

Wheelchair Accessible Vehicles Usability Research Report



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Executive Summary

Rica, experts in age and ability research, has been funded by the Motability Tenth Anniversary Trust to carry out a research project investigating usability aspects of WAVs.

The aim of the research was to uncover the strengths and weaknesses of different WAV designs and particular features, in terms of their usability and the user needs and circumstances they might suit.

The findings from this research are presented in this research report, intended primarily at professionals advising disabled people on motoring choices. The findings have also been used to update and expand on Rica's existing online independent consumer guidance (www.rica.org.uk/WAVS).

The research comprised stakeholder interviews, focus groups and two full days of user testing with six users and eight WAVs. The following conclusions have been drawn directly from the research findings and user comments and highlight the need to understand the users' needs and circumstances.

- Assessments for WAV users and their companion (if regular) are important as WAVs are an expensive, specialist product.
- It is important for users to know how to use their WAV regardless of the level of involvement interacting with the WAV during use.
- It is important to carefully research the different finance options available and weigh up the pros and cons.

- Whether the WAV has manual or powered features has a large impact on usability and determines the involvement of the wheelchair user.
- The location of the wheelchair users' access to the WAV is primarily based on user circumstances and preferences.
- Choosing between a manual tailgate or door/s is dependent on the users' ability.
- Whether to use a ramp or lift to enter the WAV is impacted by several factors based on both practicalities and user abilities.
- The type of wheelchair restraint system to use is also based on practicalities and user abilities.



Acknowledgement

The research reported in this document was funded by Motability Tenth Anniversary Trust. Rica is grateful for the support of Alfred Bekker, Brotherwood and GM Coachworks for providing demonstration vehicles for the workshops and to Queen Elizabeth Foundation (QEF) for hosting the workshops.

We would also like to thank all the staff at Motability for their help and guidance, as well as the stakeholders interviewed and the RicaWatch consumer panel members who attended the workshop.

Rica

Research Institute for Consumer Affairs (Rica) specialises in consumer research with older and disabled consumers. Founded through Consumers Association, publishers of Which?, Rica became independent in 1991.

Rica has its own [Consumer Panel – the RicaWatch panel](#) – of over 600 people and is a disability led organisation. Seven of the charity's nine Trustees have a disability. Rica carries out [commissioned research work](#) with industry, other charities, service providers and policy makers to improve products and services. With grant funding Rica also publishes free [consumer reports](#) based on independent research.

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1 Introduction

Consumer interest in Wheelchair Accessible Vehicles (WAVs) has grown rapidly along with the sales of new and second hand vehicles. At the same time the range of available WAVs and features has expanded and while considerable efforts have been made to give users the opportunity to see and try a range of products, this isn't possible for everyone. This highlights the importance of independent consumer information covering the range of products available and further insight into the usability of WAVs and the different features.

Rica, experts in age and ability research, has been funded by the Motability Tenth Anniversary Trust to carry out a research project investigating usability aspects of WAVs. The findings from this research are presented in this research report, intended primarily at professionals advising disabled people on motoring choices. The findings have also been used to update and expand on Rica's existing online independent consumer guidance (www.rica.org.uk/WAVS).

The aim of the research was to uncover the strengths and weaknesses of different WAV designs and particular features, in terms of their usability and the user needs and circumstances they might suit.

The research comprised of two elements; stakeholder telephone interviews and user testing workshops. Prior to carrying out these elements background desk research was completed by researchers.

The purpose of the stakeholder interviews was to identify product considerations relating to a user's needs and circumstances. The feedback from stakeholders, coupled with the background research, helped inform the design of the user testing workshops. These explored a variety of WAV features and assessed their general usability by identifying the different skills required for use and potential difficulties they may cause. This was completed through one-to-one research evaluations and group discussions over two full day workshops.

2 Background

2.1 Wheelchair accessible vehicles (WAVs)

Wheelchair accessible vehicles (WAVs) are made by converting standard production vehicles. There are 3 types of wheelchair accessible vehicles:

- Passenger WAV – where the wheelchair user travels as a passenger.
- Drive-from wheelchair (DFW) – where the wheelchair user remains in their wheelchair to drive.
- Internal transfer (IT) – where the wheelchair user transfers from their wheelchair to the driving seat while inside the vehicle.

WAVs are accessed by a ramp or a lift, which may be located at the side or rear of the vehicle. Lifts are always powered and ramps are either manually deployed or are powered and deployed using a remote control. Similarly, tailgates and doors can be operated manually or powered. DFW and IT vehicles have powered tailgates or doors and ramps or lifts so that they can be used independently whereas for a passenger WAV, it depends on the abilities of the individual travelling with the wheelchair user.

Inside the vehicle, wheelchairs are secured by a series of tie down straps or an automatic docking system. The tie down straps are typically attached to the front and rear of the wheelchair frame and are tightened and locked in place when the wheelchair is in the travelling position. When tie down straps are not in use they need to be securely stowed where they will not be in the way but will be easily available for when the user returns to the vehicle. A docking system is bolted to the floor in the wheelchair travelling position and requires the wheelchair being secured to have a compatible docking pin mounted to the bottom. When the wheelchair is driven to the travelling position the pin locks into a catch on the docking system securing the wheelchair in place. This allows the wheelchair user to secure their wheelchair independently. Seat belts are adapted from the vehicle's standard seat belt.

2.2 Wheelchair accessible vehicle users

People who use WAVs are usually full time wheelchair users. The WAV makes it possible to travel by road without having to transfer in and out of the wheelchair, unless an IT vehicle has been chosen. DFW and IT vehicles are designed to give wheelchair users independence as their features allow the user to operate the WAV alone.



People who use WAVs need to ensure the following steps can be completed by the wheelchair user and/or their companion; unlock and open the door or tailgate, deploy the ramp or lift, enter the vehicle, secure the wheelchair, secure the wheelchair user, stow the lift or ramp and close the door or tailgate behind them. Depending on the WAV, the order of these steps may vary and some may be combined. See figure 1 for the different methods for performing these steps.

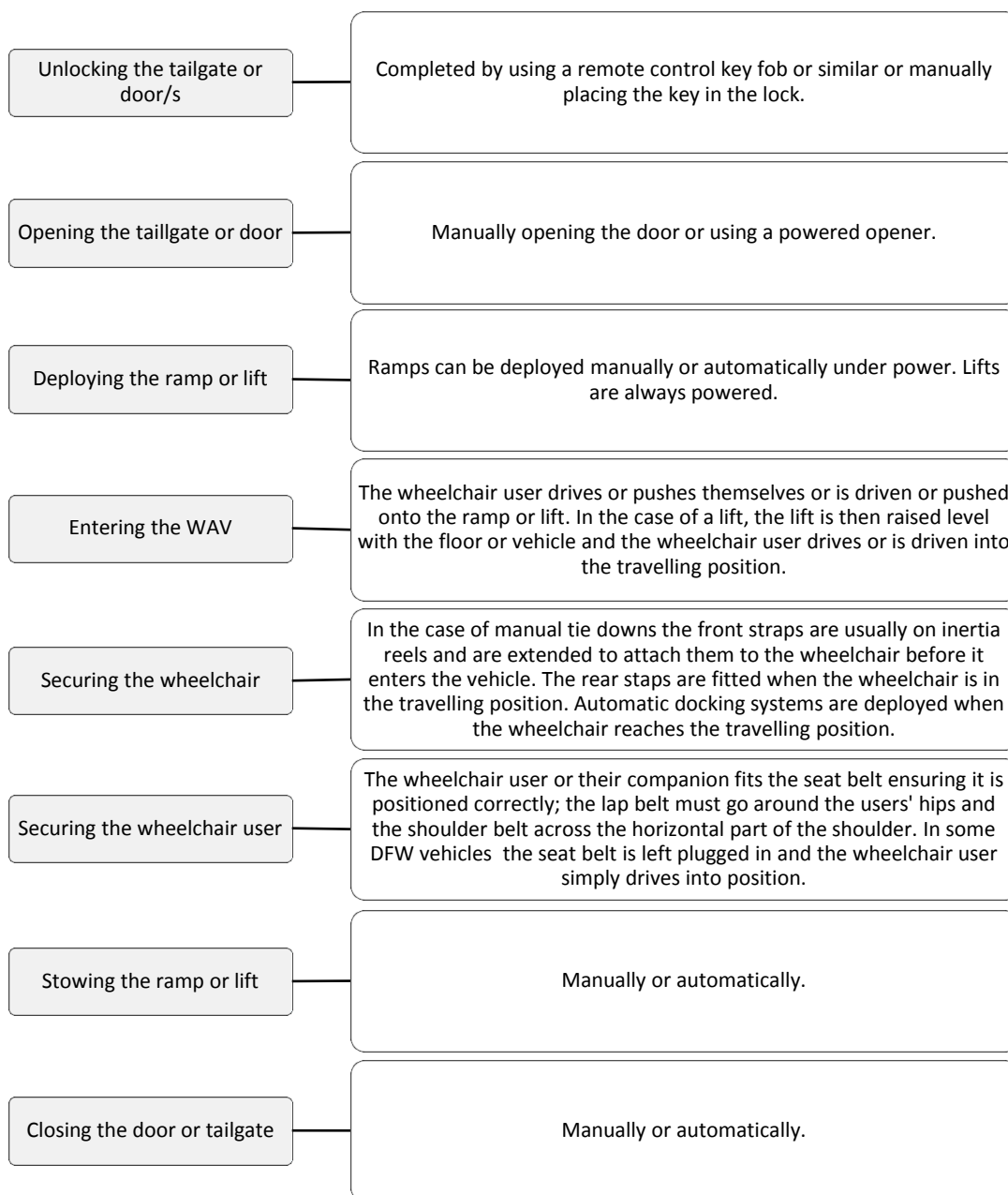


Figure 1: Steps of using a WAV



2.3 Selecting a WAV

Selecting and acquiring a suitable WAV involves considering a number of factors:

- User needs, abilities and preferences – section 2.2.
- User and wheelchair size and weight – different WAVs and features allow different size wheelchairs and weights.
- Context of use – where and how frequently the vehicle will be driven and parked and the people or equipment to be transported
- Financing

To ensure the correct WAV is chosen, first time buyers and those that are thinking of acquiring a new type or design of vehicle are advised to have an assessment and take advice from a driving assessment centre. Converters and adapters also provide information about the vehicles they supply and will bring vehicles to potential customers for a demonstration. This gives users the opportunity to try all the operations of the vehicle to ensure they will be able to carry them out. Customers on the Motability scheme are encouraged to have an assessment.

Eligibility for the Motability scheme is determined by the receipt of a mobility allowance. Receiving any of the following allowances, providing there is at least 12 months left, qualifies an individual for the Motability scheme: Higher Rate Mobility Component of Disability Living Allowance (HRMC DLA), Enhanced Rate Mobility Component of Personal Independence Payment (ERMC PIP), War Pensioners' Mobility Supplement (WPMS) or Armed Forces Independence Payment (AFIP). In addition to the weekly mobility allowance, an advance payment is also required for a WAV to cover the cost of the full lease.

Those who qualify for the Motability scheme can lease a WAV for 5 years or 3 years in the case of nearly new vehicles. The lease takes care of all the cost and hassle of running the WAV for example the servicing, insurance and tax etc. There is a Motability Grant scheme, which exists to provide additional funding where necessary, particularly for more expensive vehicles. People using the grant scheme will normally be required to obtain a comprehensive demonstration to ensure they get the right vehicle for their needs.

Those who do not qualify for the Motability scheme, or prefer not to use it, buy or lease new or second hand vehicles using their own funds. Because the vehicles are expensive people are likely to want to make a purchase that will last them a number of years so these users need to be sure they have the right information and advice to get a suitable vehicle. There is information about WAVs on Rica's website (www.rica.org.uk/WAVs) and Motability's website (www.motability.co.uk/cars-and-wavs/wheelchair-accessible-vehicle).



3 Stakeholder interviews

3.1 Method

During August and September 2015 Rica carried out a series of telephone interviews with stakeholders in the WAV sector. Telephone interviews concentrated on the range of vehicles available, their prices, availability, WAV features and the factors taken into account during user assessment and vehicle demonstration.

The following stakeholders were interviewed:

Industry

- GM Coachworks
- Fleximobility; WAVCA
- Brotherwood Automobility
- GM Coachworks; WAVCA

Advisory

- MND Association
- Queen Elizabeth Foundation
- Cornwall Mobility Centre

And consultation with Motability.

3.2 Results

3.2.1 Market factors, range and availability

WAVs are a specialist product, especially DFW and IT vehicles. Conversions are more expensive as they involve engineering and the manufacture of components to allow access while in a wheelchair to the vehicle. There are around 20 conversion companies in the UK who offer a range of conversions. Users can acquire a WAV using the Motability scheme or fund their own purchase. There are approximately 27,000 vehicles in the Motability fleet and around 3000 privately owned.

With Motability, customers might find themselves making an advance payment of £1000-£30,000 for passenger WAVs or £15,000-£30,000 for DFW/IT vehicles every 5 years (as well as paying over the Mobility Component of DLA/PIP). It is estimated that nine out of ten of DFW and IT vehicle users accessing the Motability scheme made use of a Motability grant. Of course, the Motability scheme provides insurance and maintenance (with assured continuity if the vehicle has to go into the garage for a length of time). Some users, particularly those who develop their mobility impairment after the age of 65, don't qualify for the Motability scheme.



Whereas, for private purchases although the upfront cost is higher (around £60,000), there are no insurance or cost restrictions and the vehicle would be owned rather than leased which some people prefer. Private purchases are funded from personal funds, including benefits and damages payments. Additional sources of funding include Access to Work and specialist charities.

There is quite a large second hand market for WAVs, many of which are former Motability vehicles however this option may not be suitable for people with specialist needs, since DFW vehicle conversions especially are tailored around the individual. There are also companies providing WAVs on long and short term rental. Again, this is most suitable for simple passenger conversions. It is also a common solution for care providers.

3.2.2 Properties of vehicles and conversions

The vehicle and conversions features raised by interviewees covered: vehicle size, access route, travelling position, and equipment such as ramps, lifts, winches and passenger and wheelchair restraints.

Size –

Vehicle conversion is essentially a compromise, being constrained by the design and availability of standard vehicles and by users' capabilities, needs and preferences. Many users would prefer a smaller WAV, as they are easier to drive and more economical, but of course the vehicle must be large enough to accommodate the wheelchair and any other passengers. IT vehicles require larger interiors, as there must be room to stow the wheelchair and enough headroom for the user to transfer into the driving seat.

The height of the vehicle is also constrained. If the floor is too high this makes access difficult, especially by ramp (it makes the ramp very steep). If the floor is too low this causes problems with under vehicle clearance. One way of making the floor lower is to cut out the original vehicle floor and replace it with a lower, sometimes sloping floor. This brings its own problems as it can affect clearance and more importantly cause the wheelchair user to have to travel on a slope. Some vehicles have adjustable suspension, which means the floor can be lowered for access and raised for driving.

Cut-out floors can also result in the track the wheelchair user has to follow to enter and leave the vehicle being narrow, which can cause difficulties, especially if it is not straight. Wheelchairs usually have a pair of casters at the front, which need to be able to turn around when the user is reversing out. Sometimes these can get jammed against the sides of the track.



As well as being level, the travelling position for passengers should be as far forward as possible. When the wheelchair user is travelling behind or over the rear axle, they may experience a much bumpier ride than when they are in front of the axle. This also makes it easier for them to speak with the driver and other passengers.

Rear and side access –

Different conversions allow access at the rear or the side of the vehicle. Rear access is more suitable for use in car parks and side access for parallel parking. Users need to consider how and where they will be parking their vehicle. This is to an extent a question of personal preference and of what best fits with the user's lifestyle.

Ramps and lifts –

Ramps and lifts need to be easy to operate (whether manually or under power) and have sufficient weight capacity for the user and their wheelchair. The choice between a ramp and a lift is partly a matter of preference. However, heavy users or those with heavy wheelchairs may need a lift. Additionally some users may find it difficult to negotiate a ramp, especially if they have to reverse out of the vehicle. Ramps are not usually fitted to side access vehicles.

Where the vehicle has a ramp, a winch may be provided to assist the wheelchair user getting up the ramp. This is usually combined with the front tie downs. Winches are more usual in passenger WAVs, since it is mostly impractical for a wheelchair user to attach and operate a winch while in the wheelchair.

Wheelchair and occupant restraints –

Passenger WAVs generally have tie downs consisting of straps attached manually by hand to each corner of the wheelchair which need to be operated by an assistant. DFW and IT vehicles conversions need to have a docking system that can be operated independently. These require a docking bracket to be attached to the wheelchair, which locks into a catch on the docking system which is bolted to the vehicle. They need to be positioned carefully around the user and are always fitted at the second stage of conversion.

Tie downs need to be able to hold the weight of the user and their wheelchair. However, it can be difficult for users and advisors to determine the safe working limit of the tie down. Powered wheelchairs, especially mid-wheel drive chairs and those with tilt in space and seat raisers can be very heavy. Four point tie down systems are typically rated up to 140kg. Above this a uprated 4 point system or 6 point system can be used.

Occupant restraints (seat belts) use the original vehicle equipment as much as possible. Where the wheelchair occupies a space in the middle of the vehicle adjustable straps and moveable anchorages help provide an occupant restraint that secures the user in the right position.



Where an automatic docking system is used it is sometimes possible to have a drive-in seat belt so the user just has to drive into the driving position to be securely restrained.

3.2.3 User assessments

All stakeholders agreed that a proper user assessment is critical to getting the right mobility solution. A full assessment involves considering a range of options including wheelchair and person hoists and wheelchair stowage systems as well as WAVs. An assessment at a Mobility Centre will typically give users the chance to consider a wide range of options before considering the detailed features of any particular solution. Experienced users may know what they want and need and be able to determine for themselves which solutions are suitable for them.

When the user or assessor has determined what kind of conversion and what specific features are appropriate, this specification should be used to evaluate vehicles before purchase. Convertors and vehicle dealers should always provide a full demonstration of any vehicle and allow users time to try out all features for themselves. If necessary, they should bring the vehicle to the user's home for this demo. They should not put users under any obligation to buy.

Context of use –

A proper assessment involves considering the user's abilities and requirements and all the other factors affecting their use of the vehicle, including where they live, who else travels with them and any assistance dogs, equipment or pets they may commonly transport.

DFW and IT vehicles –

If the wheelchair user is going to be driving the vehicle, their ability to drive needs to be assessed and they will need guidance from a trained professional in adapting the driving controls.

Users who do not require specialist postural control may prefer to drive from a standard car seat. The assessment needs to determine whether they have the strength and ability to transfer from their wheelchair.



4 User testing workshops

4.1 Method

4.1.1 Workshop structure

Rica held two full day workshops at QEF Mobility Services with WAV users to evaluate the usability of different WAV designs and features. Passenger WAVs were tested on 27th October 2015 and drive from wheelchair (DFW) vehicles on 28th October 2015. Both workshops had the same structure consisting of user testing in the morning, with three users testing four vehicles, followed by a group discussion in the afternoon.

For the user testing participants toured the vehicles accompanied by a researcher recording their experiences. Each user went through the steps to board and alight from each vehicle twice. The first time researchers recorded general observations and impressions and the second time asked users for detailed comments on each stage. The researcher record sheet can be seen in appendix D. Test results are presented in section 4.2 below.

During the afternoon, participants toured all the vehicles again as a group and discussed specific issues that had arisen during the testing. This was followed by a general discussion of the factors to be considered when choosing and acquiring a WAV. The results of this discussion are presented in section 4.3.

4.1.2 WAVs tested

In total eight WAVs were used for the workshops. Five WAVs were demonstration vehicles provided by converter companies and three were provided by Motability (two from operations, one from grants).

Each vehicle was demonstrated to the research team at the beginning of the day and although the converter company's and Motability staff were present during the testing, they were asked not to give instructions to the users. As can be seen from the researcher record sheet in appendix D the intuitive and inclusive nature of the design was a significant part of what was under evaluation and it was felt that this could not be properly tested if close assistance to users was given.

The following passenger WAVs were tested:

1. Ford Tourneo Connect (supplied by Brotherwood)
2. Ford Tourneo Grand Connect (supplied by Alfred Bekker)
3. Peugeot Boxer (supplied by Motability Operations)
4. Peugeot Expert Upfront (supplied by GM Coachwork)



The following DFW vehicles were tested:

1. VW Caravelle Colorado (supplied by GM Coachwork)
2. VW Caravelle Nevada (supplied by GM Coachwork)
3. Mercedes Sprinter (supplied by Motability Grants)
4. VW Caddy iCan (conversion by Sirus, supplied by Motability Operations)

See appendix C for a full description of each vehicle.

4.1.3 Participants and delegates

Participants were recruited from Rica's Consumer Research Panel. This panel is used by Rica for a range of research activities. Panel members have been recruited over several years and they and their capabilities are known to Rica's research team. They are covered by Rica's employer's liability insurance.

All participants had been using a WAV for at least ten years, except one who was in the process of acquiring a WAV having used a wheelchair stowage system (Abi-loader) for a number of years. All were wheelchair users, one able to stand for a short time, the rest full time users. Many had experience of a range of different vehicles.

On the passenger WAV testing day, participants were accompanied by a companion or professional carer who would usually travel with them, helping them access the vehicle and also driving. On the DFW vehicle testing day, participants attended alone.

Passenger WAV participants were as follows:

- User 1 – a 66 year old manual wheelchair user (assistant-propelled); current vehicle Peugeot Horizon; previous vehicle Fiat Doblo.
- User 2 – a 59 year old powered wheelchair user accompanied by his partner and an assistance dog (diabetes alert); current vehicle Renault Master; previous vehicles Renault Trafic, Peugeot Expert.
- User 3 – a 33 year old manual wheelchair user (self-propelled) accompanied by his PA; current vehicle estate car with AbiLoader wheelchair stowage system; shortly acquiring a wheelchair accessible vehicle; no previous vehicles.

DFW vehicle participants were as follows:

- User 1 – a 61 year old powered wheelchair user (able to transfer) accompanied by an assistance dog (mobility assistance); current vehicle Renault Kangoo; no previous vehicles.
- User 2 – a 70 year old powered wheelchair user accompanied by her PA and an assistance dog (mobility assistance); current vehicle Volkswagen Transporter; previous vehicles Ford Focus and Renault Kangoo.
- User 3 – an 82 year old powered wheelchair user; current vehicle Chrysler Voyager.

Two Rica researchers and two members of QEF staff attended each workshop.

4.2 Results

Because the WAVs tested represent a small proportion of available conversions, and because some may have had features that were unsuitable for individual participants but would suit other users well, the testing was not intended to provide information about the quality or suitability of specific conversions. It was intended to uncover the strengths and weaknesses of particular features and the skills required for their use.

4.2.1 Tailgates

Five of the WAVs had rear tailgates; three were operated manually and two powered. As expected, there was more difficulty with the manual tailgates and on three occasions participants reported not having enough space and time to manoeuvre themselves when opening and closing the tailgate. This was especially the case for the Ford Tourneo Connect Grand which two participants attributed to the bumper attached to the bottom of the tailgate shown in figure 2. The other case was for the Peugeot Expert Tepee as a participant thought the tailgate was high.

“[The] section sticking off the bottom of the tailgate, don’t expect to be there so gave less space when opening” – Ford Tourneo Grand Connect

“Need too much reach” – Peugeot Expert Tepee



Figure 2: Ford Tourneo Connect Grand tailgate bumper highlighted



Figure 3: Peugeot Expert Tepee tailgate

The skills selected for using a manual tailgate were balance, coordination and range of reach.

“Balance as was standing too close when opened and came up quicker and further than thought” - Balance

“Too high” – Range of reach



*“Step back to open and reach to guide up, especially as longer than expected”
– Range of reach*

None of the participants had difficulty positioning themselves when opening a powered tailgate as both were operated by a remote control which could be used at a distance from the WAV. Any difficulty in using a powered tailgate is most likely to be linked to the design of the control panel and level of dexterity required which is discussed in sections 4.2.3 and 4.2.4. Both of the powered tailgates were the start of an automatic sequence which went on to open or close the ramp or lift.

One of the tailgates was criticized for having a delay between pressing the button and the activation of the tailgate as it made participants think it wasn't working. It was suggested a noise would be beneficial to make both the users and surrounding people aware of the opening or closing tailgate.

4.2.2 Doors

Three WAVs had doors at the wheelchair entry point but each were different. Two had double doors at the rear, one operated manually and one powered, and the other had a powered sliding door at the side of the vehicle. All participants had enough time and space to position themselves when opening the doors, including for the manual doors.

The manual double doors could be opened to 180 degrees which made the entry to the WAV clearer visually (see figure 5). During one of the initial researcher observations a participant failed to notice the button which activated this however once it had been located the participant found it easy to use.

Similarly to the powered tailgate, the ease of use of the powered doors was dependent on participant dexterity and remote control design which is discussed in section 4.2.3 and 4.2.4. The sliding door remote control initially caused some confusion as researchers observed participants opening the wrong side door.



Figure 4: VW Caravelle Colorado side sliding powered door



Figure 5: Peugeot Boxer rear double manual doors



4.2.3 Ramps

Five ramps were included in the user testing; three of the ramps were operated manually on passenger WAVs and two were powered on the drive from WAVs. The ramp results have been discussed by vehicle as it was highlighted that each ramp is made up of several interacting components impacting the ease of use. The manual and powered ramps have been considered separately as they have very different components which require very different skills.

Converter, make and model	Ease of lowering the ramp (1-5)	Ease of stowing the ramp (1-5)		Ramp detail
		Raise	Secure	
Alfred Bekker Ford Tourneo Grand Connect	2	3	4	API Flexi ramp – ramp can fold flat to boot floor. Handles in centre.
Brotherwood Ford Tourneo Connect	4	5	4	Lever to release and handle on side.
GM Coachworks Peugeot Expert TePee	3	3	4	Bi-folding ramp with two handles on either side of fold.

Table 1: Manual ramps average ease of use ratings. (1= very poor, 5= very good).

As shown in table 1 above, of the manually operated ramps, the ramp on the Ford Tourneo Connect Grand had the lowest ease of use rating, the Peugeot Expert Tepee the middle and Ford Tourneo Connect the highest. All skills and capabilities were required when using a manual ramp however as expected these varied largely between vehicles and coincide with the ease of use rating. See figure 6 for the distribution across manual ramps.

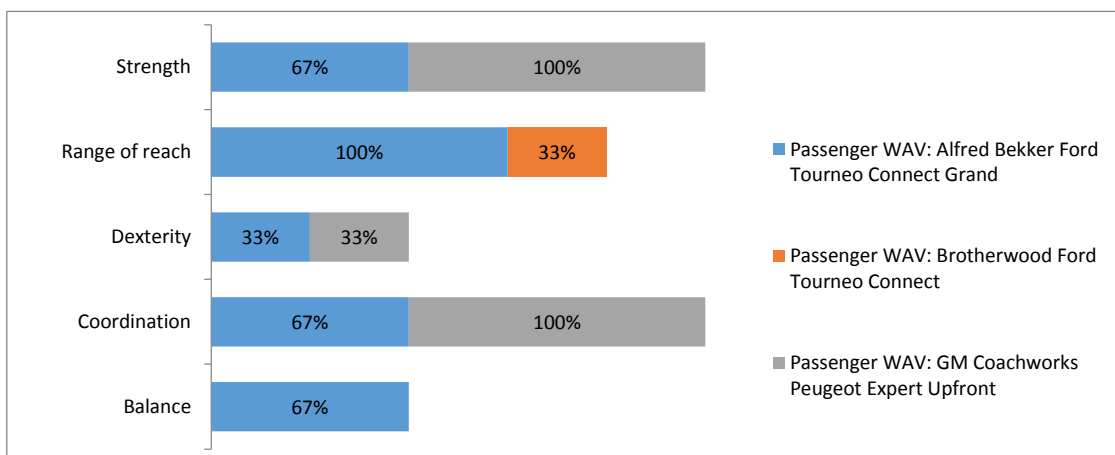


Figure 6: Percentage of participants selecting skills for lowering the ramp



The components affecting the use of a manual ramp were highlighted as:

- Ramp mechanism – each of the ramps tested had different mechanisms requiring different movements.
- Ramp control – all the manual ramps had a lever to release the ramp however they each had slight variation in design and location.
- Ramp handles – can be used to aid the lowering or raising of the ramp. With each ramp mechanism the handle design varied and participants highlighted where they felt necessary.
- Ramp size and weight

Alfred Bekker Ford Tourneo Connect Grand –

The API flexi ramp allows the ramp to lie flat to the floor of the vehicle when the wheelchair user isn't present (see figure 7). Laying the ramp flat gives some additional space and increases the visibility out of the rear of the vehicle; however, some difficulty was observed with this feature which is reflected in participant results. As seen in figure 6, this ramp required the most varied skills. In particular participants commented on the range of reach and strength required:

“Reach to get ramp from flat then requires a lot of strength to get upright”

“Awkward bend and reach”

“Ramp very heavy from flat position”

To help users raise the ramp from flat there are two plastic trimmed handles embedded in the centre of the ramp however there are no other handles on the ramp. Participants commented on the lack of handles to aid the lowering of the ramp for use. Their absence meant participants had to hold the side of the ramp, which offers a reduced grip surface, and increase their range of reach to lower the ramp. See figure 8 for the centre handles.



Figure 7: API Flexi ramp flat to vehicle floor



Figure 8: API Flexi ramp centre handles highlighted

At the right hand side of the base of the ramp there are two red levers which release the ramp for lowering. The levers are horizontal and slightly shaped. It was observed by researchers, and reflected in the results, that participants had difficulty using the levers to release the ramp. Low ratings were spread throughout the design criteria with the lowest being in identification for clarity of use. One participant commented on the lack of arrows on the levers as one lever releases the ramp so it can be stowed flat to the vehicle floor and the other releases it to be lowered for use.

“Struggled to figure out which lever did what, but fine after a while”

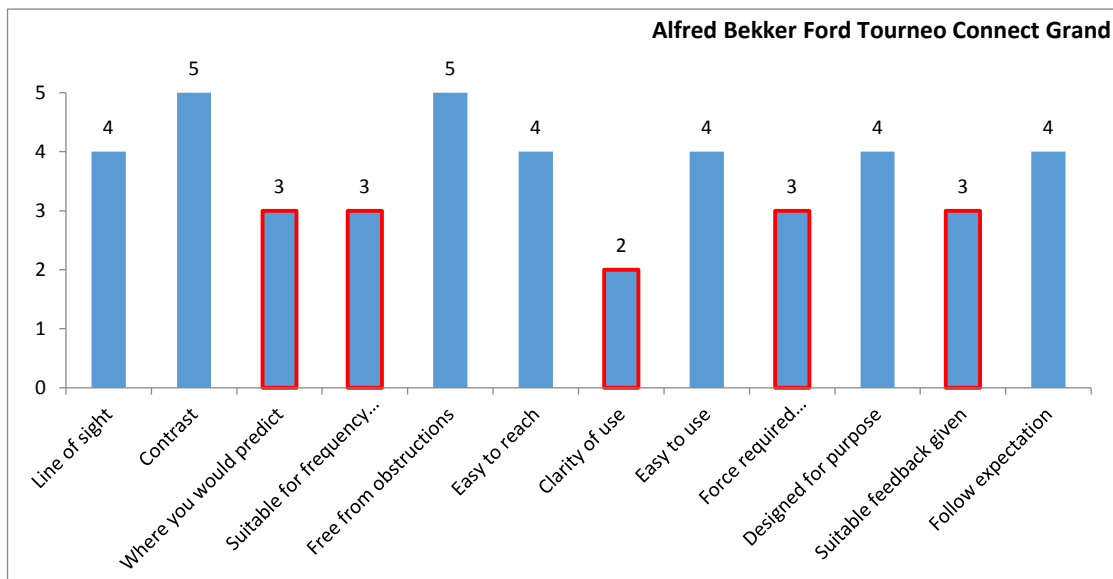


Figure 9: Ratings of Ford Tourneo Connect Grand ramp release control. (1= very poor, 5= very good). (Bars outlined in red indicate a low score).

All participants were able to use the ramp and enter the WAV however not all found it comfortable due to the sloping floor.

GM Coachworks Peugeot Expert Tepee –

The bi-folding ramp mechanism means the ramp can be longer than a standard ramp and still be stored in a similar amount of space. The longer the ramp is the lower the gradient of the ramp when in use. The ease of lowering the bi-folding ramp was 3 (see table 1) and participants unanimously thought strength and coordination was required for its use:

“Unfold as bending, as holding handles and push on ramp and pull lever all at the same time”

“More force required than thought”

“Very stiff, requires coordination to push on the ramp lever, requires too much force”

“Coordination, dexterity and strength all need to be reasonable”

One participant was observed having some difficulty at first in understanding the bi-fold mechanism and process and tried to unfold the ramp before releasing it. Once guided by the researcher the participant understood the process.



Figure 10: Peugeot Expert Tepee ramp

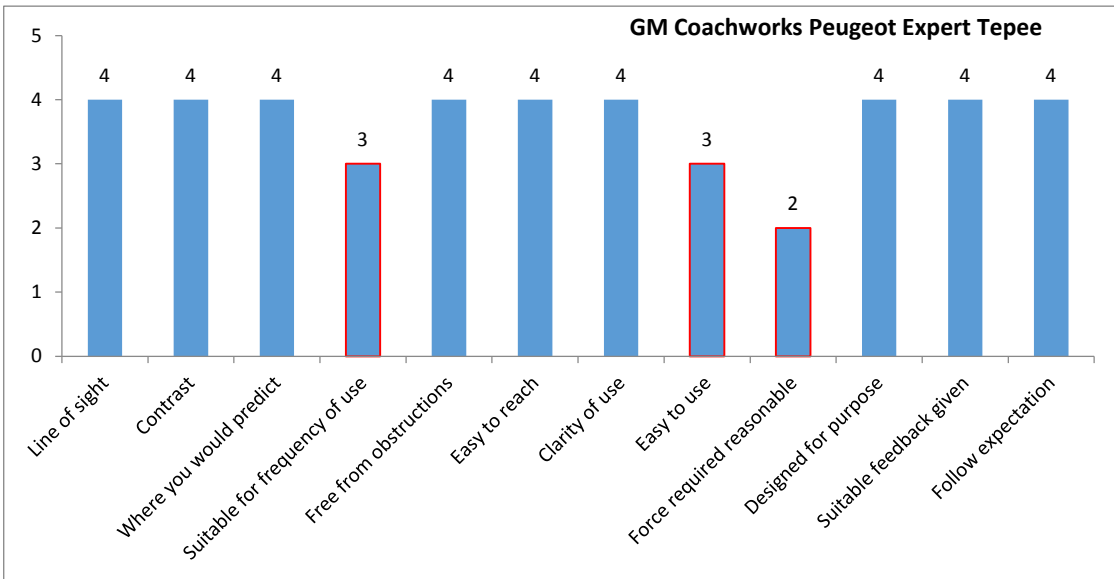


Figure 11: Ratings of Peugeot Expert Tepee ramp release control. (1= very poor, 5= very good). (Bars outlined in red indicate a low score).

Despite being the most complex ramp mechanism tested, the bi-folding ramp has the simplest control to release the ramp; a single, vertical yellow lever on the right hand side of the base of the ramp (see figure 12). Participants had some difficulty using the lever and gave low ease of use ratings on suitability for frequency of use, easy to use and force required reasonable. This is highlighted by all requiring strength for lowering the ramp.



Figure 12: Peugeot Expert Tepee ramp release control highlighted



Figure 13: Peugeot Expert Tepee ramp handles



The ramp has two handles; one on either side of the fold to help with lowering the ramp (see figure 13). Although participants commented on the coordination required, which included the use of handles to operate the ramp, the handles were considered useful.

All participants were able to enter the WAV however it wasn't comfortable for two as they found the ramp too steep. Despite having a longer ramp, the height of the vehicle meant the gradient of the ramp was still large.

	Ease of using the ramp to enter the vehicle
Getting onto the ramp	3
Using the ramp	2
Getting off the ramp into vehicle	3

Table 2: Ease ratings for using the ramp to enter the vehicle. (1= very poor, 5= very good).

Brotherwood Ford Tourneo Connect –

The ramp on the Brotherwood Ford Tourneo Connect had the highest rating for the ease of lowering and the least skills required for use. One participant commented on the quality of the conversion and mentioned the range of reach required:

“Felt smooth, like the conversion was always part of the vehicle”

“Was light”

“Was low to guide the ramp down”

The ramp is locked and stored vertically and to release it a single lever is pulled upward. The only issue highlighted with the lever was the lack of contrast to the vehicle. See figure 15 for an image of the lever and figure 16 for the full results.



Figure 15: Ford Tourneo Connect ramp



Figure 15: Ford Tourneo Connect ramp release control highlighted

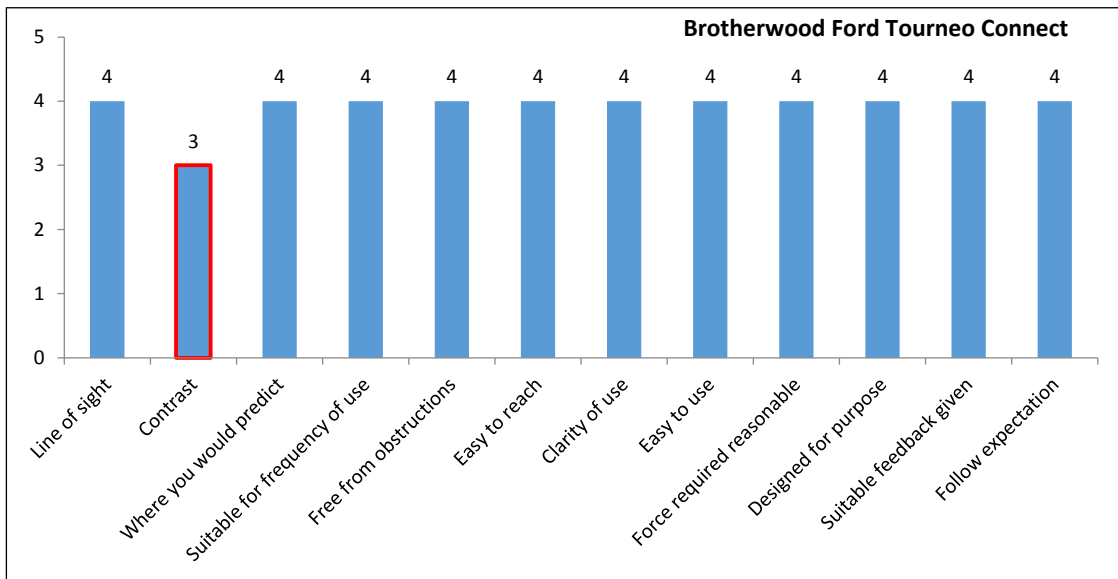


Figure 16: Ratings of Ford Tourneo Connect ramp release control. (1= very poor, 5= very good). (Bars outlined in red indicate a low score).

The ease of lowering a powered ramp was generally rated higher than manual ramps however as previously mentioned it is difficult to directly compare their ease of use due to the different in components and skills required for use. The ramp on the GM Coachworks Caravelle Nevada was rated one point higher than the Sirius Automotive VW Caddy iCan ramp at 3. See table 3 below for details. Only dexterity was mentioned as a required skill during the testing of powered ramps and this was by one participant on one WAV; the Sirius Automotive VW Caddy iCan ramp.

Converter, make and model	Ease of lowering the ramp (1-5)	Ease of stowing the ramp (1-5)		Ramp detail
		Raise	Secure	
GM Coachworks Caravelle Nevada	4	4	4	Powered ramp
Sirius Automotive VW Caddy iCan	3	4	4	Powered ramp

Table 3: Powered ramp average ease of use ratings. (1= very poor, 5= very good).

Powered ramps have less user facing components impacting the ease of use than manual ramps. The user facing components highlighted for lowering a powered ramp were:

- Remote control design
- Reaction time from remote use to ramp activation

GM Coachworks Caravelle Nevada –

The powered ramp is lowered as part of a single sequence and follows the opening of the tailgate. The sequence is controlled by two buttons on a remote control; one button opens the tailgate and deploys the ramp and the other stow the ramp and close the tailgate. As shown in figure 18 the remote control design is simple and has two white shapes as buttons positioned side by side.

Participants rated the ease of lowering the ramp at 4 and didn't think it required any of the five skills and capabilities listed. When focusing on the remote control which lowers the ramp, the ease of use was generally good with the only criteria below 4 as the clarity of use.

“Favourite WAV, two simple controls in one smooth motion”

“Very difficult to get the button to work in a reliable way. Can't see if it's working”



Figure 17: VW Caravelle Nevada ramp



Figure 18: VW Caravelle Nevada remote control

Participants recommended having feedback, audio specifically, when stowing the ramp as isn't as clear that the WAV is in use or about to be in use if the user is in the vehicle.

“Would be good to have a bleep noise to make people aware”

Sirus Automotive VW Caddy iCan –

As with the ramp on the GM Coachworks Caravelle Nevada, lowering the VW Caddy iCan ramp was part of a sequence starting with the opening of the tailgate and was controlled by two buttons on a remote control. The buttons are both grey, a similar size and shape and are positioned one above the other. See figure 20 for the remote control.



Figure 19: VW Caddy iCan ramp



Figure 20: VW Caddy iCan remote control

The ease of lowering the ramp on the VW Caddy iCan was 3; the lower rating of the two tested. There was a slight delay in the sequence between the opening of the tailgate and the lowering of the ramp which participants questioned;

“Delay is puzzling”

“Delay to ramp so don’t know is working”

“Such a delay want to press harder as think it isn’t working”

Due to the delay, participants were unsure whether the ramp and remote control were working correctly. Participants rated four of the design criteria below four for the remote control, the nature of which indicate that the design of the remote control did not lend itself to alleviating confusions caused by the delay. The four criteria were:

- Suitable for frequency of use – participants commented on the flat buttons requiring more pressure
- Clarity of use – no icons to differentiate between their use
- Suitable feedback given – none on the remote to indicate its activation
- Ease of use

“Icons not clear. Not conscious of any feedback on the remote”

“As aren’t raised don’t realise is a button. No labels”

“Flat buttons so less to pressure and more required”

“Would be good to have a bleep noise to make people aware”

4.2.4 Lifts

Three of the WAVs at the testing had lifts; two with folding lifts at the rear of the WAV and one with a platform lift at the side of the WAV. The overall ease of lowering the lift was rated above 3 for all of the lifts tested. The highest rated was the Peugeot Boxer followed equally by the Sprinter and GM Coachworks VW Caravelle Colorado. See table 4 for results.

Converter, make and model	Ease of lowering the lift (1-5)	Lift detail
Peugeot Boxer (supplied by Motability)	5	Rear folding lift
Sprinter (supplied by Motability)	4	Rear folding lift
GM Coachworks VW Caravelle Colorado	4	Side sliding underfloor platform lift

Table 4: Lifts average ease of use ratings. (1= very poor, 5= very good).

Lifts are always powered therefore, like other powered elements on WAVs, the ease of use is dependent on the remote control design. When rating just the remote control for lowering the lift, clarity of use, easy to use, force required reasonable, suitable feedback given and follow expectation were all rated below four for at least one of the lifts. See figure 21 for the distribution among vehicles.

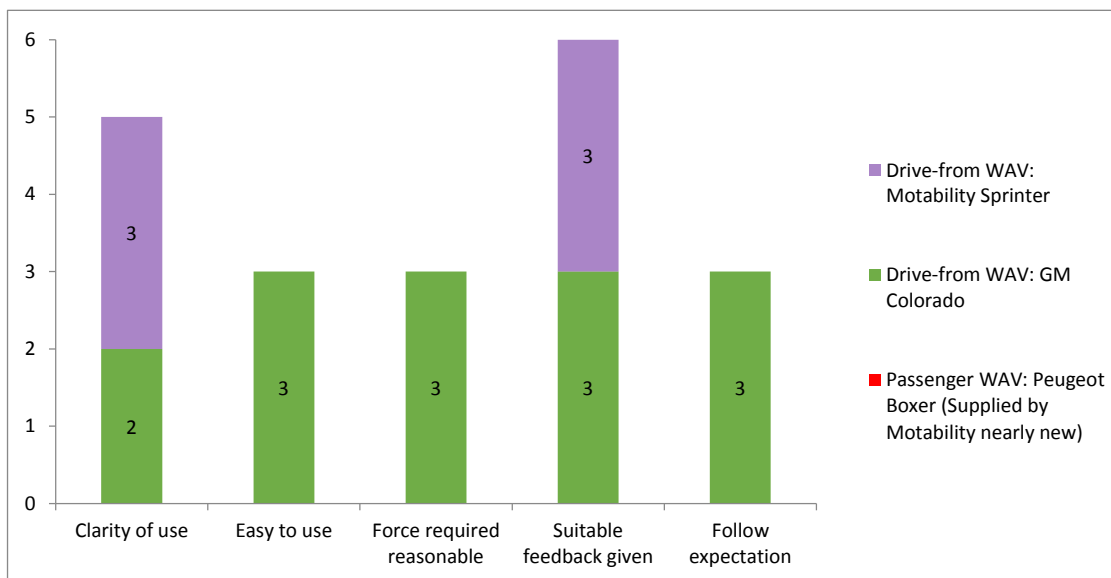


Figure 21: Design elements rated below 4 for lift remote controls

The labelling on some of the controls caused problems for participants as they thought it was unclear which button or switch initiated which function. This was especially the case with controls labelled using letters or numbers. Participants disliked this ambiguity. See figure 22 and 23 for examples.

“No visual indication as to which button does what”

“Button order not clear”

“Not clear which does what”

Participants preferred when the remote control labelling was wording however it was important the labelling was close to the button or switch it related to and the language was clear. In one instance a participant was unsure what the wording related to and subsequently used the wrong button resulting in the lift dragging on the floor.

“Liked having word labelling on controls but location of label to button not good” (With reference to figure 25 below)



Figure 22: Sprinter remote control



Figure 23: VW Caravelle Colorado remote control



Figure 24: Peugeot Boxer remote control



Figure 25: VW Caravelle Colorado remote control

One participant had a concern over the method used to attach the labelling to the remote control. This was specifically for the Motability Sprinters remote control (figure 22) as they thought it may not withstand wear and tear but this may also be applicable to other designs.

“As the ABCD is transferred on, would in time rub off so then not clear what to do”

Dexterity was highlighted by one participant for the remote control in figure 22. The participant didn't like the design of the buttons as they did not protrude much from the remote control casing so required more pressure. Adding to this was the need to hold down the button for the whole lifts sequence, which researchers observed as being difficult for some participants.

“[Buttons] not proud and a lot of pressures needed”

All participants were able to enter the WAVs using the lifts however some participants were unnerved. Three main reasons were identified for this during testing:

- Initial movement of the lift – when the lift started to rise participants felt it suddenly ‘shift’ with their additional weight
- Unfamiliar movement of the lift
- Lift platform material – the perforated lattice like material with holes caused concern to participants and researchers also observed the assistance dogs reluctance to step onto the lift.

“Due to weight shift, feel like are going to go off backwards”

“Felt unnatural and unnerving”

“Lattice base made it feel worrying” (With reference to figure 27 below)

“Like the surface on the lift” (With reference to figure 26 below)



Figure 26: Non perforated lift platform material



Figure 27: Perforated lattice like lift platform material

Users remarked on the effective lighting illuminating the lift platform included on the Mercedes Sprinter.

4.2.5 Wheelchair restraints

Three of the vehicles at the testing had the capacity to secure a wheelchair; the Alfred Bekker Ford Tourneo Connect Grand, Brotherwood Ford Tourneo Connect and the Peugeot Boxer supplied by Motability had tie downs which could be used.

Three of the WAVs had a release control for the front tie downs which was mounted on the vehicle; two had a switch control with a coloured LED which lit up to indicate its release and one a button, which also lit up. In the other WAV the release control was on the tie down. Overall the only design criteria rated below 4 was the fore/background for visibility however other criteria were rated poorly for the individual tie down controls.

The control shown in figure 28 was generally rated well however received the lowest rating of two for the fore/background:

“No contrast to side of the vehicle apart from small red light when restraints released”

The same control, located in a different position, was used in another vehicle but was generally rated poorly. The background to the control in figure 29 was much lighter and so was rated higher than the control in figure 28 however several other elements were rated poorly; suitable for frequency of use, easy to reach, clarity of use, easy to use, designed for purpose and follow expectation. The low ratings for these criteria may be as the control is located the front of the vehicle so is more difficult to get to. The control in figure 30 had the best overall ratings however the line of sight was rated as three; the control is located on the top of the vehicles side panelling and the button is in a case.



Figure 28: Ford Tourneo Connect Grand tie down release control



Figure 29: Peugeot Expert Tepee tie down release control



Figure 30: Ford Tourneo Connect tie down release control

Overall using the front ties downs’ (securing to the fixture, extending the tie down, attaching the tie down to the wheelchair and securing the tie down length) was rated highly however participants commented negatively on the front tie downs fitting and operation on some vehicles.



Ford Tourneo Connect Grand –

- The tie downs were mounted asymmetrically, so one tie down was further forward than the other, which participants found awkward.
- The straps didn't reach the end of the ramp so the wheelchair user had to be repositioned onto the edge of the ramp once it had been deployed.

Peugeot Boxer –

- As the tie downs had to be attached once the wheelchair user was in the travelling position the companion using the tie downs found it difficult to manoeuvre around the wheelchair user to access the tie downs.

Three of the WAVs had retractable rear tie downs (two Unwin, one Q'Straint) and the other had adjustable webbing rear tie downs.

Each time the WAV is used the rear tie downs have to be secured and removed in the fixture to allow the wheelchair user to enter or exit the WAV. Securing into the fixture was rated four for all the retractable tie downs however the manual adjustable tie downs were rated two. These tie downs were in the Peugeot Boxer which had tracking the length of the vehicle which allowed the tie downs to be secured in different locations. Although this offers configurability to the WAV, participants had difficulty securing the tie downs into the fixture and didn't like the ambiguity of not having a designated 'correct' place for the tie downs.

“You can't easily tell where in the tracking to attach them”

“Very fiddly to secure restraints into the tracking”

The rating for extending these tie downs was also lower than for the retractable tie downs which may be linked to the nature of the control which releases the tie down.

The adjustable webbing rear tie downs had a buckle for releasing the tie down rather than a lever. This was rated below three for; suitable for frequency of use, force required and designed for purpose. See figure 33 for the adjustable tie down.

The ratings of the control on the retractable Unwin tie downs varied despite the control being the same, however, when looking at the individual results some criteria were rated more consistently. Suitable for frequency of use, clarity of use and feedback given was rated below three by at least one participant for each of the retractable Unwin tie downs paddle lever. See figure 31 for retractable Unwin tie downs.

The rear Q'Straint tie downs couldn't be used by one participant as their wheelchair was too long for the WAV and covered the fixture points. The other two participants rated the lever control above three for all design criteria. See figure 32 for the Q'Straint retractable tie down.



Figure 31: Unwin retractable rear tie down



Figure 32: Q'Straint retractable rear tie down



Figure 33: Unwin adjustable webbing rear tie down

When using the tie downs all skills were mentioned by participants however as expected the distribution varied across the different WAVs. Examples of the circumstances where participants commented on certain skills are required when operating tie downs were as follows:

“Fitting the rear tie downs [into fixture]” – Dexterity

“Reaching front tie downs and pulling out a little difficult” – Range of reach and strength

“Bending down” – Balance and range of reach

“Very fiddly to secure restraints into the tracking. Have to line up accurately while pulling up plastic to get release then slide in” – Coordination and dexterity



4.3 Group discussion results

During the two group discussions participants gave their feedback on the vehicles tested as well as general advice for potential WAV users on choosing a WAV. The feedback on the vehicles and features tested during the workshops is reported above in section 4.2 and the general advice is summarized in this section. The group discussion with passenger WAV users focused on the capabilities of people who may be using the WAV and the comfort for the wheelchair user inside the vehicle, whereas drive from WAV users discussed more about the functionality of WAVs and their features.

4.3.1 Passenger WAVs

Participants emphasized the need for a passenger WAV user to familiarize themselves with their own vehicle, regardless of their level of involvement during its use. This was with specific relevance to WAV users with carers as it was pointed out carers may understand differently, or not understand at all, how to use a WAV. One participant commented on the potential ability for WAVs to intimidate those who are unfamiliar with them. However, if the user knows their own vehicle inside out, they will be able to instruct anyone how to use the WAV and alleviate any issues. Participants discussed the idea of carers receiving training for passenger WAVs so they have a general knowledge. As well as knowing how to use the WAV, participants noted the need to consider the capabilities of the carers/drivers using the WAV, especially for loading and unloading.

Participants thought one area of the passenger WAV which is often overlooked when choosing a WAV was the interior and its comfort. They commented that although the logistics of getting in and out of the WAV is a key factor, the design and comfort should be focused on as well. This was also touched on by DFW vehicle participants who recommended that users should decide on the direction in which they'd feel most comfortable and safe exiting the WAV, as this would impact the interior layout and the size of vehicle needed. To increase the awareness of the vehicle interior and comfort participants wanted longer demonstrations from convertors.



4.3.2 Drive from WAVs

During the discussion with DFW vehicle users, participants pointed to some specific features which they thought should be included or changed. Participants thought lighting was important and that remote control design should be refined.

- Ramps and lifts should have lighting to alert pedestrians and other vehicles of its presence and that it's in use.
- The lighting inside the vehicle should be made to stay on for longer when converted to a WAV.
- Buttons on remote controls shouldn't require pressure on an exact location e.g. exactly central for activation.
- Buttons shouldn't be small.
- The button sequence on remote controls should be logical, so the order is clear.

5 Conclusions

The following conclusions come directly from the stakeholder interviews and user testing and highlight the importance understanding the users' needs and circumstances. They are divided into general comments and feature insights.

5.1 General comments

- **Assessments for WAV users and their companion (if regular) are important as WAVs are an expensive, specialist product.**
 - Assessments are strongly recommended by mobility centres and Motability to ensure the WAV suits the user.
 - User testing confirmed their importance and value as the same vehicle tested by different participants received different ratings and comments on its usability highlighting the impact individual differences has.

- **It is important for users to know how to use their WAV regardless of the level of involvement interacting with the WAV during use.**
 - As shown in the user testing, elements of the WAV and features design can be missed or the function misinterpreted.
 - If possible, all carers should be at the handover to ensure they know how to use the WAV (which will take responsibility away from the user), however, it's useful for the wheelchair user to be clear how to use the WAV so if needed they can instruct others.

- **It's important to carefully research the different finance options available and weigh up the pros and cons.**
 - For those that are eligible for the Motability scheme it offers customers a hassle free lease, where the insurance, breakdown assistance, servicing and maintenance are organised. However, customers have to make an advance payment every 3 or 5 years, depending on their vehicle, as well as using their weekly mobility allowance. There are grants to cover the advance payment but this can limit the choice of passenger WAVs, DFW or IT vehicles.
 - Financing a WAV using personal funds requires a larger payment initially but users can keep the WAV for as long as its suitable. Users must organise the purchasing, servicing, insurance etc themselves.



5.2 Feature insights

- **Whether the WAV has manual or powered features has a large impact on usability and determines the involvement of the wheelchair user.**
 - Features under manual operation require more skill and more varied skills for use, whereas when features are powered, they are controlled only by remote control which physically only requires dexterity.
 - Whether the operation is manual or powered has a varying impact on different features e.g. a wheelchair user cannot use a WAV with a manual ramp independently however, depending on the user, they may be able to use manual doors independently.
- **The location of the wheelchair users' access to the WAV is primarily based on user circumstances and preferences.**
 - The environments where the WAV will regularly be used should be considered; rear access is more suitable for use in carparks whereas side access for parallel parking.
 - How much a user is willing to manoeuvre to their travelling position should be considered as the location of the access can impact this, especially when combined with the WAVs interior layout. Side access would require more manoeuvring to face forwards to travel whereas with rear access the wheelchair user could just drive in.
- **Choosing between a manual tailgate or door/s is dependent on the users' ability.**
 - Tailgates and doors require a different level and type of user interaction during use and users should establish which suits their abilities best.
 - The opening of a manual tailgate is somewhat automatic as once it's released it will open with little user input, however, users have to be responsive and agile to be able to move out of its path. When closing, users have to take a more active role to pull the tailgate down. To use a manual tailgate balance, range of reach and co-ordination is required.
 - Users have more control over manual doors so can take their time when opening or closing them.



- **Whether to use a ramp or lift to enter the WAV is based on practicalities and user abilities.**
 - Weight limits for different ramps and lifts vary. For safety users must be aware and adhere to these limits.
 - Lifts are always powered so the key usability consideration is with the remote control and the users' dexterity, whereas a ramp requires more interaction and skill as regardless of its operation, the wheelchair user has to push or be pushed up the ramp.
 - The strength, range of reach, dexterity, coordination and balance of the user is required when using a manual ramp and the extent can vary depending on the manual ramps mechanism.

- **The type of wheelchair restraint system to use is also based on practicalities and user abilities.**
 - Weight limits for different types of wheelchair restraints vary. For safety users must adhere to these limits.
 - A wheelchair user can secure their wheelchair with a docking system independently however manual tie downs are more complex and require more skills for use.
 - Dexterity, range of reach, strength, balance and coordination are required when using manual tie downs.
 - Users should consider how easy it is to secure the rear tie down into the fixture on the WAV floor as these have to be secured and removed each time the WAV is used.