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Smart Mobility Research

WP3 – User Experience Design Final Report

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Version: final

Summary

Through a combination of desk research, consultations and public engagements various novel concepts for user / car interactivity have been explored. The observation of the increasing use of voice interaction, together with the observations from WP1 and WP2 concerning drivers' wellbeing and their attitudes around courtesy, led to the development of an app concept focused on drivers' wellbeing and positive driving behaviour, involving voice interactions and simple visuals. This report provides details of the design process and the resulting final wireframe prototype.

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1. Overview

The WP3 User Experience Design work package aims to engage with users in the design of a basic concept for experiences both inside and outside the car, through consultation and workshops.

The themes of the research were:

- Developing a concept (prototype) based on a trajectory through a driving experience looking at the themes of memory, narrative and play
- Exploring how to link both the in-car experience of passengers and drivers and the world outside the car, using mobile phones, social media, log books etc....

The key activities involved:

- Initial overview of existing in-car applications and interfaces
- Developing a series of concepts based on the themes of memory, narrative and play
- Facilitating two public workshops (in Nottingham and London) to test the concepts, gain feedback and develop ideas for a final prototype
- Developing the final prototype with screen shots representing a trajectory through a driving experience

Additional Developments:

As the research took place the research in WP3 became more aligned with WP1 (Data Analytics) and 2 (Psychology). Rachel and Matt spent some time with the other researchers exploring crossovers between the findings from the other work packages, and the themes for the user design experiences.

Rachel also spent some time doing a rough thematic analysis of the interview transcripts from WP2. The methodology for this analysis is adapted from the methodologies employed during her PhD research, using a mixed methods approach to thematic analysis based on McCarthy and Wrights *Threads of Experience* (McCarthy et al. 2004) and coding and analysis (Braun et al. 2006).

As a result of this additional work the theme of positive driving and well-being emerged that lead to a re-focus of the themes for WP3. This focus was also supported by the feedback from the public workshops as described in Section 4 of this report.

As a response to the emerging findings from the audio transcripts collected in WP2 we aimed to address the following thematic concerns:

- The importance of 'courtesy' as a positive experience of driving
- How we might encourage 'driving courtesy' through playful and mindful interactions between the driver, the passengers and data from the car (braking, acceleration, flashing lights etc....) and the outside world (weather, pollution levels, traffic etc.)
- How we might capture the impact of weather as both positive and negative experiences, particularly how extreme weather impacts on drivers' experience
- How we support drivers' perceived behaviour in terms of safety, risk and uncertainty, including the disconnect between their own hazardous and aggressive

driving behaviour and scenarios involving other drivers, cyclists and pedestrians, as well as the impact of road works and traffic on both.

2. Research

The initial research that took place in the first phase of the project explored the following themes:

- Self Identity, Memory, Narrative and Territory
- Age and Experience
- Eco-Driving

The research took place across literature from social science and human factors. Areas that were of particular interest in the context of the user experience design were:

- a.) Issues around alienation between the driver and the outside world and the complex relationship between humans and the machine (Michael 2000, Urry 2004)
- b.) A study by Guell et al. (2015) exploring well-being, aspirations of commuters and public discourse around transportation
- c.) New research exposing differences in generational thinking and usage of cars, with a particular emphasis on young people who live in cities where their car ownership is decreasing, less young people are passing their driving test (Polzin et al. 2014, Banister 2008, Hopkins et al. 2014), with the potential '*de-materialisation of consumption*' as a result of increasingly digital cultures. (Kronenberg 2010)
- d.) Issues around eco-feedback and eco-driving applications, where applications often lose novelty over time (Harvey et al. 2013) yet opportunities for drivers to be challenged in emotional ways are increasingly explored to change their behavior - through gamification, rewards and competition (Diewald et al. 2013).

This research also outlined the most successful existing driving and transport applications, including *Waze* and *Uber*, that are increasingly enhancing driving experiences, enabling drivers to make choices beyond sitting in their own 'bubble' within the car. These applications provide very popular services yet rarely focus on drivers' well-being or how we might improve our emotional connection to the outside world, other drivers or the environment that we are driving through.

3. Concept Development

As a result of this first phase of research we came up with three key concepts:

The World Outside My Window

A computer driving game based on a Sat-Nav style interface, using real data from the car and the journey (GPS, Accelerometer, brakes, weather, camera, sound levels, lights flashing etc...). Designed for journeys with families/passengers/road trips.

The aim of this concept was to encourage healthy driving, cars and environmental factors (focusing on pollution and thinking about the wider impact of driving on climate change) and mapping car journeys using data and playing games in response. The games are based on treasure hunts and I-spy – collecting things as they go past the window, including weather,

buildings, people, as well as mini tasks that respond to the data collected in the car, from the outside world and through interactions between the driver and passengers.

The design suggests ambient aesthetics overlaid on a map of the journey, using colour, light, vibration, responding to time of day, the sky, the weather.



no

The Car That Talks

An audio driving app for smart mobile phones – that connects to a visual app to view pre or post driving. The app captures data from the car and aggregated data (traffic, weather, news, pollution etc...); connects to your car entertainment/GPS system (radio/CDs etc.); uses voice recognition or a virtual assistant to add notes and reminders to your calendar and compose emails/task lists etc.; and is designed for commuters/single drivers.

This app is a service to support the driver's wellbeing, safety and awareness whilst driving. It has three key objectives:

- As an audio diary/mindfulness app to give you time to reflect and create narratives connected to the landscape you travel through
- To provide reminders and helps you focus on your day whilst driving (including storing information)
- To improve your mood, via rewards you for courtesy and positive driving.



The Driver Not the Car

This is a service for individuals along the concept that 'I am the journey', taking the emphasis away from the car, the machine and the product and focusing on the 'experience' of being on a journey, optimised for personal, social and ecological well-being, with various machines (cars, buses, bicycles and even just your feet) and devices (mobile phone, tablet, fitbit etc...) helping you along the way. The concept is developed in response to the younger urban generations' changes in driving behaviour.

This aims to reimagine the role of key stakeholders in transportation systems - as a service to support our human experience of travel, as well as a set of products that we buy into.

This service has four key elements:

- Mode of transportation
- Data captured and interpreted throughout the journey
- Community influenced by the journey
- Environment impacting and influenced by the journey

This service would also support efficiency between stakeholders (city planners, public transport, road maintenance, environmental conservation etc..)



4. Public Workshops

The public workshops were designed to take place in Nottingham and London to allow feedback from drivers from two different urban communities.¹



¹ Future research would also focus on a rural community in the UK, particularly to support research that shows there are completely different trends and approaches to driving amongst younger generations in areas where public transport is limited (Collin-Lange 2014).

The public workshops were designed to take place in Nottingham and London to allow feedback from drivers from two different urban communities.²

The aims of the workshops were to test the design concepts with a variety of drivers, provide opportunities for the participants to come up with their own creative ideas and collate further feedback towards developing a final prototype.

The key activities in the workshop were:

- Presenting the three design concepts to the participants
- Group discussions exploring 'paper test' versions of the first two concepts
- A broader discussion on how these concepts might inform the final concept – bringing together the world outside the car with the in-car experience to inform a broader transportation experience (The Driver Not the Car) potentially across multiple car use, public transport and linking to other transportation services

In total 9 participants attended the workshop in Nottingham, taking place at the Nottingham Video Game Arcade on a Saturday afternoon and 8 participants attended the workshop in London, at the Digital Catapult Centre in Kings Cross, which took place on a weekday evening.

Lunch and gift vouchers were provided at both sessions as a thank you for taking part in the research.

Some of the participants who had previously taken part in the driving study from WP2 also attended the Nottingham workshop. A couple of participants in the London workshop worked in transport services and many of the London participants found out about the workshop through marketing of the event through the Digital Catapult and the Transport Systems Catapult. Both workshops had a wide diversity of participants in terms of age, life experiences and attitudes to driving, despite being only small groups.

All participants were asked when they registered for the workshop why they were interested in taking part and responses focused on the stress of driving, the future of driving and the impact on the environment:

When the request for this study came up, it appeared to be a continuation of those previous studies and looking at the future of driving. Some aspects would worry me (when the computer takes over in reality) but I want to see what sort of ideas are being considered.

I'm interested because I generally only travel in peak hour times when there is a lot of traffic and can find it quite stressful!! I would be interested to see what new apps there are to help with this.

I take the children to school by car due to the location of the school & would be interested in hearing how this impacts the environment

2 Future research would also focus on a rural community in the UK, particularly to support research that shows there are completely different trends and approaches to driving amongst younger generations in areas where public transport is limited (Collin-Lange 2014).

Participants were given a paper board game and a card game designed by Rachel and Matt, each with cards signifying different data inputs and outputs and game rules for the participants to play with, test ideas and to trigger discussions.



Responses:

1. Game Play:

- A focus on creating a balance and hybrid of tech Vs. real world experiences such as Pokémon Go / Ingress and Sat-Navs
- Tying up a series of journeys, calculating data over several journeys
- Personalized versions – choices of themes (environmental / urban or country)
- The car (in the game world) improves as you go up different levels
- How this would work differently in electric cars
- Creating a game that changed people's behaviours might have knock on effects like Pokémon Go (causing traffic jams)
- Can you make an interface where the driver has different rules, interactions from the passengers?
- The driver has more power but less interaction
- Responding to different personalities – personalise settings per journey, with learning (see other work packages)
- People are really affected by information about their driving- competitive people like praise - not always a competing type of person driving though...
- Sense of responsibility - i.e. What if your kid's games weren't quite so good if you're driving hadn't been great?
- Some sort of reward - rather than just being a score and different sorts of rewards
- Getting to the next level can sometimes inspire people to improve

2. Data:

- Data ethics and privacy – can we trust companies to collect data from us?
- Drivers are defensive – data about driver's behaviour shouldn't be revealed to passengers
- No data should be shared or captured with children

- Drivers could be updated at the end on their phones (different interface than passengers)

3. User Interface:

- Having a choice of themes (environmental, urban, country etc...)
- Your car icon improves as you go up levels in your interaction/game
- Incorporating the UX into the in-car interfaces and dashboard
- How does the interface responds to people of different ages
- Escape Rooms/Treasure Hunt - puzzles to solve, conundrums and brain teasers that help the driver to focus particularly when tired
- Police are getting more powers to stop people using phones/devices in the car – how does this impact on this research?

One of the most interesting responses at the Nottingham workshop came from one of the participants who had also participated in the audio diary study (WP2) about rethinking driving as a positive, collective experience. He attended with his wife as they felt he had an issue with 'negative' driving. They had a very interesting discussion around how he might respond to moments of frustration and anger whilst driving by encouraging courtesy and generosity instead of aggression. This resulted in a broader discussion around how we might find ways to 'cool down' or be rewarded for good behaviour and positive responses to other drivers.

Several interesting responses resulted from the London workshop. Firstly, several participants discussed how they 'enjoyed' road rage and it acted as a form of therapy, in fact improving their well-being by being able to release tension without affecting anyone else (shouting at drivers from the safety of the car). This resulted in a discussion about whether these levels of aggression were particularly unique to London and other large cities and more accepted in these environments, also looking at the pros and cons of releasing aggression whilst driving.





Secondly, one of the participants who had physical disabilities discussed how they absolutely relied on their car to work and that it was a fundamental part of living an independent adult life. This impacted on broader discussions about automated cars and car sharing. The same participant also admitted that driving also created high levels of stress and that having opportunities to reduce this stress would greatly improve the experience.

Finally, one of the participants who worked with transport services said that the workshop was an incredibly vital experience as there were participants from a variety of backgrounds – in this workshop there was one younger participant who didn't drive at all, the driver with physical disabilities and two women who had been single mothers with experience of driving their children daily to school. This participant indicated that other discussions around driving and ideation on the future of transportation they took part in tended to represent more physically-able male techno-centric groups, suggesting that more workshops exploring this level of diversity was needed to truly understand future transportation issues.



Feedback Summary

The feedback from both workshops indicated that whilst the concepts of '*A World Outside Your Window*' and '*The Driver Not the Car*' were interesting, they were also potentially quite niche concepts, raising concerns around data capture and sharing within the car and beyond to other services.

In contrast '*The Car That Talks*' appeared to connect more directly with concepts of encouraging positive driving through different forms of in-car feedback. It was felt by most of the participants across both groups that this concept had the potential to support well-being for drivers, possibly passengers and other drivers on the road.

The participants were particularly interested in the visualisation of the three circles and how an application might respond to these three elements of the car, driver and environmental health, what data might be collected in order to capture and feedback across these three elements and how drivers, passengers and other road users might be rewarded individually or as a community for successfully syncing these elements.

5. Prototype Development

Once the results of the workshops had been evaluated we moved into phase 3 – developing the prototype.

Using direct examples from the transcripts from WP2 we have created a trajectory through a fictitious driving experience from London to Nottingham. We then combined some of the key themes, concerns and ideas from the workshops, to develop the concept of *The Car That Talks*.

During this development, it came to our attention that Ford is working with Amazon Alexa to connect driving experiences with this AI virtual assistant. This therefore gives us an opportunity to explore some of the possibilities of bringing a virtual assistant into a car environment, how it might be integrated into a broader UX design and be integrated with data capture within and outside the car.

The final prototype focuses on the design and user experience rather than the technical implementation of a virtual assistant, although we recommend further research to support both the technical and design implementation including:

1. Exploring opportunities for integrating virtual assistants into cars
2. Future research that focuses on drivers' well-being and encouraging positive driving
3. Future technical developments around machine learning to support positive driving experiences, in line with the conclusions in WP1 and WP2

Virtual Assistants and Chat Bots

Virtual assistants and chat bots are currently a hot topic in terms of machine learning, internet of things and assisting our everyday lives from home to work.

Looking back to the original ELIZA program from the 1960s, testers found this early simple program had an amazing ability to attribute human-like feelings, particularly in terms of 'empathy', with testers often reporting a high level of emotional attachment (Weizenbaum et al. 1977).

Recent developments in artificial intelligence and machine learning are much in advance of these original experiments of course, with Alexa, Siri and Cortana widely available to the general public across mobiles, PCs and as objects that live in your house, connecting your virtual and physical internet of things and entertainment systems together.

As cars become more automated, ADAs (Advanced driver assistance systems) and Automotive Assistants are being developed such as the Dragon Drive platform (<http://www.nuance.com/for-business/mobile-solutions/dragon-drive/index.htm>). Yet most of this development is taking place around connecting the car with your home, your work and entertainment systems and less about connecting **you** and your **well-being** to your driving experience.

As with our earlier phase of research - concerns around driver interaction with an in-car virtual assistant emphasize issues of distraction. Yet recent research in this area supports the argument for recognising the impact of emotional well-being on driving behaviour and the potential for affective computing, such as emotion aware technology and virtual assistants, to support drivers' well-being (Eyben et al. 2010, Large et al. 2016).

Both studies relied on a Wizard of Oz prototype system and explored the impact on cognitive demand and driver distraction. Large et al. compared their findings with other hands free tasks (mobile phone conversation and delayed digit verbal recall task). Both works suggest the following findings:

1. An intelligent driver assistant system would generally be accepted by users if they have full control over the system and can mute it at any time
2. Based on the Wizard of Oz prototypes cognitive demand was similar to hands free mobile phone conversations
3. Voice characteristics and capabilities of speech recognition will affect the users' acceptance of these systems
4. Natural language interaction can provide less distraction to the existing visual distractions and displays in cars
5. This system helps drivers to feel safe and comfortable and as if they have company if they are driving alone
6. The system can increase driving pleasure through personalised settings and entertainment
7. The driver interface must be fully operational in hands free mode and quickly understand drivers' commands without having to remember predefined commands

It should be noted that these Wizard of Oz prototype systems didn't make mistakes and therefore additional research into the impact of miscommunication on cognitive demand and emotional wellbeing is required for future development of this work.

Focusing on positive responses and emotional wellbeing

The majority of virtual assistants focus on imparting knowledge, completing tasks and controlling systems. In contrast the concept of '*The Car That Talks*' relies more heavily on *Eliza*'s original attempt to encourage empathy and a sense of well-being.

The mixed reality, interactive media performance group *Blast Theory* recently developed a virtual life coach – *Karen* – that explored how an virtual AI bot could profile your personality and plays with how a virtual assistant can turn personality profiling into an intimate and emotional experience: <http://www.blasttheory.co.uk/projects/karen/> This work was

designed to challenge the ethical and personal issues around big data and privacy. These issues can also be seen explored in the film 'Her' (<http://www.herthemovie.com/#/home>).

Privacy, Ethics and Consent

The workshops that took place as part of our user design experience work package explored some of these ethical questions around data sharing, particularly with large corporations (such as Ford) and government stakeholders. The participants' concerns link into broader research around big data ethics, privacy and designing consent for the general public who often have a limited understanding of how the data is being used, and low literacy rates impacting on their ability to understand consent forms (Luger et al. 2013). Further work to explore the ethics of in-car virtual assistants is required as these interfaces are designed and developed, where ethics and consent alongside accessibility and language characteristics need to be integrated into the design process from the start.

By playing with these creative, ethical and challenging elements of this emerging area of human computer interaction we might be able to begin to design ways to better engage with our emotions whilst interacting with one of our most familiar machines – the car - and investigate how we can connect to both our own emotions and the world outside the car through these interactions in order to create safer, more responsible and courteous behaviour on the roads.

Final Prototype

Informed by the audio transcripts from the study in WP2 we have designed a trajectory of a commuter's journey using a prototype based on the concept 'A Car That Talks', see Appendix 1 for the full presentation.

The prototype is based on a simple visual interface that combines a series of disks that represent the key interacting factors the driver is experiencing – car health, driver well being and environmental health - which are trackable data points. When they are closest together the application rewards the driver for an optimum driving experience.

The application is linked to data in the car, data from outside the car (including other driving applications such as Waze) and through the apps community of other drivers, pedestrians and stakeholders.

A series of screen shots present these interaction modes to include:

- Start up screen
- Letting someone in
- An outraged event
- A community connection
- Pollution hotspot
- A good driving run with all the discs in sync

6. The Car That Talks

An in-car experience that focuses on drivers' wellbeing and positive driving behavior, as presented in full in Appendix 1.

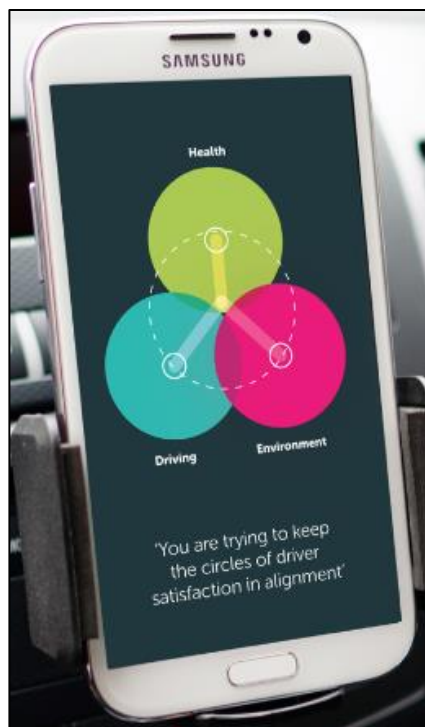
The prototype combines:

- Audio and simple visuals to avoid distraction to the driver, based on colours and visuals used with smart watches
- Going beyond niched concepts and quick fixes that would have limited engagement and scope for users
- Responding to concerns around data capture and sharing data within the car and beyond
- Opportunities for personalization, choice and levels of interaction
- Opportunities to learn to control negative driving behavior, encourage courtesy and 'cool down' in response to aggressive driving
- Considering ways to release tension in difficult driving scenarios
- Different needs and environments for drivers and how to support a more positive experience across these needs

Prototype Design

Starting the journey:

Introducing the voice of the virtual assistant and defining the interactions

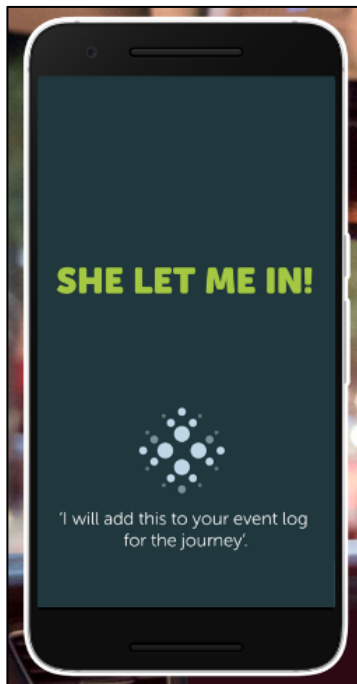


Introducing the three circles:

Aligning the circles that represent the wellbeing of the driver, the car health and the environment.

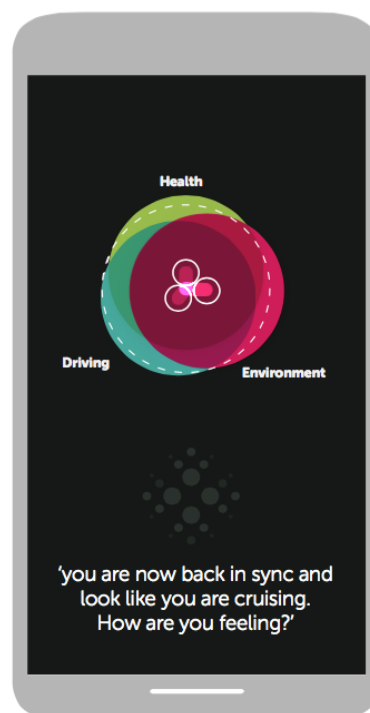
Personalisation test drive:

Calibrating the app to build an initial driver profile informed by the centralized database of driver behavior and profiles.



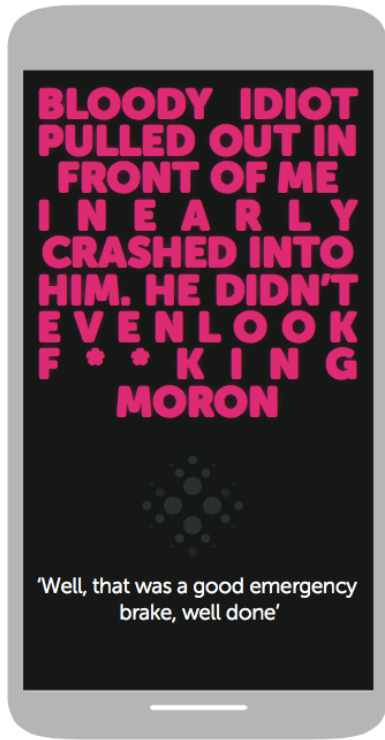
Act of Courtesy:

Rewards for acts of courtesy, good driving behavior and careful route planning, balanced against issues for the driver such as time of day, weather, importance of speed versus having a calm journey etc.



Review screen:

Options to review events, rewards, the alignment of the circles and an overview of the full journey as pre/post journey engagements or to extend to opportunities for passenger interactions.

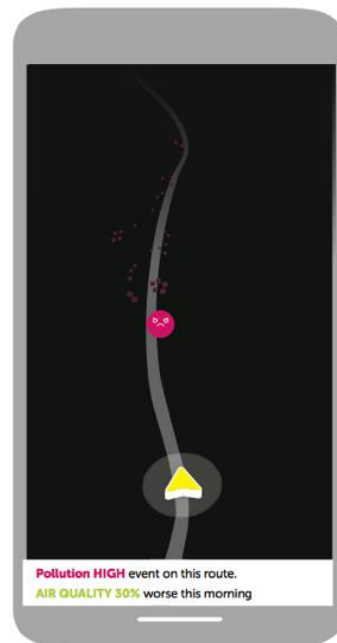
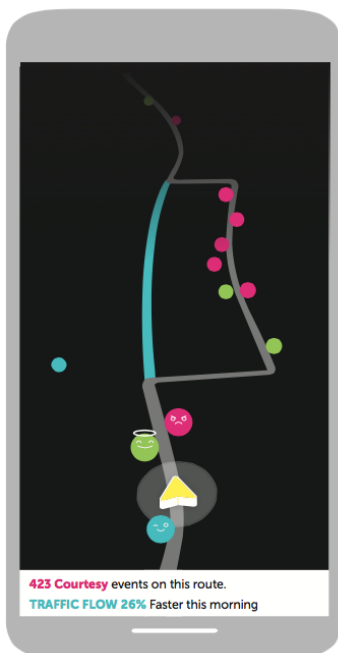


Act of aggression:

The voice of the virtual assistant echoing but not reinforcing events, working with a psychologist to explore how to support drivers to reflect and 'cool down' in response to aggressive and stressful driving scenarios.

Viewing data:

Opportunities to view specific events that triggered different alignments of the circles, such as pollution along the route inputs (e.g. environmental health along the route).



Opportunities to share information with other app users:

The potential to share thumbs up with other drivers or along specific tours focused on courtesy events and positive driving experiences.

Linking to WP1 and WP2 – Machine Learning

The prototype involves a centralised database of driver behaviors and profiles linking into the research from WP1 and 2 and Ford data analytics that would combine in-car data with driver profiling. This data would inform how the virtual assistant would learn from each individual driver.

Each individual version of the app would also build a driver profile as it learns about the specific behaviors and styles (driving and language) of the individual driver. These individual profiles would update the centralized database learning from trends and patterns revealed through the individual uses of the app.

Personalisation

The process of personalization through machine learning would be integrated into the app design and UX through:

- A 'friendship calibration' that invites new users on a test drive with the app to calibrate the relationship between the app and the driver
- Ongoing updates between the centralized database and the individual app
- Ongoing learning about the drivers behavior, preferences, routes, interactions and language

Future Developments of the Car That Talks:

1. Exploring options of AI platforms to develop the virtual assistant app such as IBM Blue Mix (that focuses on tone of voice and plug ins into existing apps and UX) and Microsoft Luis, which learns quickly from user responses.
2. Working with a virtual assistant developer and data analytics to develop the AI bot, define data inputs and outputs
3. Working with a psychologist to explore the language and process of initiating trust, friendship and engagement between the virtual assistant and the driver/passengers
4. Working with human factors and the virtual assistant developer to define the machine learning process

7. Bibliography

- Banister D. The sustainable mobility paradigm. *Transport policy*. 2008 Mar 31;15(2):73-80.
- Braun, V., & Clarke, V. . Using thematic analysis in psychology. *Qualitative research in psychology*, 2006 3(2), 77-101.
- Collin-Lange V. 'My Car is the Best Thing That Ever Happened to Me' Automobility and Novice Drivers in Iceland. *Young*. 2014 May 1;22(2):185-201.
- Diewald S, Möller A, Roalter L, Stockinger T, Kranz M. Gameful design in the automotive domain: review, outlook and challenges. In *Proceedings of the 5th International Conference on Automotive User Interfaces and Interactive Vehicular Applications 2013* Oct 28 (pp. 262-265). ACM.
- Eyben F, Wöllmer M, Poitschke T, Schuller B, Blaschke C, Färber B, Nguyen-Thien N. Emotion on the road—necessity, acceptance, and feasibility of affective computing in the car. *Advances in human-computer interaction*. 2010 Jul 4;2010.
- Featherstone M. Automobilities An Introduction. *Theory, Culture & Society*. 2004 Oct 1;21(4-5):1-24.
- Guell C, Ogilvie D. Picturing commuting: photovoice and seeking wellbeing in everyday travel. *Qualitative Research*. 2013 Jan 4:1468794112468472.
- Harvey J, Thorpe N, Fairchild R. Attitudes towards and perceptions of eco-driving and the role of feedback systems. *Ergonomics*. 2013 Mar 1;56(3):507-21.
- Hopkins D, Stephenson J. Generation Y mobilities through the lens of energy cultures: a preliminary exploration of mobility cultures. *Journal of Transport Geography*. 2014 Jun 30;38:88-91.
- Kircher K, Fors C, Ahlstrom C. Continuous versus intermittent presentation of visual eco-driving advice. *Transportation Research Part F: Traffic Psychology and Behaviour*. 2014 May 31;24:27-38.
- Konstantopoulos P, Chapman P, Crundall D. Driver's visual attention as a function of driving experience and visibility. Using a driving simulator to explore drivers' eye movements in day, night and rain driving. *Accident Analysis & Prevention*. 2010 May 31;42(3):827-34.
- Large DR, Burnett G, Anyasodo B, Skrypchuk L. Assessing Cognitive Demand during Natural Language Interactions with a Digital Driving Assistant. In *Proceedings of the 8th International Conference on Automotive User Interfaces and Interactive Vehicular Applications 2016* Oct 24 (pp. 67-74). ACM.
- Luger E, Rodden T. *Terms of agreement: Rethinking consent for pervasive computing*. *Interacting with Computers*. 2013 Feb 6:iws017.
- McCarthy, J., & Wright, P. . Technology as experience. *Interactions*, 2004 11(5), 42-43.
- Michael, M. 'The Invisible Car: the Cultural Purification of Road Rage', in D. Miller (ed.) *Car Cultures*. Oxford: Berg, 2001.
- Nixon DV. A sense of momentum: mobility practices and dis/embodyed landscapes of energy use. *Environment and Planning A*. 2012 Jul 1;44(7):1661-78.
- Polzin SE, Chu X, Godfrey J. The impact of millennials' travel behavior on future personal vehicle travel. *Energy Strategy Reviews*. 2014 Dec 31;5:59-65.
- Urry, J. 'The "System" of Automobility', *Theory, Culture & Society* 2004 21(4/5): 25–39.
- Weizenbaum, Joseph, and John McCarthy. "*Computer power and human reason: From judgment to calculation*." (1977): 68-71.