The design of vehicles and micro-level facilities

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Executive summary

This is the final report for a scoping study conducted by Loughborough University, as part of the Accessibility and User Needs in Transport consortium under the EPSRC Sustainable Urban Environment programme. The aim of the Scoping Study as a whole within the consortium was to establish current policies and practices with regard to social inclusion within the transport and the public realm. The Loughborough University focus was to investigate physical barriers that prevent people using transport or cause difficulties, and to investigate how such features came to exist, whether through design, implementation or maintenance.

The study involved conducting informal interviews with people who reported experiencing problems using transport, including buses, trains, cars, and general problems moving between transport modes. These interviews were conducted with 16 people, the majority of whom were older and/or physically disabled, but also included those with visual and auditory impairments, and one participant who experienced problems due to having a young child in a pushchair. All these people wished to use transport more fully, or with more ease than they currently are able to do so.

In addition to the interviews, two participants were accompanied on journeys on buses and trains, so that direct observation of their experiences could be made and recorded. Photographs were taken of participants and the obstacles they encountered, as well as examples of ‘good’ and ‘bad’ design as observed in the locality of the East Midlands.

In order to investigate the process by which planning for greater access is implemented and the resultant design changes assessed, contact was made with members of three local authorities to gain their views.

The results indicate that the physical design of transport and transport-related infrastructure does have a large impact on the ability of people to use them, or to use them as fully and easily as they would wish. However, the designs that cause problems vary and not all people are affected by the same things, which is not surprising given the variability of physical impairments or mobility constraints that a person can have.

It also appears that policies to improve accessibility are currently not fully implemented, and may not be sufficiently wide-ranging and detailed. The complex and fragmented nature of policy, implementation, and maintenance of transport and the environment by local authorities currently makes it very difficult for policies to be implemented fully with due assessment of their impact on social exclusion.

As such, it appears that any assistance that can be given to policy makers, designers, implementers, and maintenance engineers would serve to improve

communication and therefore increase the likelihood of social inclusion within the transport realm. Loughborough University has developed a computer-based design tool, HADRIAN, which enables the testing of designs in the virtual environment with reference to individual data sets of older and physically disabled people. This enables visual assessment of concept designs based on the abilities of real people in a virtual environment. It is anticipated that development of this tool to include transport-relevant data would provide a tool that would be accessible to all those involved in policy, design and implementation within the transport realm. The scoping study will inform the main study and the further development of the HADRIAN tool.

Contents Page

1 Introduction

1.1 EPSRC SUE programme

This report forms part of a body of research undertaken by one of four consortia in the EPSRC Sustainable Urban Environment (SUE) Programme. The consortium consists of Loughborough University, London Metropolitan University, University College London, with non-academic partners within the Royal National Institute of the Blind, Hertfordshire County Council, and London Borough of Camden. The research team worked closely with industry, government and other users to develop a fundamental understanding of the key issues in transport and urban design, and how these should be addressed in a holistic way. The consortium is known as AUNT-SUE (Accessibility and User Needs in Transport for a Sustainable Urban Environment).

As a preliminary to the main project (proposed start date 2004), a Scoping Study was carried out. The main aims of the consortium as a whole were:

- *To critically examine the various policies and practices relating to accessibility in urban transport and the public realm as these impact on socially-excluded groups;*

- *To establish an Initial Testbed area to determine the best real-world facilities for testing policies and programmes and to provide a detailed specification of one or more testbed areas to facilitate such analysis for the whole scope of the main project;*

- *To engage user groups, practitioners, and other key stakeholders in the detailed definition of access and mobility-related problems of social exclusion in order to facilitate the development of transferable solutions in the main project.*

The Scoping Study was designed to combine 'social category' and 'spatial' analysis of the relationships between transport and exclusion (Church *et al* 2000). To provide sufficient depth and breadth of coverage with available resources, a two-level 'mixed scanning' approach was adopted. The study team developed a broad framework of analysis that takes account of the needs of the wide range of people who may, in particular circumstances and spatial contexts, experience access and mobility-related exclusion. The approach thus builds on the 'social model' derived from disability theory (Paterson and Hughes 1999; Imrie 2000), recognising that the perspectives that dominate access and planning of mainstream transport systems 'exclude more groups than just those who are regarded as disabled people' (Hine & Mitchell, 2001).

1.2 Aims of the Loughborough scoping study

Consideration of accessibility and user needs requires an integrated approach to policy, design and operations research. The main AUNT-SUE project will further develop, evaluate and validate the computer-based design tool, HADRIAN (see Appendix for further details). This would enable HADRIAN to support designers of vehicles and facilities by enabling them to simulate the door-to-door journeys that an individual may wish to take, using either existing or planned transport systems. HADRIAN is a unique multivariate design tool that contains an anthropometric and

biomechanical database of a large number of individuals (of all shapes, sizes and abilities). Expansion of this database to include transport-related data (e.g. physical access, reach and operation of controls, view and interpretation of signs, ingress and egress) will enable investigation of social inclusion and task completion within the physical design of the transport realm. It is critical that designers are made aware of those individuals who are at risk of being 'designed out' (and therefore socially excluded) by any future transport system, as early as possible so that effort can be focussed on 'designing in' such people. Following very positive feedback on the existing HADRIAN system, the research team plans to extend the tool's database and functionality to support designers in improving the physical design of transport systems.

The aims of the Loughborough scoping study are to:

a) Identify current design practice, both for obtaining information on user needs and for achieving design solutions, to see where HADRIAN could 'fit in' with existing practices;
b) Identify tangible examples of the variety of barriers that people experience when attempting to interact within transport systems, by means of interviews with transport users and observations of 'barriers', to capture relevant task data for HADRIAN;
c) Investigate how and why these barriers, identified above, came into being (by means of interviews with design professionals and other associated with policy, installation and maintenance). This would identify potential users of HADRIAN, in addition to design professionals.

The collaborative nature of the AUNT-SUE consortium will involve an exchange of information with other consortium members. Links that were appropriate to the research have been investigated.

2 Review of literature on the needs of design professionals and problems experienced by older and disabled people

This literature review aims to provide brief details on the needs of design professionals with regard to computer-based support to enable consideration of older and disabled people, and the needs of older and disabled people with regard to the transport realm. The review is divided into sections, the first concerning the philosophy of 'design for all', the second briefly covering design professionals and computer-based support, and the third detailing the transport-related desires and problems experienced by older and disabled people.

2.1 'Design for all'

'Design for all' is a philosophy with the aim of producing products, environments, services and systems that are usable by *all* people, whatever their age, size, and abilities. There is not a clear point where a person with one set of physical characteristics can be said to be disabled, and someone else can be said to be able-bodied. Ability is a continuum, from the almost fully able at one end, to the severely disabled at the other (Goldsmith, 1997). No one is fully able, everyone has some activities that they have difficulties with, or cannot accomplish as well as other people. It is desirable that designers (in terms of 'design for all') design to include as many people as possible, starting from knowledge of the needs and abilities of the least able sections of the population to be included within the design.

It may be that a 'design for all' approach within all areas of product design would provide more attractive solutions in terms of usability and cost. More older and disabled people would then be able to use the design, and by default, be easier for all people to use. Kahmann (2000) stated that a designer cannot actually ever 'design for all', but designers should be aware of *who* they are excluding, rather than simply designing with no consideration of who can or cannot use the design. Older and disabled people do not all have the same problems. 'Design for all', inclusive design and universal design are all ideals to aim for.

The population is ageing: according to the World Health Organisation (1998), the worldwide population of people aged 60 years and over will have increased from 580 million in 1998 to 1000 million in 2020. Many of these people will have money and influence (Rogers *et al*, 1997; Keates, Lebbon & Clarkson, 2000; Jordan, 2000; Clarkson *et al*, 2000), and be used to voicing their concerns and having their needs met, at a time when they will begin to experience age-related problems and disabilities (Sandhu, 1997). It is likely that the level of dissatisfaction with the design of transport vehicles and systems will become greater, which is likely to result in 'design for all' becoming a more frequently considered philosophy.
In a survey of UK design professionals, conducted as part of an EPSRC-funded EQUAL initiative project[1], 23 % (7 out of 31) of the design professionals reported that market trends were changing due to changing demographics, and therefore that 'design for all' will become a necessity in the future. However, 17 % (5 out of 30) cited perceived costs and lack of market value for reasons for currently not considering older and disabled people (Sims, 2003). These findings are supported by the work of Vanderheiden and Tobias (2000) who found that universal design was seen as being too specialised and resulted in increased design and manufacturing costs by between 79 % and 83 % of the 29 design professionals they studied. Keates, Lebbon and Clarkson (2000) also found similar concerns, reporting that most designers felt that they would implement universal design only 'if it was easy to do' and did not increase costs.

The software packages containing anthropometric data available at the moment (such as PeopleSize, 1998, and SAMMIE) had not proved to be widely used or seen as useful tools, even though 50 % (14 out of 28) said that they favoured data in such a format. This is an interesting discrepancy. Either current sources are not known about, or else they do not adequately address designers' information needs. This finding may be supported by Hasdogan (1996), who found that those designers who did use human-modelling systems felt that it was open to misuse and required some prior ergonomics training. Erbug (1999) also found that ergonomics CAD packages were "lacking in the necessary information and detail", and that current computer-based resources were "too narrow", needing "more data" and wider application.

Designers favour an electronic source of data that can work in conjunction with their current computer aided design packages. It is easier and faster to communicate via visual means, such as graphics and simulations, rather than text or tables (Erbug, 1999). Also, CAD models can address some problems of communication, between for example designers and technicians, during the design process, although communication may still be difficult at the concept stage (Eckert, Cross & Johnson, 2000).

The findings of Erbug (1999) reflect the findings of Sims (2003), namely that the ergonomics information that designers require is dynamic, not static (that is, data on moving people rather than data taken from static postures), data with details of good and bad existing products, details of standards and regulations, accident analysis, end-user profiles and descriptions, anthropometry, as well as details of behaviours and responses to products and situations. Vanderheiden & Tobias (2000) suggested that design tools to assist with universal design would be most useful if tailored to the industry using it, and specific examples of 'best practice' and profitable designs that had incorporated universal design would help in encouraging further consideration. Vanderheiden and Tobias (2000) also found that the majority of their participants were in favour of some method of indicating how many people were accommodated by a change in design, with 61 % of respondents feeling that such information was essential, with another 25 % feeling that it was very important.

2.2 Problems experienced by older and disabled people

In the same EPSRC-funded EQUAL project, a survey of the problems experienced by 50 older and disabled people was also conducted. It was found that 36 % of participants were more independently mobile within their own home than when out and about. Feelings of uncertainty and lack of familiarity with the surroundings outside the home can result in people opting for more assistance away from home. Also, when out and about the distances involved are usually greater than moving around the home, and may be beyond some people's abilities.

[1] 'A design tool for the multivariate estimation of percentage accommodated', GR/M68510/01, 01/10/99-20/09/02, Prof. J.M. Porter, Prof. K. Case, Dr. D.E. Gyi, Loughborough University.

The increase in the number of motor chairs or scooters used away from home reflects the fact that these chairs are often rather bulky for home use, but offer greater independence and range of distance away from home. Such increased reliance on scooters may be at odds with independence when bus usage is required, however, with buses generally being unable to accommodate scooters. Lenker and Paquet (2001) discussed the possibility of using mobility aid-usage as a method for sampling populations of disabled people. However, from the results here it would suggest that such an approach would not reflect the fact that the majority of participants used different mobility aids depending on where they were (at home or away), the distances to be travelled, and how familiar they were with the terrain.

People are very adaptive in their own home, and can cope amazingly well in their own environment, partly due to having control over the organisation and arrangement of items such as furniture, but also due to the added confidence of being in a known environment. Most people used more conservative modes of locomotion when outside the home (for example using a stick around the house but a wheelchair when outside), and several people mentioned behaving differently in areas they were unfamiliar with, and a fear of problems occurring in unknown places. Such fear of the unknown not only prevents people from attempting to go to public buildings or use public transport, but can also prevent people from attending social events. It may be that standardisation of kerb and step sizes, widths of pavements, and the availability of public seating, accessible public toilets, and better sign-posting of such may all serve to reduce anxiety about venturing outside. Visiting friends and

social gatherings can lead to problems of accessibility, resulting in embarrassment of the individual, and other members of the group who may not have considered the problems fully. Sadly, to avoid this possibility, many people reported not going out to unknown houses or places.

Bus usage led to a number of issues arising, including inability to wait at bus stops, and inability to access standard buses due to step heights and lack of wheelchair access. Petzäll (1993) investigated older and ambulant disabled people using buses, and found that step heights and the provision of handrails were key issues. 'Kneeling' buses (ones that can be lowered by the driver so that the entrance is level with the kerb) were not discussed by Petzäll (1993). However, the design of such buses meant that 14 % of participants in this study were able to use buses when they were unable to use standard, non-kneeling buses. Such design changes may well be the answer to increasing accessibility of buses for older and disabled people: the 26 % of participants who were unable to use standard buses may well have been better able to access kneeling buses, if available in their area.

Increasing independence will improve quality of life through old age for older people, and throughout the lives of those with disabilities. Wider availability of 'kneeling' buses, accessible shopping areas, and increased access to public areas (leisure centres, cinema, etc), would all serve to improve the quality of life of many older and disabled people.

3 Empirical research

The focus of the work was to try and establish what the physical barriers are that prevent people from using transport, or make life more difficult for transport users. Attempts were made to recruit participants who experienced problems with transport, from as wide a range of ages and abilities as possible. A press release was circulated to attract local participants, and as a result the researcher was asked to speak on two radio stations (BBC Radio Leicester morning show, live; BBC Radio Sileby recorded interview and 'sound bites').

From the initial contacts, interviews were conducted by the telephone or face-to-face. Participants were asked for their experiences of using buses, trains, cars, and any other transport and travel related issues that they had. The questions asked were open-ended in structure, to enable participants to elucidate their experiences and problems.

In addition to the interviews, two participants were accompanied on journeys. These participants were those who were most familiar with the research and researcher and so were happy to be accompanied in this way. One was a visually impaired older lady and the other was a younger lady who uses a walking frame. The accompanied journeys were undertaken in order to observe first-hand the problems experienced, and to gain photographic evidence of 'barriers'. Photographs were also taken of examples of 'good' and 'bad' design as witnessed by the researcher. Observed 'barriers' included steps on pavements, buses, and trains, and timetable information and signage.

Contact was made with employees of three Local Authorities: Leicestershire County Council, Hertfordshire County Council, and London Borough of Camden (the latter two being consortium members). Their views were sought with regard to planning policy, implementation and maintenance, and to investigate how accessibility policies are implemented within the transport realm.

4 Results and analysis

4.1 Interviews

Interviews have been conducted with 16 participants. Details of the participants are given in Table 1.

	Number of participants
Gender	
Men	7
Women	9
Age	
Over 60 years of age	9
Under 60 years of age	7
Mobility/physical Constraint	
No impairments	2
Require stick(s) to walk	4
Use of manual/motor wheelchair	5
Visual impairment	3
Hearing impairment	1
Pushchair pusher	1

Table 1: Gender, age and mobility/physical constraints of participants

4.1.1 Comments made and problems reported

- Cars:
  - Access via the front seats was reported to be easier than getting into and out of the back seats (5 participants)
  - Height of seat and entry was also important (too high causes problems, as does too low) (5 participants)
  - Problems associated with driving highlighted by a deaf participant were problems with regard to contacting emergency services; emergency telephones on motorways are not always adequate for the hard-of-hearing.

- Trains:
  - Trains were used as needed by 5 participants, but rarely used by 2 participants, not used at all by 7 participants. A further 2 participants only used them with personal or railway staff assistance. Reasons given for not using included fear of the unknown, hearing 'horror stories' from peers who had used them, and previous difficult experiences.
  - The gap between the platform and the train, steps to the platform, immovable armrests of the train, visual information being out-of-date or inaccurate, and delays and overcrowding all caused problems to those participants who did use/had attempted to use trains.

- Buses:
  - Bus stops vary hugely as to whether seats or ‘leaning areas’ are provided.
  - Kneeling buses are preferable, but were not available to 4 participants.
  - Drivers (and passengers!) can be very rude and rarely offer assistance, and not all drivers wait until passengers are seated before moving off.
  - Fear and uncertainty of safety on a kneeling bus prevented 2 participants from attempting to use them.
  - Kneeling buses do not always pull in to the kerb enough, resulting in a step up/down or across. 2 participants found this to be a real problem.
  - The ‘Buggy Zone’ on kneeling buses does not have any handles or grab rails, with 2 participants reporting problems and fear due to this (combined with drivers setting off before they were seated).
  - Bus times and routes are not always convenient, and 2 participants reported low bus usage, as it was still easier for them to use the car.

4.2 Observations

4.2.1 Observations of design

Examples of ‘good’ and ‘bad’ design were recorded using photographs. Figures 1, 2 and 3 give examples of the signage associated with public lifts found at three railway stations in the East Midlands. It can be seen that for those people requiring the use of a lift there are variations in how easily such facilities can be located.

Figure 1: A well-positioned lift, easy to see and access from the platform.

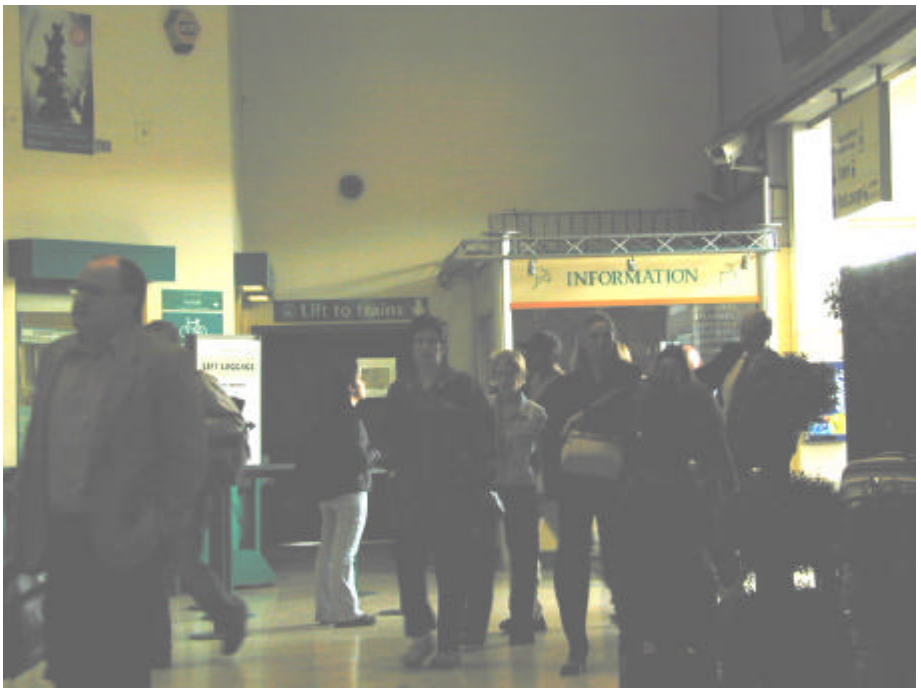

Figure 2: A hidden lift – the sign is there somewhere!
(to the left of the 'information' sign).

Figure 3: No indication of where the lift might be from the platform.

Figures 4, 5 and 6 show examples of bus stops. The facilities available at bus stops vary hugely. Some have seats, some have 'leaners' which provide for limited rest from standing, others have no facilities at all. The type of bus stop and a person's

ability to stand and wait for a bus may well impact on whether they attempt to use the available bus service or not.

Figure 4: A bus stop with seats.

Figure 5: A stand-alone bus stop.

Figure 6: A bus stop with ‘leaners’.

Figure 7 shows a bus stop that is masked by ‘visual noise’. Such ‘noise’ can be distracting to those with limited vision searching for the location of a bus stop.

Figure 7: A bus stop hidden amongst ‘visual noise’

4.2.2 Observations of people on journeys

Two people were accompanied on a journey. A visually impaired older lady was accompanied on a bus journey, and a younger lady who uses a walking frame was observed on a journey involving 3 buses and a train.

Figures 8, 9 and 10 show a participant being observed using various modes of public transport; two buses and a train in this instance. Issues raised during the observation included:

- The need to lift the frame across the horizontal gap between the curb and 'kneeling' bus, indicating that it is not just the vertical height difference that can cause problems.
- The need for assistance at the local railway station. This was required for crossing the track (and so requires extra time and preferably booking in advance). It was also noted that whilst it is possible to book assistance at the destination station, in reality it was reported that often assistance was not available or inadequate to the person's needs on arrival.
- Bus drivers vary as to how considerate they are of passengers with special needs. Some drivers will endeavour to park close to curbs, and wait until passengers are seated before moving off, others however do not. Such variations impact on how beneficial such innovations as 'kneeling' buses are in reality.

Figure 8: Participant using a walking frame to get on a level-access bus. This requires horizontal lift of the frame and is "very difficult" unless the bus is close to the kerb.

Figure 9: Participant receiving assistance to board a train, by means of assistant lifting the walking frame onto the train whilst the participant boarded.

Figure 10: Participant using a walking frame boarding a level-access bus. The proximity to the kerb can be clearly seen.

4.3 Input from other consortium members

The main source of data for comparison with that obtained in this study was the Visually Impaired Persons' focus group, as conducted by RNIB members. The focus group consisted of two sighted people who work with the visually impaired, and three visually impaired people. A further 25 visually impaired people responded with their transport needs and problems via email. The main conclusions of their discussion on problems experienced and possible design solutions were:

- Inconsistency of physical designs causes problems. On buses and trains the doors, seats, handrails and so on are often in different places. This can make getting on/off and finding a seat very difficult.
- Environmental obstacles cause problems. These can include permanent pavement structures such as bollards, litter bins, lamp posts, and so on, as well as temporary items such as bin bags, road work bollards, temporary bus stops, and so on. The inconsistency of placement of such items compounds the

problems they create, as the person is unable to predict when or where such items may occur.

- Transport staff vary as to how helpful or considerate they are to those with visual impairments.
- Information is often very limited for the visually impaired. Timetables are usually only available at bus and railway stations in printed format (and very small printed format at that, see Figures 11 and 12). Bus and train information, such as the number and destination, are generally presented only in visual format. Railway announcements can be very useful for train arrivals, destinations and platform changes, however they may be incorrect or given too late for the person to, for example, locate and make their way to the new platform.

Figure 11: Local bus information provided at a railway station.

Figure 12: Standard UK platform-based train timetable information.

Many of these problems reflect those experienced by participants in the scoping study. Whilst the problems are obviously highlighted by visually impaired people, it was found that gaining access to information, and inconsistency of seating layouts and so on caused problems for those with lesser visual impairments and non-visual impairments alike. The issues raised concerning environmental obstacles and street furniture indicates some of the problems caused by lack of cohesion between different local authority departments, as expressed in Section 6, and examples of such problems are shown in Figures 13, 14 and 15.

Figure 13: Bollards in the middle of a pedestrianised area.

Figure 14: Narrow drop kerbs, uneven drop kerbs, litter bins and lamp posts.

Figure 15: Random post positioning: the post actually holds a small plaque with parking restrictions detailed on it.

5 Discussion of empirical research

One aim of the scoping study was to work backwards from any barriers found, to find out how they came to exist as barriers, with the idea of contacting the relevant designers, installers and maintainers. However, it became apparent that the 'barriers' emerging were not necessarily specific, discrete items, but related to general infrastructure and the design of transport vehicles and environs. This reflects the views expressed in a recent Mayor of London report "Accessible London: Achieving an inclusive environment" (July 2003). Whilst it is acknowledged that there have been many improvements in the accessibility of transport in recent years, with innovations such as 'kneeling' buses, and an increasing emphasis on accessibility and inclusivity in policies, there is still a need for improvements. A holistic approach is needed to the 'door to door' transport experience, and currently this is not supported by existing practises and policies. In order to further understand how local authorities currently work to increase accessibility it was felt to be most beneficial to attempt to make contact with local authorities and ask them about policies and methods for ensuring co-ordination of design, installation and maintenance with regard to accessibility.

6. Contact with local authorities

Three local authorities were contacted: non-academic collaborators London Borough of Camden and Hertfordshire County Council, and Leicestershire County Council who are responsible for the area local to Loughborough University. Respondents from the local authorities were asked via email to describe the processes by which accessibility policy is translated into changes in the vehicles and environment with regard to transport. The three respondents were a senior engineer within the Local Transport Plan Team of Leicestershire County Council; a member of the Local Transport Service of London Borough of Camden; and a member of the Local Transport Plan team at Hertfordshire County Council. It should be noted that another AUNT-SUE consortium group looked more closely at case studies with local authorities to consider some of the same issues. The interested reader is directed towards the 'Design of Transport Systems' scoping study report.

Accessibility policy mainly concerns general issues rather than the details of design. Such policies are normally developed by, for example, a Transport Policy team in conjunction with other units and departments as appropriate. Government guidance is provided for full Local Transport Plans (LTPs), which require authorities to produce LTPs containing objectives consistent with five national objectives, one of which was "to promote accessibility to everyday facilities for all, especially those without a car". Progress is followed-up, certainly in the case of Leicestershire County Council who mentioned it explicitly, by means of Annual Progress Reports, which track progress towards the targets specified within the LTP.

Monitoring and supervision of work being undertaken varies as to whether the installation is part of a wider scheme, due to ongoing maintenance, or due to a specific request to address a problem. Monitoring within Hertfordshire County Council is reported to be generally at a strategic level through performance indicators, or to some specific performance indicators, such as the number of pedestrian crossings that meet Disability Discrimination Act (1995) standards. Leicestershire County Council state that all improvements are designed according to

national standards and criteria, or best practice if different. Design issues may be set out in specific documents, such as "Roads in Hertfordshire", which is primarily aimed at setting the standards for private developers so that they know what to achieve if Hertfordshire County Council is to adopt a new road. However, such document may also provide a convenient reference point for Council designers.

The problem that exists is that there may be a lot of people involved in any one scheme, and current design standards and policies are not always known by everyone. It could be said that there are weak links throughout the chain. However, the worst problems may not arise in new scheme design, but where maintenance occurs or where there is a very minor scheme, as the people actually conducting the work may just follow their schedule of work without any knowledge of wider policies or design standards. It may also be that once a scheme has been installed, a different department, such as Highway Management then manages maintenance. It is therefore expected that ensuring accessibility issues are picked up whenever changes are made will not be easy to guarantee, due to the nature of the work, the possible variations, and the number of people involved.

London Borough of Camden also highlighted the fact that very often it will come down to the decisions of individual officers, despite the policy framework of the authority and the fact that elected members will see and approve most schemes. Co-ordinating policy and practice, maintenance and continuity over time is not easy and is quite resource hungry, especially when multiplied over numerous issues (road capacity, environment, safety, accessibility, community issues, commercial interests, public transport, soft modes, parking, land-use etc, etc.). Local authorities will have some checks in place to ensure that work is being carried out, but it seems that often it is just a check to see that the scheme has been delivered, and the more detailed design issues are not considered (at least in respect of accessibility issues).
In order to improve the situation and keep the continuity, Hertfordshire County Council is using a ‘Transport Issues for Disabled People’ group and sending details of pedestrian crossings that have been upgraded to the various disability groups so that they can check them for themselves. However it is noted that this is only a very small percentage of all the schemes that are carried out. It is likely that other local authorities are beginning to implement similar schemes in an attempt to check accessibility issues are being addressed. Given the size of local authorities and the number of departments and people involved from policy to implementation and maintenance, it is not altogether surprising that ‘gaps’ occur.

7 Conclusions

This scoping study has highlighted some of the problems experienced by a number of older and/or disabled people when using or attempting to use transport. This provides evidence for the fact that transport and its infrastructure do cause problems to those wishing to use it, and therefore exclude those who are unable to do so. In order for designers, installers, maintainers and planners to provide vehicles, services and the infrastructure that maximise inclusion, and so improve the situation, they need access to data and tools to assist them. Reports such as "Accessible London: Achieving an inclusive environment" (Mayor of London, July 2003), highlight the fact that a holistic approach to the transport realm and accessibility is required, and that currently the tools to support design professionals, policy makers, and implementers to achieve this are lacking. These people need access to information and methods to enable them to deal with the multivariate issues that such an approach require. This will help them to identify current and future problems, and to provide acceptable solutions. The HADRIAN design tool is a computer-aided design based tool with individual datasets for a wide range of sizes and abilities of people. It can serve as a task analysis tool and also predict those people who are 'designed out' and excluded, and why. This in turn provides information for redesign, and assessment of potential design changes can also be assessed.

The 3 aims of the study were to:

a) Identify current design practice – the information needs of design professionals were highlighted in the literature review. Current design issues were documented through photographic evidence of existing designs, both 'good' and 'bad'.

b) Identify tangible examples of the variety of barriers that people experience – the photographic evidence and the interviews and observations with people served to provide a clear idea of the types of design issues that cause problems to those using transport. These include steps and inadequate alternatives, poor signposting of facilities such as lifts, inadequate information availability for those with visual impairments (due to text size, and so on), location of bollards and other pavement obstacles, and ingress/egress of transport vehicles themselves.

c) Investigate how and why these barriers came into being – this proved harder to achieve in a literal sense due to the variety of 'barriers' and problems experienced. However, contact with local authorities provided an insight into how policy is translated into design and implementation. This showed that policy recommendations are passed through many individuals, groups, and committees on the way to implementation, assessment, and maintenance of changes to transport infrastructure. The potential for short-comings and confusion that this causes can result in inadequate implementation of policies that were designed to increase accessibility of transport and transport areas.

The proposal for the main study will aim to develop the computer-aided design tool, HADRIAN. As such this will aim to provide physical, emotional and capability data on individuals in relation to transport-based tasks. Such integration of all the issues: people, tasks, equipment, vehicles, infrastructure, environment, is available within HADRIAN and will enable a user-centred approach. HADRIAN can then be made

available to a wide variety of non-specialist users, not just designers but also planner, policy makers, installers and maintainers, to highlight the needs of users and the problems experienced by real people in real transport-related situations.

Appendix

Background to the scoping study

HADRIAN (Human Anthropometric Design Requirements Investigation and ANalysis) is the name given to the computer-based design tool that was developed by Loughborough University as part of the EPSRC Extending QUAlity of Life project 1999-2001 (and graded as 'outstanding' by peer review). HADRIAN has two main aims: to provide a data base of information about individuals for designers to use when designing; and to allow designers to investigate which of these individuals could use a concept design and which could not, who would therefore effectively designed-out. HADRIAN aims to provide *multivariate* analysis of who could use a specific design and who could not.

Multivariate analysis involves considering a number of body dimensions and capabilities simultaneously, in order to predict whether an individual can achieve a specified task with a given product or environment. Anthropometry usually concerns a single variable (univariate analysis), for example, stature, or arm length. Such an approach does not allow appreciation of the variation within people, and takes no account of important aspects such as the effect of standardised data collection methods (typically in fixed postures, on the right-hand side of the body) or issues such as handedness, asymmetric impairments, and so on. In order to assess or predict performance and interaction with a product or environment, a designer needs to consider more than just one variable at a time. To consider an example of multivariate analysis, Susan wishes to buy a train ticket, using a Passenger-Operated ticket Machine (POM). In order to do this, she needs to be able to see the screen and buttons, to reach to and push the buttons, to reach to the money slot and insert her money, and to be able to reach to the slot where the ticket comes out. If Susan is unable to do any one of these things, she will not be able to use the POM and get her ticket. There may be other factors that need considering by the designer of the POM: does Susan suffer from an impairment that would make it difficult or impossible for her to push certain types of button, is she able to grasp the ticket when it comes out, and so on. Considering all these issues, of anthropometry, and ability, together at the same time is what is involved in multivariate analysis. Just considering Susan's stature or arm reach would provide some information for the designer of the POM, but not give the full picture.

Whilst it may be that a design based purely upon population eye-height and arm reach could result in an POM that is usable by a percentage of the population, some will be excluded from using the machine. Multivariate considerations allow all physical dimensions and capabilities involved in completing a task or using a product to be assessed, and so more accurately predict who could or could not use a design.

The data within HADRIAN include anthropometry and joint constraints, which are essential in order to construct the individual participants as virtual human models. Also included are the postural and behavioural analyses that enable prediction of posture and behaviour in new design scenarios, as well as reach range volumes.

Anthropometry, joint constraints, participant images, reach range volumes (see Figure 16), and responses to questions regarding handedness, grip strength and dexterity tests, and maximum comfortable weights lifted during tasks, are also available to designers as raw data in the visual database. Pictorial representations of data are instantly understandable, whereas tables, co-ordinates and reach distances require much work to produce volumes and dimensions for design use.

Further details are presented in Porter et al (2004) and Marshall et al (2004).

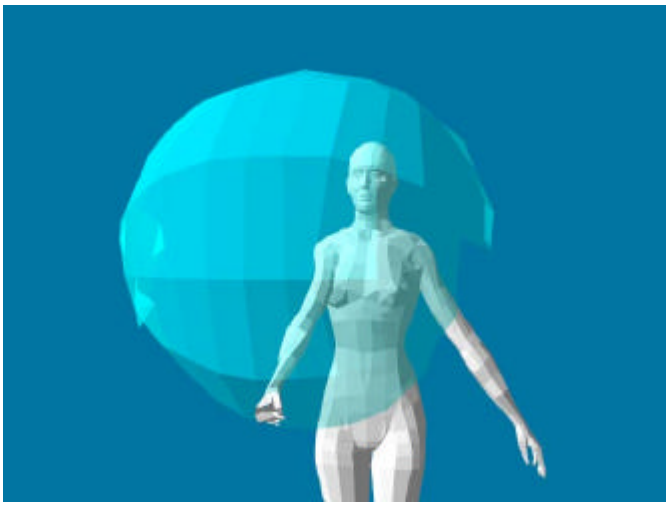

Figure 16: HADRIAN image of the reach range volume for one participant.

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