THE GAP BETWEEN VEHICLE AND PLATFORM AS A BARRIER FOR THE DISABLED; AN EFFORT TO EMPIRICALLY RELATE THE GAP SIZE TO THE DIFFICULTY OF BRIDGING IT

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SUMMARY

The gap between public transport vehicles and platforms is an important factor in the (in) accessibility of public transport. Much of the effort to increase the accessibility is directed at minimising the gap, both horizontally and vertically. There is a general idea of the widths and heights that are downright unacceptable (15x15cm being too much), but much less of what should be achieved without aids such as lifts and ramps. Organisations of the disabled may demand a maximum of 2x2cm!
It is essential to know how much can be achieved by narrowing the gap: which type and gravity of disability will be accommodated and the numbers of disabled who will profit from a certain investment to decrease the width and height of the gap.
On request of the Dutch National Office for Accessibility, Delft University of Technology performed laboratory experiments to gain quantitative insights. For these experiments, a standard platform was built in a laboratory hall. Along this platform a number of plateaus representing public transport vehicles were placed. These were positioned at different combinations of horizontal and vertical distances. Persons with physical disabilities were invited by the National Office for testing the different gaps. During thirteen days about 150 people from all over the Netherlands came to Delft to try to overcome the succession of gaps.
This opportunity was utilised to confront the participants with two different urban buses, parked in the laboratory. The process of entering the bus, reaching a seat or wheelchair site and taking and leaving it was observed and discussed with them.
In the analysis of the testing results the relation between disability and the gap size was investigated. Of course, the 2x2cm gap was hardly a problem. The 10x10cm gap constituted a serious problem for more than half the participants. The selection of participant has of course been biased towards the more active disabled and the enthusiasm shown by them in trying to bridge the gap indicates the desirability of a lower limit.
The observations at the buses demonstrated a number of sub-optimal design features to be discussed with the respective companies.

TOWARDS EMPIRICALLY FOUNDED STANDARDS

The accessibility of public transport has been improved considerably during recent decades. Low floor trains, trams and buses have been introduced in a range of countries and platforms have been adapted to these.
It is a matter of debate though what may be expected or rather demanded from minimising the gap both in terms of feasibility and effectiveness. There are limits to the technically possible, to the human possible and to affordability. On the other hand, there are limits in the character and the gravity of disabilities which can be accommodated at a given gap.
In the Netherlands nation wide operations have started in 2006 to bring the majority of platforms for trains and buses at the standard heights of 76cm and 18cm respectively.

The Dutch National Office for Accessibility (LBT), an expertise centre of and for the disabled, was confronted with far reaching demands from the disabled and less ambitious, perhaps more realistic targets of national and regional government.
The standards used in public transport proved to be ‘conventional’ in the sense, that somehow experts managed to agree that a gap of 5x5cm is a maximum ‘preferable’ gap for wheelchair users and one of 10x10cm is certainly not. One finds a figure expressing this convention in the ambitious EU COST 335 report on accessible trains [European Commission, 1999]. It is copied in the Dutch national manuals produced by the CROW institute [de Boer *et al*, 2005].
But what about the diversity of rolling aids used? And what about ambulant people? Furthermore, it is by no means clear what the respective minimum and maximum dimensions imply for the numbers of the disabled which can be accommodated.
British sources cited in the CEMT 2006 guide ‘Improving Transport Accessibility for All’ indicate that ambulant people should not be confronted with a gap of more than 20cm (horizontal and vertical gaps added) Wheelchair users need considerably smaller gaps: a maximum of 4.5cm horizontal and 2.0cm vertical [CEMT, 2006]!
It is certain though that a 5x5cm gap is hard to achieve, because the position of trains in relation to platforms cannot be completely fixed and the position of buses towards their platforms even less so. Brand new platforms for mixed traffic of light trains and buses in the Dutch government centre of The Hague cannot be approached closer than 15cm by the brand new urban buses.
The LBT proposed TU Delft to do a laboratory experiment with gaps with different heights and widths to be tested by various types of physically disabled. The results might be used to develop a national standard. A similar TU Delft experiment with the steepness of ramps in the 1970s also has been the foundation for a national standard.

A LABORATORY EXPERIMENT TO ISOLATE THE GAP FROM OTHER FACTORS

The impact of different gap dimensions can be studied in actual transport situations. This has several disadvantages with regard to testing situations, testing persons and registration of behaviour.
In actual transport it is difficult to find a range of gaps in a restricted area. It implies that one has to use a number of test sites. Moreover, in road transport the gap is rather unpredictable, especially its horizontal dimension. It depends strongly on the behaviour of the bus driver. Conditions may differ strongly with regard to factors such as light, weather and traffic.
Testing in actual transport situations is even more problematic when considerable numbers of testing persons are needed. It may cause delays in transport and health and safety problems for the participating disabled.
The value of the tests is affected severely if the registration of circumstances and behaviour is inaccurate. Both the dimensions of the gap and the ease of bridging it (if at all) have to be measured and booked with the support of cameras. Adequate locations for these are difficult to find.

In a laboratory situation all these factors may be controlled, and, most important, the research variables may be isolated from other variables in order to collect ‘pure’ information.

In the TU Delft Transport Laboratory a testing site has been constructed. The city of The Hague provided the materials for copying a platform of its new Randstadrail (new light rail network) rail/bus stops. Overviews of the laboratory set up are shown in Figure 1 and Figure 2.

Figure 1: Overview of the laboratory set up from the ground floor.

Figure 2: Overview of the laboratory set up from a higher point of view.

At one side of the platform, five wooden platforms have been erected at different combinations of horizontal and vertical distance, shown in Table 1. The closest platform, 2x2cm, represents the standard for Dutch elevators. The widest gap, 10x10cm, represents the acknowledged maximum value. A gap of 12x3cm gap was included, representing the Randstadrail reality. There, buses have to stay at a horizontal distance of 12cm to prevent damaging their doors, which are opening outward.

Table 1: Dimensions of the different gaps studied in the experiment.

Plateau	Horizontal distance (in cm)	Vertical distance (in cm)
1	2	2
2	5	2
3	5	5
4	12	3
5	10	10
6	variable	variable

The wooden platforms have been given wide entrances without handrails to study the impact of the gap as such.
At the other side of the central platform two buses were positioned at the Randstadrail 12x3cm distance. There, real entering and leaving behaviour has been studied, including parking rolling aids inside and seating behaviour. Both buses were provided with manual operated ramps (with a hinge) at the back door. Our observations of entering and leaving the two buses are not reported in this paper.
The LBT invited disabled (especially ‘rollers’) from all over the country via associations and institutions for the disabled to participate in the experiment. A wheelchair touring car was available for those who would need this type of transport. 165 Persons accepted the invitation and took part in the experiment in November and December 2005.
There were five categories of the disabled participating in sufficient numbers to draw conclusions on their difficulties with the gap. Their numbers are shown in Table 2.

The participants were interviewed and observed in their course through the testing circuit.
Before starting, a standard questionnaire was applied to assess the character and degree of disability. All phases in the test have been guarded by staff who provided help when something went wrong, who registered what happened (success or failure/refusal), helped out in case of problems, and asked what the participant thought about the respective gap.
Behaviour on the platforms and in the buses was registered by cameras.
In this paper only success and failure related to different aids are reported.

Table 2: Walking aids used by participants in the gap experiment.

Walking aid	Number of participants
Scoot mobile	19
Electrical wheelchair	18
Hand wheelchair	44
Pushed wheelchair	8
Rollator	17
Cane	8
Touch cane	16
None	30
Other	5
Total	**165**

It was remarkable to see with how much enthusiasm people participated in the test. We saw no signs at all of reluctance in the efforts to cross the barriers. The participants sooner seemed to want to show how much they could achieve. It implied that several people got stuck in gaps (with the small swivelling wheels of a wheelchair, see Figure 3), people cut capers (see Figure 4), wheels broke off sometimes and upsetting of vehicles could be prevented with difficulty only.

The general attitude of the testing persons was such that the outcomes of the laboratory experiment should be regarded with some scepticism. In real life one may expect less.

Figure 3: People got stuck in gaps…

Figure 4: With some capers, people in wheelchairs succeeded in boarding the bus at a 12x3cm gap from the platform.

EVEN MODEST GAPS INVINCIBLE FOR MANY PEOPLE

We will present the outcomes in two ways: per gap and per walking aid. This way, one can see both which types of users are lost when the gap widens, and how losses in a single user type increase. The results for the largest gaps are shown in Figure 5.

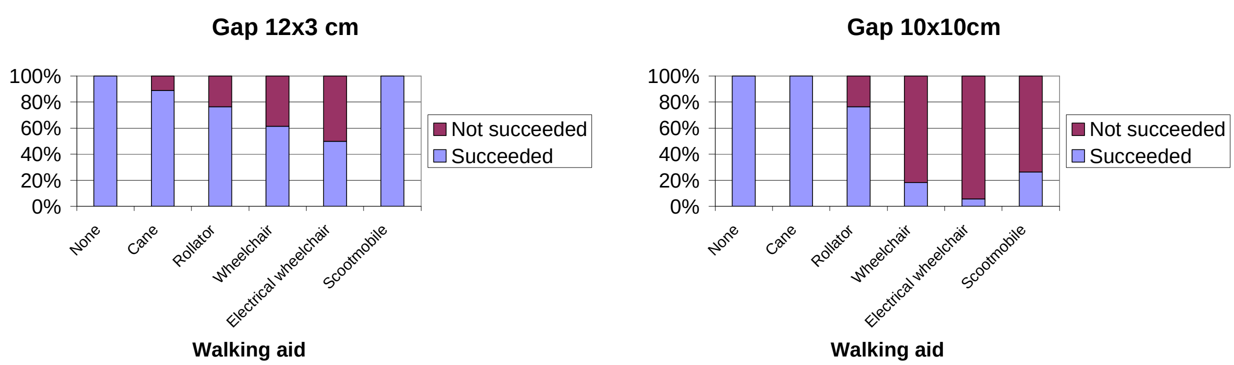

Figure 5: Results of the two largest gaps for people using different walking aids.

The following conclusions can be drawn from our data:

- The smallest gap, with the ideal measures of 2x2cm, proves to be ideal indeed: none of the participants failed to cross it.
- The ‘metrogap’ of 5x2cm was a problem only for a single wheelchair user.
- The 5x5cm gap, qualified as acceptable for wheelchair users in several manuals, proved to be problem for about one third of both hand wheelchair users and electrical wheelchair users. This confirms the outcomes of British research mentioned before.

- The 12x3cm gap was an obstacle for about half the number of electrical wheelchairs and for smaller portions of other aid categories with the exception of the scoot mobiles which have relatively large wheels which do not swivel.
- The 10x10cm proves to be disastrous for all wheelchairs as well as scoot mobiles. Rollator users can often manage still, at least without a full shopping basket (!).

The results for all gaps are compared for electrical wheelchairs and for scoot mobiles (Figure 6). The problems for electrical wheelchairs are building up gradually, whereas those for scoot mobiles are present only at gaps that are both wide and high. The forward speed is no longer sufficient to get the wheels with a diameter of about 20cm across the gap. Some of the hand wheelchair users still manage, because these can lift up the small front wheels and develop sufficient speed for the large rear wheels to cross the gap (see Figure 4). This does however require a well developed musculature.

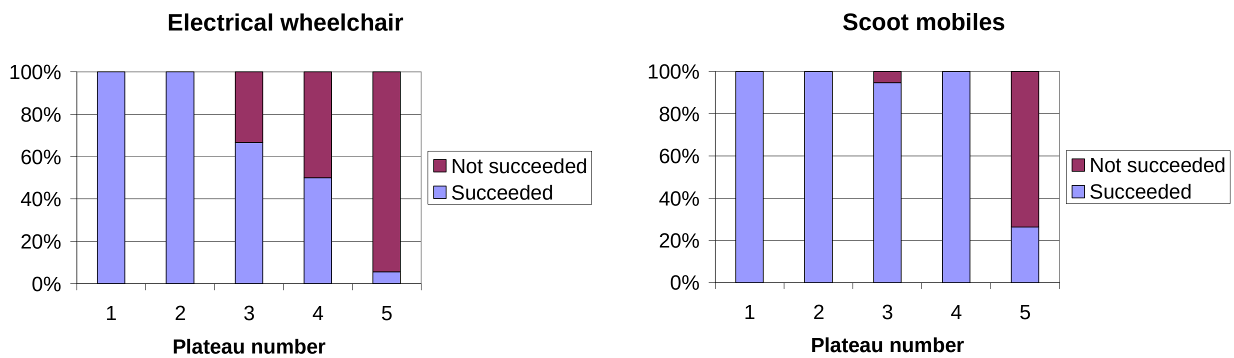

Figure 6: Results for all gaps for people using electrical wheelchairs (left) and people using scoot mobiles (right).

DISCUSSION AND CONCLUSIONS

It is clear from our analyses that some of the smallest gaps hardly constitute a problem for the disabled. These gaps do constitute a problem for transport systems though. Creating and maintaining a 2x2cm gap is virtually impossible. The 5x2cm gap is feasible only in metro systems where the distance between car and platform is fixed, but only on a straight part of a line. The Rotterdam Metro newest station, Wilhelminaplein (1997), was built in a curve (and even on an incline!).
Even a modest gap of 5x5cm is a too large obstacle for part of the disabled, especially for wheelchair users. A wide horizontal gap of 12x3cm can be bridged by any scoot mobile users, which gives them better access than wheelchair users. Dutch bus policy however is to accommodate wheelchair users and to refuse scoot mobile users, because of their large weight and their bad manoeuvrability: a wheelchair site in the bus can hardly be reached by them.

One general scientific conclusion is that we need more detailed research into factors which cause success or failure in safely boarding public transport vehicles. It no doubt has to do with the abilities of the users on the one hand and the vehicle characteristics on the other hand.

Everyone working in the field of accessible transport knows that it is virtually impossible to accommodate al disabled people in public transport. Fortunately, many disabled do not insist on getting access to public transport, partly because they can find an alternative in private transport.
Yet it is difficult to deny, that aids are required to bridge the gap for lack of the possibility to minimise it sufficiently. To return to a Dutch example: the The Hague 12x3cm gap provides insufficient access. Therefore a ramp is required for compensation. The new low floor buses of the city’s transport company HTM have a hand operated ramp. Ideally it has to be lifted by someone standing outside the bus, who can bring it down on the platform without danger for bystanders. Unfortunately, the ramp is so large and so heavy that the action is unacceptable from an ergonomic perspective. The driver has every right to refuse operating it. He anyhow is not allowed to leave his seat for reasons of safety and security.

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