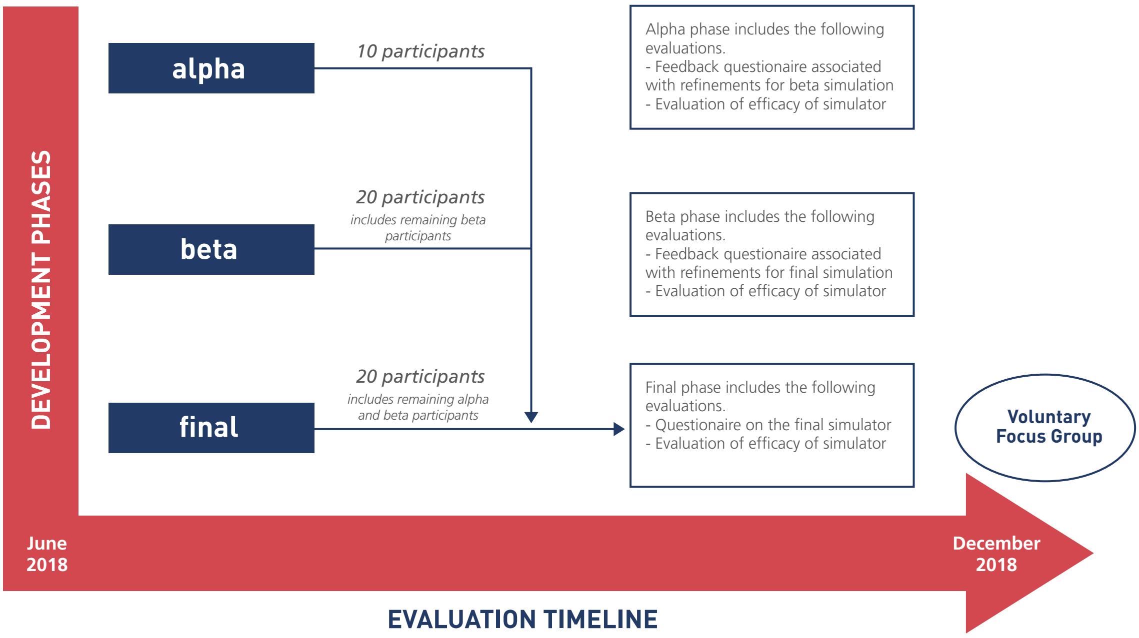


Figure 3. Participant commitment plan and duration throughout development phases

Research Activities included:

- Questionnaires
- Focus Groups
- Individual Interviews
- Collection of data from the participant's use of the simulator, including heart rate

The three participant groups were referred to as GRP1, GRP2, and GRP3. GRP1 participated in evaluation activities for the Alpha, Beta and Final Release stages, GRP2 participated in evaluation activities for Beta and Final Release stages and GRP3 participated in evaluation activities for the Final Release stage.

It is noted that given natural attrition, i.e. those who withdraw from participation, less than the full number of participants predicted may have moved from one evaluation session to the next.

Involvement in the evaluation activities took approximately one and a half hours for each participant at each evaluation phase. This means that participants in GRP1 engaged in activity for a duration of four and a half hours across Alpha, Beta and Final Release phases. Participants from GPR2 engaged in activity for a duration of three hours across Beta and Final Release phases and participants from GRP3 were engaged in activity for a duration of one and a half hours for the Final Release stage.

The duration of one and a half hours per activity, was benchmarked on the standard Occupational Therapist (OT) assessment time usually required for a driver competence assessment for elderly drivers and with due consideration of participants' age and comfort levels, with tea and coffee refreshments available.

In addition to the evaluation activities for each development phase, there was a final focus group conducted which took approximately one hour. Participants from across the three groups attended. The focus group allowed participants to provide feedback on the overall evaluation process.

As such, if a participant was involved in all three phases of the project, as well as the focus group, their total time commitment was approximately five and a half hours (spread over at least three different dates).

No remuneration was offered for participation in the research.

3.7 Data Collection Strategies

3.7.1 ACTION RESEARCH

User evaluations were undertaken across three development phases (alpha, beta and final release). The phased development approach enabled feedback by participants to inform and guide subsequent development stages in an interactive co-design process.

Each participant undertook at least one virtual driving experience, answered a series of driver behaviour questions and completed pre- and post-surveys based on a modified Technology Acceptance Model 2 (TAM-2) standardised evaluation tool (Vankatesh & Davis, 2000). Likert-scale questions were used to elicit feedback on the level of user acceptance, ease-of-use and attitudinal information relating to future intention to use the technology.

Performance and health metric data was collected as part of the evaluation when using the simulator. This was collected through non-intrusive off the shelf measurement devices (such as a FitBit) and the simulator's software and captured automatically while using the VR driving simulator.

3.7.2 FOCUS GROUPS

Focus groups are a key tool in action research and provide a rich, interactive method of data collection. They are particularly useful in the development phase of a product – offering researchers valuable feedback from the target population which then informs the usability of a product.

A focus group is generally defined as a small group of participants, with an interviewer or moderator, asking targeted questions about a specific topic. Both verbal and observational data is collected and is guided by the purpose of the research study. The focus group moderator's role is particularly important to the success of the process. Robust facilitation skills are required to present an unbiased approach whilst also building rapport and trust in the group, thus providing participants with permission to openly offer constructive or critical feedback.

Each members' experiences, language and worldview contribute, and interact with each other – potentially eliciting deep emotions, insights and motivations. Some would describe focus group research as being less clinical and more about the real world.

Research has confirmed that focus groups can be useful for examining use of technology by elderly people to assist "ageing in place." A study by Peek et al (2016) confirmed that design approaches that prioritise the needs and wishes of elderly participants during technology development is more likely to result in high rates of acceptance and to yield actual benefits for older people.

In the Hector VR project, focus groups were held at the completion of testing to provide further detail and to yield rich qualitative information to complement the quantitative data collection methods. A total of 24 participants took part in the focus groups (with an option of two different two hour time slots made available). 12 participated in each session.

The focus groups were facilitated by an experienced focus group facilitator and a series of 14 questions were asked. The questions were structured into three primary themes:

Theme 1: Technology

1. What do you believe are the best features of Hector?
2. What do you think still needs to be improved on Hector?
3. Did you find having the VR combined with a real car enhanced your experience? If so, how?
4. Is there anything that could be done to make the driving experience more comfortable?
5. What other road rules / driving competencies or scenarios do you think we should incorporate for testing?

Theme 2: Process

1. What did you enjoy about being involved in this project?
2. What words would you use to describe the way the research was managed / your interactions with the team?
3. What are your reflections on the time you were asked to give to be involved?
4. Did you feel that the project was clearly explained to you? What was done well? What could be improved?

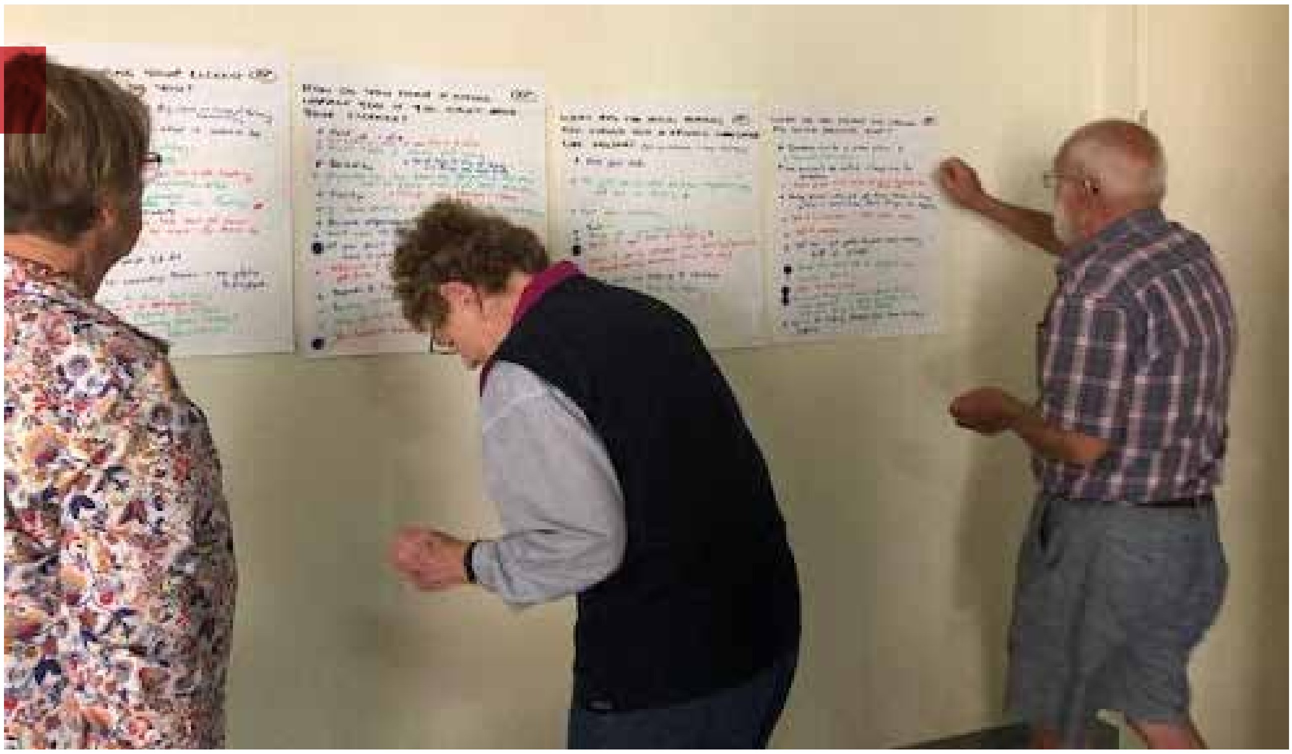
Theme 3: "Big Picture"

5. In your experience, do you find that most older drivers self-moderate their driving? How?
6. Why is keeping your licence important to you?
7. How do you think it would impact you if you didn't have your licence?
8. What are the main reasons you would use a driving simulator like Hector?
9. What do you think we should do with Hector next?

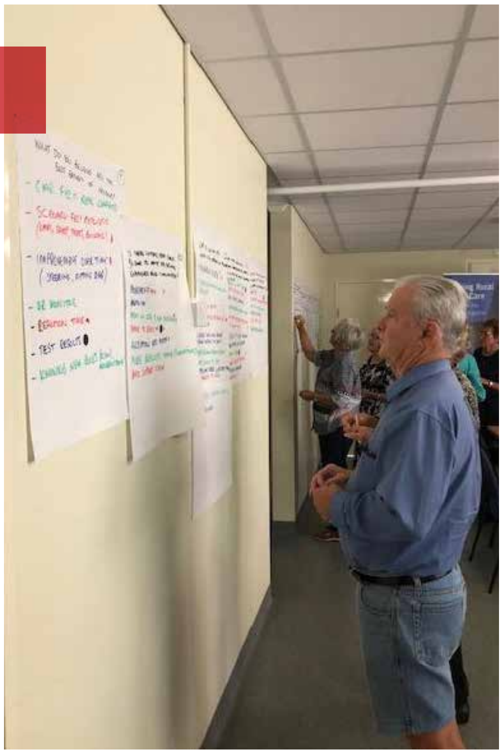
Three "table stations" were set up for the three different sets of themed questions and a staff member was stationed at each table to help facilitate conversation and ensure time frames were adhered to. The groups then rotated between the three stations.

At the end, each individual participant was given 10 coloured stickers that they used to "vote" on the discussion points that they thought were the most important or relevant to them individually.

The responses were then converted to an electronic format and thematically analysed for identification of key results.




Driving Rural
Aged Care
Killean
Residential
Services



Hector VR Focus Groups in Action

3.7.3 TAM-VR TOOL

To provide a standardized measure of participants' feedback on the driving simulator, the widely used Technology Acceptability Model (TAM) scale was selected. The TAM consists of four main domains relating to user acceptance of a particular technology. The domains examined include perceived usefulness, perceived ease-of-use, attitude towards using and behavioural intention to use. Traditionally this is then contrasted with actual system use.

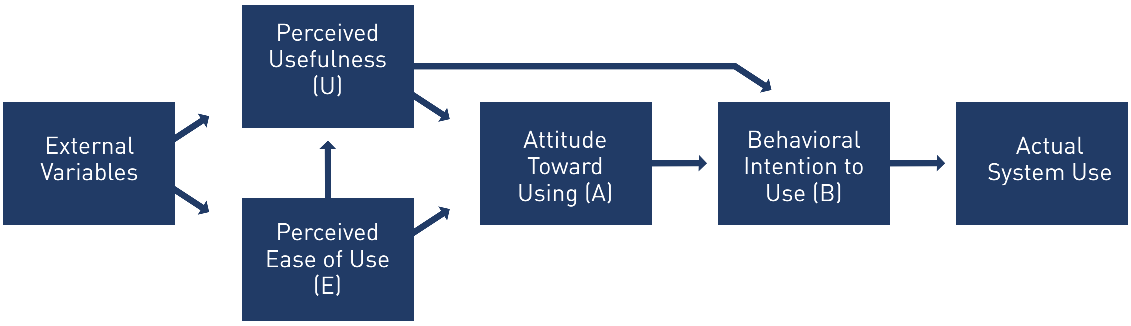


Figure 4. Technology Acceptability Model (TAM)

In the Hector VR project, the team modified the usual TAM and created the TAM VR (Virtual Reality), slightly adapting the standard questions to fit the VR focus of the project.

The TAM VR was administered to all research participants both prior to and after their use of the simulator.

3.8 Managing Potential Bias in the Sample

As this project did not include control groups, the risk of potential bias in the sampling and recruitment stages of the project was minimised.

Standardised protocols for data collection, including training of all researchers involved in gathering and entering data, minimised inter-observer variability and potential bias. Maintaining a small group of researchers involved in the gathering of data also helped to minimise potential bias between interviewers.

The design of the questionnaires used Likert based rating scales for the majority of items and careful attention to the wording of questions to ensure neutrality and avoidance of leading questions. Attention was also paid to the order of questions with general questions being asked before specific questions.

The potential for moderator acceptance bias or the tendency of respondents to give the answer they think the researcher wants to hear was factored into the research design by ensuring that the researcher who facilitated the participants' use of the simulator was not the same researcher who administered the pre- and post-participation surveys. This avoided any potential for participants to feel that they could not give honest answers to the researcher who was most closely associated with the development and administration of the simulator itself.

In relation to potential bias in the focus groups, this was minimised by the use of a highly experienced facilitator who has previously conducted focus group research and is aware of power, "voice" and contextual issues potentially influencing the process. Again, particular attention was given to the design of questions and the order in which they were asked.

3.9 Data Management

Data management strategies were implemented in line with the strategy approved as part of the Ethics application.

Paper-based data obtained from questionnaires, focus groups and individual participant interviews was digitised (scanned) and securely stored using Deakin approved Syncplicity cloud storage. Paper- based data was then disposed of using a security bin where the documents are then destroyed using a secure document destruction service.

Electronic data captured during the relevant evaluation activities from measurement devices on the simulator will be first acquired and stored on the local system capturing the data. The electronic data will then be transferred to the Syncplicity cloud storage system and deleted from the device it was originally stored on.

Only members of the project/research team listed herein will have access to the Syncplicity cloud storage project repository. Data will be retained for the minimum requirement of 5 years as outlined in Deakin's Research Conduct Policy.

Only the research team have access to the information through a password protection protocol.

3.10 Limitations of the Evaluation

It is possible that some confounding factors may have impacted the outcomes of the evaluation. For instance, reported attitudes to and perceptions of the user acceptance of the technology being utilised in the project may have been influenced by external factors such as additional exposure to new technology external to the project itself. As much as possible, the influence of external confounding factors was factored in to the research design and identified in the open-ended questions included in the questionnaires.

CHAPTER 4:

RESULTS

4.1 Participant Profile

In total, 63 older people took part in the research – exceeding the original recruitment target by around 26%.

As illustrated in Figure 5 below, the final participant group contained a good mix across various age cohorts – ranging from one 64 year-old to the two oldest participants both being 93 years old.

Except for one person who had a learners' licence, all participants held a current Australian driver licence. Slightly more women than men took part overall (57% compared to 43%). As shown in Figure 6 below, women were more likely than men to participate across more than one evaluation phase.

All participants resided in the New England region of north-west NSW – mostly in the Inverell Shire, which reflects where the concentrated recruitment activity took place, and also McLean Care's site at which the driving simulator was based for the trial period.

As reported in Figure 7 below, in terms of prior experience with technology, all participants across all three development phases reported their prior experience with VR technology as being none or only a little.

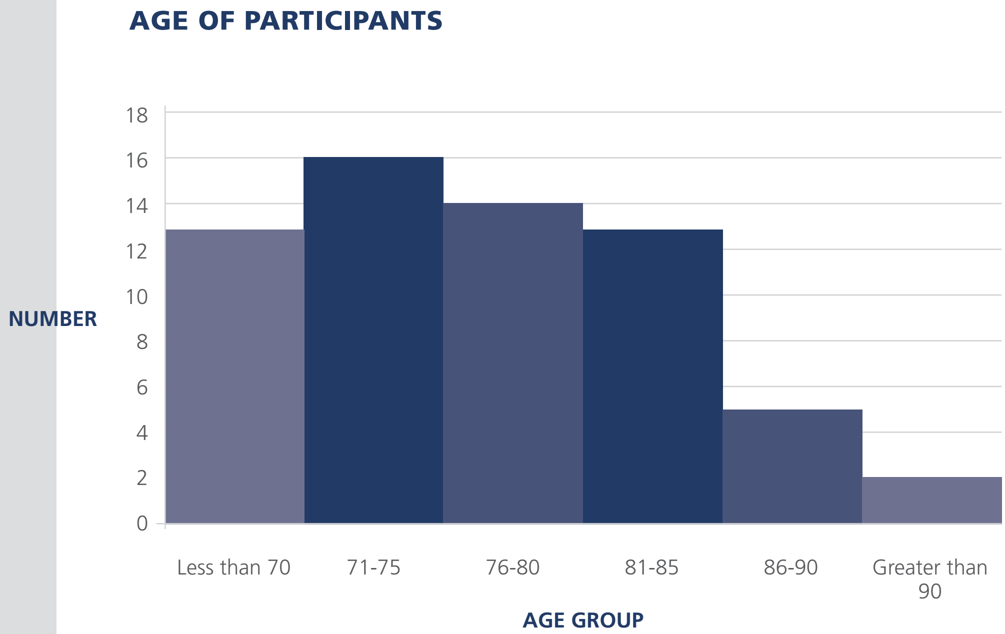


Figure 5. Participant Age Distribution

GENDER DISTRIBUTION OF PARTICIPANTS ACROSS 3 EVALUATION PHASES

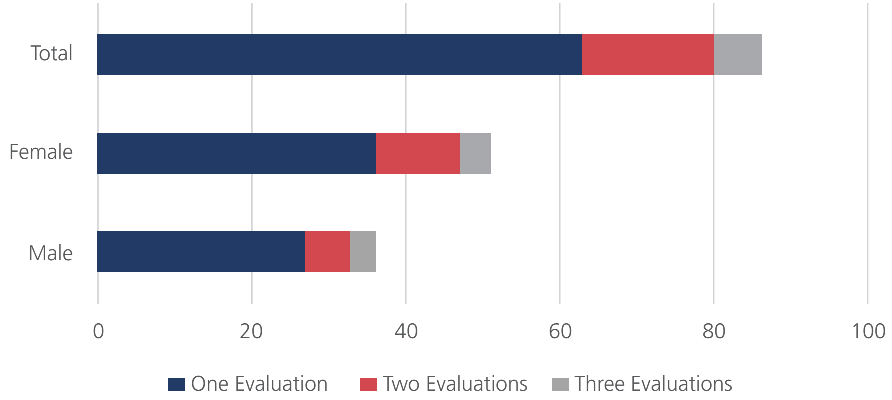


Figure 6. Gender Mix Across the Development Phases

PRIOR EXPERIENCE WITH VR TECHNOLOGY

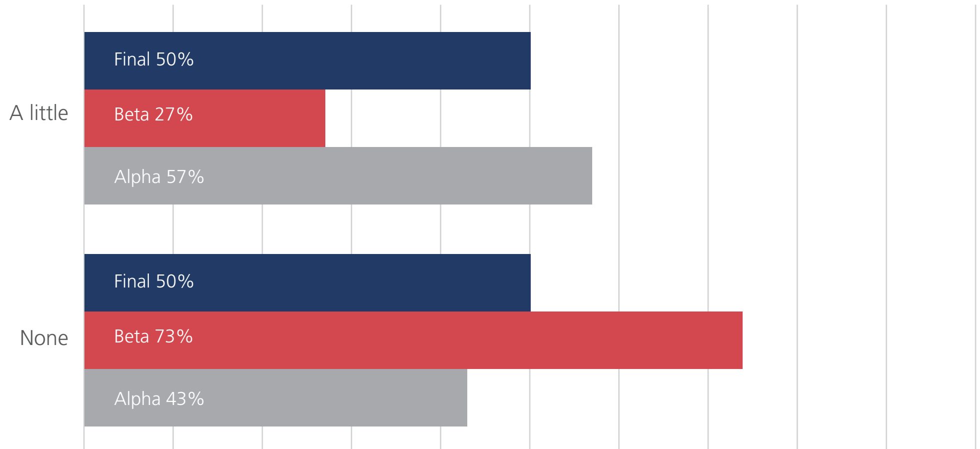


Figure 7. Participant Rates of Prior Experience with VR Across the Development Phases

4.2 Project Outcomes

4.2.1 TAM VR RESULTS

The TAM VR questionnaire tool was administered to all participants prior to and, and after their use of the simulator. Participants who took part in two or three phases repeated the TAM VR questions in each phase.

EASE OF USE

In the pre-participation questionnaire, participants were asked to indicate their level of agreement with the statement 'I expect the simulator will be easy to use'. In the post-participation questionnaire, participants were then asked to indicate their level of agreement with the statement 'The simulator is easy to use.' Both questions used a likert five point response scale.

As detailed further in Table 1 below, with the exception of the cohort of participants who participated in both the Alpha and Beta phase evaluations, all other participants reported that the ease of use of the simulator exceeded their expectations. This was based on a comparative measure between their pre-use responses and their post-use responses.

Further, there is a trend evident across the three development phases of improved ratings of usability by participants. By the final release stage, only 35% of new participants (with no prior exposure to the simulator), agreed or strongly agreed that they expected the simulator would be easy to use. In comparison, after their use of the simulator, 75% agreed or strongly agreed that the simulator had been easy to use. This means their expectations were more than doubly exceeded.

Similarly, in the final phase of evaluations, 71% of returning participants agreed or strongly agreed that they expected the simulator would be easy to use. After they had used it, this rate had increased to 88%, indicating a very high usability rate for the final release prototype.

Participant Group	Survey	Total Participants (n)	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	TAM Score
Alpha	Pre	21	0	1	12	8	0	3.33
	Post	21	2	10	4	5	0	2.57
Beta New	Pre	15	0	1	7	5	2	3.53
	Post	15	0	4	4	6	1	3.27
Beta Return	Pre	11	0	1	1	8	1	3.82
	Post	11	0	0	4	6	1	3.73
Final New	Pre	20	0	2	11	7	0	3.25
	Post	20	0	1	4	13	2	3.80
Final Return	Pre	17	0	2	3	11	1	3.65
	Post	17	0	1	1	14	1	3.88
Alpha (%)	Pre	21	0%	5%	57%	38%	0%	67%
	Post	10	20%	100%	40%	50%	0%	51%
Beta New (%)	Pre	15	0%	7%	47%	33%	13%	71%
	Post	8	0%	50%	50%	75%	13%	65%
Beta Return (%)	Pre	11	0%	9%	9%	73%	9%	76%
	Post	10	0%	0%	40%	60%	10%	75%
Final New (%)	Pre	20	0%	10%	55%	35%	0%	65%
	Post	20	0%	5%	20%	65%	10%	76%
Final Return (%)	Pre	17	0%	12%	18%	65%	6%	73%
	Post	17	0%	6%	6%	82%	6%	78%

Table 1. Survey Results – Ease of Use

PERCEIVED USEFULNESS FOR PRACTICING DRIVING

In the pre-participation questionnaire, participants were asked to indicate their level of agreement with the statement 'I expect the simulator to be useful for practicing driving'. In the post-participation questionnaire, participants were asked to indicate their level of agreement with the statement 'The simulator is useful for practicing driving'. Both questions used a likert five point response scale.

As detailed further in Table 2 below, in both the Alpha and Beta release phases, the percentage of participants who anticipated that the simulator would be useful for practicing driving was actually higher than the rate with which the same participants rated the actual usefulness of the simulator in the post-participation questionnaire.

However, the results for return participants in the final release phase indicate a changed trend in results. 89% of this sample indicated an expectation that the simulator would be useful for practicing driving. After testing the simulator, this percentage increased to 95%. This highlights that the iterative development approach used in the project appears to have yielded positive feedback from participants who were exposed to the simulator across its multiple phases of development.

Participant Group	Survey	Total Participants	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	TAM Score
Alpha	Pre	21	0	1	5	12	3	3.81
	Post	21	0	7	3	8	3	3.33
Beta New	Pre	15	0	0	1	12	2	4.07
	Post	15	1	4	2	4	4	3.40
Beta Return	Pre	11	0	0	3	6	2	3.91
	Post	11	0	1	3	5	2	3.73
Final New	Pre	20	0	0	4	14	2	3.90
	Post	20	0	4	2	11	3	3.65
Final Return	Pre	17	0	1	1	12	3	4.00
	Post	17	1	0	0	12	4	4.06
Alpha (%)	Pre	21	0%	5%	24%	57%	14%	76%
	Post	21	0%	33%	14%	38%	14%	67%
Beta New (%)	Pre	15	0%	0%	7%	80%	13%	81%
	Post	15	7%	27%	13%	27%	27%	68%
Beta Return (%)	Pre	11	0%	0%	27%	55%	18%	78%
	Post	11	0%	9%	27%	45%	18%	75%
Final New (%)	Pre	20	0%	0%	20%	70%	10%	78%
	Post	20	0%	20%	10%	55%	15%	73%
Final Return (%)	Pre	17	0%	6%	6%	71%	18%	80%
	Post	17	6%	0%	0%	71%	24%	81%

Table 2. Survey Results – Perceived Usefulness for Practicing Driving

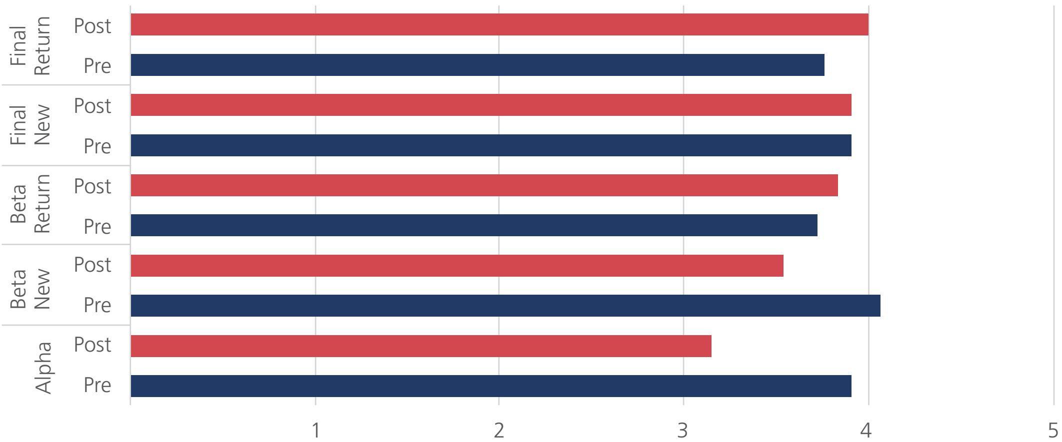
USE OF THE SIMULATOR FOR ENJOYMENT

In the pre-participation questionnaire, participants were asked to indicate their level of agreement with the statement 'I expect using the driving simulator will be enjoyable'. In the post-participation questionnaire, participants were asked to indicate their level of acceptance with the statement 'I enjoyed using the driving simulator'. Both questions used a likert five point response scale.

As detailed further in Figure 8 below, in the alpha and beta release phases, across both new and returning participants, their pre-use expectations of enjoyment when using the simulator were below their actual reported rates of enjoyment post-use, indicating their expectations were not meet.

It is expected that this result is largely attributable to the high rates of simulator sickness experienced by the majority of users during these release phases. This result is explored further in the discussion of key findings. However, by the final release of the prototype, new participants (with no prior exposure to the simulator) anticipated and actual levels of enjoyment when using the simulator were met. Returning participants in the final stage who had used the simulator before actually had their expectations regarding enjoyment exceeded. This highlights that through the iterative development process of successively improving the simulator based on user feedback in each trial, the final product reached a point of meeting user expectations in relation to enjoyment. Again, this may also reflect reduced rates of reported simulator sickness amongst participants in the final release stage.

EXPECTATIONS AND EXPERIENCES OF ENJOYMENT RELATING TO THE SIMULATOR



1 - Strongly disagree, 2 - Disagree, 3 - Neutral, 4 - Agree, 5 - Strongly disagree

Response to the pre-participation question "I expect using the driving simulator will be enjoyable."

Response to the post-participation question "I enjoyed using the driving simulator."

Figure 8. Survey Results – Attitude towards use of simulator for enjoyment

INTENTION TO USE THE SIMULATOR IN THE FUTURE

As part of the TAM VR, all participants were also asked about their intention to use the simulator in the future (assuming they had access to it), across three key domains:

- For practicing driving
- For enjoyment
- For finding out more about their driving competence.

As illustrated in Figure 9 below, 63% either agreed or strongly agreed with the statement that they intended to use the simulator in the future to practice driving. 20% of the sample gave a neutral response to the question, 16% disagreed and only 1% strongly disagreed.

INTENDED FUTURE USE FOR DRIVING PRACTICE

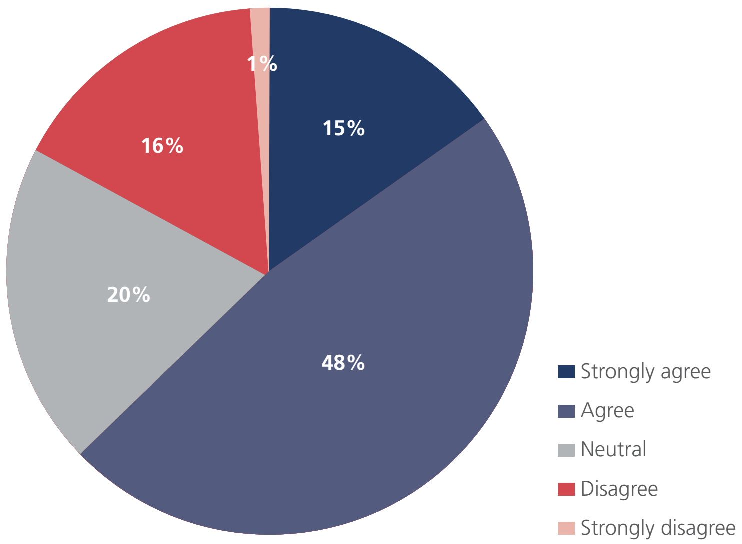


Figure 9. Survey Results – Intended Future Use for Driving Practice

INTENDED FUTURE USE FOR ENJOYMENT

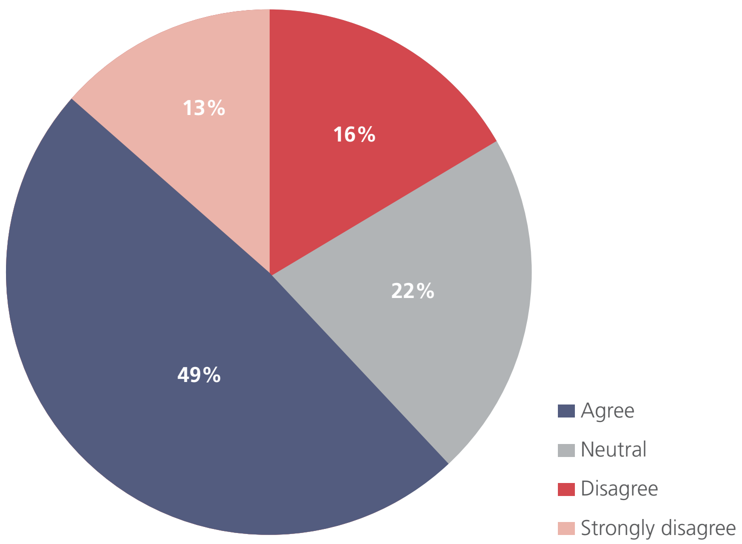


Figure 10. Survey Results – Intended Future Use for Enjoyment

As illustrated in Figure 11 below, 78% either agreed or strongly agreed with the statement that they intended to use the simulator in the future to find out more about their driving competence. 14% answered with a neutral response, and 8% disagreed. There were no respondents who strongly disagreed with the statement.

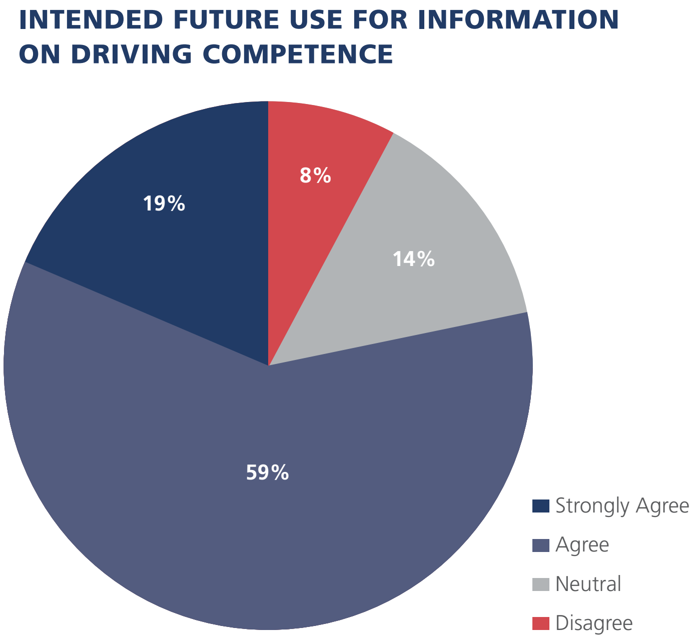


Figure 11. Survey Results – Intended Future Use for Information on Driving Competence

Overall, these results indicate that the reason most highly rated by participants to use the simulator in the future is for finding out more about their driving competence. Given this was the primary purpose of creating the driving simulator, it affirms that the overarching goal of the project has been achieved from an end-user perspective.

4.2.2 MIXED REALITY DESIGN

One of the key differentiators of the Hector VR driving simulator from other products in the market is its mixed reality design. The combination of the VR headset with the physical shell of a real car (and linking of key controls such as steering wheel, accelerator, indicators and brakes) distinguishes it from traditional 2D driving simulators and also from pure VR simulators.

All participants were asked whether they found this combination enhanced their overall experience. Their responses are shown at Figure 12 below, and confirm that this design approach was considered effective by the target end-user group involved in the project.

83.4% or more than 8 out of every 10 participants, agreed or strongly agreed that the mixed reality design had enhanced their overall experience. Approximately 17% gave a neutral response, and no respondents disagreed or strongly disagreed that the mixed reality design had enhanced their overall experience.

DID YOU FIND THAT THE COMBINATION OF VR TECHNOLOGY WITH A REAL PHYSICAL CAR ENHANCED THE WHOLE EXPERIENCE?

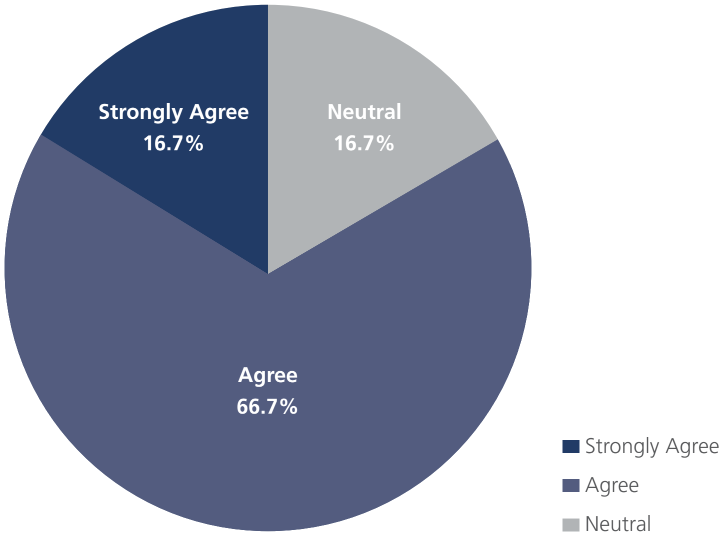


Figure 12. Feedback on Mixed Reality Design

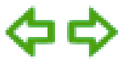
4.2.3 DRIVING TEST RESULTS

After completing the virtual driving scenarios, all users are provided with an automated test result summary. This document (sample below in Figure 13), shows individual driver data relating to adherence to common road rules such as stopping, giving way, indicating correctly at intersections and roundabouts and observing speed limits. It also shows the results of three reaction speed tests and comparative data on average results so that the driver is aware of their benchmarked performance.

Heart rate is also shown across the experience so that drivers can correlate any spikes in heart rate with driving experiences that may have caused them increased anxiety. This data is collected via a non-intrusive wearable device fitted to the driver for the duration of the driving experience.

Test Date 12/09/2018 **Total Test Time** 04:28

Test Start Time 9:48am **Rest HR** 78

TEST						
Intersection 1	84	PASS	N/A	FAIL	N/A	N/A
Intersection 2	83	PASS	N/A	PASS	N/A	N/A
Intersection 3	83	PASS	N/A	FAIL	N/A	N/A
Roundabout 1	70	PASS	PASS	N/A	N/A	N/A
Roundabout 2	74	PASS	PASS	N/A	N/A	N/A
Roundabout 3	83	FAIL	PASS	N/A	N/A	N/A
Reaction 1	82	N/A	N/A	N/A	01.1	N/A
Reaction 2	82	N/A	N/A	N/A	01.0	N/A
Reaction 3	83	N/A	N/A	N/A	00.9	N/A
Speed 1	75	N/A	N/A	N/A	N/A	FAIL
Speed 2	83	N/A	N/A	N/A	N/A	FAIL
Speed 3	83	N/A	N/A	N/A	N/A	PASS

DRIVING TEST HEART RATE

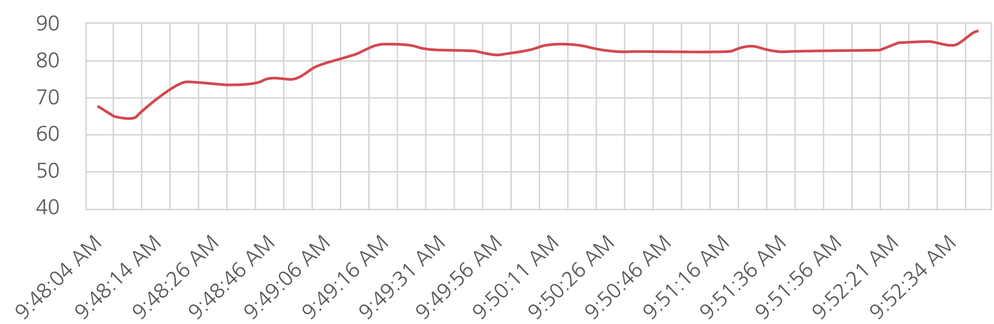


Figure 13. Sample Driving Test Results Report

All participants were asked in the post-participation questionnaires to rate their level of agreement with the statement "The driving test results are easy to understand." The final aggregated results across all testing phases indicated that 100% of end-users either agreed or strongly agreed with the statement, as indicated in Figure 14 below:

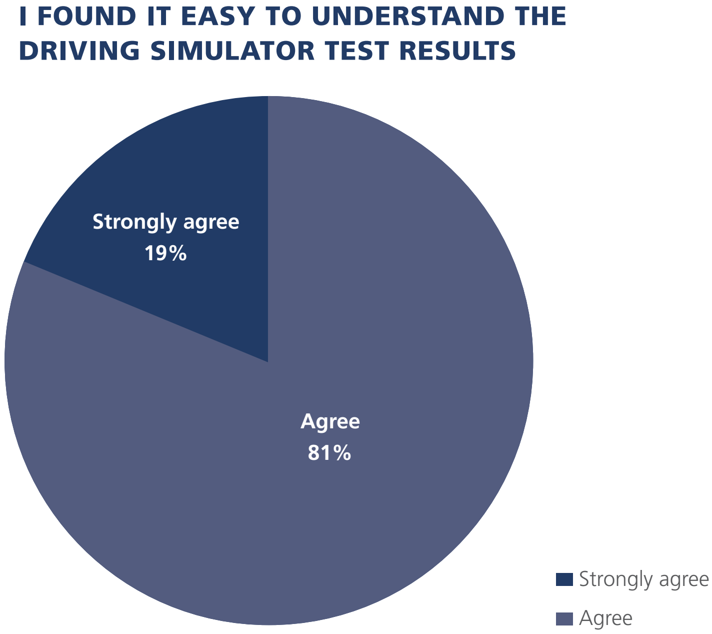


Figure 14. Survey Results – Ease of Interpretation of Driving Test Results

Participants were also asked to rate their level of agreement with the statement "The results from the simulator are useful." 97% of respondents indicated they agreed or strongly agreed with this statement, with 3% giving a neutral response. There were no respondents in the sample who disagreed or strongly disagreed with the statement.

THE RESULTS FROM THE DRIVING SIMULATOR ARE USEFUL

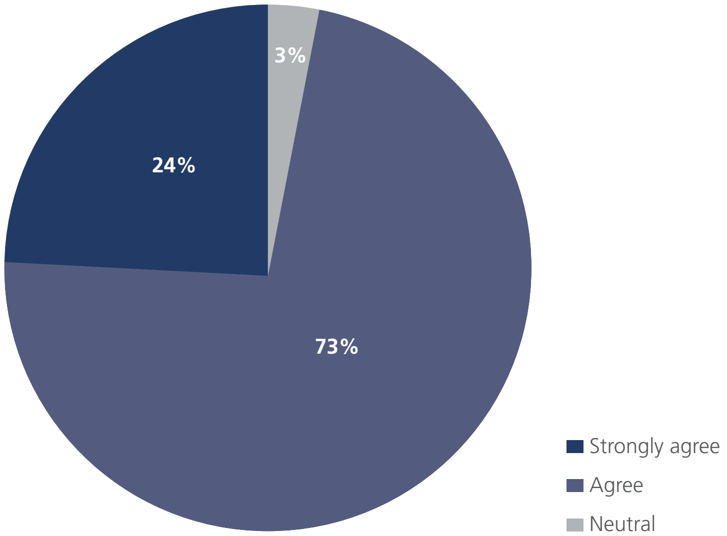


Figure 15. Survey Results - Perceived Usefulness of the Driving Simulator Results

In relation to the driving test results, all participants were also asked in the post-participation questionnaire whether the results were as they had expected. The collated responses across all development phases are summarised in Figure 16 below:

WERE YOUR DRIVING TEST RESULTS AS YOU EXPECTED?

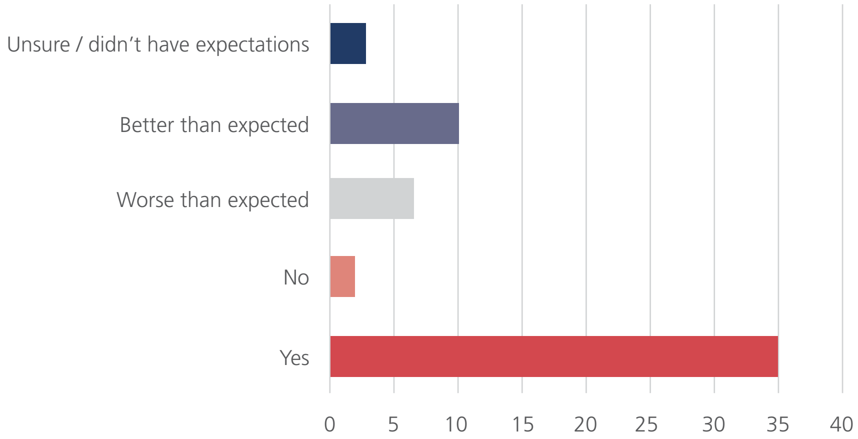


Figure 16. Expectations vs Outcomes for Driving Test Results

Overall, the significant majority of end-users involved in the testing phases indicated that their test results were consistent with their expectations. A higher number reported that the test results were better than expected as compared to those who reported that the test results were worse than expected.

4.2.4 RATES OF SIMULATOR SICKNESS

Rates of simulator sickness and the specific symptoms experienced were gathered across all three development phases.

As shown in Figure 17 below, 30% of users reported no ill effects at all, while a further 30% reported feeling "a little" impacted by simulator sickness symptoms. 40% definitely reported experiencing simulator sickness symptoms. Significantly, this did not stop any users in the final stage from completing their driving course and receiving the test results.

RATES OF SIMULATOR SICKNESS AMONGST NEW USERS IN FINAL RELEASE PHASE

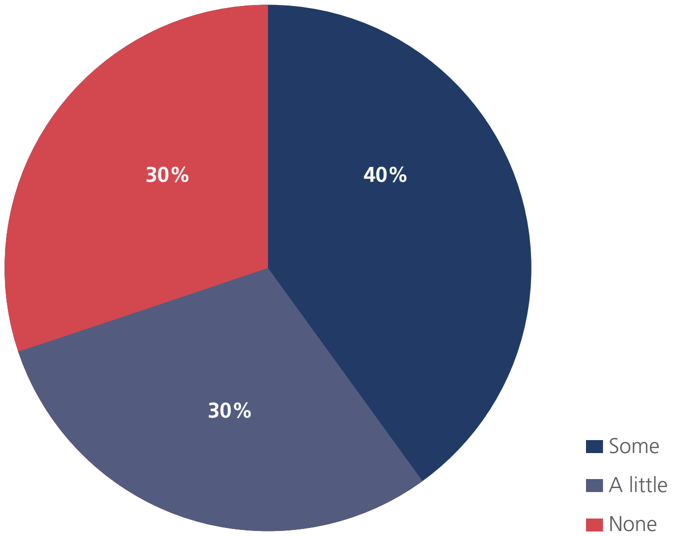


Figure 17. Rates of Simulator Sickness Amongst New Users in Final Release Phase

Data on the specific symptoms experienced amongst final phase participants reporting simulator sickness was also recorded. As detailed in Figure 18 below, the most common symptom was nausea (experienced by 40% who reported ill effects), followed equally by sweating and disorientation (20%) and then dizziness (10%).

SPECIFIC SYMPTOMS AMONGST FINAL PHASE PARTICIPANTS EXPERIENCING SIMULATOR SICKNESS

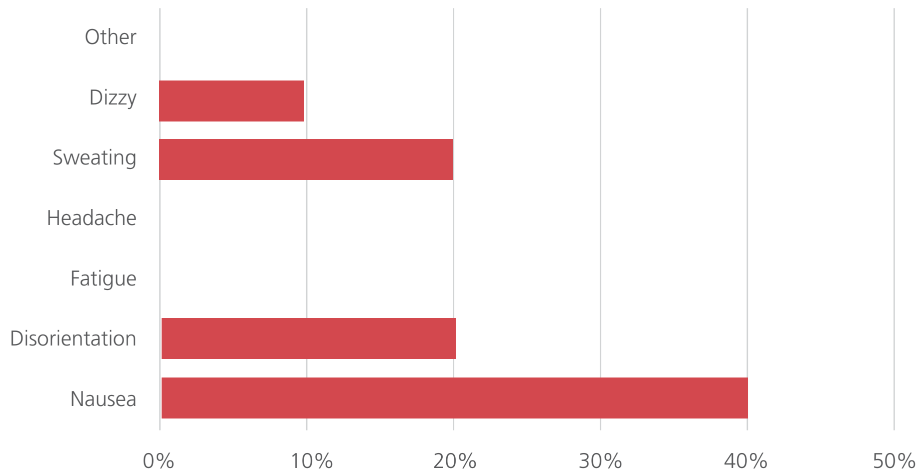


Figure 18. Simulator Sickness Symptoms Experienced by Final Phase Participants

4.2.5 OLDER DRIVER BEHAVIOUR

Drivers were asked about their behavior in regard to relinquishing their driver license in the future and any self-limitations they put on their driving currently.

A total of 46 (n) participants responded to the question "Do you put limits on your own driving license?" Exactly half of these respondents indicated that they do place limits on their driving behaviour. An additional question regarding what changes they make to their driving was then asked. It had 6 suggested categories plus an "other" option with a free text field for additional information:

(i) Limits on how far I drive
(ii) Limits to driving at night
(iii) Limits to where I drive
(iv) Automatic vehicle only
(v) Do not drive as often.
(vi) Other (free text)

Participants could select multiple answers as relevant.

As shown in Figure 19 below, 86% indicated they limit their night-time driving, 82% indicated they limit driving in certain locations, for example unfamiliar areas or areas of high traffic such as Sydney. 34% also indicated that they limit the distance they drive.

LIMITATIONS OLDER DRIVERS PLACE ON THEIR OWN DRIVING

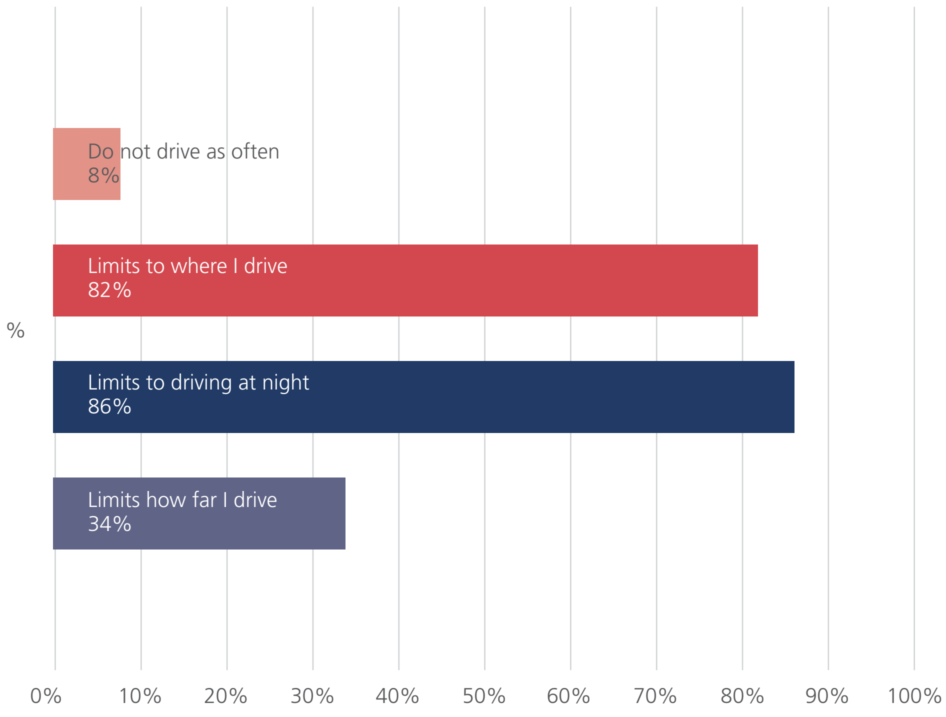


Figure 19. Survey Results – Self Imposed restrictions on Driving

This issue was also explored further in the focus groups, with the following questions being asked:

"In your experience, do you find that most older drivers self-moderate their driving? If so, how?"

The responses were thematically analysed. The results confirmed the outcomes of the questionnaires and also identified a number of secondary themes in relation to how older drivers were perceived by the focus group participants to modify their driving behavior:

- Driving more slowly,
- Being more deliberate when checking what's coming,
- Being more aware when towing a caravan,
- Not having passengers in the car,
- Using the train for longer trips,
- Not driving on dual carriageway roads,
- Selecting the time of day to drive to the shops when there are less cars on the road,
- Taking someone with them to share the driving, particularly on long-distance trips (examples given were husband, daughter, sister).

In the questionnaires, participants were also asked: ' In the future why would you stop driving?'. It had 5 suggested categories plus an "other" option with a free text field for additional information:

(i) Because I have had an accident
(ii) Because of concerns about a medical condition impacting my driving
(iii) Because of the cost of maintaining a vehicle
(iv) Because of concerns I won't pass a driving test
(v) Because I feel unsafe and am concerned about having an accident
(vi) Other (free text)

Participants could select multiple answers as relevant.

As shown in Figure 20 below, 91% indicated that they would stop driving if they were feeling unsafe and concerned about having an accident, 83% would stop because of concerns about a medical condition impacting their driving, and there was an equal response rate of 22% for respondents who indicated they would stop because of concerns about not passing a driving test and due to an accident. Only 4% indicated they would stop driving in the future if they were concerned about the cost of maintaining a vehicle.

IN THE FUTURE, WHY WOULD YOU STOP DRIVING?

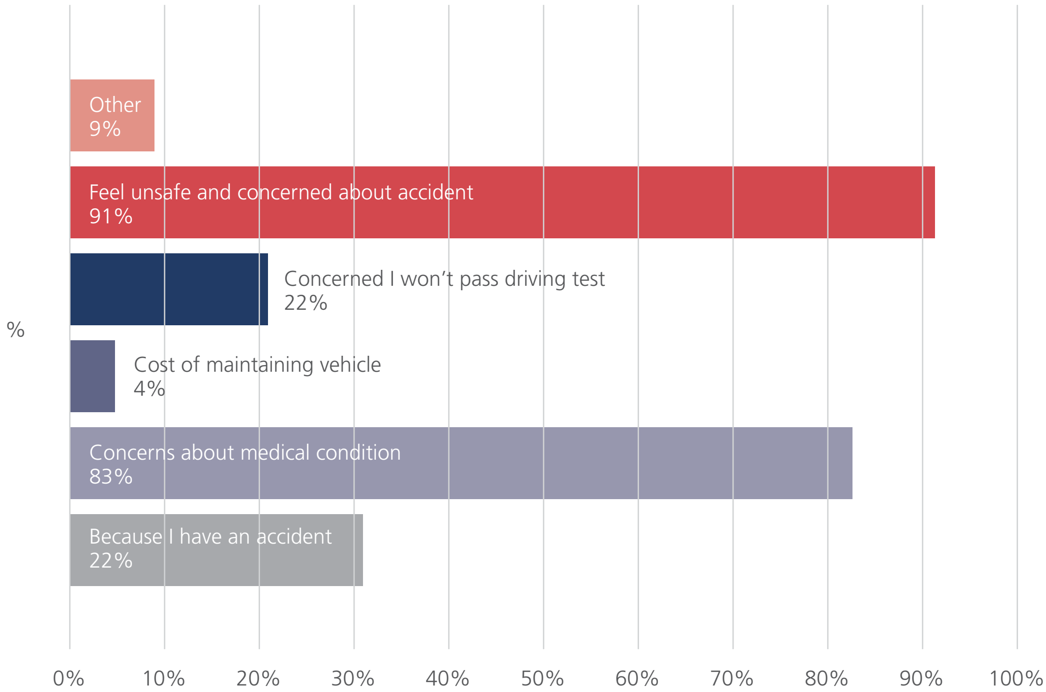


Figure 20. Survey Results – Reasons for drivers to cease driving in the future

4.3 Process Evaluation

As part of the overall evaluation framework, a process review was undertaken to determine whether the key processes and structures used to conduct the project were effective.

The key components of the process evaluation were a self-review undertaken by the steering committee, feedback on the questionnaires and targeted focus group questions for participants.

Given the project was completed on time, within budget, and all key milestones and deliverables were achieved; these are also significant indicators of the effectiveness of the overall process.

Feedback indicates that applying a formal project management methodology for the project helped to ensure all key milestones were met on time, within budget and that risks were actively managed and mitigated. The approach utilised included appointing an experienced project manager, regular steering committee meetings, running action list, active risk management and scheduled phases of work with identified decision gates.

The project Steering Committee included key staff and decision makers from both McLean Care and Deakin University who governed the project to its successful outcome.

A range of incidental benefits have been derived from this project. They include:

- Individual older participants reporting a range of benefits such as:
- Enjoyment
- A novel experience
- Social connections / interactions gained through the project
- Making a valuable contribution to a research project
- Being able to try new technology / learn something new
- Having information about reaction speeds and road rule adherence in a printed format that they could share with family and friends
- Knowing more about their driving competence

The beneficial outcomes at a project level include:

- Delivery of a fit-for-purpose driving simulator that can be used to help older drivers determine their ongoing driving competence
- The opportunity to share the learnings from the project with a broader audience
- A replicable driving simulator prototype that could also be used with other target groups such as young drivers, people impacted by a disability and people learning to drive again after an accident.

4.3.1 STEERING COMMITTEE SELF-REVIEW

It was important to seek the view of not only the end-users (drivers) but also the Steering Committee members who were able to look at the project life cycle through a variety of lenses, including project management, technological development and management of participants.

A survey was developed and responses were sought from the steering committee members and the external partner engaged in marketing the project.

The survey asked a range of questions, some of which used a likert-scale for rating responses and others which allowed respondents to provide free text responses.

Overall, as detailed further in Figures 21 – 27 below, the responses indicated that the steering committee:

- Overwhelmingly found the experience highly professionally satisfying
- Felt the project had definitely delivered against its intended objectives
- Felt that the outcomes had been shared with the sector
- That the technology developed through the project was effective
- That the promotional activities relating to the project were effective
- That the partnership between McLean Care and Deakin University was effective
- That the project management framework used was effective
- That the steering committee model used for overall governance of the project was effective.

HOW PROFESSIONALLY SATISFYING DID YOU FIND YOUR EXPERIENCE IN THIS PROJECT?

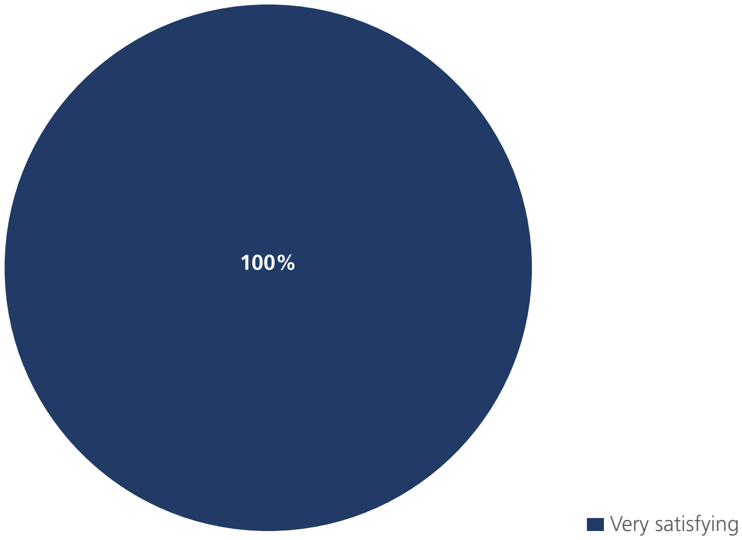


Figure 21. Self-Reported Level of Satisfaction for Project Team

HOW EFFECTIVELY DID THE PROJECT DELIVER AGAINST ITS INTENDED RESEARCH OBJECTIVES?

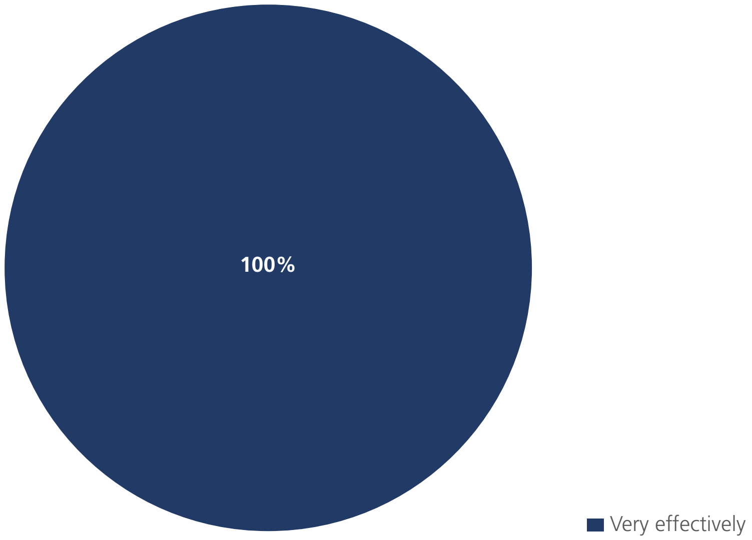


Figure 22. Steering Committee's Evaluation of Effective Delivery Against Intended Research Objectives

HOW EFFECTIVELY WERE THE OUTCOMES OF THE PROJECT DISSEMINATED ACROSS THE SECTOR?

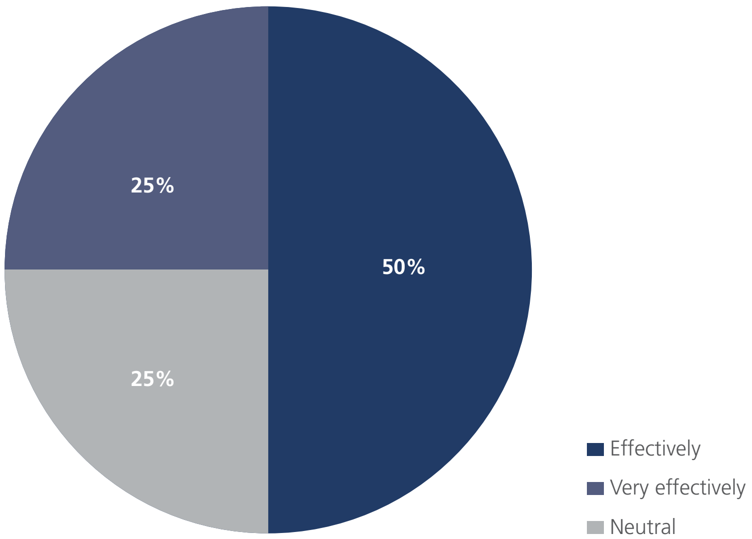


Figure 23. Steering Committee's Evaluation of the Effectiveness of Dissemination of Project Outcomes Across the Sector

HOW EFFECTIVE WAS THE TECHNOLOGY DEVELOPED THROUGH THIS PROJECT?

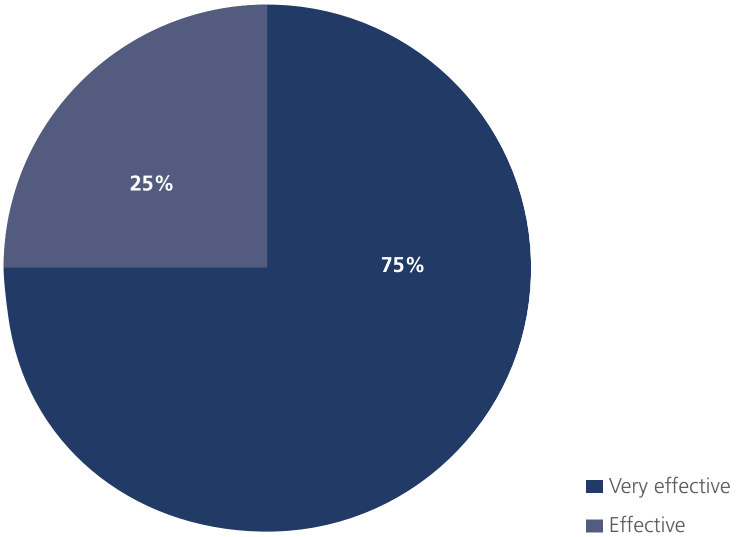


Figure 24. Steering Committee's Evaluation of the Effectiveness of Technology Developed Through the Project

HOW EFFECTIVE WAS THE PARTNERSHIP BETWEEN MCLEAN CARE AND DEAKIN UNIVERSITY?

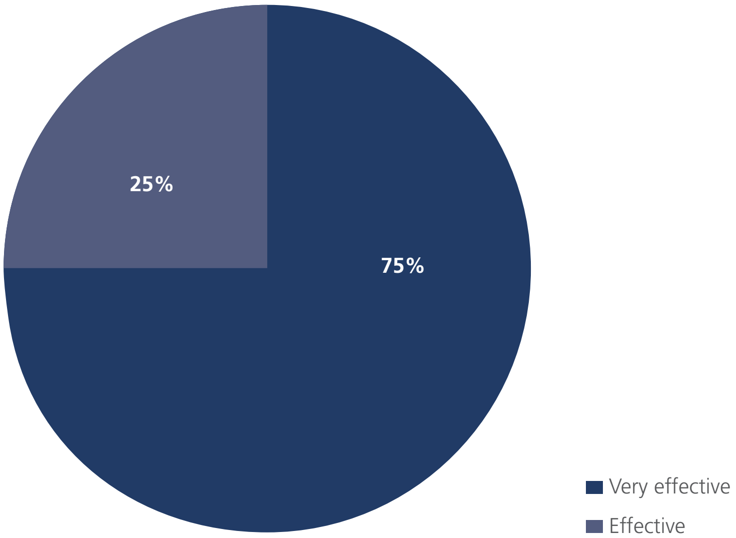


Figure 25. Steering Committee's Evaluation of the Effectiveness of the Partnership Between McLean Care and Deakin University

HOW EFFECTIVE WAS THE PROJECT MANAGEMENT FRAMEWORK THAT WAS USED FOR THIS PROJECT?

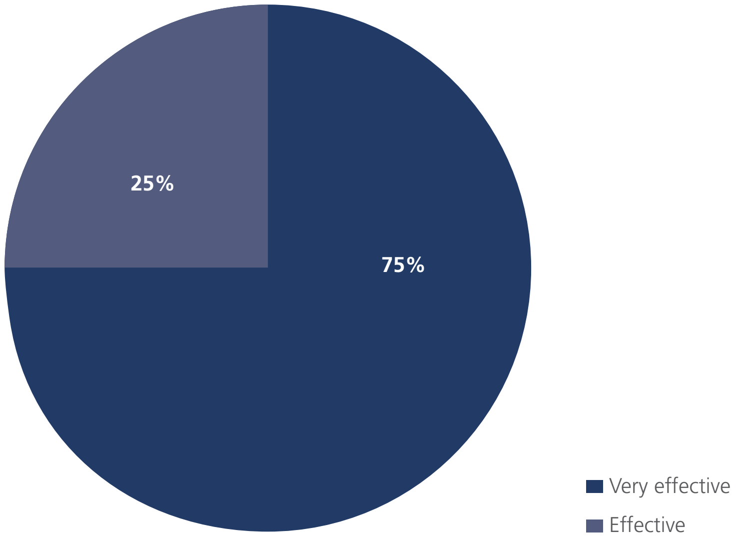


Figure 26. Steering Committee's Evaluation of the Effectiveness of the Project Management Framework Used for the Project

HOW EFFECTIVE DO YOU THINK THE STEERING COMMITTEE MODEL WAS THAT WAS USED FOR THIS PROJECT?

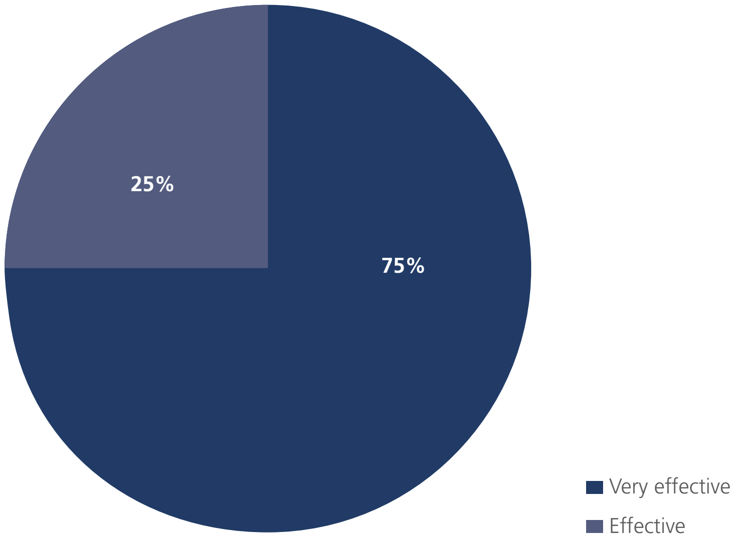


Figure 27. Self-Evaluation of the Steering Committee Model Used for the Project

The free text portion of the survey asked the steering committee to consider various aspects of the project in respect to what worked well, what could be improved and what did not work well. The full responses are provided in Appendix B.

Some of the comments in relation to what worked particularly well about the Steering Committee included:

- Collaboration, idea exchange, meetings were planned, targeted and efficient
- The steering committee meetings were well run and everyone was provided with appropriate documentation (agenda, minutes, action register) that made each meeting run smoothly

Some of the comments in relation to what worked particularly well about the relationship between Deakin and McLean Care include:

- Collaboration, communication, idea exchange, sharing of information, sense of equal partners
- Both partners worked well in providing professional insights throughout the project.
- Great, respectful communication. Subject matter experts who respected each others' areas of expertise as well. Building personal relationships and rapport by spending time in person that complemented the professional working relationships. Good will, highly professional people involved all round.

In response to the question "What do you think were the key enablers for this project?" some of the key responses include:

- The shared vision and strategy alignment of the project, ability to be flexible with project and Hector design
- The collaborative partnership between industry (McLean Care) and university (Deakin).
- The immersive experience of the car
- Right staff, right mix of subject matter expertise, well framed research approach, project manager.

In response to the question "What do you think were the main issues and barriers encountered?", the key responses were:

- The main challenge was the timeline required for development
- VR technology environment and the final location
- Unanticipated rates of motion sickness by users.

4.3.2 QUESTIONNAIRE RESPONSES

All participants were asked in the post-participation questionnaire to comment on what they most enjoyed about the experience.

A thematic analysis was undertaken of these responses and they are summarised below with highlight comments:

KEY THEME	COMMENTS
The overall experience	The whole experience I loved every minute of it. Just having the experience. Just being in the car and having the experience. It did show things like speeding, not taking corners properly, not indicating etc.
Trying VR for the first time	Experience of driving a car that's not moving! Having a go at something different Having the experience of using a driving simulator for the first time. Enjoyed the new technology. Trying something new. Having a go at the simulator. Experiencing something new. The technology.
Interaction with staff	Meeting the staff. Staff Talking to the presenters The staff
Being part of the trial	Trialling it Being involved in the development process
Receiving their test results	Knowing I had quick reflexes for stopping etc. The overall experience of actually doing it and testing your abilities. I think it could be a very useful tool. The results and that I completed.
Specific aspects of the driving experience	I enjoyed stopping at the signs. Being able to go out on the straight and put my foot down! Driving the car in the bends. On the straight road going fast. Recognising some of the locations. How impressed I was with the car.
Finishing / getting to the end / achieving a new skill / sense of succeeding at the task	Finishing! Achieving it - finishing to the end and not getting sick. Learning to turn the corners successfully.

Table 3 – Process Effectiveness – Selected Questionnaire Reponses

4.3.3 FOCUS GROUP RESPONSES

Six process-related questions were asked in the focus groups to gain a participant perspective on whether the process used for the project was effective. The responses are summarised in the table below:

QUESTION	SAMPLE OF RESPONSES
What are your reflections on the time you were asked to give to be involved?"	• Time allocated was just right • Did not feel rushed • Was not too much time to give up • Well worth it • Reasonable • Well timed
Did you feel that the project was clearly explained to you?" and "What was done well?'	• There was understanding of what was coming • Side effects were explained • Some things were needing to be experienced rather than explained • Explained well • Care taken to ensure comfort – particularly with headset • Supportive and informative • Continual instruction of what to expect throughout drive was beneficial • Reassuring was comforting
"What could be improved?"	• Unsure of reaction test – location and how it would appear • Trial of what is coming on a screen first before going into VR. Gives more idea of what is going to happen
"What words would you use to describe the way the research was managed / your interactions with the team?"	• Team was great • Feedback listened to and acted upon • Excellent • Well planned • Helpful • Care given by staff • Professional • Friendly and comprehensive • Patient • Caring • Explained well
"What did you enjoy most about being involved in this project?"	• Experiencing VR • Enjoyed the challenge • New technology • Enjoyed graphics and feedback • Interesting

QUESTION	SAMPLE OF RESPONSES
"What did you enjoy most about being involved in this project?"	• Staff were good • Discussing involvement and findings with family and friends • Trying to assist the elderly • Physical reactions were measured • To find out what it was all about • Reinforcement of road rules • Great that it was bought to rural setting • Having results printed • New experience / technology • Interesting and exciting • Finding out physical reactions to vehicle • Competitive results – bragging to family • Enjoyed noticeable improvements • Enjoyed educating others about project • Exposure to new opportunity to be involved in research – rural area • Contributing to feedback • Fun and educational for older people

Table 4 – Process Effectiveness - Focus Group questions and responses

Overall, the responses indicate that participants enjoyed a number of aspects of the project, that their commitment of time to the project was reasonable, that the project was clearly explained to them, and that the project overall was conducted professionally.

4.3.4 SUMMARY OF CHALLENGES AND ENABLERS

As part of a commitment to continuous improvement and to understand the challenges and enablers the project team compiled a summary of the key challenges and enablers for the Hector VR project. The lessons learnt, critical success factors and improvement opportunities were captured across the lifecycle of the project and are summarised below:

WHAT WORKED WELL

A critical success factor for this project was the *effective research-industry partnership* between McLean Care and Deakin University. This provided just the right mix of subject matter expertise to realise the vision for the project.

Formalising the partnership between McLean Care and Deakin University with a contract at the start of the relationship that outlined key milestones and related payment plan ensured a common understanding of expectations, roles and responsibilities and avoided potential confusion or misunderstanding later in the project. It also helped to ensure the project was delivered within budget and on time.

The *recruitment strategies* used for the research component of the project were highly successful and resulted in the target for research participant numbers not only being achieved, but exceeded.

The *media promotion strategies* were effective and resulted in a broad coverage and positive reporting on the project across a range of mediums (print, online, TV and social media).

The *iterative / action research methodology* was highly effective within the overall research and development design. Specifically, it enabled feedback from each testing phase of the project to be incorporated in to subsequent design phases to ultimately achieve a high degree of user acceptance.

This project had a range of social impacts and outcomes for older people. A *co-design methodology* was therefore particularly well suited to the project. This approach actively involves the end users in the design process. By inviting and valuing the input of 63 local older people across the Hector VR project design phases, it increased their buy-in, ongoing participation and the ultimate suitability of the simulator for its intended user audience.

Combining quantitative and qualitative data collection methodologies yielded rich data and offered a unique "human perspective" on the outcomes and impacts of the project and insight in to the impact of not having a driving licence for older people living in rural and farming communities.

Applying a formal project management methodology including the appointment of an experienced project manager helped to ensure all key milestones were met on time, within budget and that risks were actively managed and mitigated. This approach included regular steering committee meetings, running action list, active risk management and scheduled phases of work with identified decision gates.

The *project Steering Committee included key staff and authorized decision makers from both McLean Care and Deakin University* who governed the project to its successful outcome. Having these key staff involved ensured decisions could be made quickly and effectively, resources could be committed when required and there were no or minimal delays in waiting for necessary approvals.

THE CHALLENGES ENCOUNTERED

Requirement for Subject Matter Expertise: The development of a VR driving simulator required highly specialised skills and expertise. To address this issue, a review of various university specialist options across Australia was considered by McLean Care. Deakin University's CADET VR Laboratory team were identified as having the requisite breadth and depth of skills and experience and were engaged as the project partner. The relationship was formalised with a contract outlining roles and responsibilities as well as payment milestones.

Adverse Reactions to the Simulator: Research highlights that simulator sickness can be experienced by some users. The steering committee identified that there was a need to ensure participants were aware of this risk prior to giving consent to participate and to minimise the adverse reactions through design adaptations. The participant consent form was drawn up to include highlighting this risk and was approved by legal advisers prior to implementation.

The design process across successive phases also allowed for improved technology and adaptations over time that were tested by participants and found to minimise adverse reactions across the three phases.

Managing User Risks: The Steering Committee identified that there was a risk that participants may base decisions on future driving competence purely on the results of the driving simulator which was still a prototype in development. Legal advice was sought regarding appropriate disclaimers for use of the vehicle. The solution that as ultimately implemented is a requirement for all participants to sign a disclaimer on first use. A reminder disclaimer flashes on the screen at the start of each simulator use (which must be actively accepted by the user pressing the accelerator pedal in the vehicle); and the results print-out also contains a reminder that the results should not form the sole basis of decision-making.

Poor engagement from a key stakeholder: The intended research design was to benchmark the simulated driving test against the actual driving test conducted for older drivers in NSW. However, despite multiple attempts at contact across a prolonged period of time, the project team was unable to access the information

they required. When multiple attempts at contact proved fruitless, the Steering Committee discussed alternative options for accessing the information required to inform the design of the virtual driving test.

This information was eventually accessed from publicly available online sources and from reviewing academic literature on the most common factors impacting accidents by older drivers such as failing to give way and not turning correctly at a T intersection.

Automating results from the heart rate monitoring: The initial trials utilised a Fit-Bit smart watch to capture heart rate information from users during the driving simulation. However, a manual process was required to download the data and pair it with the driving simulator data. An alternative automated process using a different heart rate monitoring was trialled and implemented prior to handover of the final simulator prototype from Deakin to McLean.

OPPORTUNITIES FOR THE FUTURE

One of the design components that was raised through the development and testing phases was the potential to incorporate and *trial a motion platform in the design of the simulator.* Research on this design element indicates that it may have some impact on reducing levels of motion sickness experienced by some users. However, it was out of budget for the current project to trial this design element. The opportunity to trial it in the future may significantly improve the overall design of the simulator and reduce motion sickness amongst some users.

With additional funding, the Hector VR driving simulator could be *trialled on a much larger scale and made available to older people across regional and rural Australia* using a regional "road show" model. This next phase of the project would help to determine levels of user acceptance against a much higher sample of users, and would also ensure that the benefits of the technology are made available to a significantly higher number of older people in regional and rural Australia.

There is the potential for the simulator to be useful with a *variety of other target groups,* including learner drivers, people who are learning to drive again after an accident or illness, and people with a disability.

CHAPTER 5:

DISCUSSION OF MAJOR FINDINGS

Importance of Driving to Independence for Older People

As part of the focus groups conducted in this project, research participants were asked two questions regarding their perception of the importance of having a driver's licence. The results highlighted that the older drivers in the project felt very strongly about having a licence. When asked what they would do without one, some of the comments included:

"Fold up and die"

"One dreads to think what it would be like to lose it"

"No licence is like being in prison. (You) can't do anything."

"Would make life terrible."

"I don't know what I'd do."

When asked to comment on what they would do without a licence, focus group participants commented: I would "fold up and die" ... "No licence is like being in prison. You can't do anything."

These results are consistent with other research which has highlighted that forfeiture of driving privileges is considered a major loss by many older people (see for instance Marottoli, de Leon and Glass, 1997).

The thematic analysis of other comments made in relation to the importance of having a licence, and inversely the impact of not having a licence, was also consistent with broader research findings. For instance, a number of comments were made regarding quality of life, consistent with research by Edwards, Lunsman, Perkins, Rebok and Roth (2009). Comments included "[without a licence, I would experience] boredom," [it would impact] quality of life", "changes your lifestyle" and that having a licence allows older people to "travel / have holidays", "see family who live out of town" and "visit friends."

A further theme identified in the comments made by focus group participants was the impact losing or relinquishing their licence would have on their social life and connection to the community. Focus group participants made comments such as:

"[Without it, I would] stay at home more."

"You become house-bound."

"[It] would impact social life."

"You would have to stay at home and miss things you want to do."

This is consistent with broader research which has found that driving cessation amongst older people living in the community is linked with a decline in out of home activity levels, a decline in community access and connection and reduced social networks (regardless of the ability to use public transport) (see for instance Edwards, Perkins, Ross, & Reynolds, 2009).

Other focus group participants were concerned about how they would be able to respond in an emergency, and how they would be able to get to medical appointments, with comments such as:

"Can't respond in an emergency."

"Can't get to medical appointments."

"What happens if something goes wrong?"

Not surprisingly given the project was conducted in a regional farming community, a number of participants also highlighted that losing the independence related to having a licence was perhaps more of an issue in a country area. Comments were made such as:

"Big issue in rural/farming communities"

"If you don't have a network of family/friends here, who do you rely on?"

"Depends if family is still nearby."

"Not such a pain if you live in a city."

An additional theme identified in the analysis of the Hector VR focus groups that has not been particularly emphasised in the reviewed literature, was the sense of becoming dependent on others and not wanting to be a burden. This is reflected in the comments made by the focus group participants, such as [I] don't want to be a burden on my family" and that without a licence, they would "become dependent on others."

Overall, the focus group participants painted a compelling picture of the impact that they perceived losing their licence would have on them in the rural community in which they live. This confirms the importance of the Hector VR project and its aim of providing older people with objective information about their driving competence as a means of supporting them to make informed decisions about if and when to relinquish their licence. In turn, it is hoped that premature or unnecessary licence relinquishment is avoided for as long as possible, with associated positive impacts on the quality of life, social connectedness and independence of older Australians.

Older Drivers Modify Their Own Driving Behaviour

Although the primary goal of this project was not to explore older driver behaviour, all research participants were asked a set of basic questions regarding any modifications they make to their own driving. Initial questions were asked as part of the pre-participation questionnaire completed by all participants. Follow up questions were also asked in the focus groups to encourage further discussion and elicit more detailed responses.

Exactly half (50%) of the questionnaire respondents indicated that they do modify their own driving behaviour. This is consistent (although at a lower rate), than research from the UK, which found 100% of older drivers in their sample reported adapting their driving behaviour to reflect their changing abilities (Musselwhite and Haddad, 2010).

The main changes that drivers in the Hector VR project reported making related to limiting night-time driving and no longer driving in big cities like Sydney.

1 in 2 older people in our project identified that they modify their own driving behavior. They do this predominantly by limiting night-time driving. A number of older people also indicated that they no longer drive in big cities like Sydney and some also limit how often and how far they drive.

Self-imposed changes in driving behaviour were also discussed in the focus groups, which picked up a number of additional secondary themes such as older drivers driving more slowly, being more deliberate when checking what's coming, being more aware when towing a caravan, not having passengers in the car, using the train for longer trips, not driving on dual carriageway roads, and selecting the time of day to drive to the shops when there are less cars on the road.

A few participants also indicated that they take someone with them to share the driving, particularly on long-distance trips (examples given were husband, daughter, sister).

These findings are broadly consistent with other national and international literature, including an Australian study from 2003 that found the highest avoidance levels by older drivers were seen for busy traffic, night driving and driving at night when wet (Charlton, Oxley, Fildes, Oxley & Newstead, 2003).

The results confirm a level of self-awareness amongst participants regarding their changing level of driving competence and confidence, and a proactive approach to modifying their behavior as a means of compensating for such changes. Further research could be conducted to establish whether this self-awareness may be a contributing factor to older people being willing to use the driving simulator to access objective information about their key driving competencies such as reaction speeds.

Design Modifications for Minimising Simulator Sickness

Research has consistently identified that one of the major drawbacks of using virtual reality driving simulators is that some users experience simulator sickness, particularly older users (see for instance Brooks et al, 2010). In the Hector VR project, the rates of simulator sickness progressively decreased over successive releases of the updated prototype.

Whilst almost all of the participants in the first phase of testing ("alpha phase") reported symptoms related to simulator sickness (predominantly nausea), this reduced by approximately 30% in the second beta release testing phase. By the final release, only 47% of return participants who had gone through all three phases reported experiencing simulator sickness. The main symptom reported continued to be nausea. Significantly, although symptoms were experienced, all of the participants in this cohort still completed the test regardless of the symptoms experienced. This is in contrast to other international research which has found that simulator sickness has caused people to discontinue with driving simulator trials or to not complete the driving courses.

In the Hector VR project, the rates of simulator sickness progressively decreased over successive releases of the updated driving simulator prototype. A number of improved design features are thought to have contributed to this positive trend.

The rates of reported simulator sickness within the Hector VR research sample are consistent with other projects canvassed in the literature review, which reported rates of simulator sickness being experienced by users at rates between 30% - 59%.

The significant reduction in reported rates of simulator sickness in the Hector VR project between first use of the simulator and final use of the simulator would also tend to confirm the conclusions reached by Domeyer, Cassavaugh, & Backs (2013) that multiple exposures can reduce the rates of simulator sickness.

Further, the design modifications made across the development phases in the Hector VR project are also likely to have impacted the reduced rates of simulator sickness overall in the final release stage and in the types of sickness reported. For instance, in the alpha release phase, 33% of participants reported feeling "sweaty" when using the simulator. A small portable fan was subsequently introduced into the vehicle to encourage airflow and pedestal fans were also installed in the simulator room itself. Following these changes, by the final phase, only 6% of returning participants and 10% of new participants reporting feeling sweaty while completing the driving scenarios.

Similarly, in the initial alpha release phase, 24% of participants who experienced simulator sickness symptoms reported dizziness as one of their symptoms. Subsequent changes were made to improve vehicle control and course design (e.g. widening intersection corners), and the occurrence of simulator sickness symptoms decreased. Results also showed that simulator sickness symptoms decreased with the introduction of several shorter MR driving experiences (3-5 minutes) with a break in between rather than a single long MR experience as was trailed in the initial release (12 minutes).

These outcomes highlight that the Hector VR driving simulator is comparable with other driving simulators internationally and that effective modifications were made as part of the action research methodology based on feedback from users to reduce the overall experience of simulator sickness by the final release stage.

An area for future exploration may be more specific analysis of how repeated usage of the simulator may continue to positively reduce rates of simulator sickness by older users over time.

Research has consistently identified that one of the major drawbacks of using virtual reality driving simulators is that some users experience simulator sickness, particularly older users (see for instance Brooks et al, 2010). In the Hector VR project, the rates of simulator sickness progressively decreased over successive releases of the updated prototype.

Whilst almost all of the participants in the first phase of testing ("alpha phase") reported symptoms related to simulator sickness (predominantly nausea), this reduced by approximately 30% in the second beta release testing phase. By the final release, only 47% of return participants who had gone through all three phases reported experiencing simulator sickness. The main symptom reported continued to be nausea. Significantly, although symptoms were experienced, all of the participants in this cohort still completed the test regardless of the symptoms experienced. This is in contrast to other international research which has found that simulator sickness has caused people to discontinue with driving simulator trials or to not complete the driving courses.

The rates of reported simulator sickness within the Hector VR research sample are consistent with other projects canvassed in the literature review, which reported rates of simulator sickness being experienced by users at rates between 30% - 59%.

The significant reduction in reported rates of simulator sickness in the Hector VR project between first use of the simulator and final use of the simulator would also tend to confirm the conclusions reached by Domeyer, Cassavaugh, & Backs (2013) that multiple exposures can reduce the rates of simulator sickness.

Further, the design modifications made across the development phases in the Hector VR project are also likely to have impacted the reduced rates of simulator sickness overall in the final release stage and in the types of sickness reported. For instance, in the alpha release phase, 33% of participants reported feeling "sweaty" when using the simulator. A small portable fan was subsequently introduced into the vehicle to encourage airflow and pedestal fans were also installed in the simulator room itself. Following these changes, by the final phase, only 6% of returning participants and 10% of new participants reporting feeling sweaty while completing the driving scenarios.

Similarly, in the initial alpha release phase, 24% of participants who experienced simulator sickness symptoms reported dizziness as one of their symptoms. Subsequent changes were made to improve vehicle control and course design (e.g. widening intersection corners), and the occurrence of simulator sickness symptoms decreased. Results also showed that simulator sickness symptoms decreased with the introduction of several shorter MR driving experiences (3-5 minutes) with a break in between rather than a single long MR experience as was trailed in the initial release (12 minutes).

These outcomes highlight that the Hector VR driving simulator is comparable with other driving simulators internationally and that effective modifications were made as part of the action research methodology based on feedback from users to reduce the overall experience of simulator sickness by the final release stage.

An area for future exploration may be more specific analysis of how repeated usage of the simulator may continue to positively reduce rates of simulator sickness by older users over time.

Fit-for-Purpose Driving Simulator

The Hector VR project used an iterative design process, with successive improvements and modifications being made to the simulator across the three release and testing phases.

All participants were asked a series of questions in the post-participation questionnaire that were aimed at understanding the perceived usefulness of the product, and the likelihood that target users would engage with the technology in the future.

The results highlighted a high degree of positive feedback. For instance:

97% of users indicated that they agreed or strongly agreed that the test results printed out to summarise the driver performance are useful.

100% of users indicated that they agreed or strongly agreed that the test results were easy to understand.

83.4% of users indicated that they agreed or strongly agreed that the combination of virtual reality technology with a real physical car enhanced the overall experience.

100% of users indicated that they agreed or strongly agreed that the test results were easy to understand.

Responses to open-ended questions about whether the results were as the drivers had expected were also thematically analysed. The definite majority of users reported that the results regarding their driving competence were either as they expected, or better than they expected.

Additional feedback was gathered through an open-ended question asked in the post-participation questionnaires inviting participants to comment on their overall experience. Some of the key comments included:

"I loved it. I want one in my lounge room!"

"I thoroughly enjoyed it."

"Exhilirating!"

"Excellent"

"Very good. Terrific. Really liked it."

"More than happy to take part. I think it will be very significant."

"I was very impressed with it all. I liked the country driving as that's what it's like around here."

"Nice easy car to drive."

"I loved every minute of it."

"Exhilirating!"

"I loved it. I want one in my lounge room!"

Overall, these results evidence the success of the project in creating a fit-for-purpose driving simulator with very high rates of end-user acceptance of the technology.

Self-Reported Reasons for Older Drivers Intending to Use the Driving Simulator in the Future

As part of the TAM-VR scale administered with all participants across the three phases of the project, the older drivers were asked a set of questions regarding their intention to use the driving simulator in the future (assuming they had access to it).

The questions were deliberately intended to determine any differences in the purposes for which older drivers were most likely to access the simulator.

Overall, 63% of the total sample group indicated that they would use the simulator again in the future for enjoyment. 19% disagreed with the statement. It is likely that to some extent, this result was influenced by the rates of simulator sickness experienced by some users.

Similarly, 63% agreed or strongly agreed that they would use the simulator again in the future to practice driving, with 16% disagreeing with this statement.

In comparison, overall, 78% of the sample group indicated that they agreed or strongly agreed with the statement "if I wanted to know more about my driving competence, I would use the driving simulator." Only 8% disagreed with the statement.

Comments made in the focus group were also consistent with these findings. For instance, when asked why they would use Hector VR in the future, focus group respondents made comments such as:

"To give you an idea of how competent you still are at driving."

"Show if your skills are slipping."

"Hone your skills."

"Test your reactions."

"Check reaction times to stopping."

"Fun."

Responses to open-ended question in the post-participation questionnaire also yielded some rich insights. Comments were made such as:

"It would become second nature to just book yourself in every 6 months or so, just like going to the doctor"

Overall, the main reason older drivers gave for intending to use the Hector VR driving simulator in the future is to find out more about their driving competence. 78% of the sample group reported intending to use it for this purpose, highlighting that the project has achieved its goal of creating a simulator suitable for providing older drivers with objective information that will help them make informed decisions about their driving. Other reported reasons for accessing the simulator in the future are for practicing driving and for enjoyment.

"It would become second nature to just book yourself in every 6 months or so, just like going to the doctor"

Overall, this is a very high acceptance rate and highlights that the driving simulator is perceived by the target end-user group as being fit for its intended purpose of providing objective information to older drivers that will help them to make informed decisions about ongoing driving competence. The secondary reasons for intended use in the future were to practice driving and for enjoyment, again in line with the intended project outcomes.

CHAPTER 6:

CONCLUSION AND RECOMMENDATIONS

Conclusion

Overall, the Hector VR Driving Simulator project delivered against all stated aims and objectives and has produced valuable research and an effective prototype that could easily be replicated and utilised broadly across the Australian and potentially, the international community.

Use of the Hector VR driving simulator on an ongoing basis / broader scale is likely to yield benefits including:

o Improved quality of life for older drivers by preventing premature / unwarranted licence relinquishment

o Improved road safety outcomes

This project has highlighted the utility of an effective research-industry partnership and the application of a robust project management methodology for the development of an innovation of this nature.

The iterative co-design methodology across three development phases was also particularly effective in this context. From the outset, and throughout all stages of the project, the end users – older drivers, were made central to the process. Their views and input were highly valued and translated directly in to the design of the final prototype.

The project has yielded rich insights regarding older driver behaviour, their willingness to engage with emerging technologies such as VR, and the high degree of user-acceptance of the final product

The research outcomes are consistent with existing research in the field regarding the importance older people place on the independence, mobility and community access that having a drivers' licence offers, particularly in regional and rural communities.

It is apparent that the Hector VR driving simulator offers older drivers the opportunity to test their skills in a low-risk, safe and supported environment. The driving test results offer individual drivers objective information about their driving competence and adherence to road rules in the simulated environment. Although the sample size is not large enough to reach broader conclusions, for the sample in this study at least, the simulator has offered a tool that supports informed and dignified decision making about future driving options.

Overall, the process used and the outcomes achieved are consistent with the original aims of the study.

Recommendations

It is recommended that:

1. The results of this project continue to be widely shared and disseminated within the sector and in other appropriate forums.
2. Funding be sought to trial the simulator prototype on a much larger scale and with a variety of target user groups such as those with a disability, young drivers and older people with dementia.
3. Funding be sought to incorporate and trial a motion platform in the design of the simulator to investigate whether this reduces the rates of simulator sickness experienced by users.
4. Funding be sought to take the current simulator "on the road" and make it accessible to more older drivers across more regional communities.

Ali, A. Elnaggarz, A., Reichardtz, D. and Abdennadher, S. (2016) "Gamified Virtual Reality Driving Simulator for Asserting Driving Behaviors.", International Conference on Game, Game Art, and Gamification, pp. 1-6.

Australian Bureau of Statistics, http://www.abs.gov.au

Australian Institute of Health and Welfare, http://www.aihw.gov.au/ageing/

Brendemuhl D, Schmidt U, Schenk N. (1988) "Driving behaviour of elderly motorists in standardised test runs under road traffic conditions". In: Rothengatter J, de Bruin R, editors. Road user behaviour: theory and research. Dordrecht: Van Gorcum.

Brooks, J.O., Goodenough, R.R., Crisler, MC., Klein, ND., Alley, RL., Koon, BL., Logan, WC., Ogle, JH., Tyrrell, RA., Wills, RF. (2010) "Simulator sickness during driving simulation studies" Accident Analysis and Prevention. Volume 42, Issue 3, May 2010, pp 788 – 796.

Casutt, G.; Martin, M.; Keller, M.; Jäncke, L. (2014) The relation between performance in on-road driving, cognitive screening and driving simulator in older healthy adults. Transp. Res. Part F 2014, 22, 232–244.

Casutt, G.; Theill, N.; Martin, M.; Keller, M.; Jäncke, L. (2014 B) The drive-wise project: Driving simulator training increases real driving performance in healthy older drivers. Front. Aging Neurosci. 2014, 6, 85.

Charlton, J. L., Oxley, J., Fildes, B., Oxley, P., & Newstead, S. (2003). Self-regulatory behaviours of older drivers. Annual proceedings. Association for the Advancement of Automotive Medicine, 47, pp 181–194.

De Winter,J., Van Leuween, P., and Happee, P (2012) "Advantages and disadvantages of driving simulators: a discussion," in Proceedings of Measuring Behavior, pp. 47-50.

DfT (Department for Transport, UK) (2001) Older Drivers: A Literature Review. London: Department for Transport.

Domeyer, J., Cassavaugh, N., & Backs, R. (2013) "The use of adaptation to reduce simulator sickness in driving assessment and research" in Accident; analysis and prevention 53: pp 127-32.

Edwards, J. D., Lunsman, M., Perkins, M. Rebok, G.W. & Roth, D.L. (2009) Driving cessation and health trajectories in older adults Journals of Gerontology Series A: Biomedical Sciences and Medical Sciences, vol. 64, pp. 1290-1295, 2009. doi:10.1093/gerona/glp114

Edwards, J.D., Perkins, M., Ross, L.A., & Reynolds, S.L. (2009) Driving Status and Three-Year Mortality Among Community-Dwelling Older Adults J Gerontol A Biol Sci Med Sci. Vol 64A. No 2, pp 300 – 305. doi:10.1093/gerona/gln019

Freeman, E.E.; Gange, S.J.; Munoz, B.; West, S.K. (2006) Driving status and risk of entry into long-term care in older adults. Am. J. Public Health 2006, 96, pp 1254–1259.

Frittelli, C., Borghetti, D., Iudice, G., Bonanni, E., Maestri,M., Tognoni, G., Pasquali, L., Iudice, A (2009) "Effects of Alzheimer's disease and mild cognitive impairment on driving ability: a controlled clinical study by simulated driving test," International Journal of Geriatric Psychiatry: A journal of the psychiatry of late life and allied sciences, pp. 232-238. https://doi.org/10.1002/gps.2095

Garcia-Betances, R., Jiminez-Mixco, V., Arredondo, M and Cabrera-Umpierrez, M. (2014) "Using Virtual Reality for Cognitive Training of the Elderly" American Journal of Alzheimer's Disease and Other Dementias. Published online 7 August 2014 at: http://aja.sagepub.com/content/early/2014/08/07/1533317514545866

Hakamies-Blomqvist L (1988) Fatal road accidents involving elderly drivers. Paper presented at the commission of the European communities workshop on errors in the operation of transport systems, Cambridge.

Hakamies-Blomqvist, L.; Johansson, K.; Lundberg, C. (1996) Medical screening of older drivers as a traffic safety measure—A comparative Finnish–Swedish evaluation study. J. Am. Geriatr. Soc. 1996, 44, 650–653.

Jacobs, M., van der Zwaana, KF., Hart, EP, Groeneveld, GJ, Roosa, RA. “Comparable rates of simulator sickness in Huntington’s disease and healthy individuals” Transportation Research Part F: Traffic Psychology and Behaviour. Volume 60, January 2019, Pages 499-504. https://doi.org/10.1016/j.trf.2018.11.007

Karthaus, M. and Falkenstein, M. (2016) “Functional Changes and Driving Performance in Older Drivers: Assessment and Interventions.” Geriatrics. Published 20 May 2016.

Kyrö, P. (2004). Benchmarking as an action research process. Benchmarking: An International Journal

Langford, J & Koppel, S. (2006). Epidemiology of older driver crashes – Identifying older driver risk factors and exposure patterns. Transportation Research Part F: Traffic Psychology and Behaviour. 9. 309-321. doi:10.1016/j.trf.2006.03.005.

Lavallière, M.; Simoneau, M.; Tremblay, M.; Laurendeau, D.; Teasdale, N. (2012) “Active training and driving-specific feedback improve older drivers’ visual search prior to lane changes.” BMC Geriatr. 2012, 12, 5.

Likitweerawong, K. and Palee, P. (2018) “The virtual reality serious game for learning driving skills before taking practical test,” in International Conference on Digital Arts, Media and Technology (ICDAMT), 2018, pp. 158-161

Marottoli, RA, Mendes de Leon, CF and Glass, TA (1997) “Driving cessation and increased depressive symptoms: Prospective evidence from the new haven EPESE.” Journal of American Geriatric Society. Volume 45: pp 202 – 206.

Marottoli, R.A.; de Leon, C.F.M.; Glass, T.A.;Williams, C.S.; Cooney, L.M., Jr.; Berkman, L.F. (2000) “Consequences of driving cessation: Decreased out-of-home activity levels. J. Gerontol. B 2000, 55, pp 334–340.

Matas,N.A., Nettelbeck, T. & Burns, NR. (2015) “Dropout during a driving simulator study: A survival analysis”

Journal of Safety Research, 55 (2015), pp. 159-169. https://doi.org/10.1016/j.jsr.2015.08.004

Mezuk,B. & Rebok, G.W. (2008) Social Integration and Social Support Among Older Adults Following Driving Cessation, The Journals of Gerontology: Series B, Volume 63, Issue 5, Pages S298–303. Accessible at: https://doi.org/10.1093/geronb/63.5.S298

Michaels J, Chaumillon R, Nguyen-Tri D, Watanabe D, Hirsch P, Bellavance F, et al. (2017) Driving simulator scenarios and measures to faithfully evaluate risky driving behaviour: A comparative study of different driver age groups. PLoS ONE 12(10): e0185909. https://doi.org/10.1371/journal.pone.0185909

Mullen, NW., Weaver, B., Riendeau, JA., Morrison, L.E., Bédard, M. (2010) “Driving performance and susceptibility to simulator sickness: Are they related? American Journal of Occupational Therapy, 64 (2) (2010), pp. 288-295

Musselwhite, C., & Haddad, H. (2010). Exploring older drivers’ perceptions of driving. European journal of ageing, 7(3), 181–188. doi:10.1007/s10433-010-0147-3

Ni, R., Kang, J., and Andersen, G. (2010) Age-related declines in car following performance under simulated fog conditions Accid Anal Prev 42 (3): 818 – 826. doi:10.1016/j.aap.2009.04.023.

Peek, S., Michael, T., Wouters, E., Luijkx, K., Vrijhoef, H. (2016) “What it Takes to Successfully Implement Technology for Ageing in Place: Focus Groups with Stakeholders.” Journal of Medical Internet Research 18 (5) e98 pp 1 – 13. http://www.jmir.org/2016/5/e98/

Preusser, DF., Williams, AF., Ferguson, SA., Ulmer, RG., Weinstein, HB. (1998) “Fatal crash risk for older drivers at intersections.” Accid Anal Prev. 30(2):pp 151-159.

Redelmeier, D.A.; Yarnell, C.J.; Deva Thiruchelva, A.B.; Tibshirani, R.J. (2012) “Physicians’ Warnings for unfit drivers and the risk of trauma from road crashes. N. Engl. J. Med. 2012, 367, pp 1228–1236

Reed, N., Parkes, A., Peacock, C., Lang, B. & Rehm, L, (2007) SCOTSIM: An Evaluation of The Effectiveness of Two Truck Simulators for Professional Driver Training. Accessed at: https://www.researchgate.net/publication/276886488_SCOTSIM_an_evaluation_of_the_effectiveness_of_two_truck_simulators_for_professional_driver_training/citation/download

Roenker, D.L.; Cissel, G.M.; Ball, K.K.;Wadley, V.G.; Edwards, J.D. (2003) "Speed-of-processing and driving simulator training result in improved driving performance." Hum. Factors 2003, 45, pp 218–233

Schlag, B. (1993) "Elderly drivers in Germany – fitness and driving behaviour." Accid Anal Prev, 1993, Feb 25 (1) pp 47 – 55.

Siren, A.; and Meng, A. (2012) "Cognitive screening of older drivers does not produce safety benefits." Accid. Anal. Prev. 2012, 45, pp 634–638.

Szlyk, J.P.; Pizzimenti, C.E.; Fishman, G.A.; Kelsch, R.; Wetzel, L.C.; Kagan, S.; Ho, K. (1995) "A comparison of

driving in older subjects with and without age-related macular degeneration." Arch. Ophthalmol. 1995, 113, pp 1033–1040.

Transport Accident Commission, http://www.tac.vic.gov.au/road-safety/statistics/summaries/older-driver-statistics

Trick,LM., Toxopeus, R. and Wilson,D. (2010) "The effects of visibility conditions, traffic density, and navigational challenge on speed compensation and driving performance in older adults," Accident Analysis & Prevention, vol. 42, pp. 1661-1671.

Webber, S.C.; Porter, M.M.; Menec, V.H. (2010) "Mobility in older adults: A comprehensive framework." Gerontologist 2010, 50, pp 443–450

Whelan,M., Langford,J., Oxley, J., Koppel, S. and Charlton,J. (2006) "The Elderly and Mobility: A Review of the Literature." Melbourne: Monash University Accident Research Centre. Report No. 255. Accessible at: https://www.monash.edu/ data/assets/pdf_file/0017/216530/muarc255.pdf Accessed 13 February 2018

World Health Organisation and Alzheimer's Disease International (2012) "Dementia: A Public Health Priority." Accessed at: http://www.who.int/mental_health/publications/dementia_report_2012/en/ Accessed 13 February 2018

DEAKIN UNIVERSITY

TO: Participants Date:

PLAIN LANGUAGE STATEMENT

Full Project Title: Virtual Reality (VR) Driving Simulator for Elderly Drivers

Principal Researcher: A/Prof. Ben Horan

Student Researcher:

Associate Researcher(s): Michael Mortimer, Sue Thomson, Alicia Eugene

Introduction

You are invited to take part in this research project. You have been invited to participate because you meet the criterion for participation in relation to your age being sixty-five (65) years and older. This Plain Language Statement/Consent Form tells you about the research project. It explains what is involved in using the virtual reality driving simulator and why we are conducting this research. Knowing what is involved will help you decide if you want to take part in the research. Please read this information carefully. Ask questions about anything that you don't understand or want to know more about. Before deciding if to take part, you might want to talk about it with a relative or friend.

Participation in this research is completely voluntary. If you don't wish to take part you don't have to.

If you decide you want to take part in the research project, you will be asked to sign the consent form. By signing it you are telling us that you:

- Understand what you have read;
- Consent to take part in the research project; and
- Consent to the collection and use of your personal and health information as described You will be given a copy of this Plain Language Statement (PLS) and Consent Form to keep.

WHO IS ORGANISING AND FUNDING THIS RESEARCH?

This research project is being conducted by McLean Care in collaboration with Deakin University and Aubade Consultants.

It is funded by the Australian Government through the Dementia and Aged Care Services fund and McLean Care is the primary grant recipient. Staff from Deakin University and Aubade Consultants will receive payment from McLean Care for undertaking the research.

You and your families will not benefit financially from this research project, even if knowledge acquired through this research leads to discoveries that are of commercial value to McLean Care and/or Deakin University.

No member of the research team will receive a personal financial benefit from your involvement in this research project other than their ordinary wages.

WHO HAS REVIEWED THE RESEARCH PROJECT?

All research in Australia involving humans is reviewed by an independent group of people called a Human Research Ethics Committee (HREC). The ethical aspects of this research project have been approved by the HREC of Deakin University.

This project will be carried out according to the National Statement on Ethical Conduct in Human Research (2007). This statement has been developed to protect the interests of people who agree to participate in human research studies.

WHAT IS THE PURPOSE OF THIS RESEARCH?

Overall, this research explores whether a virtual reality driving simulator can help older drivers to test their driving competence in a completely safe, low-risk "virtual environment" and use the information generated to make informed decisions regarding ongoing driving licencing options.

Driving is the key to independence for many adults. However, the ability to drive safely can begin to decline in older drivers, and therefore there is a need to strike a balance between continued independence of individual drivers and broader considerations of general road safety. The decision as to whether to retain or relinquish a driver's licence has a direct impact on the quality of life of older people and, often, on their need to access aged care services. Some research has shown that older people are more likely to access residential aged care once they relinquish their licence, even if their preference is to stay in their own homes. Currently in NSW, it is compulsory for older drivers to take a practical driving test every two year after their 85th birthday. Similar requirements are also in place in other states and territories in Australia.

The purpose of this research is to understand:

- If participants find that using the simulator provides useful information about their driving competence;
- If participants find that this information about their driving competence is useful in informing future decisions about driver licencing;
- The level of user acceptance of the technology;
- To what extent the final product delivers against the intended design outcomes and the feedback from users in the earlier release stages;
- Whether the process utilised to deliver the project is effective.

This research has been funded by the Australian Government through the Dementia and Aged Care Services fund.

This research is being conducted through a collaborative partnership between McLean Care, Deakin University and Aubade Consultants.

WHAT DOES PARTICIPATION IN THIS RESEARCH INVOLVE?

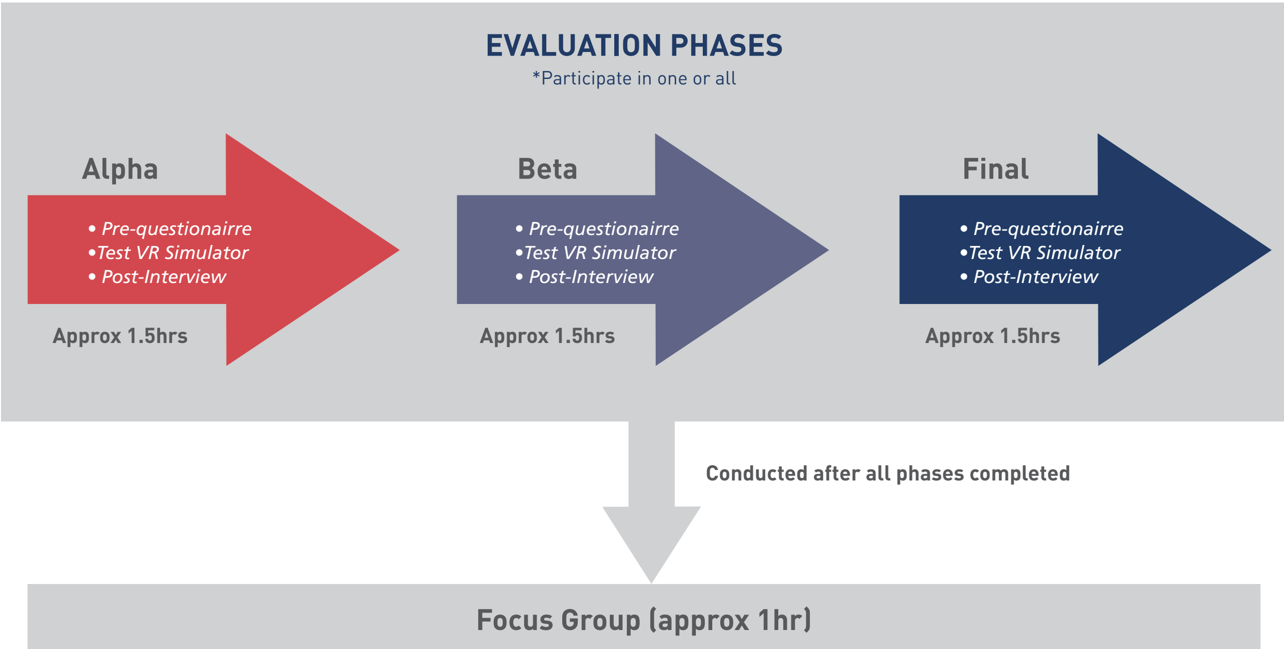
This project involves giving older drivers the opportunity to drive in a safe, low-risk "virtual" environment. It is expected that the virtual driving experience will help elderly drivers understand more about their competence as a driver and / or to practice driving without actually being on the road.

The simulator will include different road environments and realistic driving scenarios such as country driving, driving in town and responding to various levels of road traffic and commonly encountered driving hazards. It is modelled on the local township of Inverell in regional NSW.

More than just a driving simulator, it will also monitor and record a range of important data and information from the user such as their response rate times and other important health and performance metrics. This is expected to provide older drivers with important information to help them make an informed decision about their driving in a completely private, safe

and non-intrusive environment where there is no obligation to disclose or share any aspect of their driving results unless they choose to.

The project has 3 phases related to the different stages of building and testing the driving simulator itself, the diagram below shows these 3 different phases and associated participation activities and times.



Depending on when you are approached to participate in the research, you may be involved in the first, second, or final stage of the project; or a combination of these stages. You can withdraw from the project at any time including your data.

Your involvement in the project is anticipated to take approximately 1.5 hours each time you participate as well as a 1 hour focus group at the end of the project upon final release of the simulator. If you participate in all three phases of the research, as well as the focus group, your maximum time commitment will be up to a total of 5.5 hours (spread over at least three different dates).

The research will be conducted between June and December 2018. You will be contacted by the project team to advise what dates and times you have been scheduled for participation in a session.

Complimentary assistance with transport to get to the site where the research is being conducted can be provided upon request by McLean Care.

There are no costs associated with participating in this research project, nor will you be paid to participate.

The research will be undertaken in accordance with the Ethics Approval granted by Deakin University's Human Research Ethics Committee.

WHAT DO I HAVE TO DO?

There is nothing special that you need to do to participate in this research.

No prior experience with computers or technology is required to use the simulator and instruction on how to use the simulator will be provided with support available throughout your session/s.

If you normally wear a hearing aid or glasses; you should bring these with you to each session.

If you have a pre-existing medical condition that precludes you having a driver's licence; please seek medical advice before participating.

When you attend a scheduled session, you will be asked to complete some questionnaires and then take part in a simulated driving experience using virtual reality technology. You will be interviewed again after your driving experience.

The user experience for the driving simulator has been designed to mimic real life driving as much as possible. Several considerations have been factored in to the design of the simulator to ensure it is very user-friendly and accessible for older drivers, including those with mobility issues. This includes adjustable seat heights, a familiar Australian vehicle, and the graphics in the VR environment modelled on the local Inverell township. One-on-one support to fit and use the VR headset will also be provided.

WHAT ARE THE POSSIBLE BENEFITS OF TAKING PART?

By deciding to participate in this project, you will be taking part in research that is the first-of-its-kind in Australia.

You will personally receive completely private and confidential information regarding your virtual driving experience that you might find interesting such as your driving response rate times.

Some research indicates that using virtual reality technology can be an enjoyable and exciting experience for participants as it exposes people to a new experience.

Your input and participation will also help to contribute to the body of research regarding the impact that driving has on the general well-being on elderly people; and the importance of exploring emerging technologies as a tool for supporting older people to make an informed decision about their ongoing driving competence.

WHAT ARE THE POSSIBLE RISKS AND DISADVANTAGES OF TAKING PART?

There are no known or anticipated risks or disadvantages of taking part in this research.

Consistent with real-life driving experiences and the use of technology such as 4D movies and gaming technology, some participants may experience some discomforts such as motion sickness and or claustrophobia.

A trained staff member will be in the room with you at all times and if you are experiencing any discomfort, you can stop immediately and simply remove the headset. If the headset causes discomfort, you can choose to use an alternative projected visual display instead.

WILL I BE GIVEN THE RESULTS OF THE RESEARCH PROJECT?

Each individual participant can request to access the data collected from their driving experience in either a printed or electronic format.

If you indicate on this consent form (by ticking the relevant box) that you would like to receive information on the general outcomes of the research project, you will be sent a copy of a research summary document at the conclusion of the project period to the postal address or email address that you have nominated.

WHAT WILL HAPPEN TO INFORMATION ABOUT ME?

The information you supply in the questionnaires and interviews together with the results of your driving experience will be stored in a re-identifiable format and be used for general data analysis within the overall sample of 50 people.

A re-identifiable format means that all individual identifiers (e.g. your name and personal details) will be not be stored in the same location with the data collected about your use of the simulator. A unique 8-digit number will be used to store your data and you will be given a copy of this number in your first evaluation activity. This number is linked to your personal identifiers (e.g. your name and personal details) using another key which will be stored separately by the lead researcher. You will be requested to bring this number to subsequent evaluation activities. If you lose this number for subsequent research activities you can ask the research team to recover the number for you.

Video or audio recorded will also be stored securely using the same 8-digit number and without your personal details attached.

Only the approved researchers listed in this research form will have direct access to your data.

The data will be securely stored in a format approved by the University for a minimum period of 5 years in accordance with the Deakin ethics approval requirements.

In accordance with relevant Australian and NSW privacy and other relevant laws, you have the right to request access to your information collected and stored by the research team. You also have the right to request that any information be withdrawn or corrected. Please contact one of the research team members listed in the contacts section below if you would like to access your information.

It is anticipated that the results of this research project will be published and/or presented in a variety of forums. In any publication and/or presentation, information will be provided in such a way that you cannot be identified unless prior permission has been obtained.

OTHER RELEVANT INFORMATION ABOUT THE RESEARCH PROJECT

It is anticipated that a total of 50 people from the New England region will participate in this research project.

Participants may be recruited at different stages of the project. All participants of a particular phase of the project will undergo through the same process, and there are no control/case groups in this project.

All research will be undertaken at McLean Care's customised VR room facility located at 67 Killean Street, Inverell, NSW.

CONTACTS

The person you may need to contact will depend on the nature of your query.

If you want more information concerning this project or want to discuss your involvement in the project further, you can contact:

General enquiries

Name	Alicia Eugene
Position	Project Manager
Telephone	0447 336 987
Email	aubadeconsultants@gmail.com

Chief Executive Officer (CEO)

Name	Sue Thomson
Position	Chief Executive Officer (CEO)
Telephone	(02) 6721 7300
Email	sue.thomson@mcleancare.org.au

Name	Associate Professor Ben Horan
Position	Research Lead
Telephone	0401 345 711
Email	ben.horan@deakin.edu.au

COMPLAINTS

If you have any complaints about any aspect of the project, the way it is being conducted or any questions about your rights as a research participant, then you may contact:

Name	The Human Research Ethics Office
Address	Deakin University, 221 Burwood Highway, Burwood Victoria 3125
Telephone	(03) 9251 7129
Email	research-ethics@deakin.edu.au

** Please quote project number BH00028*

TO: Participants Date:

CONSENT FORM

Full Project Title: Virtual Reality (VR) Driving Simulator for Elderly Drivers

Reference Number: BH00028

I have read and I understand the attached Plain Language Statement.

I freely agree to participate in this project according to the conditions in the Plain Language Statement.

I understand that as a willing participant of the project I may be recorded either via audio or video during individual interviews or focus groups. I will have the option to review any audio, video recordings and can request the withdrawal of the recorded content or amend any transcripts created as part of the interviewing or focus group process.

I understand that the research project may consist of up to 3 different evaluation phases each requiring approximately 1.5 hours of participation as well a possible 1 hour focus group session. Participation is voluntary and I have the option to withdraw at any phase.

I have been given a copy of the Plain Language Statement and Consent Form to keep.

☐ (Tick here) I would like to receive information on the general outcomes of the research project, and send it to:

____

The researcher has agreed not to reveal my identity and personal details, including where information about this project is published, or presented in any public form.

Participant’s Name (printed) ______________________________

Signature ____________________________________ Date ____________________

STEERING COMMITTEE SELF EVALUATION SURVEY – FREE TEXT RESPONSES

What aspects of the Steering Committee worked well?	• Collaboration, idea exchange, meetings were planned, targeted and efficient • The steering committee meetings were well run and everyone was provided with appropriate documentation (agenda, minutes, action register) that made each meeting run smoothly • Dedicated project manager, enabled decision makers, scheduling in advance, agreed Terms of Reference
What aspects of the Steering Committee could have been improved?	• Conference call set up • Length of meetings
Other comments on the Steering Committee :	• The committee assisted in fostering relationships between McLean Care and Deakin
What aspects of the project management approach worked well?	• The project management approach structure work really well - particular Collaborative approach, feedback and actioning processes • Both the action and risk register were invaluable throughout the project. • It was very useful to have the running action log to keep on top of who was responsible for what. The risk register was also an effective way of proactively managing any emerging issues before they became major problems. In turn, this helped ensure the intended outcomes of the project were achieved.
What aspects of the project management approach could have been improved?	• The use of a live gannt chart could be useful in the future.
What aspects of the partnership worked well?	• Collaboration, communication, idea exchange, sharing of information, sense of equal partners • Both partners worked well in providing professional insights throughout the project. • Great, respectful communication. Subject matter experts who respected each others' areas of expertise as well. Building personal relationships and rapport by spending time in person that complemented the professional working relationships. Good will, highly professional people involved all round.
What aspects of the partnership could have been improved?	• Budget communication and discussion around alignment
Other comments about the partnership	• Look forward to working together in the future.

STEERING COMMITTEE SELF EVALUATION SURVEY – FREE TEXT RESPONSES

What aspects of the technology development process worked particularly well?	• Ability of Deakin to respond to changes that needed to be made quickly, the think tank approach form Deakin, heavily investing in consumer feedback • The development cycles and user evaluation worked excellent throughout the project • The iterative design process in which feedback from each stage was used to improve the later stages. Splitting user testing groups so there were comparisons across time longitudinally.
What aspects of the technology development could have been improved?	• A greater proportion of the project timeline could have been assigned to development • Maybe incorporating a motion platform.
Other comments about participant recruitment :	• Participant recruitment worked really well and the project had more participants than initially expected.
What aspects of the promotional activities worked particularly well?	• Media campaign • Video recordings in particular those created for the Ageing Asia Awards were extremely effective • Social media, direct contact, Media liaison and Newsletter content, experience days • The Try-VR day seemed to be very effective. Great local support generated as well. Positive local media coverage.
What aspects of the promotional activities could have been improved?	• Campaign collateral • The inclusion of a brand ambassador maybe useful in the future. • Budget restraints so traditional media was not included - TV and radio awareness would have been effective for the awareness of the project and communicating those key messages.
Other comments about promotional activities:	• Internal communications wasn't an initial focus with more around external activities. Should have been more of this from the start across the organisation to get more understanding and awareness across the Mclean care staff and current customers.
What aspects of sharing project outcomes worked particularly well?	• All print mediums, and social media • The project managed to participant in several events (awards, conferences and webinars) • Sharing in conferences, nominating for awards, publishing academic articles
What aspects of sharing project outcomes could have been improved?	• Project outcomes across non sector entities • Publishing further articles in ageing-specific academic journals vs just the tech side.
Other comments about achieving the intended research outcomes :	• TAM results taken from surveys conducted through three evaluation phases indicated that research objectives were achieved. • Highlights other potential markets • The intended outcomes were not only achieved but exceeded.

STEERING COMMITTEE SELF EVALUATION SURVEY – FREE TEXT RESPONSES

What do you think were the key enablers for this project?	• The shared vision and strategy alignment of the project, ability to be flexible with project and Hector design • The collaborative partnership between industry (McLean Care) and university (Deakin). • The immersive experience of the car • Right staff, right mix of subject matter expertise, well framed research approach, project manager.
What do you think were the main issues and barriers encountered?	• Motion sickness has been a real barrier • The main challenge was the timeline required for development • VR technology environment and the final location • Unanticipated rates of motion sickness by users.
What would you do the same in another similar project?	• Collaborative approach, idea think tanks, project deigns approach • I would do the majority of the project the same as it provided a great foundation. • Testing phase • Agreed roles and responsibilities in contract at start, project manager, running action log
What would you do differently in another similar project?	• Add additional time in for final handover - seemed a bit rushed Add an additional budget for user testing so that some of the barriers can be overcome or mitigate in a better time frame • Try and assign more development time, although this was difficult through this project as I believe it provided a good balance between research, development and promotional elements. • Publicly visible - top of the mind awareness, more people talking about it
What do you think were the main benefits that were generated out of this project?	• Developing technology solution that actively delivers a social benefit to the older person • There are two main benefits I believe were generated out of the project, the first of its kind mixed reality driving simulator that provides valuable information for oilder drivers aged 65+. The second benefit was the inclusion of older participants throughout the project, even if the Hector driving simulator wasn't a succesful the older participants who were part of user evluations and a real sense of inclusion to help benefit society through such advanced research. • The process and findings • A fit for purpose driving simulator prototype that can be used by older drivers as well as a range of other potential target groups. Positive media exposure for McLean Care. An effective industry-research partnership that can be leveraged for future projects.
Who were the beneficiaries from this project?	• People over the aged of 65 - but the project has wider applications • Mclean Care, Deakin University, driver's aged 65+ and public through possible improvements that could be made to general road safety. • McLean Care, Deakin and the Aged Care industry • Older people directly involved. Older people in general. McLean Care, Deakin University

STEERING COMMITTEE SELF EVALUATION SURVEY – FREE TEXT RESPONSES

Personally, what aspects of the project did you most enjoy?	• The unintended learning form the [project • Watching the older community participate in a project using cutting edge technology. • The entire journey. To be a part of new opportunities and the learnings that come out of that • Building great relationships with other team members and successfully delivering a great end product.
Personally, what aspects of the project did you least enjoy?	• There wasn't much of the project I didn't enjoy, the tight development timelines was probably the least enjoyable part of the project • Nothing really - enjoyed all of it.
Other comments about your personal experience of the project:	• It was great to be a part of a project that worked with industry to help resolve a real-world problem rather than theory within a lab. • An excellent project to be part of. Thanks for the opportunity!

harvest
community sector consulting