Anthrometric



CAMBRIDGE CONNECTOR

Connector

Inclusive by design

The research was structured around a single question: *what changes for passengers when the driver no longer drives?*

CONNECTOR CONSORTIUM

GREATER CAMBRIDGE PARTNERSHIP

FUSION Processing

ALEXANDER DENNIS

EST. 1919 WHIPPET

Anthrometric

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ABOUT ANTHROMETRIC

Anthrometric bridges the gap between technological innovation and human experience. We bring together diverse users and the stakeholders who design and deploy systems, so that solutions are understood, trusted and widely adopted.

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Executive summary

Cambridge is one of the most important places in the UK to test the next generation of public transport. It's growing fast, its roads are under pressure, and people need reliable ways to move around. The Cambridge Connector project brings together the Greater Cambridge Partnership, Fusion Processing, Alexander Dennis, Whippet, and Anthrometric to test how automated buses could work as part of Cambridge's public transport system. Self-driving passenger services could help provide more frequent, flexible connections and make public transport more reliable, safe, and cost-efficient. But they need to work for everyone.

Taking the driver out of the driving task is central to that promise. An automated system does not get tired or distracted, and so has the potential to reduce the human error behind many road collisions. But what changes for passengers when there is no longer a driver at the wheel? This research set out to understand how people feel about that change, what concerns they have, and how a self-driving service should work to meet the needs of every passenger.

Anthrometric conducted an inclusive human factors study of the Cambridge Connector self-driving bus service. We recruited 48 participants across a breadth of access needs, including neurodivergence, mobility-related impairment, hearing and vision impairment, mental health, age, pregnancy, parenting and caring responsibilities.

48	13	4	VR	1
PARTICIPANTS	FOCUS GROUPS	SENSORY WALKALONGS	JOURNEYS	CO-CREATION WORKSHOP

The study combined a pre-session survey, immersive virtual reality (VR) journeys, 13 focus groups and four sensory walkalongs. The VR simulation allowed participants to experience the proposed service – the bus arriving, waiting at the stop, boarding, travelling and getting off – before it exists at scale. The focus groups that followed encouraged participants who shared comparable barriers to review the experience together, challenge one another's assumptions and describe what it would take for an automated passenger service to be inclusive.

The project team carried out accompanied journeys on the self-driving bus with four participants to understand their experiences first hand. Participants included: a neurodivergent participant, a pregnant participant, a participant with a hearing impairment and a participant with a mobility impairment, each also bringing intersecting characteristics of gender, race, parenting and caring responsibilities and age to the

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journey. A final interpretation and co-creation workshop brought participants together with Connector partners from the local authority, software, operator and vehicle teams to consider what the evidence meant for vehicle and service design.

The research was structured around a single question:

what changes for passengers when the driver no longer drives?

KEY FINDINGS

01

Participants were prepared to trust the technology to drive safely.

Their questions were about the service around it: how it would work when they needed more time, more information, reassurance or help. These are design questions, and the service can answer them.

Finding 1, page 12

02

Personal-safety concerns centred on other passengers, not the technology.

Monitoring built confidence when it came with clear feedback, showing that it was active, that a concern had been noticed and that help was on the way. This mattered most to women travelling alone or at night.

Finding 2, page 14

03

A driver supports passengers in ways that go beyond driving.

They notice who is waiting, interpret what people need, confirm what is happening and step in when the journey becomes uncertain. Automation gives the chance to design each of these roles into the service deliberately, so passengers are never left to fill the gap.

Finding 3, page 16

04

Remote assistance was a condition of trust.

Participants expected a clear, accessible route to a human as standard, with onboard or nearby support added where route, time or assessed risk required it.

Finding 4, page 18

05

Pick-up and drop-off was the clearest test of whether the service would work equally for every passenger.

Participants needed detection, alignment, boarding, dwell time, access requests and fallback to work as one reliable process, not as separate features.

Finding 5, page 20

06

Information became part of the service's support system, not a navigational add-on.

Clear, accessible information at every stage of the journey can provide the confirmation and reassurance passengers would otherwise get from a driver.

Finding 6, page 22

What the service now needs to do

Before wider deployment, the complete passenger service must be designed and tested with a range of customers. The first task is to establish the human support model: deciding which of the driver's roles are automated, which are handled remotely and which are on-board, and making sure a responsible human is always directly reachable. Personal safety needs designing around feedback, response and the ability to exit the vehicle safely as monitoring alone is not sufficient. Shared space must work by design rather than negotiation, so that access never depends on passengers having to advocate for themselves.

Pick-up and drop-off must be one equal, reliable and tested process, from hailing the bus to exiting the vehicle. Information must run continuously across the whole journey, in more than one format.

Safe driving is fundamental, but it is only one part of service readiness. The research has shown the value of involving diverse customers while the service can still be shaped. Connector's next step is to use human factors evidence to pilot and test the complete passenger service.

> **The real opportunity is not just teaching the bus to drive itself.**
>
> *It is designing a transport service that supports everyone equally, at every stage of the self-driving journey.*

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Introduction

Why Cambridge? Why self-driving?

Cambridge is one of the UK's most important testbeds for automated passenger services because it combines rapid growth, severe transport constraints and nationally significant innovation assets. The city is already experiencing congestion that limits economic growth, while future plans for new homes, jobs and major growth sites such as Cambridge West, the Biomedical Campus, Waterbeach, Bourne Airfield and Cambourne North will place even greater pressure on the transport network. To support this expansion, Cambridge needs a step change in sustainable, reliable and high-capacity public transport.

Self-driving buses offer a practical route to more frequent and efficient services, with fewer operational constraints, while new busways, franchising powers and campus-based demand create a realistic pathway from trial to commercial deployment. Automated passenger services are often discussed through the lens of technology, safety cases and operational design domains.

However, this research shifts the question towards public service design: what does automation change for passengers? A service that works in Cambridge needs to work around pedestrians, cyclists, hospital and campus users, commuters, visitors, disabled people, older people, families and people travelling under time pressure.



Connector brings together the Greater Cambridge Partnership as challenge owner and future commissioner, UK-based technical capability from Fusion Processing and Alexander Dennis, operational expertise from Whippet, and inclusive co-design insight from Anthrometric. The consortium has already demonstrated delivery through live operations, vehicle conversion, safety case development, and automated driving kilometres.

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Crucially, Connector places human factors at the centre: understanding how real, diverse passengers perceive, trust and use a self-driving bus. This is essential if automated passenger services are to move beyond technical proof-of-concept and become a service that people understand, can access easily and will choose to use.

What participants told us about current public transport provision

The pre-session survey showed that participants were already dealing with unreliable services, crowding, anxiety, unclear information, and physical or digital access barriers. Delays and cancellations were the most frequently cited source of stress, followed by busy or crowded services and disruption. Participants also described difficulties with boarding, wayfinding, shared space and getting help when they needed it.

The study therefore explored what happens to those existing pressures when the driving task is automated and the familiar point of human contact changes.

How could a self-driving bus service work for a wide range of passengers?

We listened to people with different access needs, life experiences and ways of using public transport. Through their lived experience, we explored what would help an automated passenger service feel intuitive, usable, safe and inclusive across the whole journey.

This included how passengers would recognise and hail the bus, board and find a suitable space, receive information, ask for help, manage disruption and get off safely.

We were also interested in where a self-driving service might improve on current public transport, rather than replicating existing barriers.

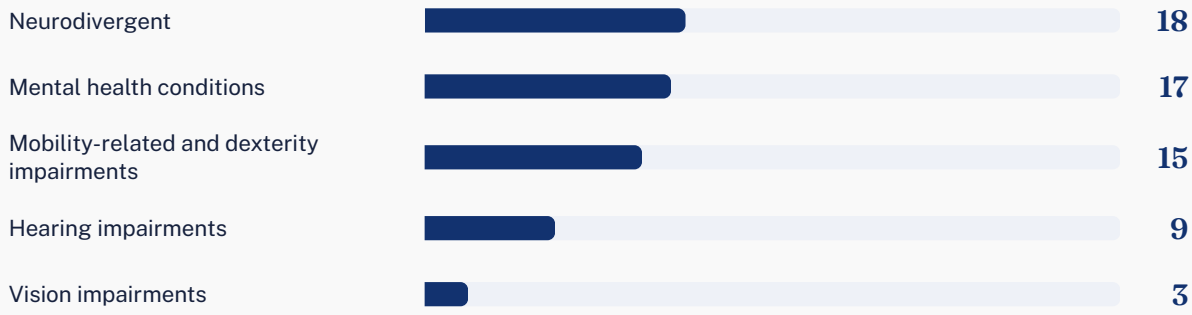
Method

Study design

The study involved 48 participants with overlapping access needs, impairments, life stages and travel experiences; 18 were neurodivergent, 15 had mobility-related and dexterity impairments, 17 reported mental health conditions, nine had hearing impairments and three had vision impairments. The wider sample also included older people, parents and carers, pregnant women and LGBTQ+ representation.

STUDY SAMPLE

Participants by access need, out of 48. Many participants belonged to more than one group.



Recruitment and group design were intentional. Focus groups were organised around shared lived experience and access needs so that participants could discuss the service with people facing comparable barriers, rather than being expected to represent those experiences alone in a general group. The study deliberately brought in voices that are often under-represented in transport design, while recognising that no category is uniform and many participants belonged to more than one group.

The research examined the complete passenger journey:

- approaching and identifying the bus;
- signalling that the bus should stop;
- boarding and payment;
- finding a seat or suitable space;
- receiving information during the journey;
- requesting a stop and getting off;
- responding to disruption, emergencies or personal-safety concerns.

The aim was to understand not only whether individual features were accessible, but whether the self-driving service made sense as a whole.

Research process

The study combined survey data, immersive experience, group discussion, real-world observation and stakeholder engagement. Together, the methods moved from attitudes to observation via a real-world sensory walkalong and then workshopped service-design requirements. The full consortium responsible for delivering the Connector service, including the local authority, software provider, operator, and vehicle manufacturer, was involved throughout the research design and fieldwork.

1. Pre-session survey

Participants completed a short survey about their current travel, bus use, access needs and expectations of self-driving services.

This provided context for the later discussion and helped identify differences between current experience and reactions to the proposed service.

2. Immersive VR journey

Participants experienced a staged self-driving bus journey in virtual reality (VR).

VR scenarios covered the bus arriving, kerb position, ramp visibility, boarding, interior layout, passenger space, information, crowding and getting off.

Immersive VR allowed participants to respond in real-time to a self-driving bus concept rather than having to imagine one from a general description of a future bus service.



3. Focus groups

Participants took part in one of 13 in-person focus groups, grouped around relevant lived experience and access needs.

The groups explored what was intuitive in the self-driving bus VR experience, what features created uncertainty, where support was missing and what would need to change for the service to be usable and trusted. Participants identified barriers, challenged assumptions and proposed practical service responses based on their own experience.

The analysis focused on identifying recurring patterns across groups, as well as differences associated with particular access needs and travel situations.



4. Sensory walkalongs

A sensory walkalong is a guided journey in which a participant describes what they notice as the journey unfolds. Four participants with intersecting access needs travelled on the self-driving bus – a neurodivergent participant, a pregnant participant, a participant with a hearing impairment and a participant with a mobility impairment, each also bringing intersecting characteristics of gender, race, parenting and caring responsibilities and age to the journey. Connector partners travelled with them on the bus all day. This brought lived experience directly in front of the people commissioning, operating, building and designing the service.

Participants drew attention to kerbs, surfaces, lighting, noise, orientation, boarding position, ramp use, interior layout and the practical demands that are easy to miss when a journey is considered only through a general discussion.

5. Final interpretation and co-creation workshop

The final workshop brought the messages from the survey, VR sessions, focus groups and sensory walkalongs together. Participants discussed their reflections with Connector partners, many of whom had been present on the bus during the sensory walkalongs; they could ask questions, test their understanding of what they had heard and consider how the evidence affected their part of the service.

Key findings

1

FINDING 1

Participants were open to self-driving technology but were not yet convinced the complete service would work for them

Participants were broadly open to the idea of self-driving vehicles. That questions a common assumption in the industry: that passengers first need to be convinced the technology is safe. Across the study, participants with very different experiences and access needs assumed a bus would not be carrying passengers unless it had been properly tested and approved. Many expected automation to reduce human error.

> *"The majority of accidents that occur are human error. So, for me ... the chances are it will be much safer to be on a [self-driving] bus than on a bus with a driver who doesn't see the cyclist or doesn't see the person walking in front of them."*
>
> — P50, FGD13

PRE-VR SURVEY

Before experiencing the self-driving bus in VR or joining a focus group, 44 participants rated two statements out of 10.

59%

rated their acceptance of self-driving vehicles at 6 or above

(1 = I completely reject them, 10 = I am completely open to them)

43%

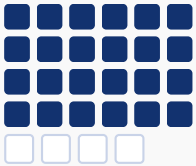
rated their confidence using an automated bus tomorrow at 6 or above

(1 = I would need more information or support, 10 = very confident)

The hesitation came when they considered the *service* around the vehicle. They wanted to know if it would continue to work if something went wrong; whether it would recognise and respond to their needs, provide clear information and human support, or manage personal safety.

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The Pre-VR survey pointed the same way. Of the 28 respondents who ticked “trust in the technology” as a concern, 24 also flagged the absence of a driver or worries about emergencies. For most, the doubt appears to have been less about the driving than about having no one to turn to.



24 *of* 28

respondents who ticked “trust in the technology” also flagged the absence of a driver or worries about emergencies

The real question was not whether the bus could drive itself. It was how the complete passenger service would work for them.

“

“Trusting its ability to drive, I’m less bothered about. But I think it’s more all the things in and around that, the getting on it, coordinating the people on it … it’s less for me about the journey itself.”

— P46, FGD12

2

FINDING 2

Personal-safety concerns centred on other passengers, and monitoring only reassured people when it included feedback and response

The most significant personal-safety concern was the behaviour of other passengers when the visible presence of a driver had been removed.

Participants described the driver's physical presence as part of the social order of the bus. A driver might notice a problem, communicate with passengers, make a judgement, call for assistance or deter antisocial behaviour.

However, drivers cannot always intervene, as sometimes doing so may put them at risk. Even so, participants attached importance to knowing that somebody was aware of what was happening. CCTV monitoring reassured people only if it had a clear feedback loop: passengers needed to know that it was active, that an incident had been noticed and what response was under way.

> *"Let's be realistic, there are people that will misbehave on buses if there's nobody on there to curb that."*
>
> — P29, FGD8

> *"I would feel safer with a bus driver there … having someone there who is like a social disincentive."*
>
> — P5, FGD13

> *"If something was to happen [in a self-driving bus], like an emergency, there'd be nobody there to take control."*
>
> — P49, FGD12

Concern about other passenger behaviour recurred across all focus groups yet had particular significance for passengers who already have to make careful judgements about their personal safety. This was especially pronounced among women discussing travelling alone or after dark. Women who raised these scenarios described the absence of a driver as something that could affect whether or not they boarded, where they chose to sit and whether they felt they would be able to leave safely if they needed to.

> *"Having a driver or not having a driver … might change some decisions [for me]. If there's a bus full of men, how would I choose in the moment to get on the bus or not?"*
>
> — Participant during sensory walkalong (Neurodivergent)

> *"I would be more reluctant to board a bus alone as a female after dark if there is no other person, other than one other passenger, and there's no way I can get off the bus."*
>
> — Participant during sensory walkalong (Pregnant)



The concern was not limited to women. Mobility aid users connected personal safety with the possibility of being stuck, unable to move, unable to deploy the ramp or unable to leave after an incident. Neurodivergent passengers and others who felt vulnerable in crowded, unfamiliar or poorly supervised situations also placed importance on knowing what was happening and whether anyone was aware of it.

> *"... the most important thing in these self-driving buses is having an emergency thing that goes through to someone straight away. That has to be completely airtight."*
>
> — P16, FGD4

Conventional buses are not always safe, and drivers cannot prevent every incident. But these findings show that technical monitoring of an automated passenger service is not enough on its own. Passengers need visible, credible feedback that someone has noticed the situation, will respond immediately and can help them leave safely, if necessary.

3

FINDING 3

The driver's hidden service functions extended beyond driving and could not simply be transferred to passengers



In a conventional bus journey, passengers may rely on the driver to answer questions, confirm the route, respond to a hail, wait while someone boards, assist with a ramp, manage behaviour or respond to an incident. They may also rely on less obvious forms of communication, including eye contact, gesture, being noticed at the stop or trusting that the driver can see they need more time.

FROM THE EXECUTIVE SUMMARY

A driver supports passengers in ways that go beyond driving.

Notice	Interpret	Confirm	Step in
who is waiting	what people need	what is happening	when the journey becomes uncertain

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“

“It’s sort of a non-verbal communication with the bus driver that subtly governs the order of the bus.”

– P46, FGD12

> *“I would speak to a driver and say, ‘can you tell me when I get near to [my stop]?’ … and the driver would come round and say, ‘this is your stop …’.”*
>
> – P38, VR session

The hidden roles performed by the driver do not disappear when driving is automated. Participants describing their usual journeys portrayed frequent tension between wheelchair users and parents with buggies for the priority seating. If a bus driver is not there to mediate conflicts such as these, existing barriers in shared public transport could worsen in automated passenger services unless designed for.

“There’s always only one wheelchair space. So, what if you’ve got two wheelchair users travelling together?”

– P21, FGD6

“It’s those conflicts among passengers really that I find the most troubling.”

– Final workshop, P3

“Suddenly you’re packed in and without a driver there … it’s just up to passengers to work out how to get yourself in and out if there’s an issue.”

– P45, FGD12

“Not having someone there to manage … how crowded it’s getting … it would make me feel a bit more nervous.”

– Participant during sensory walkalong (Neurodivergent)

These roles still need to be done. Some can be built into the vehicle or the stop. Some can be handled remotely. Others may still need a person onboard or nearby. What the service cannot do is leave these roles to passengers by default. The people left to sort things out would often be those who find it hardest to advocate for themselves. Planning a self-driving service gives the chance to assign every one of these roles clearly, and to design them in from the start.



4

FINDING 4

Direct access to a human, including remote assistance, was a requirement for trust

Across the focus groups, participants repeatedly described human support as part of the passenger service, not an optional extra.

The job title was not important to them. It was whether a person could be reached, understand the situation and act. They discussed onboard hosts, roaming staff, remote operators, control rooms and different staffing models by route or time of day.

> *"So, what about you have [self-driving buses], but they always have a host on them?"*
>
> — P19, FGD5

> *"... there needs to be an assistance button on the bus in case of an emergency, that's very visible... so we can contact the control centre."*
>
> — P42, FGD11

> *"... there'll be bigger acceptance from the public [of self-driving buses] if there's the equivalent of a guard there who can do the things like putting the ramp down and looking after people's safety, particularly at night."*
>
> — P10, FGD3

Remote assistance emerged as a major passenger requirement, not a back-office detail. Participants wanted a clearly identified, accessible way to reach a person who could understand what had happened, communicate with them and take practical action. Some were explicit that they would be less willing to use automated passenger services at certain times of day without human support.

> *"...if something fails, there has to be a control room where they would look at it and say, 'right, that's failed. But we can release the doors'...so that people are able to leave the bus safely and easily with the ramp or whatever."*
>
> — P50, FGD13

> *"... I take buses quite late at night [where] the emergency button is a lot less responsive compared to a person. And, especially as a woman, when you have some sort of intermediary, it's a lot easier..."*
>
> — P6, FGD2

> *“They need to know that somebody is there looking out for them, even if 99% of the time they don’t need any support.”*
>
> — P12, FGD3

Rather than assuming the same level of human presence across every service, participants suggested “flipping the script”. This could be running self-driving operation during lower-risk daytime journeys but keeping an onboard presence for evening and late-night services, or on routes where isolation, antisocial behaviour or personal safety concerns are more likely. This tiered approach offers a workable starting point for the consortium to explore, matching the level of human support to the level of assessed risk.

5

FINDING 5

Pick-up and drop-off emerged as a critical test of whether the service would work equally for every passenger

Across groups and access needs, pick-up and drop-off (PUDO) became central to whether participants believed the service would work for them. A ramp on the vehicle did not, by itself, create an accessible boarding process, as not all access needs were about mobility impairments. Every passenger needed a clear way to identify and hail the bus, know that they had been detected, understand what would happen next and complete boarding and alighting safely. Different access needs could require different forms of support, but the reliability of the process could not be conditional on who was travelling.

> *"Does the ramp automatically get deployed? Can I get off? Am I stuck on here because there's a [technical] error which means the ramp can't be deployed?"*
>
> — Participant during sensory walkalong (Mobility Impairment)

> *"At different bus stops, have a specific location [to wait] ... [you need to] really clarify 'this is how you can get on this [self-driving bus]'."*
>
> — Participant during sensory walkalong (Neurodivergent)

> *"You couldn't hail it in the normal way that people are used to hailing buses, by standing there and putting your hand out ... other services I have used that are automated, you press a button [on the bus stop] to tell it that you want that particular bus to stop for you"*
>
> — Participant during sensory walkalong (Hearing Impairment)

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The complete PUDO sequence matters: recognising the correct bus, knowing where to wait, signalling that the bus should stop, being detected, boarding, positioning inside the vehicle and getting off safely.

> For visually impaired participants, accessible PUDO meant predictable stopping points, clear orientation cues, reliable kerb alignment, level boarding, audible and tactile information and confirmation that the correct bus had arrived.

> For neurodivergent passengers, it meant reducing ambiguity. They wanted to know where to wait, what to do, how long they had, whether the bus had recognised them and what would happen next.

> For wheelchair users, mobility scooter users, those using mobility aids, people with buggies and passengers with mobility and dexterity impairments, it meant knowing that the vehicle would stop close enough to the kerb, that the ramp or boarding system would work, that enough time would be allowed and that they would not be left unable to get off.

> *"Am I just assuming that it will recognise that I need the ramp and deploy the ramp, or do I need to press a button? ... What do I need to do and what order do people get on and off?"*
>
> — P46, FGD12

Participants also wanted discreet ways to communicate access needs. Some passengers may need the bus to stop, wait longer, deploy a ramp, provide extra information or offer assistance. They did not want to announce those needs publicly or rely on another passenger to intervene.

6

FINDING 6

Information became part of the service's support system, not simply a wayfinding feature

Information clarity was one of the most consistently recurring themes across the focus groups, sensory walkalongs and final workshop. This is a familiar public transport requirement, but it becomes more important in a self-driving service because passengers may no longer be able to ask the driver. Information therefore does more than support navigation. It replaces some of the confirmation, explanation and reassurance that passengers currently receive through human interaction.

Participants wanted accurate, real-time and consistent information across the stop, vehicle and personal devices. This included knowing whether it was the correct bus, where it was going, what stop was next, whether the bus would stop, whether the ramp was available, whether there was space onboard, how to pay and what to do when circumstances changed.

> *"Just a simple display screen that [continually] tells you... what the next stop is, how long it's going to be... and where the final destination is."*
>
> — Final workshop, P6

> *"I'd like to see the bus number... so I knew I was on the right stop. And I'd like to [see] 'bus stopping' if the bell's already been pressed."*
>
> — P13, FGD4

Information had to operate as one end to end multi-format system across the stop, vehicle and pre-journey service. Essential information could not depend on a smartphone, and passengers needed clear confirmation when they made a request or when something changed.

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Recommendations

Automation takes the driver out of the driving seat. It should not take the support passengers rely on out of the service. Through focus groups, sensory walkalongs and a co-creation workshop, passengers told us clearly what a self-driving service would need to do to earn their acceptance and trust. These recommendations set that out.

Every role a driver performs alongside driving needs a clear home.



Some can be built into the stop and the vehicle.



Some can be handled remotely.



Others may be best done by a person onboard or nearby.

The balance can reasonably vary by route, location, time of day and assessed risk. What cannot vary is that every role is assigned.

01 Define the human support model and make it usable to passengers 24

02 A service can drive safely and still leave passengers feeling unsafe: build personal safety around feedback 24

03 Manage shared space through design, not passenger negotiation 25

04 Treat pick-up and drop-off as the critical trust point 25

05 Provide continuous, multimodal information across the journey 26

06 Test the complete passenger service with customers before deployment 26

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01 Define the human support model and make it usable to passengers

Make remote assistance the human face of the automated passenger service. Passengers need to know what support is available, how to reach it, what information the remote operator can access, what help they can provide, and what will happen next.

Every service should provide clearly labelled, two-way communication that does not depend on the passenger owning a phone. It must connect passengers directly to a human, identify the vehicle and its location automatically, confirm that the request has been received, and support communication through multi-modal formats.

> *"Who would we be calling? Where would that help request be going? And how long would it take someone to respond to that?"*
>
> — P26, FGD7

02 A service can drive safely and still leave passengers feeling unsafe: build personal safety around feedback

Design for the perception of safety, not just the ability to monitor risk. Participants, particularly women, were clear that the presence of a camera did not make them feel safe on its own. A camera may record what is happening, but it does not tell a passenger whether anyone is watching, whether a problem has been recognised, or whether help is on the way.

Monitoring therefore needs a visible feedback loop. Passengers should be able to see that the system is active and understand what area the camera covers. If a concern is detected or reported, the service should confirm that it has been received, show that a human is responding, and explain what will happen next. The passenger should not be left wondering whether the system has noticed them.

That response must lead somewhere. Passengers need a clear way to speak to a human, ask for the vehicle to stop, or leave safely if the situation cannot be resolved.

> *"If I were on a bus on my own, I have no concept of whether or not the camera that I can see, I don't know if it's working... whether there are any blind spots? ... I would want to see that because, without that, I would feel really quite vulnerable."*
>
> — Final workshop, P5

03 Manage shared space through design, not passenger negotiation

Design the vehicle for several access needs at once, not one passenger at a time. A wheelchair user may be travelling with another wheelchair user, while other passengers may have a buggy, luggage, or a mobility aid. The layout should provide enough turning space, accessible companion seating, and space for belongings without obstructing priority areas or movement through the vehicle.

Without a driver to help manage shared space, passengers will need clear and consistent cues about how it should be used. This may include physical layout, markings, signs, onboard information, or prompts that show who spaces are for and what should happen when competing needs arise. These approaches should be developed and tested with passengers, including how occupancy information could help people understand what space is available before they board.

> *"To put wheelchair users in the same space as people with prams ... [self-driving bus services will] really need to think carefully about the design layout of the bus to accommodate both."*
>
> — P29, FGD8

04 Treat pick-up and drop-off as the critical trust point

Make pick-up and drop-off the foundation of accessible self-driving service design. The stop, vehicle, and boarding process need to make visible what a driver would usually notice: that someone is waiting, that assistance is needed, that the vehicle is correctly aligned, that boarding is complete, or that a passenger needs a little more time. These are small judgements, but they determine whether everyone can use the service safely and independently.

Design and test the whole sequence as one connected process. Passengers need to be able to identify and hail the bus, know that they have been detected, board from a correctly aligned vehicle using level access or a reliable ramp, and receive clear confirmation before it moves off. Dwell time must respond to different passenger needs, with a clear fallback when any part of the process does not work as intended.

Access requests should remain discreet and flexible. Above all, boarding and alighting need to be reliable and dignified, without requiring passengers to disclose their access needs.

> *"The less I have to verbalise the fact that I need assistance or help, the better."*
>
> — P46, FGD12

05 Provide continuous, multimodal information across the journey

Provide essential information through more than one accessible channel. Multimodal information means combining clear visual displays, spoken announcements, readable text, symbols, and, where appropriate, tactile or vibration-based alerts. The same message should be consistent across the stop, the vehicle, and any digital service, so passengers do not have to interpret conflicting information.

> *"If it's only visually shown, you're taking a whole sector of accessibility away."*
>
> — P37, FGD10

Passengers should be able to find out what they need before boarding, during the journey, and when something changes. This includes the route and destination, the next stop, delays and diversions, how to board, whether accessible space is available, how payment works, how to request assistance, and what to do if the journey does not go as planned. Layer information so that it remains clear rather than overwhelming. Essential messages, such as the destination, next stop, disruption, or an urgent instruction, should be visible and audible by default. More detailed information can then be available through optional screens, help points, printed information, or personal devices for passengers who need it.

Smartphones cannot be the gateway to the service. Some passengers will not own one. Others may have limited data, poor signal, a flat battery, difficulty using apps, or accessibility needs that have not been designed for. Passengers must still be able to identify the correct vehicle, hail it, pay, request assistance, receive disruption information, and contact support using the stop and vehicle itself.

06 Test the complete passenger service with customers before deployment

Explain the service in terms passengers can use. People need to understand what will feel different from a conventional bus, what will stay familiar, and how they will interact with the service from the moment they arrive at the stop. That includes knowing how the bus detects them, how boarding and payment work, how to ask for help or more time, and what support is available if something changes. This should be explained clearly before the journey, at the stop, and on the vehicle itself.

> *"Please don't overestimate the understanding and knowledge of the general population around this kind of service. [Explain] what makes these buses different in practice. Not just 'there's no driver', but in terms of [the] experience – how's that going to be different?"*
>
> — Final workshop, P5

Co-design the service with people, not just around them. Human factors work should continue throughout early deployment, with passengers shaping how the service responds to real journeys, real pressures, and the points where confidence begins to break down.

That means deliberately involving people whose needs are often missed in transport design, and making sure their experience directly changes the service rather than simply being recorded. Co-creation should continue as the technology, vehicles, stops, and operating model develop. Where the service cannot yet support someone safely and independently, a clear alternative must remain available.

> *“[It needs to be] a service that people believe is made for them, with them in mind.”*
>
> — Final workshop, P4

Conclusion

Automating the driving task has the potential to make bus travel safer. An automated system does not get tired or distracted, and participants were broadly ready to trust it to drive. Their questions were about everything around the driving: how the service would notice them, support them, and respond when the journey did not go to plan.

The support a driver provides alongside driving will have to be designed into an automated passenger service. The stop, vehicle, passenger information, remote support and operating model must work together as one service.

The same applies to accessibility and personal safety. A ramp, camera, or screen may each play a part, but none is enough on its own. Passengers need the whole sequence to work. They need clear feedback, reliable support, and a direct route to a human when circumstances change.

Many of these requirements apply to conventional buses too. Automation makes them a design priority and gives Connector the chance to get them right before the service is built rather than after.

This research has shown the value of designing with passengers, not just for them. Participants raised questions that might otherwise have remained hidden and proposed practical answers. The local authority, software provider, operator and vehicle manufacturer heard that evidence directly and can begin considering what it means for the developing service model. That dialogue will continue as ideas are designed, tested and refined, because acceptance and trust are built with the people who will use the service.

> **The real opportunity is not just teaching the bus to drive itself.**
>
> ***It is designing a transport service that supports everyone equally, at every stage of the self-driving journey.***

CONNECTOR CONSORTIUM













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