

Institution: University College London
Unit of Assessment: 14 – Civil and Construction Engineering
Title of case study: Improving transport and access to transport for people with barriers to mobility
<p>1. Summary of the impact</p> <p>Research by UCL's Centre for Transport Studies using PAMELA, a real-world-scale facility for conducting experiments into pedestrian movement, has improved transport services for customers on Thameslink trains and the London Underground, including increasing accessibility to London's transport for people with barriers to mobility, who make 7.1 million journeys each day. The work has led to multimillion-pound savings for Transport for London by reducing the cost of Underground platform humps. It has also informed government advice on procurement and enabled the resolution of concerns raised by the Guide Dogs for the Blind Association about the safety of the Exhibition Road redevelopment in South Kensington.</p>
<p>2. Underpinning research</p> <p>PAMELA is a laboratory for the assessment of pedestrian movement: how people react in pedestrian environments, under well-controlled laboratory conditions. The full-scale facility, which was funded by EPSRC from 2003, grew out of work conducted by Professor Nick Tyler (Chadwick Chair of Civil Engineering; UCL 1987-present) for the Department of the Environment, Transport and the Regions (DETR) in the mid-1990s. Tyler conducts research into person-environment interactions, from the macroscopic interactions within cities, transport and the built environment systems to the microscopic interactions between stimuli in the environment and the person's ability to manage the physical response.</p> <p>EXCALIBUR (1998-2000): Having observed that wheelchair users and older people could not board – and therefore did not use – new low-floor buses, Tyler developed the EPSRC-funded EXCALIBUR project to work out how to make these buses more accessible. A number of bus stops were constructed using a variety of kerb and surface technologies, and then tested for their effectiveness and ease of use by both drivers and passengers [1]. This research led Tyler to develop a specific set of design specifications for bus stops, allowing buses to stop at a maximum distance of around 50mm - rather than the more common 400-500mm – from the kerb [2].</p> <p>PAMELA (2003-present): By enabling buses to get much closer to the edge of the kerb, these new stop designs helped alleviate problems with access directly to buses. They did not, however, address the problem of how a disabled person might reach the bus stop in the first place over footways that were often uneven, badly designed and inaccessible. Tyler conceived PAMELA, a novel and highly flexible laboratory in which pedestrian infrastructure could be built, changed, tested, reconfigured, studied and their detailed design evaluated in terms of accessibility and usability for pedestrians with a wide range of mobility levels and access assistant requirements. The construction of the laboratory itself, which took place between 2003 and 2006, required extensive design work based on functional specifications by Tyler in relation to lighting facilities, and the development of a flexible floor surface that retained sufficiently stiff characteristics to be representative of ground conditions with interchangeable real surface materials such as concrete pavers, stone, and asphalt; could be tilted either as a whole surface or in part; and was able to include specific elements of the pedestrian infrastructure, including pedestrian crossings and bus stops, at full scale. He also developed specifications for a range of sensing equipment.</p> <p>Thameslink 2000 (2008-present): In 2008, early plans for the £3.5bn Thameslink 2000 railway line project revealed potential incompatibility between the predicted level of demand and the proposed service frequency. The Department for Transport asked Tyler to construct a life-scale train carriage and station platform interface in the PAMELA facility in order to test the boarding and alighting performance of the proposed trains and passenger numbers [3]. The UCL team constructed a mock-up life-size half carriage to Siemens' specification for stock for the Thameslink 2000 project. The model had variable-width doors, moveable seating, and a station environment that could be varied in terms of platform heights. 150 participants were then recruited to board and alight the carriage under different loading, boarding and alighting conditions. Over 11,000 passenger</p>

movements were recorded. Various aspects were tested under the predicted load scenarios, including the distribution of passengers along the platforms in the four central London stations. The research found that the proposed demand would not be met by the proposed service frequency but that certain elements should be specified in the requirements for the new trains in the procurement process in order to minimise the problems. These specifications included door widths, vestibule design and specified platform heights at stations. Network Rail subsequently requested that UCL construct the train design being proposed by Siemens as the preferred bidder for the project's train design [4]. Further work on passenger movements has been commissioned to run in November 2013.

London Underground platform humps: In 2008 London Underground Ltd asked Tyler to use PAMELA to examine their proposed platform humps, raised sections of platform making it easier for wheelchair users, parents with buggies and passengers with luggage to board and alight Underground trains. In particular, Tyler was asked to evaluate potential safety issues relating to the humps, including the risk of wheelchairs rolling down the ramp onto the track, the likelihood of trains not stopping precisely, and the ease with which visually impaired people could use them. To that end, Tyler's team built a set of platform humps including multidirectional slopes at different gradients, surfaces and markings. Tests conducted in 2008 with a variety of disabled research participants included evaluations of the ease of their access onto and off a 'train floor' at different points on the gradients, and of whether or not proposed platform widths accommodated wheelchair manoeuvrability. This data was used in subsequent work between 2009 and 2010 to show that a time reduction of 3 seconds in the dwell time (the time the train is stationary in the station), which allowed the same train frequency with one fewer train, could be achieved by reducing the vertical gap between the train and the platform along the entire length of the platform [5],[6],[7].

London Underground New Concept Deep Tube Train: In 2012/13, London Underground commissioned the laboratory to develop a mock-up train for their New Concept Deep Tube Train Programme. In this case, a life-size full tube train carriage was constructed according to the current conceptual design, but with passenger-facing innovations such as variable door widths, interchangeable seating and grab poles, and a station environment including variable platform heights and platform edge doors. This was then tested with 120 participants boarding and alighting under different loading conditions. [9]

Tubelines Ltd (2009): Research carried out for Tubelines tested the feasibility of using portable ramps to enable wheelchair users to enter and leave tube trains. The work, which involved constructing a number of deep-tube mock-ups tested by wheelchair users and other participants, demonstrated that the proposed ramps were not appropriate, as the ramps took too long to deploy and were particularly challenging where the train floor is lower than the platform surface.

Exhibition Road (2010-2011): In 2010, Guide Dogs for the Blind Association and Transport for London asked UCL to test a variety of horizontal warning systems for the kerb-free, single-surface shared road space in Exhibition Road, home to the Natural History Museum, Science Museum and Victoria & Albert Museum. The Association was particularly concerned about the safety of a kerb-free, single-surface space shared by pedestrians and vehicles without segregation. The work carried out in PAMELA tested 54 different designs for tactile horizontal delineation intended to provide information to visually impaired people about the location of safe and less-safe areas within the shared space. These were tested with a sample of visually impaired people, wheelchair users, ambulant elderly people and others to determine which design should be used in the actual application. It found no clear winner, but showed that the existing 'corduroy' surface might be usable for this purpose, recommending a width of 600mm [8].

Other members of the team: Dr Taku Fujiyama (Lecturer at UCL since 2004); Dr Craig Childs (Research Associate at UCL, 2003-2013)

3. References to the research

1. Caiaffa M.M., N.A. Tyler (2001) Evaluation of Changes to Bus Stop Design to Benefit Elderly and Disabled People. Ninth International Conference on Mobility and Transport for Elderly and Disabled People, Warsaw, July. Available on request.

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2. Tyler N (2002) *Accessibility and the Bus System*, Thomas Telford, UK. ISBN 0727729802. Available on request.
3. Fujiyama T, Nowers J, Childs C, Boampong D, Tyler N (2008) Investigation into Train Dwell Time. Client: Department for Transport. Available on request.
4. Childs C, Tyler N (2011) Train interaction with platform experiments. Client: Network Rail/Mott MacDonald. Available on request.
5. Fujiyama T, Tyler N (2008) Performance of platform humps. Client: London Underground Ltd. Available on request.
6. Fujiyama T, Childs C, Boampong D, Tyler N (2010) Investigation into the slope gradients for humps on railway platforms, 12th International Conference on Transport for Elderly and Disabled People, Hong Kong, June. Available on request.
7. Karekla X., Tyler, NA (2012) Reduced dwell times resulting from train–platform improvements: the costs and benefits of improving passenger accessibility to metro trains. *Transportation Planning and Technology*. <http://doi.org/pwc>
8. Childs C, Tyler N (2010) Delineators in shared space environments. Client: Transport for London. Available on request.
9. Holloway C., Roan T., Tyler N. (2013) New Deep Tube Train: Features affecting boarding and alighting passengers. Client London Underground Ltd. Available on request.

References 3, 5, 9 best demonstrate the quality of the research.

Research grants: Professor Tyler has received repeated EPSRC funding for this research, including EXCALIBUR (GR/I82045/01), £99k, 1998-2000; PAMELA (GR/S44631/01), £2.1m 2004-2007; AMPERE (EP/G013071/1), £2.4m, 2008-2013.

4. Details of the impact

Each day, a total of 7.1 million trips are made on London's transport system by people with a barrier to mobility; that is, with a disability, aged over 74, or accompanied by a child under five (and therefore likely to have a buggy and/or to be carrying heavy luggage) [a]. By catalysing and informing improvements in several areas of that system, the research outlined above has not only allowed transport providers to deliver better – and often more cost effective – services, but has also improved users' access to and experience of public transport. As such, it has enhanced visitor and tourist experiences of London, encouraged wider take-up of London's transport service, and helped improve the welfare and quality of life of the millions of people who use those services every day, particularly among those with mobility barriers.

London Underground – platform humps: The research on platform humps formed the basis of recommendations London Underground used to develop specifications for the installation of humps on the Victoria Line upgrade (2010-2011), and on all other lines as they are upgraded. It found that the design could be more flexible than previously thought and the cost per hump reduced from the initial £500,000 to £300,000, with the prospect of reducing it further to £100,000. The humps were introduced on the Victoria Line between 2010 and 2011 and the Metropolitan line in 2012. As of 2012, 90 humps had been installed at 35 stations across the Underground network, representing a multi-million pound saving to TfL. [a]

The results of UCL's work on **Thameslink 2000** ensured that, in 2008, the specifications UCL recommended were supplied to all bidders for the train design and manufacture call for tenders. The Thameslink research highlighted some issues that were then pursued by Network Rail with Siemens as part of the final negotiations over the supply of these trains [output 4, above]. The work was also a cornerstone of the House of Lords Select Committee on Science and Technology Report on Government Procurement (2011), in which Tyler's empirical approach to using scientific facilities was praised as an example of best practice in innovative procurement, rather than relying on computer models alone to provide estimates [b]. The work has been made available to the Crossrail team, with the DfT's Chief Scientific Advisor recommending they adopt a similar process (although at an earlier stage) for their trains [c]. The Select Committee also commented that the Olympic Delivery Authority had taken note of the Thameslink project with a view to including its

findings in their activities for its train transport systems [b].

The research has informed transport authorities' understanding of the value of life-scale research. For example, in 2012-13, **London Underground's** use of PAMELA for the New Concept Deep Tube Train Programme [d] was the first time they started to develop the concept from the passenger perspective rather than the mechanical/engineering perspective. The results of the trials have enabled London Underground to test and consider impacts on boarding and alighting rates resulting from different options in the design of the internal and external details of the train and the platform accoutrements (such as platform edge doors). As a result, they have reduced the size of the doors on the new train design to 1600mm, for inclusion in the project tender documents [e].

Shared road space, Exhibition Road, South Kensington: The work at UCL allowed the resolution of concerns raised by the Guide Dogs for the Blind Association about the safety of including a kerb-free, single-surface space shared by pedestrians and vehicles within the local borough's £30 million redevelopment of Exhibition Road. UCL's research findings were cited in a judicial review of the project in 2010 [f]. One of UCL's recommendations was for on-street testing of the corduroy paving at "more acute" angles; Kensington and Chelsea Council commissioned this testing from MVA Consultancy in 2010 and 2011 [g]. The corduroy surface recommended in the underpinning research findings was eventually installed in the area, which is used by around 11 million visitors each year [h, f].

5. Sources to corroborate the impact

- [a] "Your accessible transport network", Transport for London, 2012. Corroborates the number of trips made on London's transport system by people with a barrier to mobility (page 7) and that 90 platform humps had been installed as of 2012 (page 10). The saving to TfL is calculated from £200,000 per hump. <http://www.tfl.gov.uk/assets/downloads/your-accessible-transport-network.pdf>
- [b] House of Lords Select Committee on Science and Technology Report on Government Procurement, chapter 3. Corroborates that the committee recognised the use of PAMELA as an innovative procurement solution, and the use of UCL's findings by Crossrail and the Olympic Delivery Authority. <http://www.publications.parliament.uk/pa/ld201012/ldselect/ldsctech/148/14806.htm>
- [c] The Deputy Chief Scientific Advisor at the Department for Transport can confirm how the DfT has used the findings from PAMELA. Contact details provided separately.
- [d] Holloway C., Roan, T-R, Tyler N. (2013), New Deep Tube Train: design features affecting boarding and alighting of passengers. Report to London Underground Ltd. Available on request.
- [e] A statement from Lead Project Engineer, Deep Tube Programme at London Underground corroborates the changes to the design prepared for the project tender. Available on request.
- [f] "Judicial review into 'frightening' Exhibition Road plan", BBC News, 5 March 2010, confirms judicial review by Guide Dogs for the Blind and the 11 million visitors to Exhibition Road. <http://news.bbc.co.uk/1/hi/england/london/8551047.stm>
- [g] Confirmation of Kensington and Chelsea Council following UCL's recommendations on page i of http://www.rbkc.gov.uk/PDF/20110616%20MVA%20Exhibition%20Road%20Delineator%20Testing_Final%20Report%20%20Appendices.pdf
- [h] Use of corduroy road surface confirmed in Guide Dogs for the Blind article: <http://www.guidedogs.org.uk/news/a-more-inclusive-exhibition-road/>