flourish

EMPOWERMENT THROUGH **TRUSTED** SECURE MOBILITY

Designing user interfaces for older users of future autonomous vehicles

Creating a user friendly autonomous vehicle experience for older people

Terminology

Connected Autonomous Vehicles (CAVs) are vehicles which have the ability to drive themselves. They are driverless.

Driverless vehicles seek to eliminate risks around driver error and to operate in a connected way. They communicate with each other to anticipate and mitigate problems occurring in the first place.

The ultimate goal of CAVs is to improve road safety and road travel efficiency, as well as creating an accessible platform for people to travel.

The experience of travel also improves - users can enjoy stress-free journeys with more freedom to use their travel time constructively.

Human Machine Interfaces (HMIs) are used to control the function of a product so that it performs as intended by the user.

The HMI within an autonomous vehicle is the technology that allows the human to communicate with the vehicle and vice versa. It is essentially the 'dashboard' of the vehicle, enabling the user to control the actions of the autonomous vehicle, and provides information about the journey to the user.

Interaction with the HMI can be via touch or voice, and feedback is provided by a visual display and speakers.

Introduction to Flourish

Flourish is a project which explores how innovations in autonomous vehicle technology could be delivered in the UK. Flourish explores opportunities to enable older adults to travel independently and flexibly in these vehicles.

Why older adults?

According to Age UK $^{(2019)}$ over 3.6 million people over the age of 75 years live alone in the UK. Autonomous vehicles offer the opportunity to reduce loneliness by providing a tool for older adults to travel, therefore supporting them to carry out everyday tasks, as well as do the things they love when they want to.

In addition, autonomous vehicles present a more accessible platform for road travel so that even people who have never driven or are unable to drive due to health reasons (such as those living with reduced mobility or visual impairment) can travel independently.

In this guide we outline some of our key learnings in designing effective user interfaces for older adults, specifically in the context of autonomous vehicles.

Please take a look at the resources at the back of this document to discover more about what has inspired and influenced the development of the Flourish HMI.

About Designability

Designability is a charity committed to creating innovative products that support people living with disabilities and long term health conditions. Designability has been responsible for designing the Flourish HMI, with support from project partners acknowledged later in this document.

design**ability**

www.designability.org.uk
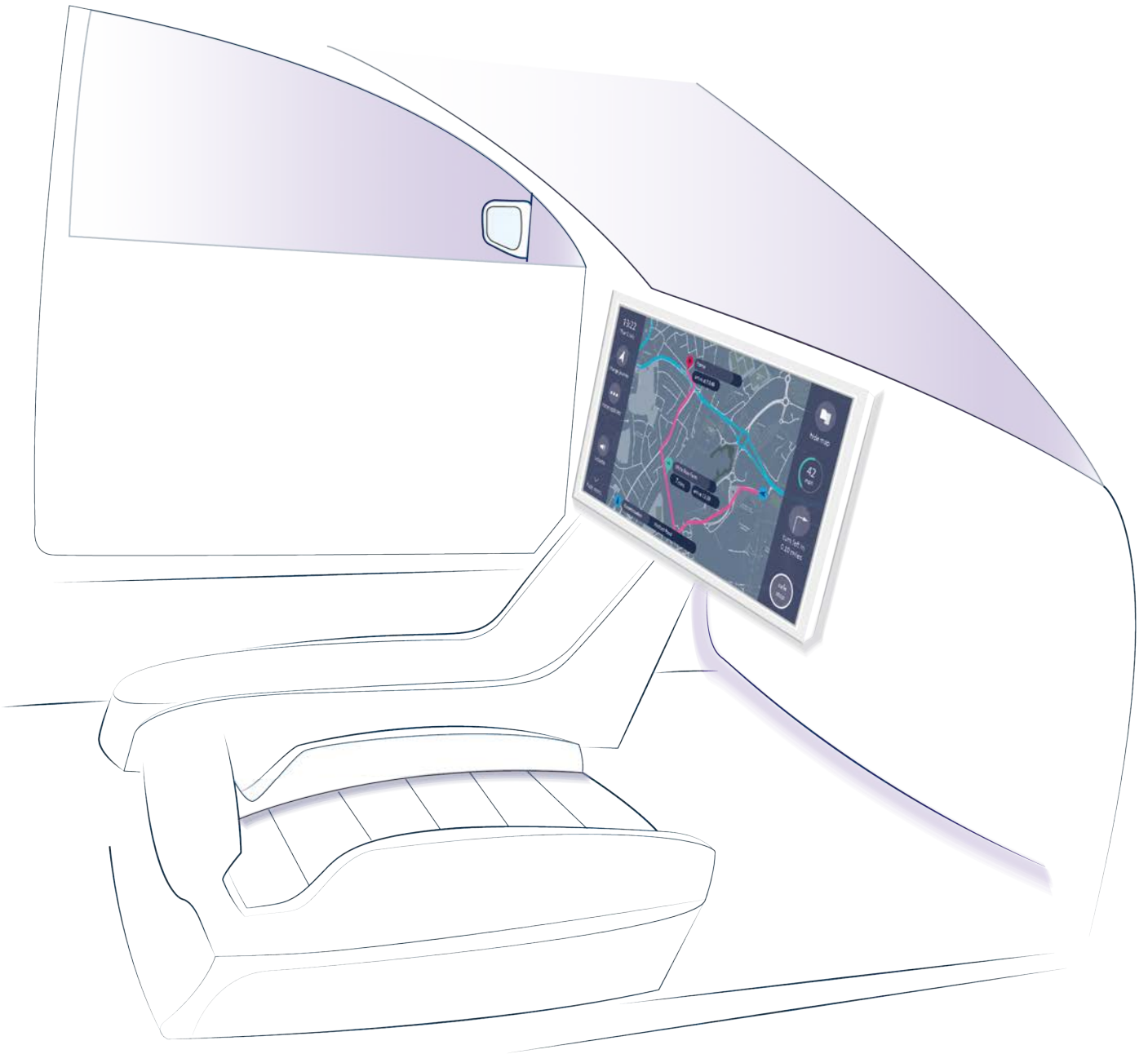
User Centred Design

User centred design places users and stakeholders at the heart of the design process. People are consulted throughout the process. They influence the design direction and support designers in delivering solutions that meets their needs and desires.

Engaging with Users

The best way to learn about the needs and aspirations of your users is to engage with them, and with the people who know them best. This can lead to new ideas, fresh ways of thinking and often challenges a designer's preconceptions and assumptions.

It requires the ability not only to be a good listener, but also the skill to determine key information, so that these insights can be translated into effective and viable design opportunities.

Engaging with older adults was essential for this project. Age related impairments such as reduced vision, hearing and dexterity were considered, as well as behaviours developed to adapt to the affects of age. By exploring some of the experiences of ageing we can make products more inclusive for everyone.

Users offer insights that can fuel new ideas and they can also guide design decisions. From these interactions you can gauge the priority of key design features and integrate these into your process to create a truly user centred design solution.

See Resources on page 28 to access useful tools for applying user centred design.

Some user research methods used at Designability are:

- Ethnographic research
- Interviews
- Focus groups
- Observation
- Surveys
- Contextual research
- Concept review
- Journey mapping
- Personas
- Scenarios
- Prototype testing

Majority had a visual impairment

3 had a severe visual impairment

13

Had a hearing impairment

145

Number of people engaged with through trials

(98 of these people also took part in the workshops)

90%

Had a driving licence

70 years old

Average age

(min 59, max 90)

**40%** Female, **60%** Male

Design Process

An effective user centred design process should incorporate prototyping, testing and iterative development. In the context of Flourish the HMI was tested in prototype feedback sessions, simulator trials and also in CAV road trials by The University of the West of England and Cardiff University. The HMI design was developed, prototyped and tested with potential users during each trial. Designability developed the interface design and worked with project partner, Connected Places Catapult to develop the software.

Alongside these trials Designability also ran in-house concept feedback and prototype testing sessions, to get feedback on and thereby refine specific HMI features.

Essential requirements for the HMI design were:

1. Functionality

2. Usability

3. Accessibility

4. Adaptability

1 Ideate

3 Test

4 Review

2 Build

5 Deliver
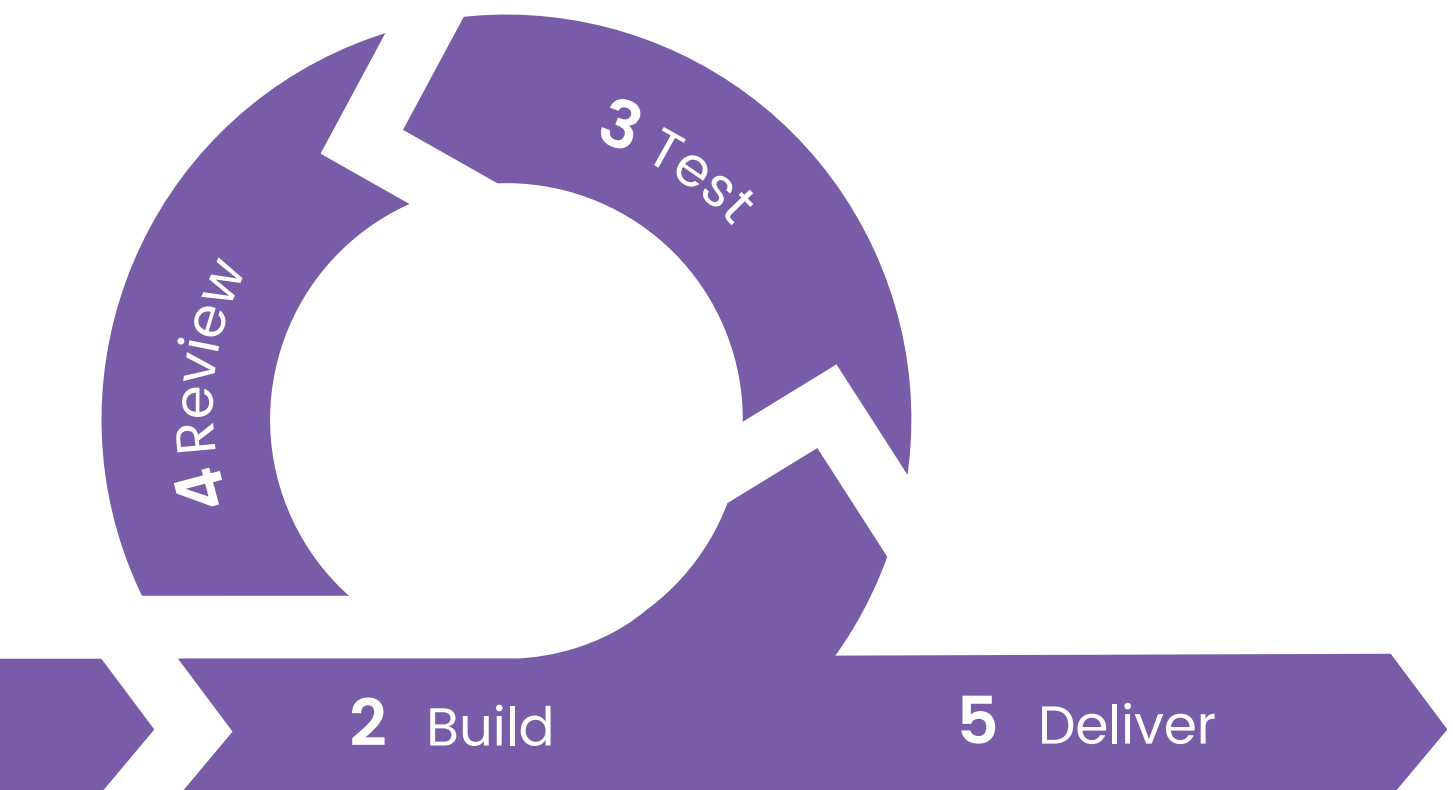
Design Insights

for Effective Autonomous Vehicle Interface Design

a collection of insights to inspire good
interface design for older adults

Make it Attractive and Clear

In order to make the interface visually accessible and clear, good interface design practice had to be considered. Inspired by user feedback we implemented the following principles across the design:

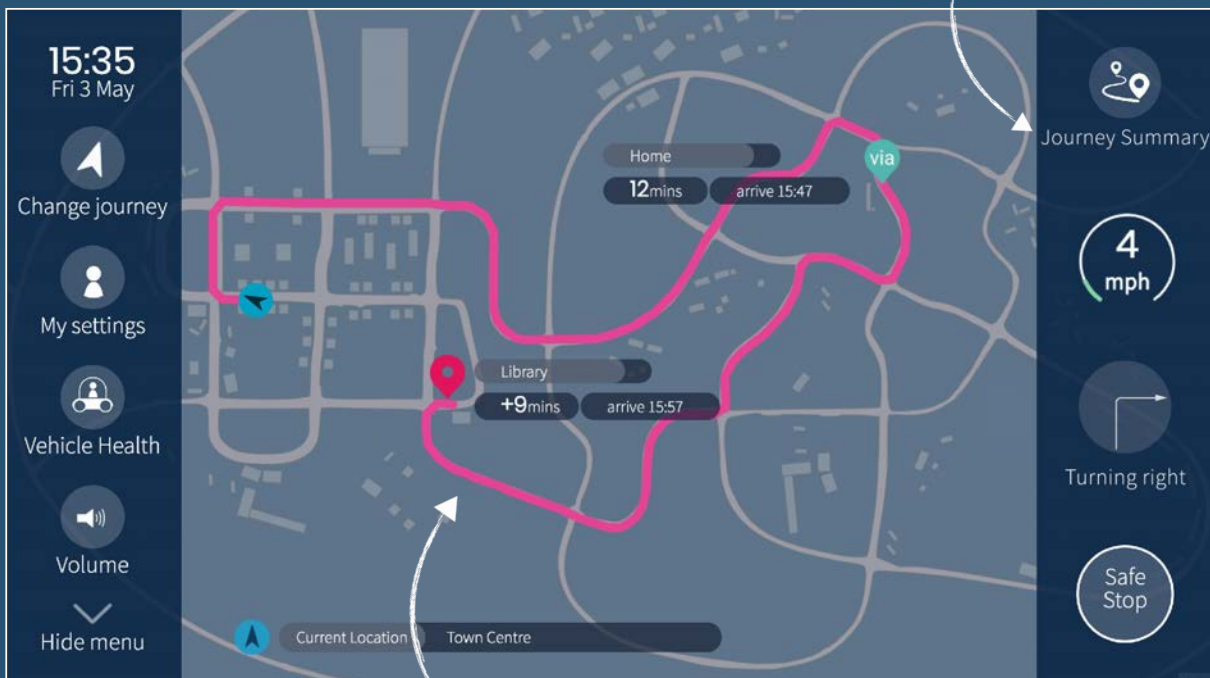**Interactions** - *It should be obvious which features are interactive.*

Font - *a large (size 14pt+) and Sans Serif font*

Displaying information - *try and break down long sentences onto more than one line.*

Consider terminology - *do not use terminology that a user may not understand (e.g. specialist terminology or acronyms).*

Colour Contrast - *high colour contrast between visual information e.g. text, an icon or a cursor, and its background.*

Large sans serif text, at least 14pt size

15:35
Fri 3 May

Change journey

My settings

Vehicle Health

Volume

Hide menu

Home
12mins   arrive 15:47

via

Library
+9mins   arrive 15:57

Current Location   Town Centre

Journey Summary

4
mph

Turning right

Safe
Stop

High contrast between route path colour and background (map) colour

Balance Function with Simplicity

Balancing simplicity and functionality can be difficult. It can be tempting to add in as many features as possible early on, but you must balance the complex with the simple. Complex features can be broken down into steps or layers within an interface to make information simpler to process for older users.

It can help to add descriptions to features to help explain their functionality.

Icons can be used to support more experienced users to process the information in front of them faster.

A map may be more difficult to interpret for users who are less experienced in reading maps. A journey summary, outlining the start point, stops and destination can be useful if the user prefers to see basic information.

Map View
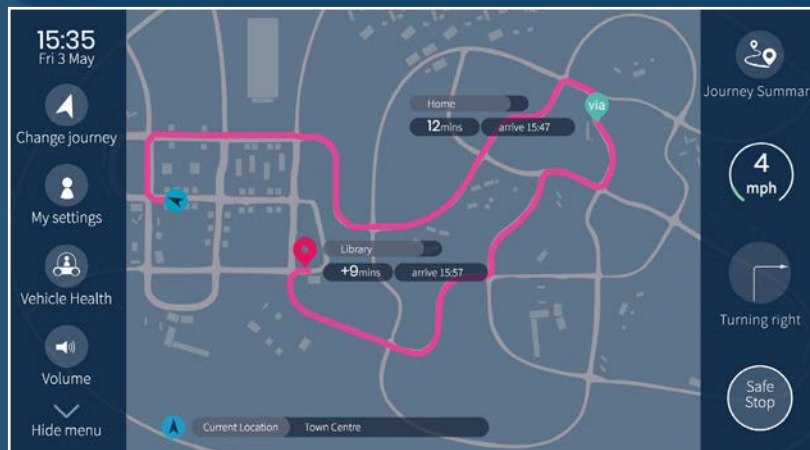
Journey Summary

Pressing the 'journey summary' or 'show map' button enables the user to view either the 'journey summary' or a 'map' view.

Anticipate User Error

It isn't uncommon for users to make mistakes when interacting with screen based products, whether pressing on the wrong button or auto-correct assuming the wrong word when the user is inputting text. It is therefore useful to offer users error prevention strategies and the opportunity to recover from error.

Some examples of how this principle has been integrated into the design are:

Go back button - to return to the previous screen if the user changes their mind or accidentally progresses to the next screen too soon
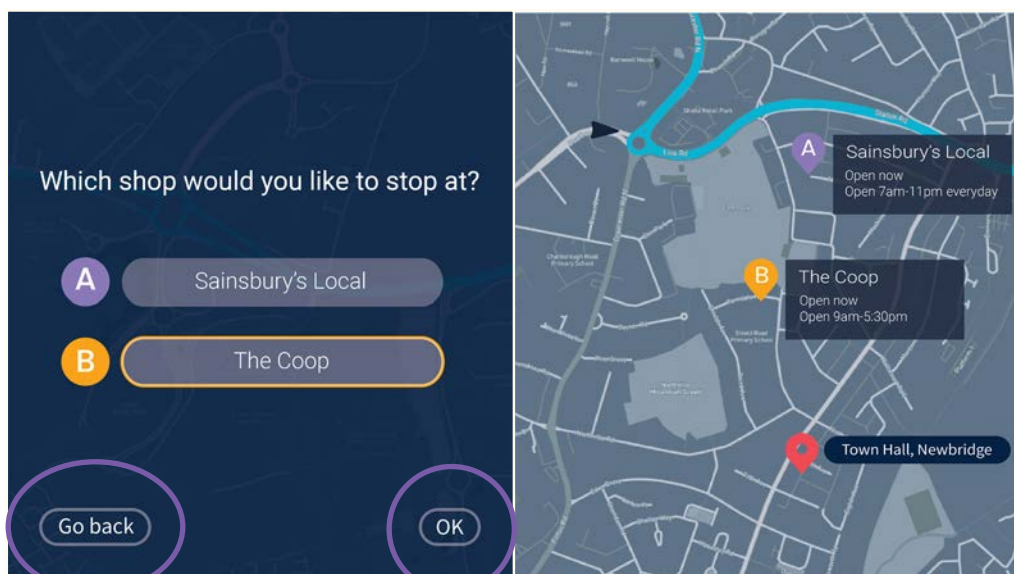
Confirmation button labelled "ok" appearing after the user makes a selection to confirm their input

Button press feedback in the form of audio feedback and a visual cue

Confirmation screens e.g. "Are you sure you would like to go to the next step?"

An Example Confirmation Screen

During the journey set up the user is asked various questions. It is possible that the user could accidentally press on a button. If this happens an 'ok' (confirmation) screen appears, to check that the user is happy with their selection. A 'go back' button also allows a user to go back a step in the process if they wish to edit their selections.

Which shop would you like to stop at?

A — Sainsbury's Local

B — The Coop

'Go back' button

Go back

OK

'Ok' button

A — Sainsbury's Local
Open now
Open 7am-11pm everyday

B — The Coop
Open now
Open 9am-5:30pm

Town Hall, Newbridge

User Journey Mapping

Mapping out various screen based content can also help identify and mitigate potential issues early on. A user journey map enabled researchers to explore the challenges that users may experience on a specific journey.

(J = Journey)
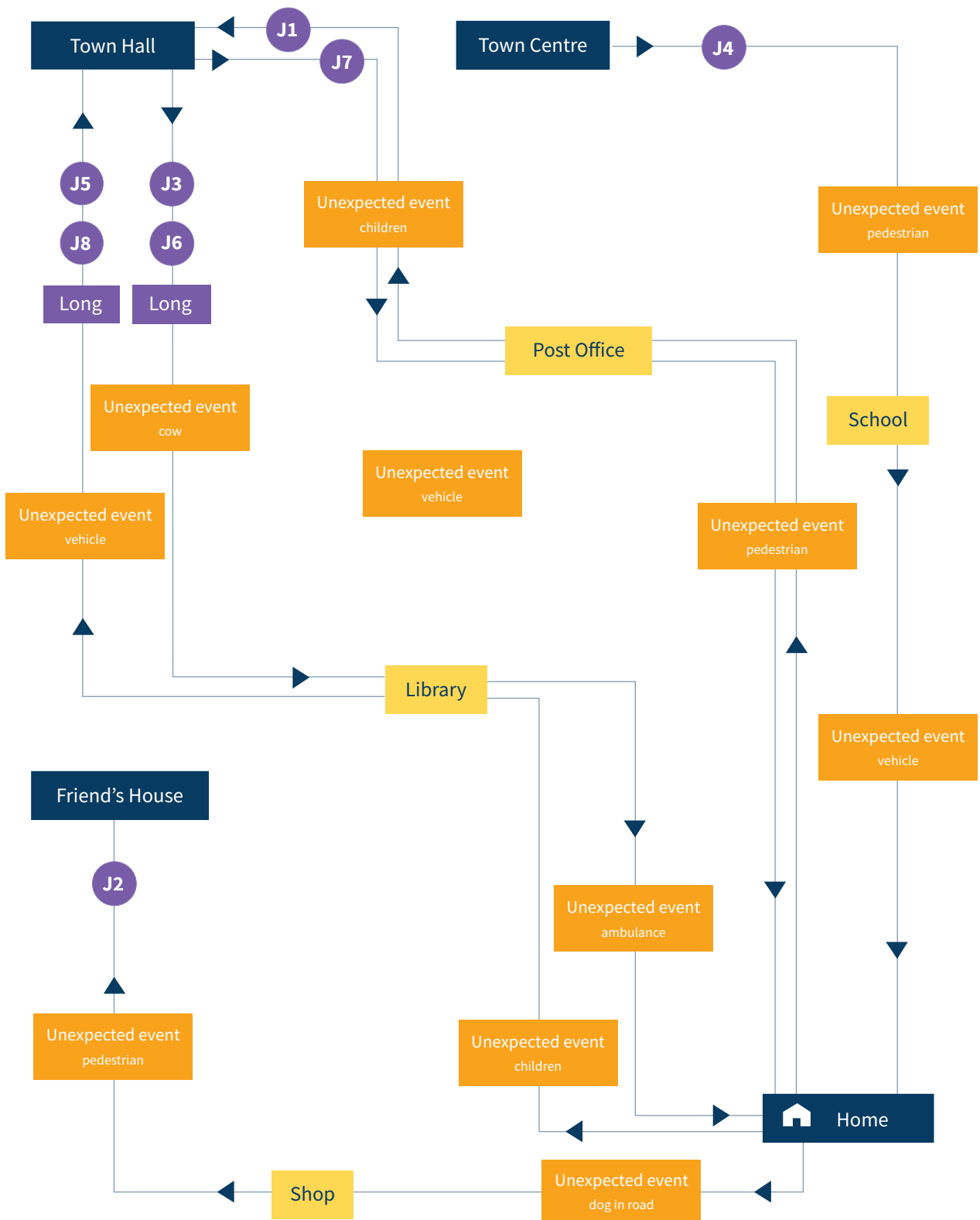
Make it Consistent

One of the most important elements of a user-friendly HMI is to ensure consistency across the design. Considering where and how users expect to navigate through an interface can support designers in being able to place features in logical places, across the interface design.

For users of screen based products, there will be expectations of where to find particular features on the screen, therefore it is important to draw on these suppositions e.g. 'close' buttons are often expected to be located in the top right corner of a screen and a 'next' or "ok" button would usually be toward the lower right of a screen. It is also essential to make sure that these features are consistently placed across the design so that these user expectations match with reality.

Consistency is key in ensuring a pleasant experience for the user and can also help reduce the risk of user error.
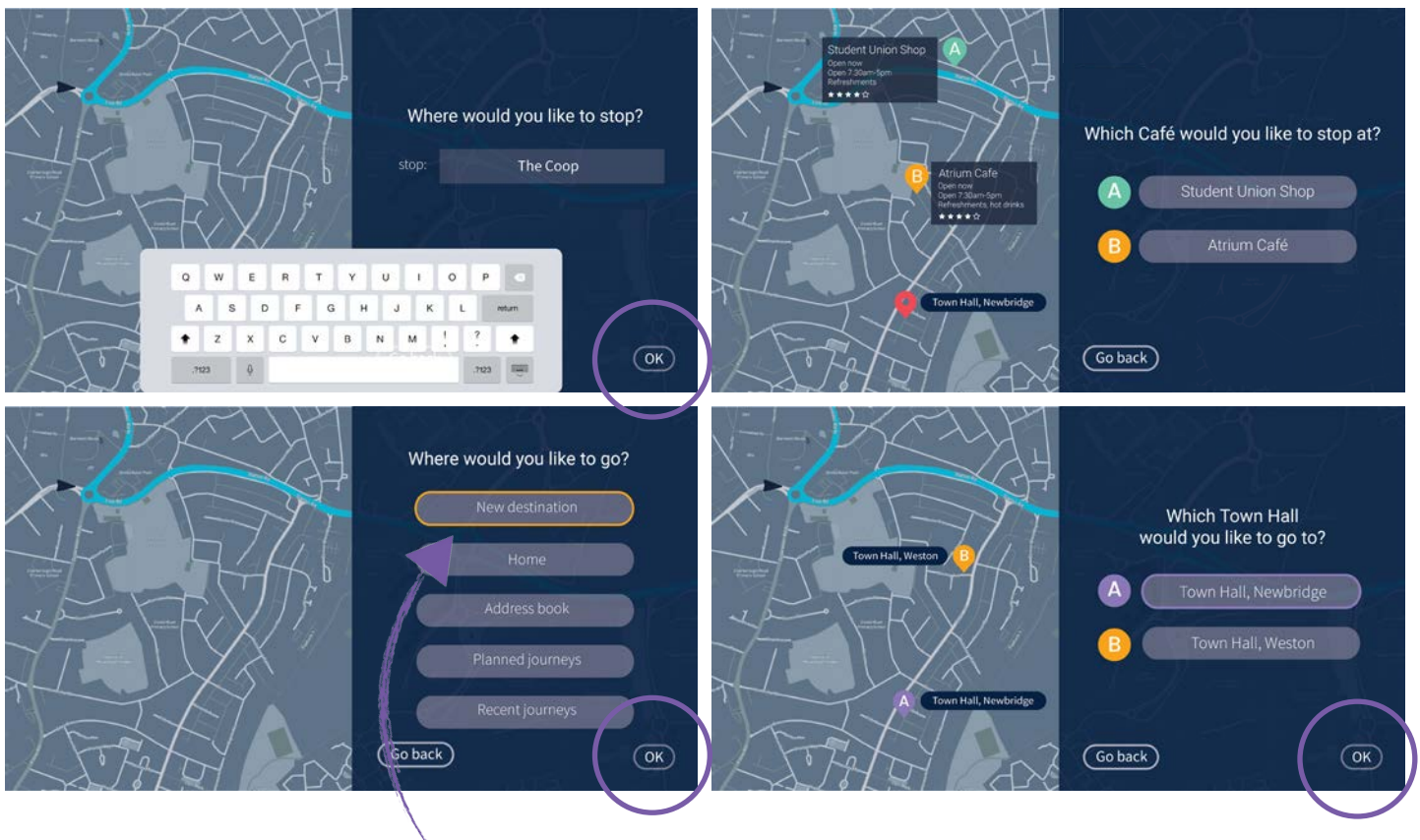
When the user makes a selection from a list it is highlighted and an 'ok' button appears

Make it Flexible

A diverse range of older people were engaged with throughout the design process. It became apparent very quickly that one size does not fit all when it comes to designing for older users, and that there should be elements of the interface that should be flexible to the needs and desires of as many people as possible.

An Example Persona

We formulated a series of personas which were based on older people, some of which were inspired by real people we engaged with early in the process. Personas can be used to explore how well the design meets the demands of users, at various stages of the project.

Some notable contrasts in user requirements included:

Technology - Some people are very familiar and interested in new technology and others, are not

Information - Some people require very basic journey information and others were interested in accessing particular details about their journey

Experience - Some people have never driven and some have driven for 50+ years

Health - Many lived with age related conditions such as hearing loss, arthritis and visual problems

Jeremy

Age: 67

Family: his wife, Celia, 2 daughters, Mary and Evelyn and grandchildren; Darcey (12months) and Charlotte (3)

Home: a spacious, modern bungalow in Minehead

Occupation: retired (Architect)

About Jeremy's life:
Jeremy is recently retired. In his free time he enjoys attending his local skittles club, painting, tending to his garden and supporting his local church.

Jeremy has early stage cataracts (which affect his vision) and has arthritis, which mainly affects his knees and wrists.

Loves: Looking after his grandchildren on wednesday and thursday – he often takes them to the beach or to local parks.
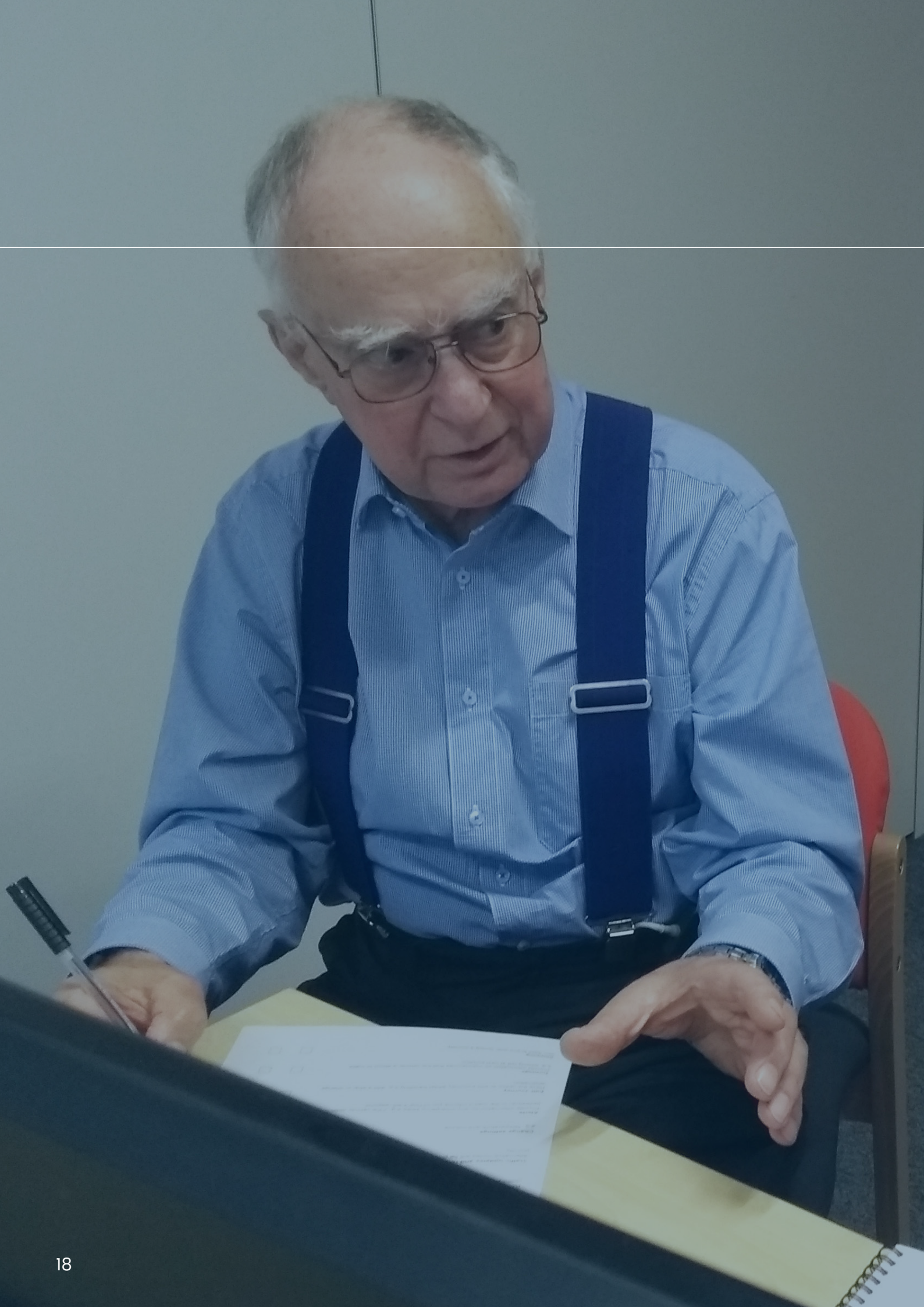
Keep the user informed

The user has the option to receive notifications on screen, or through voice messages e.g. "you are about to stop at the library". The user is also presented with the option of viewing their journey information via a map or as a timeline. These messages and maps are generated to keep the user aware of where they are in their journey and what is going on around them.

In the event of an emergency situation e.g. hazard in the road, it was found that ratings of trust vastly improved when the user was notified when the vehicle had detected an obstacle in the road, and informed them of how it would respond. This shared information (implying what the CAV is "thinking") appears to reassure the user.

During trials, voice interaction was explored through testing, where the researcher responded to user queries or inputs with scenario specific responses.

The HMI could provide information about the local area, tell you about local events and engage with the user in a fun way e.g. tell jokes.

Interestingly users were using conversational language to engage with the interface, such as "thank you Flourish" and "please can I go to...." which implies that they connect positively with the voice element of the interface.

Make it Intuitive

The definition of intuitive is "what one feels to be true even without conscious reasoning" (Cambridge Dictionary).

Imagine a naive user, for example someone who is unfamiliar with touch-screen devices using the HMI; how could we guide the user to access the information that they are looking for? How could we prioritise features based on their predicted use or importance?

Considering intuitive design can enable a user to make a decision about what to do or how to do it based on what feels right.

How could we make the design more intuitive?

Buttons should be labelled and may be accompanied with a symbol which is recognisable and clear

Avoid ambiguity - Consider if the language you are using could be misinterpreted by a user

Hierarchy - The most important features or information should be most prominent on the screen

'Safe stop' highlighted
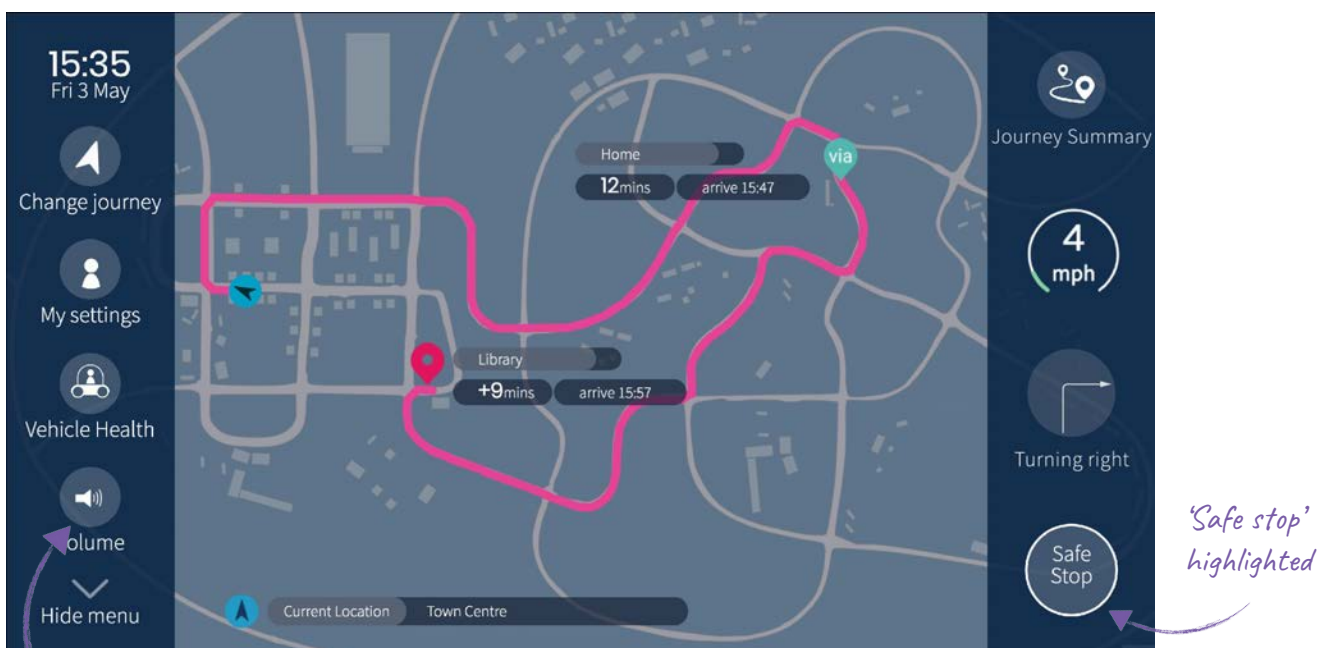
All interactive features had a shaded background

Make it Approachable

One step in making a HMI more approachable is to develop 'layers' for more complex features. This reduces visual 'clutter' and makes the interface smoother to navigate through. For example, rather than presenting all possible options for changes you can make to the journey you are on, you could have a button that is labelled 'change journey', which when pressed on links to a page displaying your options.

Some people who we have interacted with have had high expectations of the HMI, based on their prior experiences of screen based technology. For other people there may be strong perception of difficulty associated with using new technologies, which is often based on prior negative experience. We should therefore consider making the system viable for both novice and more experienced users.

As users gain more experience in using the HMI they will want to use shortcuts and have features that guide them to quicker results. This will require less conscious thought to navigate through the interface, therefore helping to prevent user frustration.

" *Enjoyable. Touch interaction is more reassuring as reacts straight away, voice is a bit slower.* "

" *Very interesting and easy to learn, not complicated.* "

" *I like to chat even when driving, so having voice interaction was entertaining. More conversation options would be useful.* "

Credit: Quotes taken from The University of the West of England product trials.
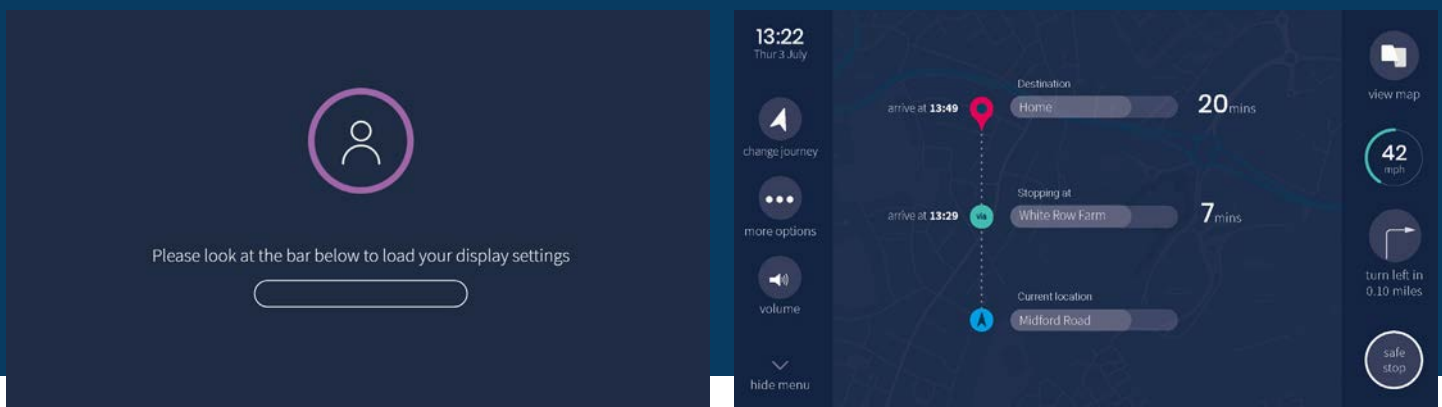
Break Down Tasks into Steps

Breaking down complex or unfamiliar tasks into more manageable steps can be really advantageous in terms of usability. Information is more digestible and easy to manage when broken down. Presenting too much information at once can lead to ambiguity, confusion and a user feeling overwhelmed.

The 'planning a journey' task within the HMI is a prime example of how we applied this principle. Rather than presenting all of the information at once we broke down each task into individual steps and offered clarity around how the user should respond e.g. 'where would you like to go?', 'Would you like to add a stop to your journey?'. This enabled the user to navigate through the steps efficiently and at their own pace.

Considerations to make when breaking down tasks:

Do not overburden the user - Ask short, consise questions in each step of a process *e.g. where would you like to stop?*

Explore how options could be grouped together to help direct the user through the process *i.e. rather than listing all possible grocery shops you could stop at, could you provide "recently found" or "favourites" lists?*

Consider adding a prompt to make it clear how the user should respond to an on screen instruction *e.g. 'press 'ok' if you would like to go back to the dashboard'*
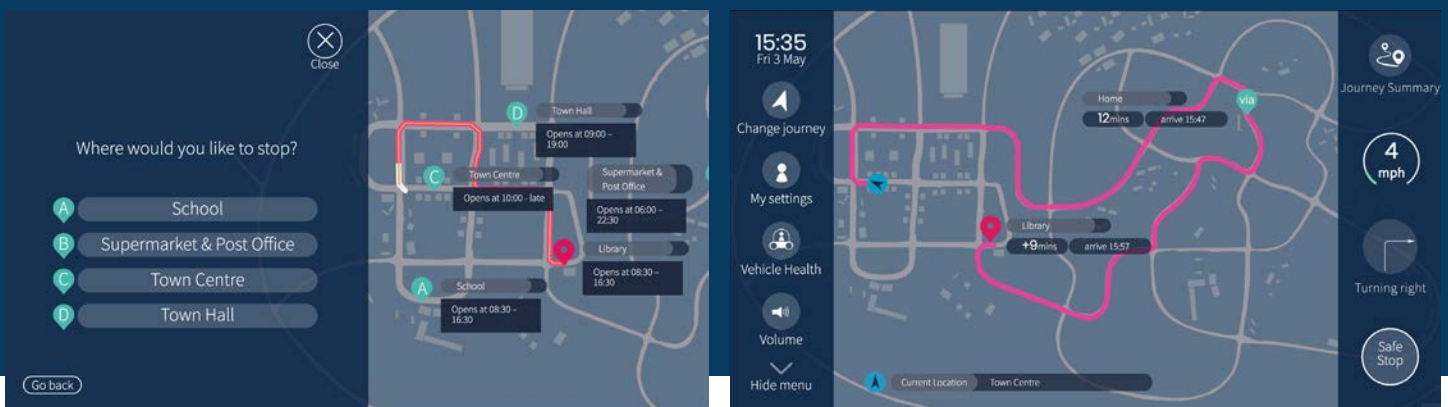
Make it Adaptable

A popular feature during our user research was the need for adaptability within the HMI. This is so that the user can adapt their HMI to their preferred settings and have the flexibility to adjust these at any given time.

It would also be possible for the system to 'learn' about you and your preferences. For example; the HMI could 'learn' about your interface settings, your preferences (e.g. voice interaction) and your regular destinations. As a result the product could become more tailored to your aspirations so that it could make recommendations of places to visit or events to go to, or even offer information about the surrounding area.

In order to offer this adaptability we added in a "my preferences" section to the set-up process and to the settings section of the interface, to enable the user to define their preferences of appearance, information and interaction.

Some examples of elements that can be adapted to suit needs:

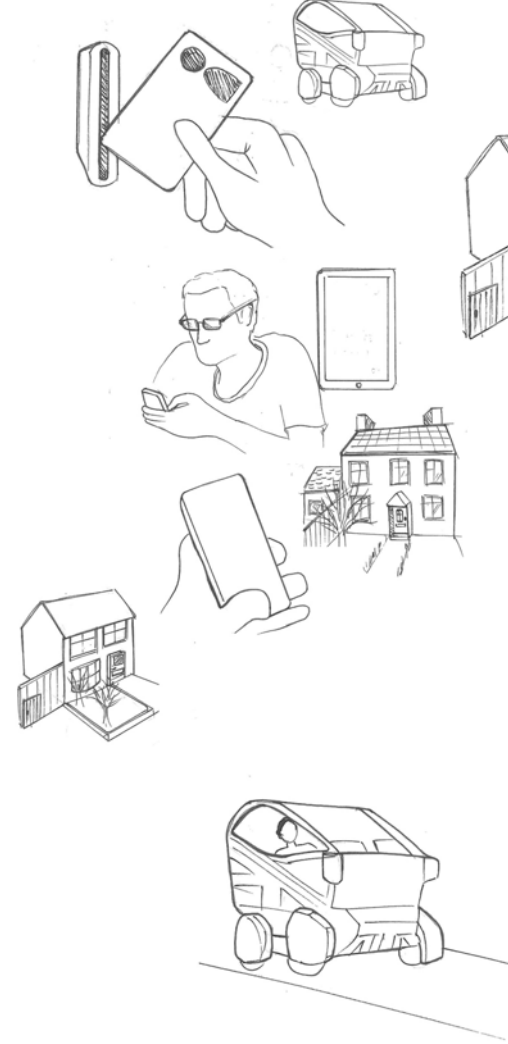**Dashboard features** - turn some features on and off

Colour - change colour settings, including high contrast for visual impairment

Font - three different sizes available

Voice - choose the voice and volume

Notifications - choose voice or visual or both, and turn on and off

Sounds - as notifications appear

Summary

Offering features that support the older user to feel safe and aware from the start is really important. Older people should not be expected to learn a new system. However, the concept of relinquishing control within a vehicle, particularly for experienced drivers will take time to get used to.

Ratings of trust were higher when users were provided with notifications that communicated what the vehicle was "thinking" and what it would do next e.g. "There is an obstacle in the road ahead. Your vehicle is stopping".

Over time and with experience, trust should naturally build toward the HMI. There is an expectation that the interface will keep the user informed of journey progress and share information that requires their attention.

Voice communication was widely regarded as a highly desirable feature as it provides an accessible means to communicate with the interface. Particularly as the user may not always be looking at the screen.

Fuel level: **70%** (72miles)
Fuel required for current journey: 20%

Building trust will demand that features may be integrated into the system initially and withdrawn as trust toward the system builds.

Despite the vehicle being responsive in emergency situations many people wanted reassurance that stopping remained in their control and saw this as a key feature. A "safe stop" was implemented into the dashboard to give users peace of mind that they could safely pull over at the next available opportunity, should they need to.

The insights within this document are user inspired, and highlight the importance of engaging with users throughout the design process.

These learnings touch on essential considerations in designing effective interfaces for older adults; accessible aesthetic design, offering flexibility for users with various needs and structuring the content in a logical and clear way.

These ideas can all contribute to an enhanced product experience.

> **"** It would give me my independence back because I can't stand getting the bus or Metrolink. For someone used to being independent it is difficult **"**

Resources

IDEO Design Kit

Ideo is a global design company. They have developed a plethora of methods for effective user centred design and case studies.

www.designkit.org

InVision

Prototyping tool for screen based applications.

www.invisionapp.com

Nielsen's 10 Heuristics

10 general principles for interaction design.

Nielsen's Heuristics are 10 principles for designing effective user interfaces which are often used by user experience or interaction designers to guide their process. We applied these principles during the development of the HMI and have been inspired to summarise our own set of learnings from this project, some of which are similar to or have been influenced by these heuristics.

www.nngroup.com/articles/ten-usability-heuristics

Find out more

To discover more about the Flourish project please visit:

www.flourishmobility.com

Key partners

We have worked closely with Connected Places Catapult, The University of the West of England and Cardiff University to develop the HMI and to test the design with potential users.

A special thanks to our key partners who have supported us with this project:

The University of the West of England led the user research trials.

www.uwe.ac.uk

Traverse delivered public engagement, focus groups and interviews.

traverse.ltd

Cardiff University supported the user research trials.

www.cardiff.ac.uk

Age UK supported social research for the project

www.ageuk.org.uk

Connected Places Catapult developed the HMI software.

cp.catapult.org.uk

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