1. INTRODUCTION

How do people behave at bus stops? This was the question to be answered to inform the publication of Transport for London’s design guide for accessible bus stops.

Five sites across London were surveyed by camera to observe the interaction of bus passengers and pedestrians at various times of day. All had different characteristics and volumes of movement. A simple hypothesis of movement at bus stops was developed based on a literature review and compared to observations.

1.1 Rationale for Study

Despite the pioneering work of Fruin (1970) into the issues of pedestrian movement, interaction and space published over 30 years ago, there is a lack of research building on it. This is particularly true of the bus passenger’s waiting environment on the footway and the interaction with pedestrians. Fruin noted how "little attention (has been) given to providing adequate areas for waiting pedestrians, or to assure that these pedestrians will not impede the flow of others."

Research carried out on pedestrian movements has focused on improving the streetscape, enhancing its attractiveness and making it easier for everyone to use. Meanwhile bus passenger research has concentrated on issues such as how close buses can get to the kerb and how buses stop at the stop itself (particularly since the introduction of low-floor/non-step access vehicles) in order to make buses accessible to all.

In short, bus passengers and pedestrians are treated separately and interaction is mostly ignored.

1.2 The Study Sites

The sites identified by TfL for monitoring bus passenger and pedestrian interaction were:

♦ Brixton Town Centre

A busy retail hub at the southern terminal of the Victoria Line, Brixton is an important interchange between the Underground and buses serving destinations further south. The bus stop chosen serves southbound buses, situated outside a Woolworth’s retail store on the main Brixton High Street.
Close to Angel Underground station and adjacent to a nearby shopping centre, this bus stop along Upper Street serves destinations to the north of Islington. The site differs from all others in the study in that pedestrian flows on the footway are physically segregated from waiting bus passengers.

Bruce Grove Station, Tottenham
Located on the busy Tottenham High Street outside Bruce Grove national rail station, this site poses the narrowest footway of any of the sites studied, and serves many buses travelling north of Tottenham.

Thurloe Street, South Kensington
Located outside South Kensington Underground station, this bus stop serves fewer buses per hour than many of the other sites in the study, but is a pinch point between shoppers, bus passengers and tube passengers.

George Street, Richmond Town Centre
The only site in the study located away from an interchange with another mode of transport, this bus stop is located in the heart of Richmond Town Centre, serving buses from across southwest London.

2. METHODOLOGY

2.1 Data Collection

Video footage was collected at all sites for two days in the same week, Tuesday and Thursday, from 7am to 11pm, encompassing all peak periods throughout the day. Camera locations aimed to maximise the amount of footway (and road space) visible from the video: high enough above street level to avoid interference yet low enough to capture movements within the bus stop as well as surrounding areas.

Site visits were carried out to take key measurements and support the video analysis.

2.2 Literature Review

The literature review enabled a simple theory to be developed and tested against observations made at the sites. (The literature review is not included in this paper).

2.3 Primary Observations

Video footage was analysed for the Thursday (the Tuesday data was not needed in the end). Peak periods of bus passenger movement were identified from BODS data provided by TfL, and confirmed by analysis of the video footage for the day surveyed. Graphs of passenger and pedestrian activity throughout the day were produced so that peak periods could be identified for each site and analysed in greater depth.

Detailed data extracted from the sites at peak periods included:

- Time the bus was stationary at the stop.
- Number of passengers that boarded.
- Number of passengers that alighted.
- Number of passengers that were still waiting once above bus had left the stop.
Pedestrian speeds through the bus stop area.
Average numbers of pedestrians that passed through the bus stop area.

2.4 Detailed Pedestrian Observations

Pedestrian movement group Intelligent Space undertook further analysis into the movement of pedestrians through the site and how such routings are governed by passengers waiting for buses as well as any patterns amongst crowds at bus stops.
3. SIMPLE THEORY OF PEDESTRIANS AT BUS STOPS

A simple model of pedestrian behaviour was developed from the literature review for testing in the project.

It was recognised that a number of factors could affect the interaction of pedestrians and bus passengers. On the supply side, environmental and geometric conditions could have an influence, i.e. frontage conditions, vehicle speeds, footway width and street furniture. On the demand side, the flow of people would result from the location of the site and time of day, and the frequency, popularity and vehicle design of the buses.

The simplest quantified relationship that could be developed was based on: effective footway width ($e_f$ – metres), flow on the street ($F_1$ – people/second), passengers waiting to board ($F_2$ – people) and alighting passengers ($F_3$ – people/second). See Figure 3.1.

Figure 3.1 – Key parameters affecting conditions at bus stops for pedestrians

Fruin defines service levels for pedestrian movement as below:

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>35 square feet (3.25 sq.m) or greater per pedestrian</td>
</tr>
<tr>
<td>E</td>
<td>5-10 sq.ft. pp.</td>
</tr>
<tr>
<td>F</td>
<td>&lt;5 sq.ft. pp.</td>
</tr>
</tbody>
</table>

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A simple hypothesis was postulated based on Fruin (1970) that an acceptable congestion limit for pedestrians occurs at the border of Service Level B and C, i.e. roughly 2.5 m² per pedestrian. This limit would apply to flows along the street, i.e. $F_1$ plus $F_3$ (alighting passengers joining the main flow). At theoretical capacity:

$$F_1 + F_3 \leq 0.5 \, e_r$$

Taking account of the boarders was more difficult. A simple theory was that the boarders gradually obstruct the footway as they arrive, and therefore the effective footway width reduces as boarders build up. If each person is 0.6m wide, and every sixth person obstructs the footway further, then:

Reduced effective footway width = $e_r - 0.1 \, F_2$

...and therefore combined flow

$$F_1 + F_3 \leq 0.5(e_r - 0.1 \, F_2)$$

This relationship was tested using some dummy values. It was found that values of $F_1 + F_3$ are very small, and the greatest influence on $e_r$ is the number of boarders $F_2$. In other words, the assumptions made about the behaviour of boarders have a much greater impact on the footway width required than the quantities of people on the footway.

3.1 Link to Methodology

Based on the evidence of the literature review and the simple theory, it was decided to focus on observing the behaviour of boarders at peak hours at each site, to see how they did influence conditions for through movement of pedestrians.
4. RESULTS

4.1 Peak Periods

The busiest times at each site were identified and analysis focused on these periods:

- Brixton Town Centre: across the day
- Upper Street, Islington: evening peak and late evening
- Bruce Grove: morning peak
- South Kensington: around midday
- Richmond Town Centre: evening peak

4.2 Summary of Service Levels

Service levels (Fruin, 1970) identified at bus stops for pedestrians and bus passengers for all the five sites studied are shown in Table 4.1.

Table 4.1 – Summary of service levels for pedestrians and bus passengers

<table>
<thead>
<tr>
<th>Site</th>
<th>Service Level for Pedestrians</th>
<th>Service Level for Bus Passengers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brixton Town Centre</td>
<td>Mostly A/B, some C</td>
<td>Mostly F, some E</td>
</tr>
<tr>
<td>Upper Street, Islington</td>
<td>E/F</td>
<td>Mostly F, some E</td>
</tr>
<tr>
<td>Bruce Grove</td>
<td>Mostly A/B, some C</td>
<td>Mostly E, some D</td>
</tr>
<tr>
<td>South Kensington</td>
<td>Mostly A/B, some C</td>
<td>E/F</td>
</tr>
<tr>
<td>Richmond Town Centre</td>
<td>A/B</td>
<td>D, E &amp; F</td>
</tr>
</tbody>
</table>
4.3 Site Specific Results

4.3.1 Brixton

As Brixton Town Centre is busy throughout the day, serving a mixture of commuter, leisure and educational trips, several times of day were chosen for analysis. The footway at the bus stop is 4.5 metres wide with an effective footway width of 2.5m, the widest of any amongst all the sites studied. The Pedestrian Service Level across the day was usually level A/B and at times level C, yet for bus passengers this jumps to level E/F. Figure 4.1 shows pedestrian and bus passenger levels from across the busiest times at the site across each ten minute interval.

Figure 4.1 - Pedestrian and Bus Passenger flows at peak periods at Brixton Town Centre
4.3.2 Upper Street, Islington

Islington has a segregated footway and bus waiting area, resulting in little conflict between passing pedestrians and bus passengers. However, this does not eliminate conflict between boarding and alighting passengers particularly as pavement space is severely reduced as a result of the physical segregation – this site has the narrowest effective footway width of any of the sites (just 0.4m). Figure 4.2 illustrates this much smaller number of pedestrians passing through the site compared to the number of bus passengers. The introduction of articulated buses on routes through this site has also introduced new constraints.

Figure 4.2 - Pedestrian and Bus Passenger flows at peak periods at Upper Street, Islington
4.3.3 Bruce Grove

A large proportion of those passing through this congested site during the morning peak period are school children with a greater focus on commuters during the evening peak. Pedestrian levels fluctuate across the time periods studied far more than levels of bus passengers, probably due to incoming rail services, as indicated in Figure 4.3. The morning peak period was chosen as a more significant period to monitor at Bruce Grove more closely than the evening peak period.

Figure 4.3 - Pedestrian and Bus Passenger flows at peak periods at Bruce Grove
4.3.4 South Kensington

A narrow footway with substantial amounts of clutter and several entrances to retail outlets fronting onto Thurloe Street creates a difficult environment for pedestrians and waiting bus passengers alike at South Kensington. A lunchtime period was observed at this site, to present a range of times across the day observed at the sites in the study.

Figure 4.4 - Pedestrian and Bus Passenger flows at peak periods at South Kensington
4.3.5 Richmond Town Centre

Weather conditions at Richmond Town Centre at the time observations took place resulted in extremely limited visibility from the camera installed and resultantly pedestrian movements were extremely difficult to monitor. This may have also influenced the actual number of people passing through the site, which during the evening peak period was smaller than in other areas studied. Bus routes served are popular with both shoppers and commuters; the area immediately surrounding the site has a good amount of footway space with an effective footway width of at least 2.3m.

Figure 4.5 - Pedestrian and Bus Passenger flows at peak periods at Richmond Town Centre
5. DETAILED PEDESTRIAN BEHAVIOUR

As part of the project, pedestrian movement specialists Intelligent Space Partnership Limited (ISP) undertook an observation study of space use and crowding around bus stops. The aim of this work was to identify different type of activities among crowds at bus stops, show how they related to pedestrians movement patterns around the bus stop and identify the effect of the crowd on through-movement. The results were used to inform the design guidance.

Five bus stops in London were selected for the survey. These locations were recorded by CCTV and DVD footage of peak times was provided to ISP by Atkins. One of the locations, Richmond Town Centre, was unsuitable for analysis as the camera was located too far from the bus stop to provide an accurate picture of space use. The remaining four survey locations are Brixton Road in Brixton, High Road in Bruce Grove, Thurloe Street in South Kensington and Upper Street, Islington.

One cycle of bus activity was analysed at each bus stop, showing the crowd before bus arrival, during boarding and alighting, and after the bus had departed. The details of each peak time at each location surveyed can be seen in Figure 5.1 below.

![Figure 5.1 - Breakdown Survey Detail](image)

<table>
<thead>
<tr>
<th></th>
<th>Bruce Grove</th>
<th>South Kensington</th>
<th>Brixton</th>
<th>Islington</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of Surveying</td>
<td>03/11/2005</td>
<td>03/11/2005</td>
<td>03/11/2005</td>
<td>03/11/2005</td>
</tr>
<tr>
<td>Time of Surveying</td>
<td>Morning</td>
<td>Lunch</td>
<td>Late Afternoon</td>
<td>Evening</td>
</tr>
<tr>
<td>Waiting</td>
<td>08:07:00</td>
<td>12:40:30</td>
<td>16:18:55</td>
<td>20:10:00</td>
</tr>
<tr>
<td>Boarding</td>
<td>08:08:08</td>
<td>12:41:30</td>
<td>16:20:05</td>
<td>20:12:00</td>
</tr>
<tr>
<td>Weather Condition</td>
<td>Good</td>
<td>Rain</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Bus Type</td>
<td>Double decker/ Single</td>
<td>Double decker</td>
<td>Double decker</td>
<td>Articulated</td>
</tr>
<tr>
<td>Pavement Width (m)</td>
<td>3.08</td>
<td>2.7</td>
<td>4.3</td>
<td>2.24</td>
</tr>
<tr>
<td>Average</td>
<td>3.08</td>
<td>2.7</td>
<td>4.3</td>
<td>2.24</td>
</tr>
<tr>
<td>Minimum</td>
<td>2.03</td>
<td>1.6</td>
<td>3.8</td>
<td>1.64</td>
</tr>
<tr>
<td>Maximum</td>
<td>3.45</td>
<td>2.9</td>
<td>4.5</td>
<td>2.99</td>
</tr>
</tbody>
</table>

Figures 5.2 to Figure 5.5 overleaf show the still images taken from DVD for each phase observed (waiting, alighting, boarding and departed) in each location. The observed static snapshot of the space use in each location has been mapped and this can be seen in Figure 5.7 to Figure 5.10.
Figure 5.2 - Brixton surveyed static snapshots

Figure 5.3 - Bruce Grove surveyed static snapshots
Figure 5.4 - South Kensington surveyed static snapshots

Figure 5.5 - Upper Street, Islington surveyed static snapshots

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5.1 Key Findings Analysis

Space use was mapped into plan view from the CCTV footage stills of each bus stop. The standard human body ellipse was taken from Fruin’s dimension, as shown below in Figure 5.6 below. The activity of each pedestrian has been colour coded in our analysis in order to distinguish standing, sitting, boarding, alighting and through movement.

![Figure 5.6 - Body ellipse (From Fruin)](image)

5.1.1 Brixton

The analysis of Brixton can be seen in Figure 5.7. The key findings for this stop are as follows:

- There are two through movement routes around this stop. The main route is between the bus stop and the wall. However, another route that is used is on the roadway surface itself next to the stop, when the pavement is too crowded to use.
- Waiting at this stop occurs in line with the bus stop and along the wall, in quite a long linear extension away from the bus stop.
- During the alighting phase, a large number of people queue outside the bus, waiting to board whilst people alight disperse into the main movement route. The single boarding point is reflecting in a single crowding point.
- There is still strong through movement route during the boarding and departed phase.

5.1.2 Bruce Grove

- The analysis of Bruce Grove can be seen in Figure 5.8. Key findings are:
- The main through movement route is between the stop and the buildings
- The waiting crowds gather in three locations: around the bus shelter, along the wall and south of the phone booth where they can first see the bus. This is because the phone booth creates barrier to visibility. It also causes a set back curve to the through movement as it is not aligned with the shelter.
- When the bus stop near the phone booth, boarding alighting are disrupted by the objects on the footway.

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5.1.3 South Kensington
The analysis of this stop can be seen in Figure 5.9. Key findings are:

✦ The bus stop is not heavily used compared with the other three locations. However, as the bus stop is located outside the tube station, the area around the bus stop is heavily used by people travelling to and from the station.
✦ As in Brixton, we found that people use the roadway as a second through movement route. Here, this is because multiple street clutters near the bus boarding zone causes congestion when alighting.
✦ People also wait against the wall at this location rather than at the bus stop.
✦ It should be noted that it was raining at this location during the survey time. This could affect the number of people catching bus.

5.1.4 Islington
The analysis of this stop can be seen in Figure 5.10. Key findings are:

✦ The bus stop on Upper Street has a different design to the others as through movement takes place on an upper level and the lower level has a separate area for bus waiting, boarding and alighting.
✦ Crowding in the waiting area is more marked at this stop, possibly because there is not the possibility of extending linearly as far along the footway as at other stops.
✦ This bus stop is the most heavily used out of the surveyed locations. In all phases, people use every available pavement space (even outside of the survey zone). There were also some people standing on the upper pavement for better visibility of approaching buses.
✦ This location differs from the other three as it is served by articulated (“bendy”) buses. We found that this type of bus affects the pattern of boarding and alighting, as boarders cluster around the multiple entrances.
✦ The ticket machine and email stand point are located at the end of the bendy bus and this interfered with boarding and alighting.
Figure 5.7 – Brixton common movement routes

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Figure 5.8 – Bruce Grove common movement routes
Figure 5.10 – Islington common movement routes
6. DISCUSSION

6.1 Waiting patterns of bus passengers

People did not seem to form compact groups when waiting at bus stops at peak periods. Results from each site revealed that people tended to avoid busy pedestrian through-flows if possible. The most popular locations for waiting passengers were in line with the bus stop or at the back of the footway (where shop frontages permitted). Where passenger numbers were high, two longitudinal queues tended to form along the footway, often as long as 20m. Brixton Town Centre, South Kensington and Bruce Grove displayed the most prominent linear pattern of waiting bus passengers, probably because they all have a single narrow footway with high passenger numbers.

6.2 Movement of pedestrians passing through

Section 3 suggested that quite narrow effective footway widths could accommodate quite large pedestrian flow volumes. This was generally confirmed by observations – for instance, a clear width of around three metres could accommodate significant two-directional flow.

The patterns of boarders described in Section 5 tended to determine the route of pedestrians passing through the site. Given the tendency of boarders to congregate in two lines, pedestrians usually moved directly between them. This suggests some typical standards to be applied to footway widths: if roughly three metres clear is serviceable, and people tend to line up with the bus shelter and along the back of the footway in lines roughly a metre wide, then about four metres clear between the back of footway and the bus shelter should be serviceable in a range of situations.

An alternative pedestrian movement stepping onto the carriageway was observed – for example at Bruce Grove, where footways are narrow and passenger numbers are high. It was less apparent in detailed pedestrian analysis of the sites, but the detailed analysis considered only one bus stopping per route, and times when buses were not present at stops (when the effect ought to be more pronounced!) were not analysed in detail.

6.3 Boarding passengers versus alighting passengers

Boarding passengers move in very different ways to those alighting. Alighting passengers leave the bus and merge, usually seamlessly, into moving pedestrian flows. However it is boarding passengers who create most of the congestion on the footway due to their static nature. Crowding around the bus entrance(s) occurs at busy periods and such congestion heightens conflicts between boarders and pedestrians on the move. This was particularly visible at South Kensington and Bruce Grove where passengers that crowded around bus door areas when buses were present constricted pedestrian flows.

This observation is consistent with the conclusions of the theory in Section 3 that congestion is more sensitive to static people than moving people.
6.4 Street Furniture

Street furniture appears to be one of the most important factors constraining free-flowing movement along the footway. Increasing amounts of street furniture have been placed across the streetscape in recent years, from litter bins and telephone boxes to road signs and electricity boxes – a large proportion of this furniture is of no benefit to the pedestrian, yet is encroaching on pedestrian space and most street furniture has emerged without any thought given to its position in and relation to the rest of the street.

Three main problems were observed to be attributable to street furniture:

♦ Blocking access to/from the bus

Poorly located street furniture at bus stops is a problem for all passengers, obstructing paths for those alighting from the bus and exacerbating crowding difficulties for those boarding. South Kensington illustrated the tendency for both bus passengers and through pedestrians to step onto the carriageway as a result.

♦ Reducing footway width

Similarly, the overall footway width can be severely reduced by street furniture, which is a particular problem where the footway is already narrow. It was observed to be commonly located in the areas popular for waiting passengers, encouraging them to shift position and come into conflict with through pedestrians. This was particularly noticeable at Bruce Grove, where the already narrow footway was populated with apparently functionless furniture to the detriment of both passengers and pedestrians.

♦ Reducing visibility

Larger items of street furniture can also obstruct visibility for those waiting for buses, encouraging passengers to relocate to other parts of the footway in order to see the bus approaching the stop and causing similar problems to those outlined above. Bus shelter side panels often further impede the visibility of buses from passengers at the stop.

Considering the behaviour of boarders discussed in Section 4, street furniture should be avoided upstream of the bus stop, for example by moving furniture downstream of the bus stop, rationalising it or removing it altogether. This will enhance the visibility of approaching buses as well as increasing pedestrian space.

6.5 Interaction of boarding and alighting passengers on different vehicles

Upper Street, Islington is the only site within this study where new articulated ‘bendy’ buses are in operation: however bendy buses have recently been introduced on many new routes as well as those previously operated by older vehicles. Dual-door buses accommodate one-way movements of bus passengers getting on and off buses, with little or no conflict between the two groups of passengers. Whilst bendy buses have brought an extra door to buses and thus easier boarding for passengers, the one-way system has been removed and conflict between the two now operates at every door (to a lesser degree at the front door). This is very apparent at Islington, where times for boarding passengers can be delayed by up to a minute or more because of passengers leaving the bus – likewise, passengers leaving the bus are
faced with a mass of awaiting boarders at every door and merging onto the footway often proves difficult.

Additionally, bendy buses require a much longer space along the footway clear of obstructions such as litter bins, to enable to deployment of electronic ramps should they be required.

The overall effect of introducing bendy buses is an increase in the need for clear footway space.

6.6 Walking Speeds

A standard walking speed of 1.2 metres per second (m/s) highlighted at the beginning of the study has been found to be a poor representation of people’s actual walking speeds through the five sites observed. Whilst severely clogged areas such as Upper Street, Islington often had pedestrian speeds reduced below 1m/s, average speeds across the sites tended to be closer to 1.5m/s to 2m/s. This is as expected, because the 1.2m/s standard is based on a conservatively low representation of people’s walking speed for use on pedestrian crossings where people with mobility impairments need to be able to cross safely.

Walking speeds differed very little across the sites studied, across both busy and quiet periods, possibly indicating that people’s walking speeds are not determined by static pedestrians unless there is a large number of people obstructing the footway – pedestrians may often find alternative routes such as diverting into the road, to avoid slowing through congested areas.

6.7 Potential interventions on the study sites

Based on the variety of interventions suggested in this discussion, it is useful to consider how the study sites could be modified to improve pedestrian and bus passenger environments, improve flows and reduce conflicts. Suggestions include:

♦ South Kensington: (i) remove street furniture around the bus stop; (ii) relocate flag so that buses stop upstream of the shelter (to enable passengers to board without having to navigate around shelter and allow boarding for passengers with mobility problems).

♦ Brixton Town Centre: (i) increase the length of shelters and bus cage (due to the large numbers of passengers in this location); (ii) reduce street furniture.

♦ Bruce Grove: (i) given the limited amount of footway space present, bus shelters could be modified to become street shelters jutting out from the currently unobstructed wall; (ii) seating should be reduced to a minimum to maximise space for all; (iii) remove street furniture.

♦ Richmond Town Centre: (i) reposition street furniture (the site generally works well but alighting could be improved).

♦ Upper Street, Islington: as discussed, this site already physically segregates bus passengers from pedestrians and the issue of conflict lies with boarding and alighting passengers. A wider footway at the bus shelter location would relieve some congestion; alternatively, an additional bus stop would more easily spread the number of passengers across the street.
7. CONCLUSIONS

♦ Given the tendencies for waiting bus passengers to congregate along the footway in a linear pattern, adjacent to the road or to the back of the footpath, street furniture should be avoided in these areas. As queues can reach up to 20 metres upstream of the bus stop flag, clear areas should be created within this entire zone where possible, by moving furniture downstream of the bus stop or removing it altogether. Such clearance will enhance the visibility of approaching buses as well as increasing pedestrian space and making it easier for bus passengers with mobility difficulties to board the bus.

♦ Footways should have a clear linear movement zone roughly three to four metres wide. Such a gap, for instance between the bus shelter and the rear of the footway, would allow for passengers’ tendency to stand at the rear of the footway in congested conditions.

♦ Footway widths can be substantially reduced by street furniture such as telephone boxes and litterbins, causing problems for bus passengers and subsequently passing pedestrians. Street furniture should be rationalised, for example by attaching litterbins to lamp columns.

♦ Physical segregation of passenger and pedestrian flows may not solve congestion if there is still a lack of space for passengers to alight.

♦ Where articulated buses operate, additional footway space is desirable to enable boarding and alighting to occur smoothly at all doors.

7.1 About Passenger Behaviour

Some conclusions are outlined below:

♦ People do not stand in a tight crowd around the bus stop. Instead they tend to form a linear strip extending along the pavement and towards the back of the pavement (against the wall). This can be seen in all four study areas, and is illustrated in Figure 6.1. This linear strip extends at least 20m. For this reason, we suggest that a much larger strip of footway needs to be considered as the ‘design zone’ for bus stop design.

♦ Street clutter around bus stops (such as poles or other fixed objects on the footway) has a significant effect on how people stand and move. Clutter restricts movement and vision. Large objects such as a telephone box can have a very big effect on the pattern of static activity as people waiting for a bus will relocate in order to see it properly. This can be seen in Figure 6.2. For this reason we recommend that obstructions are avoided within the larger 20m design zone.

♦ People position themselves where they can get a good view of the road. This generally means that people stand on the pavement area before the bus shelter, where they can first spot the approaching bus, rather than at the bus stop itself.
People standing outside of the bus stop area restrict through movement for the entire area in view at each stop. This means that reduced movement is not only found at the bus stops.

The location of the bus shelter affects through movement. Where the shelter is on the road side of the pavement, pedestrians pass either side of it, with some people walking in the roadway. This was seen in Upper Street, South Kensington and Brixton. In Bruce Grove, where the bus shelter is located against the back of the pavement against a building, pedestrians pass in front of it between the two linear strips of waiting crowd.

Bendy buses have a different pattern of boarding and alighting as this is distributed alongside the bus rather than clustered at a single point.

Weather conditions affect where people stand. Generally, people only stand at the bus stop when it is raining.

**Figure 7.1 – Crowd extend linearly away from bus stop**
Figure 7.2 – Crowd move to where approaching bus is visible
This shows how much available pavement space is (in grey colour) with people’s distribution along the pavement during the standing, alighting, boarding and departed phases. A map of each segment width of the pavement is shown below in 6.3.

The bus shelter takes up half a metre on the pavement. However, the biggest setback is at the phone booth which takes up 1 metre of the pavement space (between segment 9 and 10).

There is a clear separation on where people stand during the waiting phase (chart one). People wait around the bus stop and 7 metres ahead.

During the alighting and boarding phases, the movement space became extremely tight around the phone booth area (as can be seen in the second chart).

Figure 7.3 – Use of pavement space around the bus stop in Bruce Grove
7.2 Recommendation for Future Guidance

♦ Provide sufficient pavement space for people waiting for bus and also allow through movement. The evidence shows that pedestrians use a large area of pavement either side of the bus stop for waiting. So the design zone for the bus stop should be 20 metres.

♦ Make sure that there is no street clutter between waiting people and incoming buses to provide maximum visibility.

♦ The placement of clutter and shelters is important for a longer section of the street area as it should be aligned next to each other away from the most crowded section of pavement.

♦ Review the design implications of the bus shelter and location of the station objects.

♦ Bus shelter position should be the other way round in Brixton and South Kensington (such as the bus shelter in Oxford Street) allowing sufficient waiting space under the bus shelter and provides clear visibility to the buses. This will also separate the through movement from crowding around the bus stop.

♦ This analysis is only one peak time in each location. To get more detail results, additional surveys are required to provide more evidence.
ADDRESSES FOR CORRESPONDENCE:

Stephen Hall
Atkins Transport Planning
Euston Tower
286 Euston Road
London NW1 3AT
Stephen.hall@atkinsglobal.com

Jake Desyllas
Intelligent Space
Parchment House
13 Northburgh Street
London
EC1V 0JP
Jdesyllas@intelligentspace.com
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