TELSCAN code of good practice and handbook of design guidelines for usability of systems by elderly and disabled drivers and travellers

This item was submitted to Loughborough University's Institutional Repository by the/an author.

**Citation:** NICOLLE et al, 1999. TELSCAN code of good practice and handbook of design guidelines for usability of systems by elderly and disabled drivers and travellers. CEC Transport Telematics Project TR1108, TELSCAN Deliverable 5.1.

**Metadata Record:** [https://dspace.lboro.ac.uk/2134/2269](https://dspace.lboro.ac.uk/2134/2269)

Please cite the published version.
TELSCAN
TELematic Standards and Coordination of ATT systems in relation to elderly and disabled travellers

TRANSPORT TELEMATICS PROJECT NO: TR 1108

TELSCAN Code of Good Practice and Handbook of Design Guidelines for Usability of Systems by Elderly and Disabled Travellers

Status: Final

Distribution: Public

Document ID Deliverable No. 5.2

Date: December 1999

Commission of the European Communities
Telematic Applications Programme - Transport Sector
**TELSCAN Code of Good Practice and Handbook of Design Guidelines for Usability of Systems by Elderly and Disabled Travellers**

**Editors:**
C. Nicolle, G. Burnett  
HUSAT Research Institute

**Contributors:**

**The TELSCAN Consortium:**

A. Naniopoulos | Aristotle University of Thessaloniki (AUTH) | GR  
E. Bekiaris / | TRD International | GR  
E. Nanthamai / |  |  
P. Christidis |  |  
N. Pantelelis | NTUA | GR  
J. Pierre | Mobility International | BE  
C. Nicolle / | HUSAT Research Institute, Loughborough University | UK  
G. Burnett / |  |  
M. Maguire |  |  
R. Veenbaas | TNO/Vehicle Dynamics Department | NL  
W.B. Vervey / | TNO / Institute for Perception | NL  
W. van Winsum / |  |  
M. Gobel |  |  
J. Brekelmans | De Langstraat | NL  
R. Schopp / | Univ. of Stuttgart/IAT | DE  
H. Widlroither |  |  
B. Peters | Swedish Road and Transport Research Institute (VTI) | SE  
B. Nielsen | AMU Gruppen | SE  
M. Börjesson / | Lunds Universitet | SE  
A. Stahl |  |  
C. Marin-Lamellet | INRETS-Lesco | FR  
A. Simões | Tech. Univ. Lisbon (UTL/FMH) | PT  
P. Oxley / | Cranfield University | UK  
P. Barham |  |  
P. O’Neill | Traffic Solutions Ltd. | UK

**Project Coordinator:**  
Dr. A. Naniopoulos  
Aristotle University of Thessaloniki  
School of Technology, Transport Engineering Laboratory  
54006 Thessaloniki, Greece  
Tel: +30 31 256033, Fax: +30 31 256037  
Email: naniopou@mailhost.ccf.auth.gr
TELSCAN Code of Good Practice and Handbook of Design Guidelines for Usability of Systems by Elderly and Disabled Travellers

Introduction ........................................................................................................................ 1
What is the aim of the TELSCAN Handbook? ................................................................. 1
What is TELSCAN? ........................................................................................................ 1
How have users’ requirements been considered? ....................................................... 1
What does the Handbook contain? ............................................................................ 5
Who is this Handbook for? ......................................................................................... 6
How were the guidelines selected/developed? ............................................................ 7
Summary and contact details ..................................................................................... 8

Disclaimer ..................................................................................................................... 9

Part 1. Overview of User Requirements for Elderly and Disabled Travellers .......... 10

Part 2. Usability Principles and Code of Good Practice ............................................ 18

Part 3. General Guidelines for All ATT Systems ..................................................... 24
3.1 Controls / Input ...................................................................................................... 24
3.2 Displays / Output .................................................................................................. 32
3.3 Smart Cards ......................................................................................................... 47
3.4 Internet / World Wide Web .................................................................................. 51
3.5 Training/Documentation .................................................................................... 54
3.6 Other physical characteristics of ATT system ................................................... 55

Part 4. Guidelines for Contexts of Use ................................................................. 56
4.1 Public access terminals / kiosks ......................................................................... 56
4.2 Public transport display signs ............................................................................ 66
4.3 Driver systems ..................................................................................................... 70
4.4 Multi-modes (i.e., changing the form of transport) .......................................... 81

Part 5. Guidelines for Specific Systems ................................................................. 82
5.1 Pre-Trip Planning ............................................................................................... 82
5.2 Trip Information .................................................................................................. 84
5.3 Access to Vehicle ............................................................................................... 90
5.4 Vehicle Control .................................................................................................. 91
5.5 Parking ................................................................................................................ 103
5.6 Dealing with Weather and Environment ......................................................... 106
5.7 Emergency Warning and Traveller Support ..................................................... 107
5.8 Ticketing / Payment/ Toll Collection .................................................................. 112

Part 6. The TELSCAN Interface Design Checklist .............................................. 116

References and bibliography ......................................................................................... 123
Appendix 1 - Car Adaptations for Drivers with Disabilities ...................................... 135
Appendix 2 - Summary descriptions of field trials/simulator testing ...................... 137
What is the aim of the TELSCAN Handbook?

The aim of the TELSCAN Handbook is to raise awareness within the Advanced Transport Telematics (ATT) design industries of the need to include elderly and disabled people in the design and evaluation process. Accessibility to systems for drivers and travellers should be considered early in the design process, just as much as other features such as the need for security, communications capabilities, and low maintenance costs (Nordic Cooperation on Disability, 1998).

Ideally, telematic systems should be designed from the very beginning to be usable by everyone. However, the wide ranging and diverse characteristics of elderly and disabled people may make this impractical. A key recommendation is, therefore, that systems should be flexible and easy to adapt to individual user requirements.

The TELSCAN Handbook of Design Guidelines promotes the ‘design-for-all’ concept whereby systems will be designed, as far as possible, so as not to exclude elderly people or people with disabilities from using and benefitting from transport telematics. Guidelines are recommended for designing systems so that they are easy to use by elderly and disabled drivers, using their own cars, or travellers, whether it be as a passenger in a car or in various modes of public transport.

The TELSCAN Handbook of Guidelines will help to ensure that the needs of elderly and disabled people are considered. Following the guidelines, however, will not in itself guarantee a perfect system. It is important to include information in the system that is relevant to all users. User testing must also be done, following an evaluation methodology which will include different impairment groups who may be likely to use the system. By considering the users’ requirements, TELSCAN is able to provide assistance to designers in all these areas.

What is TELSCAN?

The TELSCAN project (TELematic Standards and Coordination of ATT systems in relation to elderly and disabled travellers) is part of the Transport Sector of the Telematics Applications Programme of DG XIII of the CEC (TR 1056). The project aims to ensure that the needs of elderly and disabled travellers are taken fully into account in the development and application of Advanced Transport Telematics (ATT). ATT systems can very simply be defined as computerised or intelligent technology for transport, but people who could most benefit from their use are sometimes excluded from the design and evaluation process.

How have users’ requirements been considered?

During TELSCAN Workpackage 3, requirements were identified for travellers having a wide variety of impairments and using a range of transport modes. Four distinct types of user requirement can be identified, and the following diagram (with accompanying text) demonstrates how they have been integrated into the project’s output. The illustration also highlights how the primary outputs of the TELSCAN project (including the Design Guidelines Handbook) are related to each other.
1. Interface requirements

People who are elderly or disabled may experience difficulties with various aspects of the interface to an ATT system. For instance, a system which utilises a visual display containing text may be a problem for those with poor sight and/or language skills. Consequently, travellers’ interface requirements have contributed to two important products of the TELSCAN project:

- **Design Guidelines Handbook.** This provides guidelines on interface design to ensure that ATT systems are easy to use by elderly and disabled travellers.

- **Assessment Methodology** (Marin-Lamellet, Burnett and Nicolle, 1999). This document (available through the project) outlines the methods, tools and protocols that are required so that elderly and disabled people can be adequately included in the assessment process for ATT systems. An important aspect of the methodology concerns the choice of user groups for an assessment, and in this respect the likely problems experienced by different user groups as a result of interface characteristics will be an important indicator. For instance, if the ATT system includes controls which are close together this may cause particular difficulties for travellers with co-ordination/dexterity limitations, as well as those with severe upper-limb impairments.

2. Information requirements

Systems for travellers should include information which an elderly or disabled person needs in order to make a journey safely and in comfort. For example, travellers may need to know:

- which buses have a low floor for easier access
- whether there are reduced fares for people who are retired or disabled
- how long it will take to walk from one platform to another
INTRODUCTION

• if there are any stairs to climb

These information requirements have been developed within TELSCAN as the Travel Information Checklist (Veenbaas, 1998), available in paper and prototype electronic formats, to give designers this sort of advice.

3. Protocol requirements

The users requirements, as well as experience of the TELSCAN partners in conducting collaborative testing with other transport telematic projects, have identified certain protocols that should be followed when including elderly and disabled people in the design and evaluation process. Various methods and tools either may not be appropriate for certain people or may require specialist knowledge in their use. For example, focus groups with people having hearing impairments need to consider whether a sign interpreter would be helpful, both for signing and to assist in understanding speech. Also, including elderly or disabled drivers in simulator testing must consider various issues such as accessibility of the simulator to people with lower limb impairments, the use of car adaptations, fatigue, and simulator sickness, all of which can either cut short the testing, or eliminate certain users entirely.

4. System function requirements

TELSCAN has identified the numerous difficulties experienced by elderly and disabled people when travelling via different modes of transport (TELSCAN Deliverables 3.1 and 3.2). Such problems can be alleviated via the functionality offered by ATT systems, for instance, a wheelchair user might benefit from increased knowledge to aid in trip planning, such as whether there are any lifts at the destination station.

These requirements are reflected in the Mobility Indicator from TELSCAN’s Assessment Methodology (Deliverable 4.2). Although clearly the provision of functionality within an ATT system can be considered important for all travellers, the methodology helps evaluators identify which different user groups are most likely to benefit from the provision of certain high-level functionality within an ATT system.

* * * * * *

The above sections describe how the user requirements have promoted the development of 3 valuable outputs of the TELSCAN project - the Design Guidelines Handbook, the Travel Information Checklist, and the Assessment Methodology. However, it is important to stress the interaction between these 3 outputs.

It is not enough that the system interface is designed with the user’s needs in mind - it must also contain relevant information for different user groups, information which can be found in the Travel Information Checklist.

Furthermore, as suggested above, the Problem Indicator in the Assessment Methodology will point towards design guidelines for that system, and the Design Guidelines Handbook will help to eliminate some of the problems people with different types of impairments have when using the system. Likewise, the Mobility Indicator of the Assessment Methodology will suggest which different user groups are most likely to benefit from the provision of certain
ATT systems, and of course from the provision of relevant travel information to meet specific needs.

As described above, the TELSCAN user requirements form a basis for three important products of the project - the Design Guidelines Handbook, the Travel Information Checklist, and the Assessment Methodology. Together they can provide a design and evaluation package which will lead to more usable systems for all.
What does the Handbook contain?

The following diagram sets out the six basic parts of the Handbook, and their inter-relationships. Part 1 provides background information on the needs of elderly and disabled people in a travelling context. Throughout Parts 2 to 5, there is a general progression from general to specific guidance, as reflected by the inverted triangle. All users of this Handbook should be familiar with the guidelines in Parts 2 and 3, as they relate to all systems and will constitute good ‘design for all’. Parts 4 and 5 provide guidelines for contexts of use and specific system functions. Part 6 serves as a useful summary of the fundamental guidelines within the document, and can be referred to at any point in the design process.

A brief summary of each of the Parts of the Handbook follows:

**Part 1. Overview of User Requirements for Elderly and Disabled Travellers**
This section presents a summary of results from TELSCAN's data capture activities and identification of requirements for different impairment groups when travelling.

**Part 2. Usability Principles and Code of Good Practice**
This section discusses the concepts of usability and user-centred design and their application to designing for elderly and disabled travellers. Remember that adherence to these principles constitutes good design for all users.
Part 3. General Guidelines for All ATT Systems
This section specifies guidelines which are applicable to all ATT systems for elderly and disabled travellers, whether by car or by public transport, with regard to controls, displays, smart cards, the Internet, training/documentation, and other physical characteristics of the system.

Part 4. Guidelines for Contexts of Use
This section identifies key design issues with respect to the context in which the telematics system is being used. This includes whether the system is used as an interactive public access terminal, non-interactive public transport display signs, in the driving context, or in multi-modes (i.e., changing the form of transport).

Part 5. Guidelines for Specific Systems and System Functions
This section identifies elements of the travelling task which can and should be supported by telematics. A designer can choose the function which is performed by the system under design or evaluation. Alternatively, the designer can choose a specific system if such guidelines are available and relevant. For example, the function Trip Information is provided to the traveller through Route Guidance and Navigation Systems. With respect to the function of Vehicle Control, particular guidelines for Adaptive Cruise Control systems and Collision Avoidance systems have been proposed.

Part 6. The TELSCAN Interface Design Checklist
The checklist is a summary of the most important guidelines contained within the Handbook. If taken into consideration, it is expected that the usability of an ATT system for elderly and disabled would be significantly improved. References to Handbook sections are provided, so that the reader can discover the rationale behind specific guidelines and observe relevant examples.

References and bibliography
This section provides references and additional sources, including guidelines/standards for in-vehicle systems and systems for travellers, examples of guidelines/standards for computer/product accessibility by disabled and elderly people, and examples of office environment or equipment guidelines/standards that might be applicable to travellers.

Appendices
Appendix 1 describes some of the common car adaptations used by drivers with disabilities which are referred to in the Handbook. Appendix 2 gives a summary of TELSCAN’s collaborative testing with EC-funded Transport Telematics projects, together with earlier simulator testing and field trials held during the TELAID and EDDIT projects.

Who is this Handbook for?
The TELSCAN Handbook serves five purposes:

i) System manufacturers can use the Handbook as a guide in the design and development process.

ii) System manufacturers can use the Handbook as a checklist during the evaluation process, in order to accommodate elderly and disabled travellers.
Car adaptation manufacturers can use the Handbook to help ensure that a particular ATT system is installed so that it is usable by a particular traveller with special needs and compatible with other car adaptations for that particular driver.

Human-factors experts will find the Handbook useful for evaluating systems for travellers against criteria for Human-Computer Interaction.

Researchers and standards bodies can use the Handbook to identify areas where knowledge or standards exist and those areas where further research is required.

In each case, users of the TELSCAN Handbook will come closer to achieving usability of ATT systems not only for older or disabled travellers, but for everybody by following the design-for-all principle.

How were the guidelines selected/developed?

The guidelines have evolved through a number of activities, starting in the TELAID (Telematics Applications for the Integration of Drivers with Special Needs) and EDDIT (Elderly and Disabled Drivers Information Telematics) projects, and culminating in TELSCAN:

- **Identification of the Requirements of Elderly and Disabled Travellers**
  The constraints, limitations and requirements of elderly and disabled travellers were identified in field studies and literature reviews, and focus groups/interviews (Nicolle et al., 1992; Nicolle et al., March 1998; Börjesson et al., May 1998).

- **Survey of Existing Guidelines**
  A survey of existing guidelines and standards, which may be relevant to vehicles, ATT systems, and travellers with special needs.

- **Identification of Design Issues**
  From the problems experienced by drivers with special needs, design issues were identified which need to be considered in the design of in-vehicle systems.

- **Simulator testing/Field trials/Collaborative testing**
  See Appendix 2 for a short description of the tests.

A multitude of guidelines constitute good design practice and are equally relevant for all travellers regardless of age or disability. This Handbook does not attempt to repeat all usability guidelines. However, it does highlight those design issues which are particularly important to certain user groups. User groups which are particularly relevant to a guideline are noted, although it is important to stress that all user groups will benefit, not just elderly people and people with disabilities. The Handbook also points designers towards sources of general guidelines, where appropriate. For example, general information for designers and others about design-for-all of telematics devices and services can be found on the INCLUDE project’s website at:

http://www.stakes.fi/include/
Some guidelines for the design of ATT systems exist already and some are under development, although they are not aimed specifically at elderly and disabled people. There are also guidelines for other applications that are useful in this area, for example, guidelines for computer accessibility by disabled and elderly people (e.g., Nordic Cooperation on Disability, 1998; Trace R&D Center, 1998), or standards for equipment use in an office environment (e.g., ISO 9241, and EEC 90/270). However, due to the complexity of the travelling task and a changing environment while travelling, some interpretation or testing may be necessary.

Summary and contact details

The TELSCAN Code of Good Practice and Handbook of Design Guidelines for Usability of Systems by Elderly and Disabled Travellers fills many of the gaps in current general guidelines. Inclusion of travellers with physical, perceptual and cognitive impairments in the design, development and evaluation of ATT systems will make the use of such systems safer for everyone. And remember that “designing for all” will make your travelling easier as we enter the third millennium!

The Handbook, as well as other outputs of the project, can be obtained in electronic format via TELSCAN’s worldwide web site, where a searchable database version and downloadable Word document can be found. The address is:

http://hermes.civil.auth.gr/telscan/telsc.html

The Handbook is also available on CD-ROM.

To help us develop the guidelines further, please contact us with your questions and comments:

Dr. A. Naniopoulos (Project Coordinator)
Aristotle University of Thessaloniki
School of Technology
Transport Engineering Laboratory
54006 Thessaloniki, Greece
Tel: +30 31 256033
Fax: +30 31 256037
Email: naniopou@mailhost.ecf.auth.gr
TELSCAN WWW address: http://hermes.civil.auth.gr/telscan/telsc.html

or

Colette Nicolle and Gary Burnett
Editors of the Handbook
The HUSAT Research Institute
Loughborough University
The Elms, Elms Grove
Loughborough, Leics. LE11 1RG UK
Tel: +44 1509 611088
Fax: +44 1509 234651
Email c.a.nicolle@lboro.ac.uk
http://www.lboro.ac.uk/research/husat/
**Disclaimer:**
This Handbook presents the results of a careful collation of available evidence regarding guidelines for the design of ATT systems to ensure their usability by elderly and disabled travellers. Nevertheless, neither the TELSCAN project partners, nor the institutions of the European Union, nor the authors whose work is quoted, accept any responsibility for any use which may be made of the material contained herein.
This section presents an overview of the user requirements for elderly and disabled travellers. They were identified in TELSCAN's data capture activities - first published as Deliverable 3.1, Inventory of ATT System Requirements for Elderly and Disabled Drivers and Travellers (Nicolle, et al., March 1998), and then updated and summarised in Deliverable 3.2, ATT Systems and their Relevance to Elderly and Disabled Travellers (Börjesson, et al., May 1998), and Deliverable 3.3, Updating of User Requirements of E&D Drivers and Travellers (Börjesson et al., September 1999).

TELSCAN followed a functional classification of impairments, based on the International Classification of Impairments, Disabilities and Handicaps (World Health Organisation, 1993, and updated as the ICIDH-2, International Classification of Functioning and Disability, 1999). This means that, from a functional point of view, a person who has lost the use of lower limbs because of an accident, for example, may have similar mobility problems to those of an older person with arthritis.

TELSCAN found, however, that many of the requirements of an elderly person with mobility problems can be very different from those of a young wheelchair user. For example, a younger driver may have the strength to move across from wheelchair to driver’s seat, whereas an older driver may not have the strength in the upper limbs to do so. So, as well as considering each group in the functional classification, we should also include elderly people as a separate category. To say someone is elderly, however, does not imply that he or she is disabled. Elderly people do not form a homogenous group, and many elderly people have active and healthy lives, even though the natural process of ageing has reduced certain abilities to some extent.

An overview of TELSCAN’s functional Classification is given in the following table. Complete information on TELSCAN’s data collection methods, tools and techniques, including the E&D Functional Classification and Definition of the Travelling Task, are available to designers and other projects as a paper document (Nicolle et al., 1997), or by downloading the file from the TELSCAN WWW site. These tools can be used to capture a more detailed definition of user requirements for a specific application area or system.
Overview of the TELSCAN E&D Functional Classification

<table>
<thead>
<tr>
<th>Impairment</th>
<th>Disability</th>
<th>Potential Problems related to ATT Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>SKELETAL - Motion of lower limbs</td>
<td>eg, Cannot walk</td>
<td>eg, obtaining information on accessibility</td>
</tr>
<tr>
<td>SKELETAL - Motion of upper limbs</td>
<td>eg, Cannot use arms</td>
<td>eg, Use of ticket machines</td>
</tr>
<tr>
<td>SKELETAL - Motion of upper body</td>
<td>eg, Cannot turn head/neck</td>
<td>eg, Restricted scanning of environment</td>
</tr>
<tr>
<td>SKELETAL - Anthropometrics</td>
<td>eg, Short stature</td>
<td>eg, Reaching ticket machines</td>
</tr>
<tr>
<td>SKELETAL - Co-ordination/dexterity</td>
<td>eg, Difficulty using hand controls</td>
<td>eg, Using small buttons/ knobs</td>
</tr>
<tr>
<td>SKELETAL - Force</td>
<td>eg, Reduced force in arms/hands</td>
<td>eg, Pressing buttons/keys</td>
</tr>
<tr>
<td>VISCERAL</td>
<td>eg, Sudden loss of consciousness</td>
<td>eg, Obtaining help</td>
</tr>
<tr>
<td>VISION</td>
<td>eg, Blind or reduced vision</td>
<td>eg, Obtaining written information</td>
</tr>
<tr>
<td>HEARING</td>
<td>eg, Total or partial deafness</td>
<td>eg, Hearing announcements or warnings</td>
</tr>
<tr>
<td>LANGUAGE AND SPEECH (Communication)</td>
<td>eg, Cannot read or speak</td>
<td>eg, Obtaining travel information</td>
</tr>
<tr>
<td>INTELLECTUAL/PSYCHOLOGICAL Cognitive Functions</td>
<td>eg, Difficulty with new tasks or in decision making</td>
<td>eg, Operating new technology</td>
</tr>
</tbody>
</table>

User requirements for different categories of travellers are given below, including how particular ATT systems are relevant, or can be made more relevant, to meet their needs.

1.1 Skeletal – Motion of lower limbs
The interface of the ATT system itself is usually no problem to people with impaired lower limb mobility. If the system is located inside a building or vehicle, the buildings and vehicles
PART 1: Overview of User Requirements for Elderly and Disabled Travellers

must of course be accessible. But otherwise, impairments of lower limb mobility cause no problems when using an information system, or a system for ticketing, parking or toll payment. It is the location of the devices that can cause problems for persons with impaired lower limb mobility, but usually not the system itself. Examples of possible problems are height and location of controls and screen and whether wheelchair users can get close enough.

The greatest problem for this group is that transport systems are usually not accessible. There are differences in elevations, and steps that could cause problems, or simply make the journey impossible. If information systems do not include information about physical obstacles, the passengers cannot have confidence in the transport facilities and cannot make arrangements to prevent disturbances during the trip. To be of relevant use, the pre-trip planning system and the trip information system need to include information concerning the physical obstacles that present problems for people with impaired motion. Information systems accessible from home or at travel agents would also be relevant, particularly if virtual reality technology is employed to provide ‘dry runs’.

Relevant information is necessary not only when travelling by public transport, but also when making trips by private car. When travelling by car, people with walking problems need to know if there are accessible parking places, accessible toilets, and other services. Navigation systems/travel and traffic information systems have the potential to benefit drivers in many of these tasks. Gap acceptance systems, speech recognition systems and parking aids may also be useful to drivers within this impairment group. The use of smart cards may enable disabled people to pay tolls, fuel costs and parking fees without getting out of the vehicle.

Since people with lower limb problems have trouble with slippery conditions, information about the weather and road conditions is valuable. ATT systems relevant for people with functional impairments can also facilitate making reservations, e.g. for accommodations adapted to their specific impairments when travelling or parking. During the trip, people need information about such things as whether elevators and escalators are working, and, if not, what alternative solutions may be available. An ATT system can offer advice when elevators or escalators are not functioning, and can also warn operators of the needs of an individual during a particular journey.

Problems are also experienced by the transport authorities themselves, which affect travellers with a mobility impairment (and disabled and elderly people in general). For example, transport authorities are often not informed as to an elderly or disabled person’s special needs, and subsequently staff cannot organise the most efficient assistance. Intelligent booking systems are a potential solution to this difficulty, so that impairment details are logged at the ticket purchase stage.

1.2 Skeletal – Motion of upper limbs

Using the controls of information systems is often a problem for people with limited arm movement. Pre-trip information systems require that information about the starting point and destination of the trip are provided in one way or another. Keys for entering information are available on telephone systems, computer systems, and so on. People with limited or no ability to move their arms have trouble communicating via keyboards or keypads. To be accessible, the information system must be designed to allow communication without using the hands, e.g. voice activated.
PART 1: Overview of User Requirements for Elderly and Disabled Travellers

People with this problem encounter similar difficulties when negotiating tickets for parking or paying tolls. Contactless smart cards can be the answer for people using public transportation. Car drivers can get help by being able to reach and communicate with equipment in the car that provides information during the trip, monitors the vehicle, and pays parking fees and tolls with an integrated system. Such integrated solutions may consist of remote controlled systems for communicating with information systems, opening doors, paying parking fees, etc.

Various trip information systems often present data without requiring that any measures be taken. For example, updated information for passengers on public transport is provided at bus stops and terminals, and for motorists on changeable signs. These systems present no problems for people with limited arm movement. ATT systems should contain information about any obstacles that may be encountered during a trip, e.g. manually operated doors, manual payment procedures, etc. A good ATT system can provide automatic solutions for such obstacles – voice activated door opening and contactless smart cards for making payments.

1.3 Skeletal – Motion of upper body

People who have trouble moving the upper body suffer from a limited field of vision because they cannot twist around and have trouble reaching equipment placed at certain angles. The location of different kinds of ATT systems is thus important. Equipment must not be placed too high up, but within the natural field of vision. In cars, for example, controls should be placed close to the driver’s line of sight. Information can be reflected on the windscreen in the form of head-up displays where appropriate. The problem of limited field of vision resulting from impaired mobility can be relieved by ATT systems that can extend the field of vision and view the surroundings when driving and parking a car.

Keypads and keyboards for communicating with a travel information office should be placed where they are easy to reach. Good ATT systems can permit seat selection and a certain choice of seat design when making reservations.

1.4 Skeletal – Anthropometrics

The positioning of information systems can be a problem for short people. They may find it difficult to reach the keypad or keyboard in order to communicate or pay a parking fee or purchase a ticket. They may also have trouble seeing information placed too high for them; on the other hand, for very tall people, they may find it uncomfortable to bend over to read. The problem of not being able to reach, or comfortably reach, keypadkeyboard keys can also arise in the location of equipment and controls in automobiles.

The available information should contain descriptions of potential physical obstacles for short or very tall people during a trip. It should also pinpoint vehicles that may be difficult for some people to board or disembark.

An ATT system can be useful when driving by replacing the need to physically reach different controls, c.g. via voice activation.

1.5 Skeletal – Co-ordination/dexterity

This kind of functional impairment entails difficulties in using or reaching keypads and keyboards to communicate with ATT equipment. The problems are obvious when trying to access pre-trip information, buy tickets, or pay parking fees and tolls. To provide
accessibility, it must be possible to communicate with the system without the need for physical contact. The solution can be found in voice-activated systems and payment with contactless cards.

The physical obstacles for the trip itself resulting from problems with coordination/dexterity are few. The requirement for special content in the information system is limited to how communication with various ATT systems is to take place. To some extent, there may be a need for information about physical obstacles.

The ATT system can be of major assistance by carrying out certain functions automatically or via voice activation. An integrated solution can store information about personal preferences and needs on a smart card, which simplifies requests for pre-trip information, reservations and paying for tickets as well as requests for assistance.

1.6 Skeletal – Force
This impairment entails problems like inability to open doors and insufficient strength to handle normal equipment in a vehicle or to depress the keys on communication devices. To provide accessibility for people with this impairment, it should be possible to communicate without manual contact or with very little strength. The problem occurs both in pre-trip information systems, where information about the desired trip must be entered, and in payment systems. In public transportation, for example, the ticketing machine can be a problem, and a relevant solution should permit contactless payment.

When driving, strength is required for manoeuvring the vehicle. ATT systems can be helpful through contactless communication and systems for reducing the strength needed for operating various controls.

Information systems must include the potential physical obstacles for people with limited strength, e.g., doors that must be opened manually or escape procedures that require strength in case of accidents. Some travellers might not have the strength to operate an emergency exit and would be best not occupying a particular seat. A ‘smarter’ boarding card, which could record relevant special needs or difficulties, would benefit both the traveller and the transport’s emergency procedures. However, a vital component of such a system would be awareness-raising to demonstrate the reasons for and confidentiality of the information recorded in the system.

1.7 Visceral (Sudden loss of control)
People who risk losing consciousness need good information before travelling about where help is available throughout the entire trip. Another important aid is being able to attract the attention of persons who can provide help.

If changes occur during the trip, relevant ATT systems must provide information about where it is possible to rest or get help along the modified route.

1.8 Vision
Most travel information is conveyed in a form that presumes being able to see. People with little or no vision must therefore be able to receive information presented some other way in order to benefit from it. People who have impaired vision must be able to get close to and
PART 1: Overview of User Requirements for Elderly and Disabled Travellers

enlarge a text in order to access its information. People with no vision must be able to receive the information aurally.

Differences in station environments (e.g. platform length, positioning of ticket machines/windows) and the design of buses/trams/metros/trains (e.g. number of steps, location of doors) can cause numerous problems, particularly when travelling on novel journeys. Sources of navigation information (e.g. tactile flooring, braille on signs) will help in these tasks, although it must be remembered that only a small minority of people with visual impairments can read braille.

ATT systems relevant to people with visual impairments will contain information about the layout of the stations or transport, bus stops and parking places, whether there are passageways or particular landmarks to help orientation. People with guide dogs need to know about possible restrictions on having animals on various modes of transport.

Written information is provided during a trip, e.g., directional signs, ticketing information, departure timetables, and emergency instructions. A person with limited vision needs to know whether that information will affect the rest of the trip and to have it spoken or read aloud. This is especially important for messages in connection with accidents or emergency situations. It is another urgent function for ATT systems to warn people with impaired vision about hazards of various kinds, e.g. places where there are uneven surfaces, large differences in levels, or vehicular traffic.

Timetables (whether on paper or at a stop) often utilise very small text, and it may be difficult to identify whether the desired bus/tram/metro/train has arrived at a particular stop. ATT systems which utilise a speech input/output interface are of great relevance to this group.

A number of different ATT systems may aid in visual-related elements of the driving task, and thus aid the visually-impaired driver, e.g. in-vehicle navigation, gap acceptance, speech recognition, collision avoidance, parking aids, and vision-enhancement. However, visual accommodation between an in-vehicle display and the road ahead may cause problems for drivers with some of these systems, unless the systems are designed with their needs in mind.

1.9 Hearing

Most information provided for pre-trip planning and during a trip is presented in written form and is thus accessible to people with limited or nonexistent hearing ability.

At bus stops, stations and terminals, and in some vehicles, information is presented by loudspeaker or in some other spoken form. People with impaired hearing must be able to adjust the volume in order to be able to receive the information. If hearing is significantly impaired, one must be informed that information has been given and what it contains. This is especially important for messages providing warnings, and in the event of accidents or emergency situations.

Several new ATT systems in cars, such as in-vehicle navigation, or travel and traffic information systems, provide spoken information so that the driver need not look away from the road to read a text. Hearing impaired people must be able to access this information in writing or through symbols. Car drivers may communicate with one another by blowing their horns. People with impaired hearing can benefit from aids that translate acoustic signals into visual or tactile information.
into another medium, whether visual or tactile. Similar systems can help in knowing when some part of the vehicle is making unusual or alarming noises.

1.10 Language and Speech
For an information system to be accessible to people who cannot read or speak, there must be an alternative to text messages for presenting information. It is very helpful to have the information read aloud or presented through symbols.

It should be possible to receive information without asking for it in speech or writing. Pre-trip information normally provides all the data in written form. Those who cannot read must then have access to pictures and symbols for asking questions and receiving answers. People with language and speech impairments can often read a clock, and departure times can thus be presented on a clock face. Personal navigation equipment would be very helpful. This can show pictures of the route, the bus stop and the appropriate vehicle.

1.11 Intellectual / Psychological (Cognitive)
People with impaired intellectual, psychological or cognitive functions have difficulties orientating themselves, absorbing new information and encountering unfamiliar situations. For these people, advanced ATT systems can themselves be obstacles, even though they are able to help with both planning and carrying out a trip. For these systems to be accessible, it should be possible to use them in stages; a person can learn one stage at a time, and gradually become acquainted with the various functions. The information should also be presented in the form of pictures and symbols to make it easy to understand.

Personal navigation equipment would be very helpful. This can show pictures of the route, the bus stop and the appropriate vehicle. The use of smart cards for payment would also overcome any difficulties in buying tickets or using ticketing machines.

The limitations that drivers with cognitive impairments have in general information processing and memory functions have a number of implications for aspects of the driving task. For example, people with cognitive impairments may have the following types of problems: using complex spatial information (e.g., a map), reacting to the sudden appearance of hazards, driving over bridges and/or through tunnels (due to phobias), estimating the speeds/distances of the surrounding traffic, navigating in an unknown area, and lining up car with kerb when parking. Well-designed, easy-to-use ATT systems have the potential to aid drivers within this impairment group, for example, in-vehicle navigation, collision avoidance and parking aids.

1.12 Elderly
Elderly people often have several different functional impairments; however, to say someone is elderly does not imply that he or she is disabled. It is important to stress that elderly people do not form a homogenous group, and many elderly people have active and healthy lives, even though the natural process of ageing has reduced certain abilities to some extent. It is, therefore, not unusual for older people to experience restricted mobility and declining vision, hearing and reaction time. The ATT systems relevant for these specific impairments are thus also valuable for the elderly.

Similar to mobility-impaired travellers, elderly people often like to be sure of procedures prior to travel. Information systems accessible from home or at travel agents are a potential solution to this problem. Elderly travellers may wish to ensure that a taxi is waiting for them.
PART 1: Overview of User Requirements for Elderly and Disabled Travellers

when returning from a destination. A longer-term booking system or an easy-to-use, short-term booking system accessible from abroad may be helpful.

1.13 Medical functional impairment

In addition to the impairment groups considered above, there are people with medical disabilities for whom ATT systems can be helpful. For example, people with allergies could travel more confidently if they could have prior information on the levels of air pollutants along the route, pollen counts, and the existence of compartments where no animals are allowed. It is also worth mentioning the medical disabilities that involve knowing where one can rest or the locations of public toilets.
PART 2: Usability Principles and Code of Good Practice

Introduction

Usability is concerned with all aspects of a product or system with which a user may interact. This not only includes the hardware, such as the screen and controls of a system, but also the software user-interface in terms of the screen layout, ease of navigation, user support and error handling.

A definition of usability was first attempted by Miller (1971) in terms of measures of ‘ease of use’. This has evolved towards a formal definition of usability by Shackel (1991):

‘the capability, in human functional terms, to be used easily and effectively by the specified range of users, given specified training and user support, to fulfil the specified range of tasks, within the specified range of environmental scenarios’.

This has now been simplified within the Esprit MUSiC (Bevan and Macleod, 1994) project and the International Standards Organisation (ISO 9241-11) to be:

‘the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use’.

The importance of these definitions is that they recognise that usability is not an intrinsic quality which is the same for all situations. The features that make a system usable will depend on the situation or context in which it is used. For example, a public information system will be judged as usable if it can be operated by travellers without extensive skills or experience with computers, and also by users who are disabled or elderly. A route guidance and navigation system is regarded as usable if destinations can be found effectively, efficiently and safely, while the usability of a collision avoidance system will focus on preventing the user making serious errors.

The importance and benefits of usability

Usability is now widely recognised as critical to the success of an interactive system (Shackel and Richardson, 1992; Eason, 1984; Whiteside et al, 1988; Nielsen, 1994). Many poorly designed and unusable systems exist, which users find difficult to learn and complicated to operate. This results in their becoming under used, misused or even to fall into disuse as frustrated users return to their original working, or travelling, methods. The outcome is costly, or dangerous, for the person or organisation using the system, and harmful to the reputation of the company who developed and supplied it.

There are a number of benefits in considering usability in the design of ATT systems for travellers. These are reflected in the quality of the user interface to the system (Maguire, 1997):

• Increased Efficiency. A system designed to sound human factors principles and tailored to the users’ preferences will allow the traveller to operate effectively and efficiently rather than lose vital time struggling with a poorly designed user interface, which for in-vehicle systems could be highly dangerous.
• **Improved Productivity.** A usable system will allow the user to concentrate on the travelling task, rather than the human-computer interface, arriving at his or her destination safely, with least effort and on time. If the interface is designed inappropriately, it can extend rather than reduce the time to perform a task, as well as directly affecting other aspects of performance, quality or safety.

• **Reduced Errors.** A significant proportion of so-called ‘human errors’ can be attributed to a poorly designed user interface. Avoiding inconsistencies, ambiguities or other interface design faults will reduce user error.

• **Reduced Training.** A poorly designed user interface can prove a barrier to an otherwise technically sound system. A well-designed interface can reinforce learning, thus reducing training time and effort.

• **Improved Acceptance.** This is not usually the primary objective in improving the interface, but is nevertheless an important outcome. Most users would rather use and would be more likely to trust a usable human-computer interface which provides the information in a format which is easy to assimilate and use.

To realise these benefits for elderly and disabled users requires consideration of their constraints and limitations during the design and evaluation process, and TELSCAN can help designers do this.

**Main activities in designing for usability**

There are a number of essential user-centred design activities which should take place during the design process, as described by Eason (1982), Gould and Lewis (1983) and Bevan (1996). These are:

• **Understanding and specifying the context of use:** the nature of the users, their goals and tasks, and the environment in which a product will be used

• **Specifying the user requirements** in terms of effectiveness, efficiency and satisfaction; and the allocation of function between users and the system

• **Designing the user interface** to meet the user requirements and context of use.

• **Prototyping the user interface** allowing users to visualise the system design and to demonstrate how it would operate.

• **Performing user based assessment** to obtain feedback on the prototype as a basis for redesign if necessary.

**Understanding and specifying the context of use**

The context in which the system will be used should be identified in terms of the characteristics of the intended users, their tasks and the environment. The Handbook provides guidelines for specific contexts of use in Part 4, covering interactive public access.
PART 2: Usability Principles and Code of Good Practice

terminals or kiosks, non-interactive information systems for public transport, driver systems, etc. Relevant characteristics of the users may include knowledge, skill, experience, education, training, physical attributes, habits and motor and sensory capabilities.

Specifying user requirements

Requirements elicitation and analysis is widely accepted to be the most crucial part of software development. Indeed, the success of the user-centred approach largely depends on how well this activity is done. The RESPECT project has provided general help and support for these activities (Maguire and Kirakowski, 1997), and the TELSCAN project provides data collection methods, tools and techniques specifically for the Transport Telematics sector. See Part 1 for an overview of requirements and the tools used to capture them.

Designing the user interface

There are a number of sources of guidance for designing usable systems. Shneiderman (1987) for instance, presents eight ‘golden rules’ for interface design:

1. Strive for consistency
2. Enable frequent users to use shortcuts
3. Offer informative feedback
4. Design dialogues to yield closure (feedback and satisfaction in completing a group of actions)
5. Offer simple error handling
6. Permit easy reversal of actions
7. Support internal locus of control (allow users to initiate and feel in control of actions)

Another well known, practical source of information is Galitz (1980) who has produced specific guidelines for screen design. However, it is important to relate guidelines to the particular application area in which the design is taking place.

Prototyping the user interface

In carrying out evaluations of a user interface design, a valuable technique is the use of computer simulations or rapid prototypes of the future system. This may consist of a series of screen layouts and a partial database allowing potential users to interact with, visualise and comment on the system. Such simulations or prototypes can be produced both quickly and easily in the early stages of the system development cycle for evaluation by human factors experts, user representatives and members of the design team.

Changes to the design may then be made rapidly in response to user feedback so that major problems with the design can be identified before system development begins. This helps to avoid the costly process of correcting design faults in the later stages of the development cycle.
Performing user-based assessments

User-based assessment is an essential activity in user-centred design. Assessment can be used to:

- provide feedback which can be used to improve design
- provide evidence that user and organisational objectives have been achieved

Early in design the emphasis will be on obtaining feedback (typically consisting of a list of usability defects) which can be used to guide design, while later when a realistic prototype is available it will be possible to measure whether user and organisational objectives have been achieved.

In the early stages of the development and design process, changes are relatively inexpensive. The longer the process has progressed and the more fully the system is defined, the more expensive the introduction of changes will be. It is therefore important to start evaluation as early as possible.

The assessment of usability should normally include analysis of both the users’ performance and the users’ attitudes as these provide complementary information. Since elderly or disabled travellers may already be working closer to their limits of strength and capability than most non-disabled people (Haslegrave, 1988), their performance and attitude to the system should be crucial.

Some specific usability principles that are particularly relevant to elderly and disabled travellers are given below for each of the above design activities.

Usability Principles

2.1 Avoid high workload on residual capabilities

Physical impairment induces higher workload due to over-taxed or limited residual abilities, and elderly or disabled travellers are often working closer to the limits of their abilities. It is important not to overload a user's residual abilities, so offer alternative means of input or output.

*Example* - The visual channel must not become overloaded for people with hearing impairments. Similarly, the tendency to use synthetic voice and other acoustic output might lead to some people becoming travellers with special needs if they are not able to hear a message or warning from the system.
2.2 Include elderly and disabled travellers in the design process

Specify user requirements in terms of the needs and characteristics of all potential users.

*Examples -*

Certain user groups may require specific information from a travel and traffic information system, for example whether a roadside café is accessible to people who use wheelchairs.

User groups may have different feedback requirements, especially in critical situations. For example, a person with hearing impairments may not be able to use auditory warnings (type of feedback), or an elderly driver may wish to hear/see a warning earlier than other travellers (timing of feedback).

Consider a modular system design, whenever possible, where system components could form building blocks which can be interchanged to meet specific and changing users’ needs.

2.3 Ease of use for more people

Design should be optimised for the cognitive, perceptual, and physical capabilities of elderly and disabled people. In general, simplicity is preferable to complexity.

Remember that a good design for an elderly or disabled traveller is also often better for other people. In other words, follow the “design for all” principle.

2.4 Flexibility / Adaptability

Systems should be flexible enough and easy to adapt to individual user requirements.

*Example –* An older person should be able to increase the contrast or font size on a display.

Consider a modular design for systems, which lends itself to adaptability to meet specific needs and easier updating.

Safety critical or intricate adaptations of systems should be done by a competent specialist.

2.5 Ease of learning

During the design process, the required skills and capabilities of the intended users should be identified, with the aim to redesign if necessary to include all potential users and their varied abilities. These then should be specified in the system documentation (ICE Ergonomics, 1994). Necessary skills and capabilities are also valuable criteria for the evaluation of the system. This is important for all users, but could be critical for people with cognitive limitations, such as learning and memory impairments.

2.6 Familiarity / Conformance to expectations

Ensure that the system controls/displays feel familiar and conform to the expectations of the user. This is especially important for people with perceptual and cognitive impairments, and
PART 2: Usability Principles and Code of Good Practice

for elderly people who may be slower at learning new techniques or absorbing new information.

2.7 Comfort in operation

Evaluate comfort aspects of use. This is even more crucial for elderly and disabled travellers who often show higher levels of physical or cognitive fatigue and workload.

2.8 Compatibility with other aids and systems

Standard hardware and software should be designed so that assistive devices can be easily connected and used as alternative modes of input or output (Nordic Cooperation on Disability, 1998).

2.9 Include elderly and disabled travellers in the evaluation process

System evaluation should include elderly travellers and travellers with disabilities.

Use methods and tools for requirements capture and evaluation which will facilitate the process of including special needs (e.g., Poulson et al, 1996).

TELSCAN has developed an Assessment Methodology to give advice on:
- which user groups to include in the assessment
- what to remember in certain testing environments and contexts; and
- methods, tools and protocols to follow when testing with different user groups

This is available through the TELSCAN WWW site and on CD-ROM
PART 3: General Guidelines for all ATT Systems

3.1 CONTROLS/INPUT

The following sections (3.1.1 to 3.1.5) contain key guidelines to aid in the design of accessible system controls for elderly and disabled people (e.g. choice of controls, locating controls, identifying and interacting with controls). They are generic and therefore applicable to any ATT system which requires an input via controls.

The majority of the guidelines within this section are based on the following two references, and the reader is referred to the original sources for extensive information on designing accessible controls. Although these guidelines were not developed specifically for systems with travellers, they represent fundamental concepts which are relevant to all users who are elderly or disabled:

1. Guidelines for the design of accessible consumer products, available from the Trace R&D Center (1998), and on the WWW at: http://tracecenter.org/docs/consumer_product_guidelines/toc.htm

2. Guidelines for computer accessibility, developed by the Nordic Cooperation on Disability, edited by Clas Thoren (1998), and on the WWW at: http://www.NSH.SE/IN_ENGLISH/PUBLICATIONS.htm

Specific guidelines drawn from other sources are referenced within the text below.

3.1.1 CONTROLS/INPUT: General issues

Guidelines

Ensure that the type of control is easy to find, reach, and use for as many people as possible.

Controls should be easy to distinguish by location, shape, texture, colour, size, labelling, illumination or mode of operation (Galer & Simmonds, 1984).

The size of control buttons should be designed and tested with special consideration of the needs of people with mobility, vision and cognitive impairments.

The relative benefits of integrating functions within a small number of controls needs to be carefully considered - testing with disabled and elderly people is essential.

Rationale - Elderly people and/or people with a cognitive impairment may experience difficulties with an interface in which the same controls or keys are used for different functions. However, a person with limited range or reduced strength may benefit from integrating functions into a reduced, but usable, set of controls.

The direction of movement of the control should clearly relate to the change that it effects in the associated display (Galer & Simmonds, 1984).

Rationale - Compatibility of movement will improve the usability of a control, particularly for people with an intellectual or psychological impairment. However, this concept may not apply if the traveller does not have the appropriate ability/force to operate the device/control following the natural movement direction.
Relevant User Groups

All
PART 3: General Guidelines for all ATT Systems

3.1.2 CONTROLS/INPUT: When to use specific controls

Guidelines
Consider the use of speech recognition as an input device for people with physical impairments who might be working to the limits of their physical capabilities.

Rationale – Speech recognition has great potential as an input mechanism for elderly and disabled travellers. In particular, speech provides an alternative means of entering information to those who are limited in their abilities to use traditional manual controls, such as rotaries, push buttons, sliders etc.

Push buttons and sliding mechanisms are preferable for persons who may have limited range, reduced strength or reduced precision in their movements.

Single, sequential, finger-operated or palm-operated push buttons are suitable for many applications.

Membrane touch keys are not recommended unless:
• the keys have a matt, nonslip surface,
• the edges are raised,
• the keys are clearly coded, for example by colour,
• a positive click is felt when the key is pressed.

In emergency applications, a mushroom-shaped button would facilitate rapid and positive action for many people, as such a button could more easily be struck with the fist or whatever residual ability or force is available (Boff, et al., 1986).

Rationale – This design would benefit people with upper limb impairments, impairments in dexterity, coordination, or force and also those who have visual impairments or slower reaction times.

Relevant user groups
All

Cross References
Part 3.1.3 How to design speech input systems
3.1.3 CONTROLS/INPUT: How to design speech input systems

More widespread use of speech recognition would be a solution for people with various types of disabilities. The following guidelines have been developed from knowledge learned through reviews of the human factors of automatic speech recognition (ASR) (Graham and Carter, 1998). Although their review concentrated on aspects particularly relevant to in-car use, many of the issues are important for TELSCAN to consider for all systems for travellers, for example in pre-trip planning systems via kiosks, the internet and other technologies.

**Guidelines**

Speech systems should be designed to be as undemanding as possible to use, so that all users, especially people who are elderly or disabled, will be able to use them effectively.

Since older travellers will have particular problems when carrying out concurrent tasks and machine-pacing, speech system dialogues should be user-paced where possible.

Alternative means of input should always be provided to cater for the needs of every user group. Speech interfaces should therefore be an addition to, rather than a replacement for, existing visual and manual interfaces.

Back-up systems should be available in case the ASR fails.

*Rationale* - TELSCAN always recommends alternative modes of input/output for people with disabilities and back-up devices, and in the case of ASR, they are even more crucial. Back-up systems will also act as a safety measure in case of emergency, or can be used when the user becomes too busy or fatigued to use the ASR effectively.

An effective performance evaluation must include a range of users, including elderly and disabled people, and should be performed in actual use in the travelling environment, where the user will be subjected to concurrent tasks, time pressure, emotional stress, and fatigue effects.

General training on the use of speech recognisers and specific training to cope with high levels of stress, workload or fatigue are important for all users, but especially for people who are elderly or disabled.

Performance of inexperienced users (which is likely to include people who are elderly or disabled) can be improved if they are given a demonstration of system use by an experienced user. This is more beneficial if they are just given verbal instructions.

The speaker database used to train the ASR device should include male and female users, older people, non-local accents, inexperienced users, etc.

**Relevant user groups**

Motion of lower limbs, Motion of upper limbs, Co-ordination/dexterity, Force, Elderly
3.1.4 CONTROLS/INPUT: How to facilitate interaction

Guidelines
When designing hand-operated controls, consider carefully the wide variation in physical characteristics of elderly and disabled people.

Example - Persons with impaired hand functions may have limited strength, only be capable of small movements, and/or experience difficulties with sweeping movements.

Provide controls which will allow sole operation with either left or right hand.

Rationale - Approximately 8% of users can be expected to be left-handed and there may also be times when other users may want to use either hand, e.g., due to an injury.

Controls should be able to be adapted so that they can be operated in the direction of maximum strength and/or capacity.

Rationale - Elderly and disabled drivers may have variable strength in various directions or movements (e.g., twist, push, pull movements, etc.)

Ensure that the size, shape and surface of controls are designed so that the elderly or disabled person can easily grasp them.

Simultaneous operations with different fingers should be avoided.

Auto-repeat activation (as the push-button or key is held down) should be avoided.

Avoid the use of controls that need to be pushed and rotated at the same time.

There should be no obstructions nearby which would prevent the user from easily making contact with the control.

Example - Ideally, a public access kiosk should have a space beneath the facia of the kiosk to allow a wheelchair user to get close enough to easily reach the controls (Gill, 1997).

As a maximum, a control should not require a pushing force of more than 2 Newtons. However, for certain control types a reduced force is recommended:

Examples--

The Nordic Cooperation on Disability recommend that the force required to operate pointing devices (i.e. a mouse) for personal computers should be between .3 and .6 Newtons, although preferably it should be adjustable.

Trace R&D Center recommend, for consumer products, that concave buttons should require less than 1 Newton of force.

Relevant user groups
Motion of lower limbs, Motion of upper limbs, Co-ordination/dexterity, Force
PART 3: General Guidelines for all ATT Systems

Cross References
Part 4.1.3 Public Access Terminals / Kiosks: How to design the display and controls
Part 4.3.3 Driver Systems: When to use specific controls
3.1.5 CONTROLS/INPUT: Where to locate controls

Guidelines
As far as possible, there should be both flexibility and adaptability in the positioning of ATT controls to suit the specific impairment of an individual.

Rationale - People with mobility-related impairments (e.g., short arms, small stature) can vary considerably in their reach capabilities. A fixed location for a particular control is unlikely to enable all potential users to easily access the ATT system.

When designing and assessing the location of controls, performance-based testing is recommended using people with different skeletal impairments.

Controls being used for similar functions should be grouped for easy identification.

Related controls should also be placed separate enough from each other so that they are easy to grasp, avoid confusion, and so that people do not activate them by mistake.

Relevant user groups
Motion of upper limbs, Anthropometrics, Co-ordination/dexterity
3.1.6 CONTROLS/INPUT: How to facilitate identification of controls

Guidelines
Any text on controls should use large, lower case lettering and achieve high contrast between the letter/symbol and background - all of these design features will facilitate readability.

*Example* - Avoid low contrast combinations like light grey on slightly darker grey.

Text on the keys should be printed in sans-serif characters, which are considered easier to read than other typefaces.

*Examples* –
This is an example of a sans-serif font (Helvetica).
This is an example of a serif font (Palatino).

Any lettering or symbols contained on controls should use most of the surface of the key top.

*Rationale* - The use of large, easily readable lettering or symbols, designed with special requirements in mind, improves the learning process and efficiency of occasionally-used equipment.

Primary and hazard controls should be identifiable both visually and by touch.

*Rationale* - Such redundancy is critical for elderly people and those with disabilities, so as not to “design out” some user groups.

*Example* - A common approach for providing tactile markings on keypads is to put nibs on the front edge of the F and J or D and K keys, as well as a dot on the 5 key of a numeric keypad. Other suggestions can be provided by e.g. the Royal National Institute for the Blind, London - [http://www.rnib.org.uk/](http://www.rnib.org.uk/)

**Relevant user groups**
Vision, Cognitive, Elderly
PART 3: General Guidelines for all ATT Systems

3.2 DISPLAYS/OUTPUT

The following sections (3.2.1 to 3.2.7) contain key guidelines to aid in the design of accessible system displays for elderly and disabled people (e.g. choice of display modality, locating displays, presentation of visual information, design of auditory displays, touchscreens). They are generic and therefore applicable to any ATT system which provides an output via displays (utilising the visual, auditory or tactile senses).

3.2.1 DISPLAYS/OUTPUT: General issues

The majority of the guidelines within this section are based on the following two references, and the reader is referred to the original sources for extensive information on designing accessible displays. Although these guidelines were not developed specifically for systems with travellers, they represent fundamental concepts which are relevant to all users who are elderly or disabled:

1. Guidelines for the design of accessible consumer products, available from the Trace R&D Center (1998), and on the WWW at: http://tracecenter.org/docs/consumer_product_guidelines/toc.htm

2. Guidelines for computer accessibility, developed by the Nordic Cooperation on Disability, edited by Clas Thoren (1998), and on the WWW at: http://www.NSH.SE/IN_ENGLISH/PUBLICATIONS.htm

Specific guidelines drawn from other sources are referenced within the text below.

Guidelines

Consider which skills and capacities are required by users to obtain information from the system, and whether there is an alternative mode of output to meet the needs of elderly and disabled travellers.

Examples -

1. Haptic (or tactile) “displays” have much potential as an output device for people with hearing impairments.

2. Auditory displays can only be backup to visual displays and must not be the sole source of information, as travellers with hearing impairments would not be able to safely and effectively use the system.

3. A facility which enables a user to select the display modality which best suits their particular impairment can be extremely valuable. For instance, users with a hearing impairment may wish the ATT system to provide full visual redundancy for all audio output.

4. The presence of a headphone jack provides the opportunity to plug in a small LED that would provide a visual cue whenever sound was emitted from the speaker. Another method is to wire in a small LED in parallel with the speaker to provide visual feedback of auditory activity.
3.2.1 DISPLAYS/OUTPUT: General issues (Cont…)

Guidelines
To avoid redundancy resulting in clutter for people without disabilities, users should be able to easily disable alternative modes.

Investigate the feedback requirements for all users (e.g., modality/type of feedback, frequency of feedback), especially in critical situations.

Feedback and prompts should be adjustable according to experience and user preferences.

The system should be forgiving and flexible.

*Example* - If the user misspells a word, the system should still recognise the request.

Relevant user groups
All
3.2.2 DISPLAYS/OUTPUT: How to configure visual displays

Guidelines
Ideally, an ATT display should be capable of being located in any position to suit an individual’s needs.

However, if a fixed position is required for an ATT display, then it should be easily adjustable vertically and horizontally (tilted and turned).

Examples - Travellers should be able to easily and comfortably view the display if they were sat in a wheelchair, were of small stature, had a limited range in upper body movements, etc.

It should be possible to attach a larger display (for systems dedicated to certain user groups) or to enlarge the image in order to adapt the visual output to individual users' needs.

The minimal display illumination for small displays (e.g., mobile telephones) should be 200 lux (HOME project, 1997).

Provide protection of the display from reflections and from the sun’s glare.

Rationale - Older travellers are especially susceptible to slower accommodation to sudden changes in light levels and also to glare, due to the increased lens opacity of the older eye.

Relevant user groups
Motion of upper limbs, Motion of upper body, Anthropometrics, Vision, Elderly
3.2.3 DISPLAYS/OUTPUT: How to present visual information

The following sections (3.2.3.1 to 3.2.3.3) contain guidelines to aid in the design of accessible visual displays for elderly and disabled people (e.g. display contrast/brightness, use of colour, design of text). They are generic and therefore applicable to any ATT system which provides an output via a visual display.

3.2.3.1 General issues

Guidelines
Where alternative formats for presenting information are available (e.g., text vs. symbols, alternative symbol sets, etc.), provision should be made for users to select their preferred option.

Alternatively, clear documentation should be provided for a specialist to customise the system to meet the needs of a person with disabilities.

The user should be able to adjust the size for both characters and icons to meet specific visual requirements.

Avoid screen clutter.

*Rationale* - This is crucial for travellers whose cognitive processes have slowed or are slowing. Elderly people find it more difficult to select appropriate information from complex displays, increasing not only errors but also reaction times (Graham & Mitchell, 1996).

The user should be able to choose larger displays or enlarged images to cater for specific needs.

Enlargement of images should ensure that clear resolution is not compromised.

The contrast and brightness should be easily adjustable and adaptable to the user’s needs and the travelling environment.

*Rationale* - A person aged 60 requires, on average, three times as much light as a person aged 20 in order to view the same image.

The contrast between the text/graphics and their background should be
Minimum 3:1
Preferred 7:1

This contrast ratio is calculated according to the following equation:

Luminance emitted by the area or element of greatest intensity (i.e. text/graphics)
Luminance emitted by the area or element of least intensity (i.e. background)

*Rationale* – This guideline is based a number of studies which consider the requirements of older people, as cited in Campbell, Carney and Kantowitz (1998), page 3-3.
Relevant user groups
Vision, Cognitive, Elderly
3.2.3 DISPLAYS/OUPUT: How to present visual information

3.2.3.2 Use of colour

**Guidelines**
The use of colour in displays can be helpful but the colours used must be clear, distinctive and high in contrast.

*Rationale* - Many elderly and disabled people have a degree of visual impairment and may find it difficult to distinguish between subtle variations in colours and shades.

Start the design in black and white, adding colour later, and not relying on colour coding as the sole source of important information. (Examples of other coding are: shape, size, and location.) Remember that in conditions of low light, even if colours have been chosen with care, colour perception will be markedly reduced.

Use dark characters against a light background.

*Example* - Black characters on yellow background. Recommended colours of background are: white, grey, yellow, light blue (ATTACH, 1997).

Avoid using saturated primary colours (red, green and blue) next to or on top of each other.

*Rationale* - Using such colours from the opposite end of the spectrum are difficult for users to focus on at the same time. This is caused by the so-called chromostereopsis effect, where objects of different colours are perceived as being in different horizontal planes, leading to visual fatigue.

Avoid using certain combinations of colours, e.g. red/green and blue/yellow colour combinations.

*Rationale* - This will assist the 8-10% of males and 0.4% of females who are colour-blind. In addition, with ageing there is a build up of a natural yellow pigment in the lens of the eye and on the back of the eye at the point where light is best focused. The effect is to filter out blues and violets.

Systems should be capable of providing a variety of colour saturations - for example, through the use of a colour contrast control.

If coloured areas such as symbols are to be presented on a coloured background, it is recommended that the symbols be outlined in black.

*Rationale* - This will increase discrimination when the ambient environment is bright (Stokes, et al., 1990; Ross, et al., 1996), and will be particularly important for travellers with visual impairments and/or older people who have a greater need for strong contrasts.
### Guidelines
Several of the above guidelines for the use of colour in visual displays are summarised in the following table (drawn from the ATTACH project -Poulson et al., 1998):

<table>
<thead>
<tr>
<th>Colours</th>
<th>Meanings</th>
<th>Attention getting value</th>
<th>Contrasts well with:</th>
<th>Avoid pairing with:</th>
<th>Area of display</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>unsafe danger heat alarm financial loss</td>
<td>good</td>
<td>white</td>
<td>green</td>
<td>centre of the vision field, foreground colour</td>
</tr>
<tr>
<td>Yellow</td>
<td>danger warning hazard abnormal state oil</td>
<td>good</td>
<td>black dark blue green but use with care</td>
<td>white</td>
<td>white (too little contrast)</td>
</tr>
<tr>
<td>Green</td>
<td>safe satisfactory normal state</td>
<td>poor</td>
<td>white</td>
<td>red</td>
<td>centre of the vision field, foreground colour</td>
</tr>
<tr>
<td>Light blue</td>
<td>advisory aerated water cool</td>
<td>bad</td>
<td>black</td>
<td>yellow</td>
<td>peripheral vision, background colour</td>
</tr>
<tr>
<td>Dark blue</td>
<td>advisory untreated water</td>
<td>poor</td>
<td>white</td>
<td>yellow</td>
<td></td>
</tr>
<tr>
<td>Magenta</td>
<td>alarm state</td>
<td>good</td>
<td>white</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>advisory steam</td>
<td>poor</td>
<td>green black red dark blue magenta</td>
<td>light blue yellow</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>gain in the financial world</td>
<td>poor</td>
<td>white light blue yellow</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Relevant user groups
Vision, Elderly
3.2.3 DISPLAYS/OUPUT: How to present visual information

3.2.3.3 Design of text

Guidelines
The height of text characters (numbers and letters) should increase as the distance between the viewer and display increases.

Rationale – It is critical that a designer considers the needs of wheelchair users who may be at an increased distance from a display. Context will determine exactly the degree of change in the height of text with distance from screen.

Distances between characters and between lines should be large enough to provide good readability. The ratio of space-between-characters to character-height should aim to be 0.25:1 (Campbell, Carney and Kantowitz, 1998).

In the design of text, the interface should not rely solely on boldface, italics or colour to provide information.

Use sans-serif typefaces, that is, those fonts without ornamentation. Choice of typeface should be available.

Examples –
This is an example of a sans-serif font (Helvetica).
This is an example of a serif font (Palatino).

Multiple word text displays should preferably be in a mixture of lower and upper case, rather than entirely in capital letters.

Rationale - Word recognition is considered quicker and easier if a mixture of upper- and lower-case is used. This combination helps us to recognise whole words and phrases by their shape (using ascenders, descenders, etc.).

However, there are instances when all capital letters are preferred and more easily recognisable (Arthur and Passini, 1993).

Rationale - Context may determine whether upper case or a combination is most suitable. Many lower-case letters can be confused with one another (e.g., b and d, p and q, u and n), and there may be a good case for using all capital letters to reduce confusion. If there is a tactile element, then all upper case is likely to be easier to read by people with visual impairments. Testing is recommended.

Example –
Liverpool
NEXT RIGHT
PART 3: General Guidelines for all ATT Systems

3.2.3 DISPLAYS/OUPUT: How to present visual information

3.2.3.3 Design of text (Cont…)

Guidelines
Text should be justified on the left (not fully justified to both margins).

Display text in wider, rather than narrower, columns, as this is easier to read.

Underlining should be avoided.

  Rationale - Underlining causes the text to flow together for some visually impaired people.

Relevant user groups
Vision, Elderly
PART 3: General Guidelines for all ATT Systems

3.2.4 DISPLAYS/OUTPUT: How to configure auditory output

Guidelines
All auditory output should be capable of being heard against variable ambient noise.

Example - A warning signal should be around 15 dB above the background noise level, but continuous operating noises should be kept below 55 dB(A) where a quiet environment is needed. (Mamdani et al., 1997).

Auditory output should not be easily confused with other auditory sounds in the surrounding travelling environment (either produced by the ATT system or external sources).

A confirmation bleep sound from a system (e.g. in buses) should be between 500 Hz and 750 Hz at 70 dB.

Rationale – This range represents the lower limit of audible signals which can be easily perceived by the majority of elderly people, without disturbing other passengers (from TELSCAN collaboration with the ADEPT II project).

Ideally, the volume, pitch and frequency of auditory output should be automatically adjusted according to the needs of an individual and the ambient conditions.

Rationale - This guideline will avoid the use for dedicated controls which may inherently be difficult for travellers with upper limb impairments or limited coordination/ dexterity to access.

If the above guideline cannot be followed, at a minimum, it should be possible to adjust the sound volume. The means of doing this should be very obvious and easy to use.

Example - The use of a large, well-placed volume knob is, by far, preferable to a volume control mechanism contained within a menu structure.

Provide a clear visual indication of the volume setting.

Rationale - People with hearing impairments often do not realise that the volume levels are set painfully high for others.

Relevant user groups
Motion of upper limbs, Coordination/ dexterity, Hearing
3.2.5 DISPLAYS/OUTPUT: How to design warnings

Guidelines
Warnings should be made available in alternative forms - auditory, visual or tactile.

Rationale - This will allow travellers with visual or hearing impairments to adapt the warnings to their own individual abilities.

Separate auditory warnings should be easily distinguishable from each other.

Where more than one system is in simultaneous operation, alarms or warning signals for the different systems should be distinct and not lead to confusion.

Alarm tones should ideally use frequencies of no higher than 2000 Hz.

If an alarm uses frequencies that are higher than 2000 Hz, it should also use at least one additional frequency in a low to mid range (500-2000 Hz).

Rationale – There are a large number of people across Europe who suffer from moderate hearing loss (estimated to be 80 million – Gill, 1997). Such people often cannot hear sounds that utilise frequencies above 2000 Hz. In addition, it is the higher frequencies that are the first to deteriorate due to age or exposure to industrial noise.

If warnings are provided visually, then they should be placed where they can be seen easily, and where they are likely to capture a user’s attention, i.e. close to the natural line of sight.

Warnings and similar alert messages must remain stable for a sufficiently long time to be discovered by the user.

Blinking should only be used for warnings or other emergencies, and should be disabled when the user has acknowledged the message (Mamdani et al., 1997).

The recommended blink rate is between 1 and 5 times per second (1 to 0.2 Hz) and preferably 2 to 3 times per second. Time ‘on’ should be 50%. No more than 2 blink rates should be used in an application. The higher rate should apply to the most critical warning. (Mamdani et al., 1997).

Relevant user groups
Vision, Hearing, Cognitive, Elderly
3.2.6 DISPLAYS/OUTPUT: How to design symbols/icons

Guidelines
Use symbols where possible rather than words or abbreviations, but keep the number of symbols manageable and easy to learn.

Three objectives need to be reached when designing and assessing symbolic language (Vernet, et al., 1992):

1. Symbols should be easily understood by users.
2. The choice of symbols should minimise learning time.
3. There should be no overlapping in meaning to avoid confusion with other symbols.

Common symbols should be used, to ensure that each symbol has the same meaning wherever it is encountered (i.e. in different countries, languages and cultures).

Ensure that symbols can be immediately recognised by people with hearing impairments who communicate using sign language.

Rationale - Certain terms (often concepts or abstract words) are meaningless for people who cannot hear. Sign language is predominantly based on the description of real objects and situations that have been experienced in one’s daily life. These objects and situations can then be generalised into sign language, often in the form of metaphors. In the TELSCAN evaluation of the PROMISE internet site, users who were deaf did not immediately understand the meaning of certain icons (Guyot and Marin-Lamellet, 1998).

Remove unnecessary details from symbols and exaggerate characteristic ones (Mandoni et al. 1997).

Example - Hair style and bow will provide visual redundancy to distinguish between a child and a woman, rather than just a simple difference in size of the symbol (Mandoni et al., 1997)

Text labels should be provided along with the symbol.

Rationale – Text labels are critical for unfamiliar or non-intuitive symbols. However, some travellers who are elderly or have a cognitive impairment may have lower comprehension levels for particular symbols; therefore, duplication is recommended, i.e., use of both text and symbol.

Relevant user groups
Vision, Language and speech, Cognitive, Elderly
3.2.7 DISPLAYS/OUTPUT: Touchscreens

The following guidelines have been validated by TELSCAN’s collaborative testing with the ROMANSE Project, Evaluation of ROMANSE Triplanner (Mk I) (Barham and Alexander, 1998), and also TELSCAN’s collaborative testing with the Infopolis 2 Project (Simões, et al, 1999b). Most guidelines are also relevant to the design of touchscreens, as part of a public access terminal.

Guidelines

Travellers should receive clear instructions on the use of a touchscreen.

*Rationale* – Current generation elderly travellers are very likely to be unfamiliar with the whole concept of a touchscreen, so they will often need to be prompted and instructed as to how they should input their instructions.

*Example* - At the very least, the initial “page” of the program’s sequence should include the instruction “Touch Screen”, or something similar. Advise the user to tap the screen lightly with one finger. This might seem an obvious method of interacting with the screen for users who are familiar with computers and similar technology. However, Human Factors research has indicated that it is by no means uncommon for some members of the public to keep their finger on the screen for a prolonged period of time, or to drag their finger across the screen (validated by TELSCAN’s collaborative testing with the ROMANSE project). Unfortunately, both of these actions tend to interfere with the functionality of many touchscreens.

Users should be able to position themselves as close to the touchscreen as they feel is appropriate.

*Rationale* - Some people, e.g., those with arthritis, will find it tiring and/or painful to have their arm out-stretched for more than a few seconds (experienced by users in TELSCAN’s collaborative testing of the ROMANSE Triplanner -MkI).

No icon that users might be required to touch should be more than 1200 mm from the ground (Gill, 1997).

*Rationale* – This recommendation is in line with the general UK Department of Transport (now DETR) guideline that no operable parts of a vending machine or information terminal should be above this height (Barham, Oxley and Shaw, 1997).

Where a touchscreen is used, it is common for the screen area to be the location of all of a terminal’s operable parts. In such circumstances, it is particularly important for the screen to be easily reachable. There are two reasons for this: firstly, touchscreens are often associated with a problem of parallax when viewed from a (vertical or horizontal) angle; and secondly, people of small stature or those using a wheelchair might find it hard to reach some, or all, of the touch sensitive areas of the screen.
Example – In TELSCAN collaborative testing with the EUROSCOPE-ROMANSE project, it was found that the lowest icons/buttons on the Mk1 version of the TRIPlanner interface were located at a height of 1219 mm. This proved to be a particular problem throughout the evaluation for people using wheelchairs. The photo below also illustrates the importance of a foot recess in the kiosk to enable a person in a wheelchair to get close enough to reach the control buttons or touchscreen (Photo by permission from ROMANSE office).
PART 3: General Guidelines for all ATT Systems

3.2.7 DISPLA YS/OUTPUT: Touchscreens (Cont...)

Guidelines
The screen of a touchscreen terminal should be flush with the outer casing of the terminal that surrounds it.

Rationale – This is to help people with low levels of manual dexterity (e.g., people with arthritic hands), who might find some areas of a recessed screen inaccessible. If a recessed screen is deemed to be unavoidable (due to problems with sunlight, etc.) then buttons should be positioned away from the periphery of the screen.

Example - Empirical observations in TELSCAN, as part of collaborative testing with ROMANSE, have shown that it may be difficult for a person with arthritic hands to touch peripheral parts of a touchscreen that is recessed by only a few millimetres.

Allow plenty of space between touch sensitive areas (i.e. ‘buttons’).

Rationale - Some users, e.g., with arthritis, have difficulty in touching a discrete portion of a screen without inadvertently also touching another sensitive part of the screen with another finger or thumb.

Ensure that, when an instruction is entered by mistake, there is a clear procedure for the user to cancel and/or reverse this instruction.

Provide feedback (both visual and audible) on information that the user has entered and on choices that have been made.

Rationale – A major drawback with touchscreens is that they provide no tactile feedback to the user. Because of this it is important to provide, wherever possible, audible and/or visual confirmation every time a choice is made, and to inform the user of the instructions that have been received. Such feedback of information is particularly useful for people who are elderly, or who have limited experience of using such technology, and may also be useful to those with impaired vision.

Software programs should be designed to maximise the user’s freedom of movement within the various pages that are available.

Relevant user groups
All

Cross Reference
Part 4.1 Public Access Terminals/Kiosks
3. SMART CARDS

The following sections (3.3.1 to 3.3.3) contain a summary of general guidelines relating to the application of smart cards for use by elderly and disabled people. They are drawn from the following sources:

1. ‘Access Prohibited?’ (Gill, 1997), available via the WWW at:
   http://www.eyecue.co.uk/pats
2. Earlier work conducted in the EC funded project SATURN (Gill, 1994).
3. Recent collaborative work conducted by TELSCAN with the ADEPT II project (Bekiaris and Mathiou, 1998b).

3.3.1 SMART CARDS: How to facilitate identification of card

Guidelines
Tactile marking on the smart card is recommended to facilitate the identification of the correct card by a visually impaired traveller.

As a means of achieving this, it is recommended that cards incorporate an embossed capital letter at least 10mm high with an embossing of at least 0.7mm.

*Rationale* - Such embossing will help visually impaired travellers to select the correct card when travelling or making payment.

For cards which are not embossed, a 2mm notch should be incorporated into the trailing edge of the card (Illustration below, with permission, from Gill, 1997).

*Rationale* - Many elderly and visually impaired people have problems in inserting a card in the correct orientation. Embossing can aid in this respect, although a notch is preferable.

Relevant user groups
Vision, Elderly

Cross References
Part 4.1.4 Public Access Terminals/Kiosks: How to provide flexibility of input and output
PART 3: General Guidelines for all ATT Systems

Part 5.3  Access to Vehicle
Part 5.5.1 Parking: Use of smart cards.
Part 5.7.1 Emergency Warning and Traveller Support: Use of smart cards
Part 5.8  Ticketing/Payment/Toll collection
3.3.2 Smart Cards: How to facilitate interaction with reader

Guidelines

The use of swipe card readers should be avoided.

*Rationale* - Elderly and disabled people with dexterity problems can find these readers difficult to use, since they require accurate control.

However, if the use of swipe card readers is unavoidable, it is recommended that:

a) The card slots are not too small.

b) The user is given adequate time to perform the required operations.

c) The card reader acts as a funnel to help guide the card in correctly.

d) A support rail is provided for the user to hold while sweeping the card (if necessary to keep balance) (Westerlund and Stahl, 1999, illustrating adjustable Demand Responsive Transport booking terminal for standing and sitting users. Design solution: LO Design in Tibro with support from Västrafik AB in Skövde.)

Contactless cards have great potential as a means of helping those who experience problems in placing a card in a slot. If used, they should be capable of operating at a distance of up to 10 cm from the reader.

If a card has to be inserted into a reader, when it is returned it should protrude at least 2 cm from the slot surround. In addition, the force required to remove the card should be no more than that needed to stop the card from falling out from the reader.

*Rationale* – People with arthritis in particular can experience difficulties in gripping and then pulling a card from a reader.

Relevant user groups

Co-ordination/dexterity, Force, Vision, Elderly

Cross References

Part 4.1.4 Public Access Terminals/Kiosks: How to provide flexibility of input and output

Part 5.3 Access to Vehicle

Part 5.5.1 Parking: Use of smart cards.

Part 5.7.1 Emergency Warning and Traveller Support: Use of smart cards

Part 5.8 Ticketing/Payment/Toll collection
3.3.3 SMART CARDS: What information to include within the card

Guidelines
Information should only be stored on a card with the consent of the user.

Consideration should be given to the provision of information within a smart card to aid elderly and disabled travellers. The following examples highlight how general information contained within a smart card could be of particular benefit:

Examples -
Additional time requirements - older travellers and those with a cognitive impairment may prefer to be given more time to use the ATT system.

Simplified choices - for instance, when using a ticket machine, an elderly or disabled person may always prefer to be issued with a ticket for a certain destination.

Enlarged screen/Larger characters - of particular importance for individuals with a visual impairment.

Alternative output modes - visually impaired travellers would benefit from a card which informed the ATT system to give audio output. In particular situations (e.g. public access kiosks), this may not be desirable or should only be used for non-confidential information.

Relevant user groups
All

Cross References
Part 4.1.4 Public Access Terminals/Kiosks: How to provide flexibility of input and output
Part 5.3 Access to Vehicle
Part 5.5.1 Parking: Use of smart cards.
Part 5.7.1 Emergency Warning and Traveller Support: Use of smart cards
Part 5.8 Ticketing/Payment/Toll collection
3.4 INTERNET / WORLDWIDE WEB

This section contains key guidelines to aid in the design of accessible World Wide Web (WWW) pages for elderly and disabled people. Fundamental statements have been extracted from Gallagher (1998). These have largely been confirmed by TELSCAN’s collaborative work with the QUARTET PLUS project (Börjesson, 1998).

Further guidelines related specifically to accessibility of public transport internet sites by people with visual impairments were developed as a result of TELSCAN’s collaborative testing with the ROMANSE and INFOPOLIS projects (Bruyas and Marin-Lamellet, 1999).

For extensive information on designing accessible WWW pages, see the Web Content Accessibility Guidelines at: http://www.w3.org/TR/WD-WAI-PAGEAUTH

Edited by: Wendy A. Chisholm and Gregg C. Vanderheiden
Trace R and D Center, University of Wisconsin – Madison, U.S.A.
Ian Jacobs – World Wide Web Consortium

It is also helpful to assess the accessibility of a Web Site using the BOBBY tool, available at: http://www.cast.org/bobby/

3.4.1 General issues

Guidelines

Pages must be designed for efficient storage and transmission, and optimum server accessibility.

Rationale - Downloading time exceeding approximately 4-5 seconds causes the user to feel irritation and uncertainty.

Provide an option for a sound signal indicating that downloading is in progress to assist people with visual impairments.

The web pages must be designed to work efficiently with different types of available computers, screen sizes, and types of programmes.

Follow basic ergonomic requirements concerning VDU’s. See ISO 9241, Ergonomics requirements for office work with visual display terminals (VDTs), 17 parts.

Avoid frames in the design of web sites, or include a ‘no frames’ option.

Position hyperlinks and important information close to the top of the page.

Rationale – People with visual impairments should be able to find links and important information easily in order to access available information and services.
PART 3: General Guidelines for all ATT Systems

3.4.1 INTERNET/ WORLD WIDE WEB: General issues (Cont…)

Guidelines
For each web page, provide a very clear instruction as to what the user should do and how.

Where search or scrolling functionality is available, this facility, and how to use it, should be clearly indicated.

For vocal synthesis of web page text, provide an option for differentiating between frames, links, pull down menus etc.

Rationale – The use of different voices would considerably improve a user’s understanding of a web site’s structure and the hierarchy of the different menus.

Avoid the use of initials and abbreviations, as these could be misread by a text-to-speech synthesiser.

Example – The abbreviation of Lyon Satolas Airport (LYS) is read as “Lys”

Relevant user groups
Vision, Elderly

Cross References
Part 3.2 Display/Output (General Guidelines for all ATT systems)
3.4.2 INTERNET / WORLDWIDE WEB: How to use graphics and tables

Guidelines
Information should not be provided only in a graphical format. The traveller should be able to read the web page in a text-only version without borders, tables or graphics.

Rationale - Text readers for people with visual impairments are not able to ‘see’ graphical images and may find it difficult to read text in tables. If tables are used, however, the distance between columns must not be too small, as that can make it difficult for the visually impaired person's display reader to interpret the text.

Every button/image should have descriptive text (ALT text) associated with it which reflects the function of the button/image.

Rationale – This recommendation is all the more relevant in the context of a transport information service, as the use of maps, plans and lists is very frequent.

If it is difficult to clearly convey the meaning of an image via ALT text, then include a link to a page that describes the image.

Minimise the use of tables in the design of web pages.

Rationale – Tables cannot be readily translated by a text-to-speech synthesiser for people with visual impairments.

In any tables are used, provide a heading for each column, use a paragraph or line break at the end of each cell, and minimise the number of columns used.

Rationale – A vertical layout is easier to translate from left to right, and top to bottom, by a text-to-speech synthesiser which reads the text line-by-line.

When a table includes empty cells, use separators in those cells which can be identified by the voice synthesiser.

Relevant user groups
Vision, Elderly

Cross References
Part 3.2 Display/Output (General Guidelines for all ATT systems)
3.5 TRAINING / DOCUMENTATION

Guidelines
The needs of elderly and disabled travellers must be considered when developing the training procedure for ATT systems.

*Rationale* - Many difficulties experienced by elderly users result from their need for training and documentation. Advertising and promoting the system can help alleviate some of the difficulties (as evidenced by TELSCAN’s collaborative testing with INFOPOLIS on the SIT public transportation information unit, Simões, et al, 1999b).

Provide clear, concise and simple instructions for the use of the system, preferably in the form of an on-line help.

System documentation should be written in a language that is easy to understand.

*Example* - Designers must consider how documentation might be written for persons with hearing impairments, for persons with aphasia, and for people speaking different languages or coming from different cultural backgrounds.

System documentation should specify the skills or capabilities the user requires to operate the system (ICE Ergonomics, 1994). These skills and capabilities will also be valuable criteria for the evaluation of the system.

Supplement the system with personal service if required. Furthermore, those who depend on such personal service should not have to pay more for it (National Swedish Board for Consumer Policies and the Swedish Handicap Institute, 1995).

While stationary, to ensure that any paper documentation can easily be read by persons with upper limb impairments, the documentation binding should allow the user to place the documentation open on a surface and turn the pages with one hand.

Memory aids could be provided through the use of a quick reference card, useful for all travellers, but especially for people with a slight degeneration in cognitive functions.

**Relevant user groups**
All

**Cross Reference**
Part 4.1.6 Public Access Terminals: How to accommodate user experience, training and support
3.6 OTHER PHYSICAL CHARACTERISTICS OF ATT SYSTEM

Guidelines

It is important that there is no electromagnetic interference between the ATT system and any assistive devices being used by the elderly and/or disabled traveller.

*Example* - An ATT system could interfere with the electromagnetic characteristics of the induction pick-up coil on a hearing aid, or the electric cables of car adaptations, e.g. adapted accelerators.

The surface of the controls or any item on the ATT system which may be in contact with the skin (e.g. something that is worn on the wrist) should not contain chromium, nickel or other material which may cause allergy.

If there is a likelihood that the ATT system will use the same power source as an assistive device, careful consideration should be given to the amount of power utilised.

*Rationale* - Assistive devices for travellers with special needs can use considerable power, and, as a result, increasing the risk of electronic overload and fire (Nordic Committee on Disability, 1993).

*Example* - In driver systems, car adaptations (an example of an assistive device) can consume as much as 15% of overall engine power. Furthermore, adaptations may discharge the vehicle’s battery more quickly. Many elderly and disabled drivers travel short distances which may make it difficult to retain battery charge, particularly in winter.

Consider a backup system in case of power failure. Furthermore, ensure that in case of system failure, the consequence is predictable and will not result in a safety hazard.

*Rationale* - Elderly and disabled people may be more reliant on the ATT system than others, and for this reason the consequences of system failure may be more critical.

**Relevant user groups**

All
4.1 PUBLIC ACCESS TERMINALS / KIOSKS

The following sections (4.1.1 to 4.1.6) contain key guidelines to aid in the design of public access terminals for use by elderly and disabled people (e.g. locating kiosks, display/control design, information requirements).

The majority of the guidelines within this section are based on the document ‘Access prohibited?’ (Gill, 1997), and the reader is referred to the original source for extensive information on designing accessible public access terminals. The document is also available on the WWW at: http://www.eye.cue.co.uk/pats

Specific guidelines drawn from other sources are referenced within the text below.

4.1.1 Where to locate kiosks

Guidelines
Position systems at different height levels to cater for users of wheelchairs and short people (National Swedish Board for Consumer Policies and the Swedish Handicap Institute, 1995).

Do not position the system in a noisy and open environment where the user could feel stressed and insecure (National Swedish Board for Consumer Policies and the Swedish Handicap Institute, 1995).

Allow sufficient turning radius for people in wheelchairs to get to and away from the kiosk.

Rationale - The length of a wheelchair is usually less than 1.25 m, including the footboard, and its width is in most cases less than 0.75 m. This gives a necessary turning radius of 1.4-1.5 m.

Avoid bright light sources when positioning a kiosk.

If the environment is very bright (natural or artificial light), the kiosk should have a sun-shield to avoid reflections.
4.1.1 Where to locate kiosks (Cont…)

Guidelines
Provide a knee/foot recess below the user interface.

*Rationale* - A recess will enable people who use wheelchairs to get close enough to view the screen and minimise the problem of reach when entering instructions.

*Example* - In TELSCAN’s collaborative testing of the ROMANSE Triplanner MK I touchscreen, 9 out of 13 wheelchair users could not get close enough to operate the terminal properly (Barham and Alexander, 1998) – see the photo in Part 3.2.7.

Provide a simple peg or recess on which a crutch or cane could be rested (as found in TELSCAN’s testing with the ROMANSE Triplanner MkII).

Provide if possible a small shelf on the front of the terminal where wallets and other items can be placed while the terminal is used (Westerlund and Stahl, 1999, illustrating adjustable Demand Responsive Transport booking terminal for standing and sitting users. Design solution: LO Design in Tibro with support from Västtrafik AB in Skövde.)

**Relevant user groups**
Motion of lower limbs, Vision

**Cross Reference**
Part 3.2.7 Displays/Output: Touchscreens
4.1.2 PUBLIC ACCESS TERMINALS / KIOSKS: Where to locate the display and controls

Guidelines
If a person in a wheelchair can only approach the kiosk from the front, the maximum height of any interactive part of the terminal should not be higher than 1.2 metres. The lowest height of an operable part should not be less than 0.7 metres.

Examples – To accommodate the needs of all travellers an effective solution will be to provide two terminals at different heights, as shown by the illustration below on the left (provided with permission from Gill, 1997). Alternatively, (illustrated on the right) TELSCAN’s collaborative testing of booking terminals with the SAMPLUS project found that a terminal height of 900 mm would be acceptable for more people as long as the angle of the terminal display was adjustable (about 45 and 30 degrees) (Westerlund and Stahl, 1999, illustrating adjustable Demand Responsive Transport booking terminal for standing and sitting users. Design solution: LO Design in Tibro with support from Västrafik AB in Skövde.)

Rationale – It is difficult to find a compromise of fixed position for a terminal that can be used by both people in wheelchairs and standing users. Persons seated in wheelchairs generally require a low placement and a relatively wide display angle, while standing persons desire a higher placement and smaller display angle.
4.1.2 PUBLIC ACCESS TERMINALS / KIOSKS:
Where to locate the display and controls (Cont…)

Guidelines
The display should be viewable from the eye level of a person sitting in a wheelchair. Depending on the angle of the screen, the maximum height for the screen will vary, according to the following illustration (with permission from Gill, 1997):

Example - More care needs to be given to the height of the screen to meet the needs of some people with disabilities. In TELSCAN’s collaborative testing of the ROMANSE Triplanner MK I touchscreen, 10 out of 13 wheelchair users could not see the screen properly because it was too high. In addition, 4 wheelchair users could not reach the touchscreen, and a further 10 could only do so with difficulty.

People with low vision should be able to get close to the screen to see it more clearly.

Relevant user groups
Motion of lower limbs, Motion of upper limbs, Vision, Elderly

Cross References
Part 3.1 Controls/Input (General Guidelines for all ATT systems)
Part 3.2 Displays/Output (General Guidelines for all ATT systems)
Part 3.2.7 Displays/Output: Touchscreens
4.1.3 PUBLIC ACCESS TERMINALS / KIOSKS:
How to design the display and controls

Guidelines
Wherever possible, use at least 16 point type. The minimum for special headings should be larger, i.e., 18 or 20 point font and larger, depending on the level of heading. The height of capital letters (not including spaces between rows) should be at least 4 mm.

Rationale - Many people with visual impairments are still able to read clear, 16 point type.

Example – This is an example of 16 point.

When using a touchscreen, or when lining up function keys with the display, be aware of the problem of parallax. Using lines on the user-interface leading from the key to the surface of the display will help to alleviate this problem.

Rationale - Parallax indicates an apparent displacement of an object, caused by an actual change of point of observation. A tall person or someone in a wheelchair may especially find this is a problem. Because of the lack of tactile feedback from a touchscreen interface, users may then be unaware they have not hit the correct part of the screen. They can therefore become confused and disillusioned when the system does not obey their instructions.

Example - In TELSCAN’s collaborative testing of the ROMANSE Triplanner MK I touchscreen, 12 out of 53 elderly or disabled users experienced problems due to parallax. This was a problem not only for those who had to look up at the screen from below, but also for one subject who was very tall (Barham and Alexander, 1998).

Do not run type across photographs or illustrations.

Rationale - Type across photos or illustrations is harder to read, lacks contrast and can confuse the eye.

If maps are used, ensure that they are simple, with good contrast and definition of important locations.
PART 4: Guidelines for Contexts of Use

4.1.3 PUBLIC ACCESS TERMINALS / KIOSKS:
How to design the display and controls (Cont...)

Guidelines
Ensure that the terminal’s outer casing does not obscure the view of the lower row of buttons/icons.

Buttons should be at least 2-2.5 cm in width (Poulson et al., 1998).

Square keys are recommended, rather than rectangles (Poulson et al., 1998).

Precise movements and sensitivity for using the control panel should not be required. It should be possible to control the system with the hand in bandages or gloves (National Swedish Board for Consumer Policies and the Swedish Handicap Institute, 1995).

Relevant user groups
Motion of lower limbs, Motion of upper limbs, Vision, Elderly

Cross References
Part 3.1 Controls/Input (General Guidelines for all ATT systems)
Part 3.2 Displays/Output (General Guidelines for all ATT systems)
Part 3.2.7 Displays/Output: Touchscreens
4.1.4 PUBLIC ACCESS TERMINALS / KIOSKS: How to provide flexibility of input and output

Guidelines
The user should be able to choose input/output language.

*Rationale* - Travellers are often not from the local area and should not be ‘disabled’ because they are unable to speak/understand the local language.

The user should be able to choose input/output mode to cater for the needs of elderly people and people with disabilities.

*Example* - For people with visual impairment, an auditory output would be essential.

However, it is important to consider whether confidential information might need to be provided by a user. In these cases, audio output might not be desirable.

With auditory information, enable volume control and inductive coupling (National Swedish Board for Consumer Policies and the Swedish Handicap Institute, 1995).

Consider carefully the means by which auditory information is conveyed to members of the public.

*Examples* – Headphones are not recommended, for hygiene reasons, for use with a public access system. Furthermore, locating the speaker on the front of the system would facilitate the use of a small microphone and amplifier to pick up and present information.

Complementary forms of information should be provided, including both textual and pictorial.

*Rationale* - The use of pictograms in conjunction with text will help to ensure clarity and understanding of the messages.

The user should be able to increase the size of the font to accommodate individual visual requirements.

*Example* - An option can be provided on a menu to request a larger font size, or alternatively, this requirement can be stored on a smart card.

The use of clear and unambiguous icons is advisable, but should also be accompanied by text labels.

*Example* - Street and number is represented in the INFOPOLIS system by a telephone directory. The same item could, however, be represented by a street with buildings. More investigation is needed on developing universal pictograms which will provide clear information for all travellers (Simões, et al., 1999b).
PART 4: Guidelines for Contexts of Use

4.1.4 PUBLIC ACCESS TERMINALS / KIOSKS:
How to provide flexibility of input and output (Cont...)

Guidelines
Alternative methods or routes of finding information should be available to the user.

Example - When trying to find a particular street in an information system, the user could enter more than one character, therefore more quickly elicit a smaller list of possibilities to choose from. Alternatively, the user may wish to define the starting and arrival points in different ways, e.g., by street and number, crossroads, metro station or bus stop, or a place of special interest (from TELSCAN expert evaluation of the SIT public transport information unit for INFOPOLIS project, Simões, et al, 1999b).

The user should be able to take relevant information away from the kiosk as a printed copy of reasonable quality (from TELSCAN expert evaluation of SIT public transport information unit for INFOPOLIS project, Simões, et al., 1999b).

Relevant user groups
All

Cross References
Part 3.2.6 Displays/Output: How to design symbols
Part 3.3.2 Smart cards: How to facilitate interaction with reader
PART 4: Guidelines for Contexts of Use

4.1.5 PUBLIC ACCESS TERMINALS / KIOSKS:
What information do elderly and disabled travellers need

Guidelines
Systems should include information which an elderly or disabled traveller needs in order to make a journey safely and in comfort. TELSCAN has developed a traveller information checklist to provide this design advice (initiated as part of collaborative work with the INFOTEN project). This will be available on the TELSCAN database and CD-ROM.

Example - Provide accurate information on walking distance to the desired destination.

Rationale - A person with mobility problems needs to know how far he/she would need to walk within a station or station to bus stop.

Provide a standard “wheelchair” icon in order to enable a traveller with a disability to specify and receive the most appropriate route to meet requirements, whether they be related to mobility, perceptual or cognitive needs (Simões, et al., 1999b).

Relevant user groups
Motion of lower limbs, Elderly
4.1.6 PUBLIC ACCESS TERMINALS / KIOSKS: How to accommodate user experience, training and support

Guidelines
Provide information to the public on the system’s use and its benefits in the form of pamphlets and demonstrations.

*Rationale* - Elderly people may not feel comfortable at first with the use of new technology. Some people with disabilities may not realise that a system is accessible to them, and would welcome a demonstration of how to use it.

The progression through the information menu should be simple and logical.

*Rationale* - Many elderly users will be unfamiliar with computer-based technology and can become confused by complex processes that appear logical to younger users more familiar with the technology. By the same token, computer-related jargon such as “scroll” and “input” should be avoided.

Training and documentation will be made that much easier if keys, arrows, maps, pictograms, etc., are well defined and easily understood. An ‘intuitive’ interface should require little training.

On-screen instructions, both on the functionality of the system and the use of the controls or touchscreen, should be clear, concise and simple, for example in the following areas (as found in TELSCAN’s collaborative testing with INFOPOLIS on the SIT public transport information unit, Simões, et al., 1999b):

- The use of a moderate pressure to activate a touchscreen in order to avoid the activation of two or more successive menus.
- The necessity to confirm previous actions
- The ability to return to the previous menu or main menu

Relevant user groups
All

Cross Reference
Part 3.2.7 Displays/Output: Touchscreens
Part 3.5 Training/Documentation
PART 4: Guidelines for Contexts of Use

4.2 PUBLIC TRANSPORT DISPLAY SIGNS

The following sections (4.2.1 to 4.2.3) contain guidelines to aid in the design of accessible public transport displays for elderly and disabled people (e.g. the presentation of real-time information, where to locate displays). The guidelines are primarily based on TELSCAN Deliverable 8.1 (Oxley, 1997) and the collaborative evaluation work that TELSCAN has conducted with QUARTET PLUS (Börjesson, 1998). Although they have been developed in the context of design of real-time display signs on buses and at bus stops, it is felt that they are equally applicable to the design of display signs for other forms of public transport (i.e. trams/trains/metros). Nevertheless, testing with elderly and disabled people is recommended.

4.2.1 General issues

Guidelines

Letters and numbers should be at least 10 mm in height for every metre of viewing distance, with no lettering smaller than 22 mm in height.

Rationale - The size and contrast of text should be sufficient for travellers with impaired vision to read it. The precise size of text used will depend on a number of factors, including proximity of the screen to the user, ambient light levels and clarity of the image. Therefore, the usability of the screen needs to be tested in situ with a range of users.

Fibre-optic signs are preferred to LEDs in terms of legibility, though both are acceptable and are better than ‘flip-over’ signs.

Real-time information should be displayed as minutes left to departure.

Example - In collaborative testing with QUARTET PLUS, the following recommendation was made for real time information at bus stops:

<table>
<thead>
<tr>
<th>Route 6</th>
<th>Sahlgrenska</th>
<th>3 min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route 8</td>
<td>Sahlgrenska</td>
<td>10 min</td>
</tr>
</tbody>
</table>

The word "route" can be replaced by a symbol for the route and mode of transport, bus, tram, boat, etc.

The route number, destination and number of minutes left should be displayed separated in such a way that no misunderstandings arise.

The display ought to have four lines available to make it possible to inform about routes as well as disturbances.

Where messages are scrolled on the screen, the time of display should be sufficient for travellers to read and understand the message. A period of 10 seconds is suitable. Symbols can be more easily and swiftly comprehended, provided they are clear, unambiguous and well tested with users including elderly people and people with disabilities.
PART 4: Guidelines for Contexts of Use

4.2 PUBLIC TRANSPORT DISPLAY SIGNS: General issues (Cont…)

Guidelines
Audible information should be made available at key points along an individual’s journey.

Rationale - For people who have no or low vision, audible information is particularly important during the course of their journey.

Example - Computerised speech information systems can be used to give the name of the next stop or station, the side of the train or metro which will be against the platform, and other safety related information.

Relevant user groups
All

Cross References
Part 3.2 Displays/Output (General Guidelines for all ATT systems)
Part 5.7.2 Emergency Warning and Traveller Support: Public transport disturbances.
4.2.2 PUBLIC TRANSPORT DISPLAY SIGNS: Where to locate displays and how to present information

Guidelines

On board (i.e. on buses/trams/trains/metros, etc.)

On-board displays should be located at least 1.5 m above floor level.
Route numbers should be at least 250 mm high.
The destination name should be in letters at least 125 mm high.
White or bright yellow lettering on a black background is the most easily visible.

Off board (i.e. at bus/tram stops/train/metro stations, etc.)
Displays with texts and symbols/icons should be placed so that they are easy to find.
Displays should ordinarily be located 1.4-1.6 metres above the ground.

Rationale - As found in collaborative testing with the QUARTET PLUS project, this height is suitable for reading by eye and also facilitates reading by touch, if any tactile marking is included.

Displays intended to be read from a distance, which are at risk from being obscured, should be placed at least 2.1 m above floor level.

Character size on displays should be at least 12 mm and the relief (i.e. raising of text) at least 1 mm, if any tactile marking is included.

Important displays that are meant to be seen from a distance of some metres should have character size of 24-40 mm.

Relevant user groups
Vision, Elderly
PART 4: Guidelines for Contexts of Use

4.2.3 PUBLIC TRANSPORT DISPLAY SIGNS: What level of Illumination is required

Guidelines
For the sake of legibility, it is important that the light does not dazzle.

*Rationale* - A person with a visual impairment may need to view the screen from a very short distance or may need to use visual aids. Older eyes are also more susceptible to glare.

The light should be adjustable within the area of 1,000-5,000 lux, depending on environmental conditions.

The light should be free of flickering.

If possible, do not use TV-monitors outdoors.

*Rationale* - They are difficult to place where passengers can easily read them due to daylight, sunshine and weather conditions.

Relevant user groups
Vision
PART 4: Guidelines for Contexts of Use

4.3 DRIVER SYSTEMS

The following sections (4.3.1 to 4.3.8) contain guidelines to aid in the design of accessible in-vehicle systems for use by elderly and disabled drivers (e.g. ensuring adaptability, choice of and positioning of controls, design of displays, timing of information presentation, use of head-up displays).

4.3.1 General issues

Guidelines

The implementation of ATT controls and displays needs to be integrated through a systems approach followed by a whole-vehicle test procedure.

Design and testing of the ATT system should account for the car adaptations that might be used by people with disabilities.

*Rationale* – These two guidelines are of particular importance, given that a disabled driver might be using a variety of car adaptations. A description of typical adaptations is given in Appendix 1.

Careful consideration should be given to the amount of control designated to the system and to the driver.

*Rationale* - If too much control lies with the ATT system, then a driver may experience underload, in which the potential for fatigue-related accidents is much greater. This may be a particular problem for people with, for example, Sleep Apnea Syndrome.

A system should be capable of functioning ‘optimally’ as a visual only or auditory only system.

*Rationale* - In this respect ‘optimally’ refers to the choice and presentation of information to suit a single modality solution. Thus, it is anticipated that a system set up procedure could include preferences to enable either single (visual or voice) modality or dual modality presentation.

System documentation should clearly specify the correct procedure to follow in case of system failure (ICE Ergonomics, 1994). This guidance should be easily accessible and readable for all.

Relevant user groups

All
4.3.2 DRIVER SYSTEMS: How to ensure adaptability

Guidelines
Designers should make all vehicles, assistive devices and ATT systems adaptable or easy to adapt through modular design wherever possible.

The fitting of an ATT system should be both secure and adaptable within a particular vehicle (ICE Ergonomics, 1994) and, if possible, between vehicles.

The ATT system should be easy to customise by the driver or, where safety is crucial, by a competent specialist.

Example - A driving instructor can help the driver analyse his or her requirements and choose the best possible options and modes of operation.

In addition to an “adaptable” system which can be customised, consider where possible an “adaptive,” automated system, which will automatically conform to the user’s requirements.

Accidental adjustment of information system settings/default parameters should not occur while driving; indeed, it is vital that such adjustment should not occur to safety-critical parameters, e.g., how soon the driver receives a collision warning.

Temporary adjustments (such as loudness/balance, brightness/contrast) should be easily made while on the road because conditions are constantly changing.

Relevant user groups
All
Guidelines

When choosing an ATT control, it is important to consider the needs of drivers who are using car adaptations for primary and secondary control of the vehicle.

*Rationale* - Drivers using particular car adaptations (e.g., a segment accelerator) find it difficult to simultaneously accelerate or brake at the same time as using another control (Verwey, 1995). (See Appendix 1 for a description of these car adaptation aids for drivers with disabilities.)

*Examples* - Ring accelerators are preferred over segment accelerators. This holds for drivers with disabilities driving with or without telematic applications because of the discomfort associated with the segment accelerator. (Verwey & Veenbaas, 1993; Verwey, 1995).

Reaction time on ATT control messages is seriously influenced by the type of controls used by drivers with disabilities; e.g., there is a much shorter reaction time when using an accelerator ring than a segmented ring - reaction time even shorter than for the non-disabled driver (Verwey & Veenbaas, 1993).

Consider carefully the number of additional controls that are introduced into the vehicle.

*Rationale* - Drivers with very limited or absent hand functioning can operate only a minimum number of secondary controls in total. During driving, these controls are used for crucial functions, e.g., operating indicators, lights, horn, wiper/washer.

The use of controls on the driver’s head-restraint should be considered for people with physical disabilities.

*Rationale* - These controls result in faster responses than rotary switches and push buttons of various diameters. However, caution is needed as steering frequency increases somewhat. People with disabilities also show little preference for head controls, so they may not choose to purchase or accept them (Verwey, 1995).

The driver’s elbow, voice activated secondary controls, or other innovative possibilities should be reviewed as alternative input modes for various groups of drivers with disabilities.

*Rationale* – This is critical for disabled drivers with high workload on particular residual abilities, or for elderly drivers who will have more difficulty in dividing their attention between different situations or tasks.
PART 4: Guidelines for Contexts of Use

4.3.3 DRIVER SYSTEMS: When to use specific controls (Cont...)

Guidelines
It is suggested that touchscreens are only used when the vehicle is stationary and that a secondary keyboard designed for special needs can be attached, if required.

*Rationale* - Touchscreens place a high visual workload on the driver and could interfere with the primary driving task (ICE Ergonomics, 1994), especially for elderly or disabled drivers, who may be working to the limits of their abilities. In an evaluation of a route guidance system, 30% of the elderly subjects found it difficult to enter a destination using a touchscreen (Oxley, et al., Dec 1994).

Keypad keys, like those found on a telephone or calculator, are not recommended for use by the driver while the vehicle is in motion (ICE Ergonomics, 1994), since visual and auditory confirmation of hitting the correct key is required.

Larger buttons (around 24 mm) are preferred to smaller buttons (around 4 mm). This is particularly the case for tasks of higher priority.

*Rationale* - Larger buttons require less looking at the button before it is activated. However, the effect on driving safety may be similar for small and large buttons in that large buttons may tempt the driver to activate the button immediately, whereas activation of smaller buttons is postponed until a demanding driving situation has finished (Verwey, 1995 – See Appendix 2 for a brief summary of the testing).

Relevant user groups
Motion of lower limbs, Motion of upper limbs, Motion of upper body, Co-ordination/dexterity, Force
4.3.4 DRIVER SYSTEMS: Where to locate controls

Guidelines
Ideally, the positioning of ATT controls should be flexible and/or adjustable to meet the specific needs of a person with a disability.

Rationale
- People with disabilities may be using a wide range of different car adaptations within a vehicle to suit their specific requirements. The use of a specific adaptation will determine where a control for an ATT device might best be located. (See Appendix 1 for a description of car adaptation aids for drivers with disabilities.)

Example
- Adapted accelerators (e.g., segmented accelerator), which require continuous operation by one hand, limit the number of possible locations of ATT controls (structural interference). With adapted accelerators which can either be operated by the left or right hand (e.g., ring accelerators), the disadvantage for drivers with disabilities is less (Verwey, 1995).

The positioning of controls needs to consider the location of other aids for drivers with special needs, e.g. adaptable control aids or mobility and car adaptation aids.

Rationale
- Due to capacity interference, similar limbs (driving with hand operated controls) are more difficult to use for independent movements (accelerating and activating control elements) than different limbs (Verwey, 1995 - See Appendix 2 for a brief summary of the testing). ATT controls should not obstruct access to other driving aids. Likewise, other controls for drivers with disabilities (e.g. a lever for acceleration/ braking) must not obstruct the view of the road ahead or output from ATT systems. Where a choice must be made, safe and effective use of the primary controls must take precedence over the introduction of an ATT system.

If it is not possible to achieve bespoke positioning, then it is recommended that the following order of priority is used when locating controls (ICE Ergonomics, 1994):

1. Controls for primary visual tasks
2. Primary controls associated or interacting with primary visual tasks.
3. Controls positioned near associated displays.
4. Controls that are to be used in sequence.
5. Controls that are used frequently.
6. Consistency with other system layouts.

Relevant user groups
Motion of upper limbs, Motion of upper body
4.3.5 DRIVER SYSTEMS: General issues for visual displays

Guidelines
Where appropriate, different ATT-related information should be integrated within common displays.

Use only simple messages of 3 or 4 information units (Ross et al., 1996; Campbell, Carney and Kantowitz, 1998).

The size of the characters on an ATT display must be large enough and the contrast high enough so that the driver does not need to bend toward the display to read the information.

A person should not be expected to move their head or upper body in order to view a display. Furthermore, for older drivers who are wearing driving glasses, but not their reading glasses, it should not be necessary to peer over their glasses in order to accommodate the close proximity of the display (Graham & Mitchell, 1996).

Provide a “zoom in” or screen enlargement feature wherever possible. However, whilst driving, the driver should not be required to manually zoom in and out to different scale levels. Instead, the system should automatically present the optimum amount of usable information.

In-vehicle display tasks should not require an unacceptable amount of a driver's attention.

Rationale – The visual distraction of an in-vehicle display has a strong link to system safety. This is particularly the case for the elderly and disabled population who may already be working to the limits of their attentional resources (due to either perceptual/cognitive limitations and/or from using car adaptations). Unfortunately, there are no established criteria for what constitutes an unacceptable level of distraction. The following ‘cut-off’ criteria have been proposed in the literature. As can be seen there is much debate regarding a definitive recommendation.

Examples –

No in-vehicle display task should require more than 5 seconds total viewing time. Ito et al. (1997) found that when the total time required for all glances needed to read a display exceeded about 5-7 seconds, drivers rated the system as stressful and driving performance deteriorated.

No in-vehicle display task should require an average glance duration of more than 2 seconds or necessitate more than 4 separate glances. Drawing on the results of a series of experimental trials, Zwahlen et al. (1986) proposed a design guide based on the probabilities of a vehicle deviating out of lane whilst the driver glanced towards an in-vehicle display.

In-vehicle navigation tasks which take longer than 15 seconds in total whilst the vehicle is stationary, should not be permitted whilst the vehicle is in motion. This proposed guideline is specific to route guidance and navigation systems (Foley, 1999), and is based on the probability of an accident arising from different in-vehicle display/control tasks.
Guidelines

For in-vehicle displays, the height of text characters (letters and numbers) should be:

\[
(\text{Distance of viewer from the display}) \times (\text{Tangent} – \text{Visual Angle})
\]

Recommended visual angles, based on the function of the text are given below (Campbell et al., 1998):

- Titles and other key elements = 0.50 degrees or 30 arcmin., minimum
- Dynamic or critical elements = 0.33 degrees or 20 arcmin., minimum
- Static or non-critical elements = 0.266 degrees or 16 arcmin., minimum

The following illustration highlights the relationship between viewing distance, text character height and visual angle.

Rationale – This guideline is based on standard human factors reference sources and has been developed to meet the needs of older drivers.

Relevant user groups
Motion of lower limbs, Motion of upper body, Vision, Elderly
4.3.6 DRIVER SYSTEMS: Where to locate visual displays

Guidelines
The optimal positioning of in-vehicle displays should consider the particular requirements of elderly and disabled people.

Rationale - Drivers with special needs, especially those with lower limb impairments, may require different H-point measurements to define and to install an ATT display in its optimum position (ISO 6549).

The most used/useful information should be located close to the line of site (Green et al., 1995).

No information should be presented more than 30 degrees away from the line of sight (Green et al., 1995).

ATT displays should not obstruct access to car adaptations.

Relevant user groups
Motion of lower limbs, Motion of upper body, Vision, Elderly
PART 4: Guidelines for Contexts of Use

4.3.7 DRIVER SYSTEMS: When to present information

Guidelines
All ATT driver systems should present information in a timely manner.

*Rationale* - If messages are given unnecessarily early, drivers may forget the instruction (a particular problem for elderly drivers or people with cognitive impairments), or will tend to prepare and execute actions while negotiating complex driving situations (Verwey, 1995). Conversely, if an instruction is presented too late, it could cause a dangerous, forced response, or a missed opportunity.

To cater for individual differences, default times should be easy to customise within a safe, tried and tested range. Ideally, a trained driving instructor should be able to help the driver analyse his or her requirements and choose the best possible timing.

Any information (visual and/or auditory) that is intended to only be available for a limited time should be capable of being repeated.

*Example* - Some RDS-TA receivers already incorporate a memory feature (up to perhaps 30 seconds) allowing the driver to demand repetition of a message.

It should also be possible for a user to extend the time that a visual message is displayed on the ATT screen to meet their specific requirements.

*Rationale* - Elderly drivers, whose speed of cognitive processing is slower, would particularly benefit if the display time of messages on the screen could be increased (Graham & Mitchell, 1996).

Relevant user groups
Cognitive, Elderly
4.3.8 DRIVER SYSTEMS: The use of Head-Up Displays (HUDs)

Guidelines

Consideration should be given to the use of HUDs for presenting ATT-related information.

*Rationale* - HUDs have much potential, since theoretically they allow drivers to continue attending to the road ahead whilst taking in information more quickly from the display (Ward and Parkes, 1994). They may be particularly beneficial for older or visually impaired drivers who experience difficulties in rapidly changing accommodation between near and far objects.

In a simulator trial comparing a HUD that presented route guidance information with an equivalent LCD on-dashboard display, the response time of older subjects was reduced when information was presented in HUD form (Marin-Lamellet et al., Feb, 1994). Using an audible signal to warn that a visual message was about to be displayed had further effects, inducing a more relaxed attitude among the subjects. An illustration showing route guidance information conveyed by a HUD and in-vehicle display is provided below.

Provide an audible signal to warn that a visual message is about to be displayed.

Care should be exercised to avoid a cluttered HUD that would unduly distract the driver from the primary driving scene. This is particularly the case if such displays overlay the forward scene rather than the car bonnet (Weintraub & Ensing, 1992).
4.3.8 DRIVER SYSTEMS: The use of Head-Up Displays (HUDs) (Cont…)

Guidelines
Consider carefully the position of the HUD image to ensure the needs of elderly and disabled people are accounted for.

Rationale – Many elderly people wear bifocal or multifocal glasses and may have to use the top half of their glasses to view a low HUD image (as a ‘far’ image). As a result, frequent nods of the head will be likely and important road scene information may fall above the glasses and hence be out of focus.

A HUD eyebox (i.e. the eye positions where a HUD image can be seen by a driver) must be adaptable to ensure that drivers of varying heights can be catered for.

Relevant user groups
Vision, Anthropometrics, Elderly
4.4 MULTI-MODES: General issues

Guidelines
Elderly and disabled travellers may wish or need to change from one mode of travel to another in order to arrive at their destination. Such travel may involve not only different modes of transport, but also different telematic systems. Such systems should be integrated in a seamless fashion so that the information flow is accurate and efficient, and the traveller need not be handicapped with the transition from one mode to another.

Our survey of user requirements identified particular problems which could be solved or alleviated by integrated telematic solutions. As an example, we found that elderly travellers often experience problems in booking taxis in advance for when they return from a destination. They may leave a cold UK airport for a winter break in the sun, and ask the taxi to pick them up 3 months later. Needless to say, the taxi may forget because a foolproof system does not exist to meet this need. A solution could be a longer-term taxi-booking system, integrated with an airport information system, or an easy-to-use, short-term booking system accessible from abroad.

Smart cards pose an exciting opportunity for elderly and disabled travellers. The same card could be used to obtain personalised detail from an information system, to book a taxi, to reserve a train seat which is wheelchair accessible, to pay the fare for different modes of transport, or to purchase a newspaper and coffee en route.

Relevant user groups
All

Cross Reference
Part 3.3 Smart cards
Part 5.1 Pre-Trip Planning
Part 5.8 Ticketing/Payment /Toll collection
5.1 PRE-TRIP PLANNING

The following section contains specific guidelines to aid in the design of accessible pre-trip planning systems for elderly and disabled people, in particular the requirements such people have for particular types of information. The reader is referred to Parts 3 and 4 of the Handbook for other relevant guidelines.

Guidelines

A passenger should be able to use a system for public transport pre-trip planning even if they are not at all familiar with the public transport network (e.g. rail routes, bus stops).

It should be possible to use search words other than the names of stops and routes, i.e. street names and well known buildings and places.

Pre-trip planning systems should include information which an elderly or disabled traveller needs in order to make a journey safely and in comfort. TELSCAN has developed a comprehensive traveller information checklist to provide this design advice (originally as part of collaborative work with the INFOTEN project), and this will be integrated in the TELSCAN database and CD-ROM.

Example - In addition to the requirements for public transport trip planning required by everyone (which includes modes available, origins and destinations, departure and arrival times), elderly and disabled travellers may also need the following types of information (Oxley, February, 1997):

- whether mode of transport is accessible to wheelchair users
- whether assistance from staff is available on the bus/train, etc.
- whether stations and terminals:
  (a) are accessible for wheelchair users
  (b) have accessible toilets, refreshment facilities, telephones and help points
  (c) have accessible waiting rooms with information (visual and audible) on transport services
  (d) are staffed (during which hours)
  (e) have ticket/information offices with induction loops for people with hearing aids
  (f) provide guidance through the terminal for visually impaired people
  (g) have audible as well as visual announcements
- what sort of interchange (distance, time to walk) is required for multi-modal journeys
- availability of local modes (e.g. taxi) from principal destination terminus
- journey (ticket) cost including availability of reduced fares for people of retirement age
- information on how to book a ticket or reserve a seat (of particular importance to wheelchair users and blind travellers) and method(s) of payment (ticket purchase, smart card, etc.)
5.1 PRE-TRIP PLANNING (Cont…)

Further examples of information which an elderly or disabled person would find useful for trip planning follow:

- information on types of wheelchair that will be accepted on the mode of transport (e.g., maximum dimensions/weight of wheelchair)
- procedures for speech impaired travellers to book services or to request information at ticket/information offices
- availability of parking spaces reserved for elderly and disabled travellers, and methods of payment
- location of petrol-filling stations that provide assistance to drivers who cannot, or have difficulty, using self-service facilities
- procedures to be followed at terminals which are only used occasionally, e.g., airports, ferry terminals. This information should cover such matters as location of parking areas, transfer from parking area to terminal, location of check-in facilities, waiting areas, toilets, etc.

Relevant user groups

All
PART 5: Guidelines for Specific Systems

5.2 TRIP INFORMATION

The following sections (5.2.1.1 to 5.2.1.4) contain specific guidelines to aid in the design of accessible trip information systems for elderly and disabled people, in particular the design of route guidance/navigation systems. The reader is referred to Parts 3 and 4 of the Handbook for other relevant guidelines.

5.2.1 TRIP INFORMATION: Route Guidance/Navigation

Route guidance/navigation systems help drivers to plan a route and find unfamiliar destinations. It knows the car’s location and stores information about the road network. It can determine the most efficient route to take and give the driver directions to follow this route. The term Dual Mode Route Guidance usually refers to equipment combining the autonomous mode - finding the optimal route solely from the map - and the dynamic mode, which takes account of real-time traffic speeds, throughout the network.

The status of research in the route guidance/navigation area is such that comprehensive guidelines are now available, both in Europe (Ross et al., 1996), and in the US (Green et al., 1995; Campbell, Carney, and Kantowitz, 1998). The following four fundamental guidelines are especially relevant to elderly and disabled drivers.

5.2.1.1 Use of turn-by-turn guidance versus map-based information

Guidelines

Guidance should be given in the form of simple, step-by-step (turn-by-turn) instructions at each manoeuvre (Ross et al., 1996).
5.2.1 TRIP INFORMATION: Route Guidance/Navigation

5.2.1.1 Use of turn-by-turn guidance versus map-based information (Cont...)

Guidelines
Whilst driving, drivers should not be expected to process complex information to obtain the desired route, i.e. the system should not display a map with a highlighted route (Ross et al, 1996). Examples of map-based and turn-by-turn interfaces are highlighted below.

![Map-based Information Example](image1)

**Rationale** - If these guidelines are followed, the system will be subjectively less demanding and will minimise visual and attentional distraction from the main driving task (Ross et al, 1996). Reducing the demands of the navigation task is of particular importance for elderly drivers and people with cognitive impairments. It is also important for people with hearing impairments, as their visual channel already has a higher workload and the situation must not be made more difficult through the introduction of ATT.

The guideline above differs from that provided by Green et al (1995) from the US, since Green et al recommend that map-based information can be provided whilst driving, as long as maps are “simple”. The European guideline is preferred here, given the difficulties that people with cognitive impairments (such as a lack of spatial awareness or an inability to process complex sources of information) are likely to experience with map-based information.

Map-based information may be made available to the driver, on request, whilst the driver is stationary (Ross et al, 1996).

**Rationale** - Map-based information is well suited for (a) providing an “overview” of a given environment and (b) enabling drivers to recognise their current location. Both of these points will increase driver’s confidence in the capabilities of a system, a consideration of greater importance for older drivers who may be wary of new technology. However, maps should be carefully designed to avoid a cluttered display, particularly in relation to the use of line graphics (Green et al, 1995).

**Relevant user groups**
Cognitive, Elderly
5.2.1 TRIP INFORMATION: Route Guidance/Navigation

5.2.1.2 Display modality

Guidelines
Route guidance information should be available in both visual and auditory modalities (Ross et al, 1996; Green et al, 1995).

Rationale - Guidelines both in Europe and US recommend the use of dual modality systems (i.e. visual and voice). This is to be commended, since it enables drivers (in general) to adapt their strategies for information uptake according to the driving and navigating task conditions. However, design from a dual modality perspective may not be optimal for drivers who have severe hearing difficulties or visual/reading impairments. Therefore, the following guideline is also provided:

A route guidance system should be capable of functioning ‘optimally’ as a visual only or auditory only system.

Rationale - In this respect ‘optimally’ refers to the choice and presentation of information to suit a single modality solution. Thus, it is anticipated that a system set up procedure could include preferences to enable either single (visual or voice) modality or dual modality presentation.

Relevant user groups
Vision, Hearing, Language and speech, Elderly
5.2.1.3 Timing of final auditory instructions

Guidelines

The timing of the final auditory guidance instruction on the approach to a turning should ideally be adjustable to cater for the needs of different user groups.

The following equation should be used to calculate the distance at which the final auditory guidance instruction should be given (Green and George, 1995):

\[
\text{Ideal Distance (m)} = 0.305 \times [-389 + 119 \times \text{(Age code)} + 113 \times \text{(Sex code)} + 95 \times \text{(Turn code)} + 15 \times \text{(Vehicle speed)} + 21 \times \text{(Number of vehicles)}]
\]

Where:
- Age code = 1 (aged 18-30); 2 (aged 31-64); 3 (aged 65+)
- Sex code = 1 (male); 2 (female)
- Turn code = 1 (right); 2 (left) - based on driving on the right hand side of the road
- Vehicle speed (miles per hour)
- Number of vehicles = number ahead of the driver prior to manoeuvre

**Examples** - To highlight how values differ as a result of driver age and gender, the following table shows the recommended distance (in metres) for younger males (18-30) and older females (65+).

<table>
<thead>
<tr>
<th>Speed (KPH)</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>90</th>
<th>100</th>
<th>110</th>
<th>120</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed (MPH)</td>
<td>19</td>
<td>25</td>
<td>31</td>
<td>37</td>
<td>44</td>
<td>50</td>
<td>56</td>
<td>62</td>
<td>68</td>
<td>75</td>
</tr>
<tr>
<td>Young male distance (m)</td>
<td>95</td>
<td>124</td>
<td>152</td>
<td>181</td>
<td>209</td>
<td>237</td>
<td>266</td>
<td>294</td>
<td>323</td>
<td>351</td>
</tr>
<tr>
<td>Older female distance (m)</td>
<td>156</td>
<td>185</td>
<td>213</td>
<td>241</td>
<td>270</td>
<td>298</td>
<td>326</td>
<td>355</td>
<td>383</td>
<td>412</td>
</tr>
</tbody>
</table>

**Rationale** - Two studies have specifically addressed the critical issue of when to present a voice message on the final approach to a manoeuvre (Green and George, 1995; Ross et al, 1995). Of these, only Green and George included driver age as an independent variable, and so is preferred here. As can be seen in the table above, older drivers requested messages to be given earlier than did younger drivers.
5.2.1 TRIP INFORMATION: Route Guidance/Navigation

5.2.1.3 Timing of final auditory instructions (Cont...)

Guidelines
If a route guidance system does not know or cannot use age/gender parameters to influence timings, then it is recommended that the worst case timing from the above table are used. The following illustration highlights appropriate timing for a vehicle speed of 80 KPH (50 MPH):

Relevant user groups
Hearing, Language and speech, Cognitive, Elderly
5.2.1 TRIP INFORMATION: Route Guidance/Navigation

5.2.1.4 Stacking of instructions

**Guidelines**
Information about one (preferably) or two (if necessary, and at a maximum) manoeuvres ahead should be the maximum presented to the driver at any one time (Ross et al, 1996).

If two successive turnings are in close proximity, visual and auditory turn-by-turn directions should be ‘stacked’, that is, two instructions given within the same message (Ross et al, 1996; Green et al, 1995).

*Rationale* - These guidelines are critical from a timing perspective. If messages are not stacked, drivers may be poorly prepared for an immediate second manoeuvre - this may be even more important for older drivers with slower reactions and reduced abilities to deal with time-critical situations.

Careful consideration should be given to deciding on what constitutes close proximity of successive turnings for older and/or disabled drivers.

*Rationale* – It is paramount that turn-by-turn directions are only stacked when it is absolutely necessary to do so. A stacked display will place additional demands on drivers’ short-term memory and information processing abilities.

*Examples* - Unfortunately, the literature varies in what is defined to be ‘close’. For instance, Green et al. (1995) recommend that for distances less than 0.1 mile (approx. 160 metres), stacking is required.

In contrast, Ross et al. (1996) provide an equation which determines whether stacking should occur based on the drivers’ approach speed. As an example, for an approach speed of 50 mph, stacking is required if the distance between two successive manoeuvres is less than 179 metres.

Finally, Alm and Berlin (1990) suggest that stacking should occur if the driving time between manoeuvres is less than ten seconds.

**Relevant user groups**
Hearing, Language and speech, Cognitive, Elderly
5.3 ACCESS TO VEHICLE

The following section contains specific guidelines to aid in the design of systems which can assist elderly and disabled people in accessing a vehicle, in particular the use of smart cards for use in a public transport context. The reader is referred to Parts 3 and 4 of the Handbook for other relevant guidelines.

Guidelines

Consideration should be given to the provision of information within a smart (preferably contactless) card that can aid a disabled or elderly person in accessing a public transport vehicle (Bekiaris and Mathiou, 1998; based on TELSCAN’s collaboration with ADEPT II).

*Examples* - Visually impaired passengers would particularly benefit from information accessed via a smart contactless card which would help them locate the door of the bus. In this respect, the card could request a sound to be made (such as a repeated tone) close to the bus door.

A card could also enable a request to be made for automatic lowering of the floor of a bus or for a ramp to come out. Both of these would help a disabled traveller to enter a bus.

Relevant user groups

Motion of lower limbs, Vision, Elderly

Cross Reference

Part 3.3 Smart cards
5.4 VEHICLE CONTROL

The following sections (5.4.1 and 5.4.2) contain specific guidelines to aid in the design of vehicle control systems for elderly and disabled drivers, in particular the design of adaptive cruise control and collision avoidance systems. The reader is referred to Parts 3 and 4 of the Handbook for other relevant guidelines.

5.4.1 VEHICLE CONTROL: Adaptive cruise control (ACC)

Adaptive Cruise Control (ACC) systems keep the car at a steady speed (‘speed control’), whilst maintaining a constant time gap to the car ahead (‘distance control’). It accelerates or decelerates the car to ‘keep in touch’ with the car ahead or maintains a fixed speed if the road ahead is clear. The system can be overridden by the driver or ignored at any time.

The following guidelines emerged from the simulator trials conducted in the TELAID project (Peters, 1996; Nicolle and Peters, 1999). See Appendix 2 for a brief summary of the testing.

5.4.1.1 Adjustable Headway

Guidelines

It is important that headway is individually adjustable, by a qualified specialist, according to driver's characteristics and preferences.

People with different types of impairments should be included when the adjustable range of the headway is determined. This need for adjustable headway becomes even more pronounced in poor weather conditions or night-time driving, or when the severity of a driver’s impairment increases.

Headway should not be altered by the driver, especially not while driving.
5.4.1 VEHICLE CONTROL: Adaptive cruise control (ACC)

5.4.1.1 Adjustable Headway (Cont…)

As a starting point it is recommended that the ACC system uses a headway which is 0.7 seconds longer compared to that used for able-bodied drivers.

Example - An often-used headway value is 1.4 seconds in ACC systems. This value should be prolonged to 2.1 seconds. It is recommended, however, that testing in real traffic is undertaken to validate this guideline. The figure below illustrates the proposed guideline on ACC headway. If you have access to the figure below in colour, the red, yellow and green fields approximate to the most commonly used specifications for ACC headway. Red indicates values of 1 s and below. The yellow area represents headways most frequently used, and as the area become more blue we approach the values of the proposed headway.

If your TELSCAN Handbook has no colour, the darkest shading on the right indicates values of 1 s and below. The middle area represents headways most frequently used and as the area becomes darker towards the left, we approach the values of the proposed headway.

Rationale - An evaluation of one ACC system with drivers with lower limb impairments revealed that this group of drivers prefer a longer average headway, or distance to a leading vehicle, than that which the system used. The study found that mean headway was approximately 0.7 seconds shorter for the ACC condition. This means that on average the subjects were driving 17 m closer at a speed of 90 km/h to the leading vehicles. This shorter distance was accepted but it does not conform to the distances found under the unsupported condition. Some comments explicitly stated that the ACC used headway that was too short.

It is recommended that the ACC be adjustable only by a qualified specialist for the following reasons: Firstly, given the broad range of drivers who may be disabled or elderly, we need to ensure that they all have the insight to make the proper, safe adjustments. In addition, when looking towards the future, ACC functionality is likely to merge with that of anti-collision systems, making such adjustments even more safety critical.

Relevant user groups

All
PART 5: Guidelines for Specific Systems

5.4.1 VEHICLE CONTROL: Adaptive cruise control (ACC) (Cont…)

5.4.1.2 Relevant Feedback

Guidelines
The input and output of the ACC should be designed with respect to the function provided as viewed by the driver. Do not allow the driver to believe it is a Collision Avoidance System instead of an ACC by displaying irrelevant information.

Example – Explicitly displaying that a vehicle is in front might make the driver think the system has the functionality of a Collision Avoidance System, even if this is not the case.

Rationale - The purpose of an ACC system is to assist the driver in controlling the speed of the vehicle. But the extended functionality of ACCs, compared to conventional cruise controls, might confuse the driver, who might expect to be able to use it as a Collision Avoidance System. It is very important, therefore, to make this distinction clear to all drivers, especially when the feedback or information presentation subsystem of the ACC is designed. With respect to the ACC system tested, information about detection of the lead vehicle could be confusing to the driver.

Relevant user groups
All
5.4.1 VEHICLE CONTROL: Adaptive cruise control (ACC) (Cont…)

5.4.1.3 Adaptable Controls

Guidelines
It should be possible to adapt the ACC controls easily so that they can be operated simultaneously with the primary driving task, but without interfering with it.

Example - If the ACC controls are placed on an acceleration lever or accelerator ring for drivers requiring hand controls (See Appendix 1 for a description of common car adaptations), then the driver could activate the ACC at the same time as controlling the speed.

Rationale - In the evaluation of an ACC system with drivers with lower limb impairments, the controls were placed on the direction indicator stalk at the left-hand side. However, one switch had three different effects depending on the status of the ACC. The switches were obscured by the steering wheel, which made it difficult visually to identify the controls. In order to operate the switches, it was necessary for the driver to release his/her hand from the steering wheel. The study found that it is important that the ACC controls are adaptable to cater for such requirements, regardless of the type of hand controls used for accelerator and brakes.

Relevant user groups
All
5.4.1 VEHICLE CONTROL: Adaptive cruise control (ACC) (Cont…)

5.4.1.4 Integrated Feedback

Guidelines
The ACC feedback to the driver should be integrated into existing instruments as far as possible, as long as relevant information can be accurately and quickly deduced.

Feedback from the ACC should also be adaptable so that the needs of individual drivers with disabilities can be considered.

Example - In the tested ACC system, feedback was considered well designed and well integrated into existing instruments, using the speedometer to display selected speed (as shown by the illustration below). When the ACC was switched on, the word CRUISE would appear in amber at the lower right on the dashboard. The speedometer had a circle of amber LEDs which were lit to display the currently selected speed, as long as the driver did not brake or turn the ACC off. From this testing, however, it is not possible to provide a specific guideline on appropriate feedback for an ACC system. In order to do this, it would be necessary to compare one system with another, and this needs testing in the future.

Relevant user groups
All
5.4.2 VEHICLE CONTROL: Collision Avoidance Systems (CAS) or Anti-Collision Assist (ACA)

Collision Avoidance Systems (CAS) or Anti-Collision Assist (ACA) help the driver to avoid collisions by detecting other vehicles or obstacles (e.g. using radar). It can warn when approaching another vehicle/obstacle ahead too quickly, and judge the relative speeds of the lead and approaching vehicles. This allows the system to alert the driver to situations that could lead to potential collisions.

5.4.2.1 General Issues

Guidelines

An emergency warning system should warn the driver when the front tyre crosses the lane marking on the same side of the road in excess of 30 to 40 cm.

*Rationale* - Although this guideline will protect all drivers, older drivers or certain drivers with disabilities might be likely to cross the lane markings more often (for example people who suffer from Sleep Apnea syndrome).

In collaborative testing between the SAVE and TELSCAN projects, older drivers performed poorer on lateral control of the vehicle compared to younger drivers. Further testing with drivers with sleep apnea syndrome also found that these drivers cross into adjacent lanes more often and this tendency increases with time (van Wimsun, 1998; Muzet et al., 1998).

Non verbal auditory signals, or tones, are an appropriate means of conveying collision warnings (Ross et al., 1996). However, the same information should be available in an alternative mode to meet the needs of people with perceptual limitations in the primary modality in which the warning is presented.

*Rationale* - Visual displays combined with auditory alerts were found to be the most effective form of collision warnings (Hirst, et al., 1997).

*Example* - A flashing LED is a possible way of providing additional visual information to accommodate the needs of people with hearing impairment.

The number of non-verbal signals available should be restricted. Ideally, only one non-verbal auditory signal should be available for collision warnings (Ross et al., 1996), since there are many other non-verbal sounds in the vehicle.

*Rationale* - Some elderly people or people with hearing or cognitive impairments may not be able to process many different warnings without confusion.

Auditory signals should either be adjustable or adaptable in volume to accommodate the level of hearing of a particular driver. A voice controlled system should be considered as a means of adjusting the volume.

*Rationale* - Manual adjustment of loudness for people with physical impairments may be problematic, if not impossible, as they may already be using their upper limbs to the limits of their abilities.
PART 5: Guidelines for Specific Systems

Relevant user groups
Motion of lower limbs, Visceral, Vision, Hearing, Cognitive, Elderly
5.4.2 VEHICLE CONTROL: Collision Avoidance Systems (CAS) or Anti-Collision Assist (ACA)

5.4.2.2 Auditory Signals: Frequency and Intensity

**Guidelines**

An in-vehicle acoustic warning should have a high signal repetition rate (Ross et al., 1996).

Auditory signals should alert but not startle (Ross et al., 1996).

*Rationale* - Although a minimum, audible limit should be set for warning/alarm signals, sudden noise could cause muscle spasticity for some people with disabilities and could be hazardous in a driving context.

To avoid auditory signals which might startle the driver, abruptly rising waveforms should not be used in the first 0.2 seconds of a signal (ICE ergonomics, 1994).

Frequencies between 500 and no higher than 2000 Hz are recommended. If an alarm uses frequencies that are higher than 2000 Hz, it should also use at least one additional frequency in a low to mid range (500-2000 Hz).

*Rationale* - Although other guidelines (e.g., Ross et al., 1996) suggest acceptable frequencies between 500 and 3000 Hz, a recommended highest frequency is 2000 Hz to accommodate the needs of elderly people and some people with disabilities. This is because hearing impairment (due to age, exposure to industrial noise, etc.) is typically in the higher frequencies.

If an auditory non-verbal signal is used, it should be between 15 -25 dB above background noise, but it should not exceed 120 dBA (Ross et al., 1996).

A driver should be able to control the intensity, or volume, of an auditory signal (but not below a set minimum).

*Example* - Acceptable intensities to alert a driver may differ for different people. A driver may prefer louder intensities in an emergency situation from those he/she would choose in a non-critical, neutral situation. However, as a safety related system, it should be argued that intensities have a set minimum. Any further adjustments should be performed by a competent specialist and appropriate documentation be provided to guide the process.

**Relevant user groups**

Visceral, Hearing, Cognitive, Elderly

**Cross References**

Part 3.2.5 How to design warnings
5.4.2 VEHICLE CONTROL: Collision Avoidance Systems (CAS) or Anti-Collision Assist (ACA)

5.4.2.3 Visual Displays

Guidelines
If a visual display is used, an auditory display should also provide information if required.

If a visual display is used for collision avoidance system signals, then it should be simple, such as a flashing LED (Ross et al., 1996).

Rationale - People with a hearing impairment will be receiving visual information from other ATT systems, and thus their visual channel may become overloaded. When older people have to deal with too much information, they are likely to take longer to perform a task. Also, the more complex the information presented on the screen, the greater the number of errors made, especially by older drivers.

A driver should be able to control the intensity, or brightness, of a visual signal to meet individual requirements (but not below a set minimum).

Rationale - With ageing, there is a progressive decrease in contrast sensitivity, or a person’s ability to distinguish between light and dark. This is due to less light coming through the lens onto the retina.

Relevant user groups
Vision, Hearing, Elderly
5.4.2 VEHICLE CONTROL: Collision Avoidance Systems (CAS) or Anti-Collision Assist (ACA)

5.4.2.4 Tactile Displays

Guidelines
Warnings from a collision avoidance system may be delivered via an ‘active gas pedal’. However, it must be noted that the usefulness of tactile displays is still to be demonstrated in a robust way (Ross et al., 1996), especially with elderly people or people with disabilities.

Rationale - An active gas pedal may prove to be a desirable interface device because it provides an unusual stimulation to the sole of the foot, which is particularly sensitive to vibration. However, this option may be inappropriate for people with physical impairments where, for example, limb sensitivity is absent or restricted. However, it may be very appropriate for those with hearing impairments where the visual channel could be overloaded.

Relevant user groups
Motion of lower limbs, Hearing
PART 5: Guidelines for Specific Systems

5.4.2 VEHICLE CONTROL: Collision Avoidance Systems (CAS) or Anti-Collision Assist (ACA)

5.4.2.5 Activation

Guidelines

A Time to Collision criterion of 4 seconds has been a well used criterion, though more research is required in this area (Ross et al., 1996).

*Rationale* - People with reduced cognitive functions may have slower response times or reduced information processing ability. People with skeletal/physical impairments may be working under higher levels or mental or physical workload. Therefore we recommend that this guideline be tested with a wider range of user groups to confirm its suitability.

The activation criterion for the CAS may need to be adjusted to accommodate individual differences in reaction times.

*Rationale* - Older people tend to have longer reaction times than younger people, especially as tasks become more complex.

Use both kinaesthetic (tactile) and audible warnings – both are feasible.

*Rationale* - From TELSCAN collaborative testing with the AC-Assist project, it is recommended that either kinaesthetic (brake jerk) and/or audible (spoken) warnings are given at about 4 seconds time-to-collision, on the assumption that speed difference is constant. However, if there is a change in speed difference, it should be reflected in the calculation of a safe time distance. This design of a collision warning considers the needs of elderly drivers, and would allow for alternative warnings in case of, for example, a hearing impairment. A warning should be followed if necessary by automatic intervention (emergency brake) (Nilsson and Peters, 1999).

It is recommended that emergency brake intervention consists of an initially hard braking which then declines.

*Rationale* - From TELSCAN collaborative testing with the AC-Assist project, it is recommended that an ACA system intervention is designed so that initially the braking is hard (-8 m/s²) and the decline still satisfying the criteria of avoiding a collision. This intervention design of an ACA system seems to respond to an inclusive design with respect to elderly drivers (Nilsson and Peters, 1999).

Adequate documentation should be provided to enable a competent specialist to adapt the system to meet the specific needs of a person with disabilities.

Relevant user groups

All
5.4.2 VEHICLE CONTROL: Collision Avoidance Systems (CAS) or Anti-Collision Assist (ACA)

5.4.2.6 Reliability testing

**Guidelines**
There should be the capability to test the functioning of the CAS, even when the vehicle is in motion (Ross et al., 1996).

*Rationale* - Elderly and disabled drivers may rely more, at least psychologically, on the system functioning and may feel more confident if able to test the system on a regular basis.

Reliability testing should be available by different modes (e.g. the option of voice activation) in order to accommodate the needs of elderly and disabled drivers who may already be working to the limits of their capabilities.

**Relevant user groups**
All
PART 5: Guidelines for Specific Systems

5.5 PARKING

The following sections (5.5.1 and 5.5.2) contain specific guidelines to aid in the design of parking aids for elderly and disabled drivers. The reader is referred to Parts 3 and 4 of the Handbook for other relevant guidelines.

5.5.1 PARKING: Use of smart cards

Guidelines

Consideration should be given to the provision of information within a smart (preferably contactless) card that can aid a disabled or elderly person in parking their vehicle (Bekiaris and Mathiou, 1998; based on TELSCAN’s collaboration with ADEPT II).

Example – People with disabilities would particularly benefit if a smart card was aware of their right to a special parking place, and was able to request the opening and closing of a bar, thus protecting the parking place from unauthorised use (from TELSCAN’s collaboration with the DISTINCT project in developing an automated gate barrier).

Relevant user groups
All

Cross Reference
Part 3.3 Smart cards
Part 5.8 Ticketing/Payment/Toll collection
5.5.2 PARKING: Reversing and parking aids

Reversing and parking aids detect obstacles behind a vehicle (e.g. using radar). They inform the driver of the distance to obstacles immediately behind and to the side of the car. They can depict the car and adjacent obstacles in a plan diagram, or sound a variable signal (e.g. a tone increasing in pitch) to indicate closing distance. Visual displays could be on the parcel shelf, the dashboard, or over the rear view mirror.

The following guidelines emerged from a limited number of field trials conducted in the TELAID project (Peters, 1996) and the EDDIT project (Barham et al., July 1994 and Dec 1994). (See Appendix 2 for a brief summary of the tests.)

Please note that these guidelines are the result of a limited number of tests with disabled and elderly drivers, and more testing is recommended in some areas.

Guidelines
Provide both auditory and visual feedback.

Rationale - The system that provides both auditory and visual feedback gives better support to and is preferred by the driver. This is strongly suggested in limited testing by TELAID, Peters, 1995, and by EDDIT, Barham et al., July 1994 and Dec 1994. As is proven in other tests, auditory feedback is more omnidirectional than visual feedback and seems to interfere less with the primary reversing task. However, for people with hearing impairments both means of feedback are required. If you provide visual feedback both through the rear view mirror and through direct view, it will make visual feedback more omnidirectional (Peters, 1995).
5.5.2 PARKING: Reversing and parking aids (Cont...)

Three warning zones, as defined by the existing standard ISO TR 12155 support to the driver for reversing tasks, and are illustrated below. In TELAID testing these zones were found to be acceptable for people with lower limb disabilities (Peters, 1995).

Positioning the parking display on the rear parcel shelf tends to have a less detrimental effect on drivers’ visual and mental workload whilst manoeuvring.

**Rationale** - In the EDDIT trials with two types of reversing aids, the systems differed in their positioning within the test car. Whilst the display of the infrared device occupied a position on the car’s dashboard, the lights constellation of the ultrasound system was mounted on the rear parcel shelf (and so could be viewed using the car’s rear view mirror). Subjects viewed the display almost exclusively through the rear-view mirror. In terms of the manoeuvring time spent glancing in each direction, the introduction of this system resulted in a substantial increase in the use of the rear-view mirror, and a marked decrease in glances over both shoulders and at both wing mirrors. The dashboard-mounted display both increased the number of changes of glance made by subjects and increased manoeuvring time (indicating an increase in drivers’ visual and mental workload whilst manoeuvring). This was not the case when using the display positioned to the rear (Barham et al., July and Dec 1994).

**Relevant user groups**
Motion of lower limbs, Motion of upper body, Vision, Hearing, Elderly
5.6 DEALING WITH WEATHER AND ENVIRONMENT

5.6.1 DEALING WITH WEATHER AND ENVIRONMENT: Vision Enhancement

Vision enhancement systems provide additional visual information to drivers about the road scene ahead when driving at night and/or in other reduced visibility conditions (e.g. fog, rain). With respect to technological solutions, in the near term ultraviolet headlights can improve drivers’ discernment of UV-reflecting objects. In the future, it is intended that cameras and LIDAR will compensate for poor visibility using frequency ranges that the human eye cannot perceive. The pictures thus obtained will be processed electronically and displayed to the driver, most likely via a Head-Up Display (HUD).

The following guidelines have emerged from a series of human factors evaluations of Jaguar’s Night Vision System, using a sample of elderly drivers, and conducted by Cranfield University in the UK (Barham et al., 1997).

Guidelines

A vision enhancement system must be intuitive in operation

*Example* – Drivers must be able to identify a pedestrian as “a pedestrian”, rather than merely “something in the road ahead”.

Drivers’ perception of depth must not be compromised by the use of the system.

*Rationale* - The ability to correctly perceive depth (and hence the relative movements and positions of other vehicles, road users, pedestrians etc.) is a critical requirement for safe driving. In particular, many elderly drivers with reduced visual acuity or individuals with seriously impaired vision in one eye currently experience difficulties in accurately perceiving and estimating distances. A vision ‘enhancement’ system must not add to these problems.

The level of brightness of the enhanced image must be appropriate to enable normal adaptation of the eye.

*Rationale* – The enhanced image must not be too bright, such that the visibility of objects in the non-enhanced areas of the road scene is compromised. This is particularly important for older drivers who may have low contrast/glare sensitivity and thus experience difficulties in alternating between images of varying brightness/contrast.

Relevant user groups

Vision, Elderly
5.7 EMERGENCY WARNING AND TRAVELLER SUPPORT

The following sections (5.7.1 to 5.7.2) contain specific guidelines to aid in the design of accessible ATT systems which support elderly and disabled people in emergency situations, in particular how smart cards can store medical data, and how to deal with emergency situations on public transport. The reader is referred to Parts 3 and 4 of the Handbook for other relevant guidelines.

5.7.1 Use of smart cards

The guidelines within this section have emerged based on TELSCAN’s collaborative work with the SAVE and ADEPT II projects (Bekiaris and Mathiou, 1998a, 1998b).

Guidelines

The most important medical information that should be capable of being stored on a smart card includes epilepsy, severe heart problems and visual problems.

It should be possible to include additional medical information on a smart card, such as blood type, diabetes, light heart problems, allergies and other permanent diseases or disabilities.

Medical data should not be transmitted or be available in any way to third persons (e.g. surrounding traffic, other road users). However, it should be possible to transmit medical data to an emergency centre for use by medical staff, with the consent of the user.

Personal medical data should not be available for legal action and fault attribution, e.g. in the event of an accident.

*Rationale* - The previous four guidelines are based on a survey of medical experts regarding the legal implications of storing information on the user’s medical state.

Ideally, a smart card should contain fields that enable a user to make an emergency telephone call to pre-defined people/services.

*Rationale* - Drivers with disabilities can experience particular difficulties in accessing emergency or even public phones in the event of an emergency or breakdown. A contactless smart card has great potential here, since the traveller no longer has to attempt to reach the device or dial the number.

Relevant user groups

All

Cross Reference

Part 3.3 Smart cards
PART 5: Guidelines for Specific Systems

5.7.2 EMERGENCY WARNING AND TRAVELLER SUPPORT:
Public transport disturbances

The following sections (5.7.2.1 to 5.7.2.2) contain specific guidelines to aid in the design of accessible ATT systems which support elderly and disabled people when there has been a disturbance on public transport (e.g. due to a rail accident, the traveller’s route must be diverted). The reader is referred to Parts 3 and 4 of the Handbook for other relevant guidelines.

5.7.2.1 General Issues

The guidelines within this section have emerged from TELSCAN’s collaborative work with the QUARTET PLUS project (Börjesson, 1998).

Guidelines

Do not just announce that traffic has been interrupted, but also explain the cause of the stoppage.

*Rationale* - Information about the cause of the stoppage helps passengers to get some idea of how long it will be before normal traffic is resumed. If they can assess the consequences of the stoppage they will have fewer doubts about what to do.

*Example* - Collision at Brunnsparken
No tram routes passing
Kungsportsplatsen

It is easier to see what routing options are available if route numbers are grouped according to the departure points of the bus/tram/train/metro.

*Example* – In the display below, bus no.3 is departing from Källtorp. To get to Hisingen it will be necessary to get on the no.5 bus which departs from Drottningtorget.

| 3  | Källtorp |
| 5  | Hisingen depart from Drottningtorget |

Give the name of the end-of-line destination as a guide to the routes affected.

*Rationale* - A clear majority of the test subjects felt that just giving the points of the compass is not enough to indicate the directions of the routes affected. Many passengers are uncertain whether the end of the line is north, south, east or west of the stop they are standing at. The name of the end-of-line destination is a much more reliable guide. If points of the compass alone are used to indicate direction, it is important to supplement the message with further information, e.g. route maps on which the points of the compass are clearly marked.
5.7.2  EMERGENCY WARNING AND TRAVELLER SUPPORT: 
Public transport disturbances

5.7.2.1  General Issues (Cont...)

The guidelines within this section have emerged from TELSCAN’s collaborative work with the QUARTET PLUS project (Börjesson, 1998).

Guidelines
Explain which routes can be taken to reach the alternative point of departure.

*Rationale* - This information is considered essential for unaccustomed travellers who are strangers to the area, or passengers unfamiliar with the public transport network. Route maps and area maps at bus and tram stops are other aids that make it easier for passengers to decide how to proceed on the next leg of their journeys.

*Example* –

<table>
<thead>
<tr>
<th>Passengers for 1, 6, 8 Valand</th>
</tr>
</thead>
<tbody>
<tr>
<td>take 1, 6, 8, 40, 58 from stop A</td>
</tr>
<tr>
<td>and change at BRUNNSPARKEN</td>
</tr>
</tbody>
</table>

Ambiguous words and expressions can give rise to doubts, so choose words that cannot be misunderstood.

*Example* - It is advisable to describe a route by the names of the stops which appear not only on the route maps but also in timetables and other types of traffic information. Do not use street names which are not shown on route maps.

Relevant user groups
All

Cross Reference
Part 4.2.1  Public Transport Display Signs: General issues
Part 5.1  Pre-Trip Planning
PART 5: Guidelines for Specific Systems

5.7.2 EMERGENCY WARNING AND TRAVELLER SUPPORT:
Public transport disturbances

5.7.2.2 Information/Communication

The guidelines within this section have emerged from TELSCAN’s collaborative work with the QUARTET PLUS project (Börjesson, 1998).

Note: Information is defined as a message (e.g. instructions) and requires no direct response - but it does require a receiver. Information should be simple and clear and not contain too many elements. Communication, on the other hand, implies that the receiver responds to the message sent.

Guidelines
All information should be repeatable, whether written, spoken or animated. Written and spoken information should be presented in easily understandable, colloquial language.

Provide warning information in alternative modes to meet individual requirements.

Example - For those who cannot read, it is important for information to be provided via symbols or by speech. However, do not base information solely on the use of icons, unless they are standard, well known and tested with all user groups. People with both visual and hearing impairments should be able to receive information and communicate by touch.

Warnings and similarly important messages should remain/be repeated sufficiently long enough to be noticed by the user. Alternatively, they should remain/be repeated until actively removed by the user.

The rate, volume, intonation and frequency of spoken information should be adjustable. A control permitting the volume to be raised by ca. 20 dB is very helpful to those who have hearing impairments.

Spoken information should have a background free of interference in order to be clear, and should always be accompanied by a written text.

Communication based on textual input should be able to accept misspellings or suggest alternative spellings or corrections.

Communication should not require the user to speak, but the user should be able to communicate via other modes.

Address information directly to passengers with the words "Passengers for..."

Rationale - Addressing information directly to passengers gives them the agreeable feeling that they are important and that the public transport operator cares about them personally as customers.
PART 5: Guidelines for Specific Systems

Relevant user groups
All

Cross Reference
Part 4.2.1 Public Transport Display Signs: General issues
5.8 TICKETING/ PAYMENT/ TOLL COLLECTION

The following guidelines are based on TELSCAN’s collaborative testing with the ADEPT II Bekiaris and Mathiou, 1998b), and ICARE/CALYPSO (Simões, et al., 1999a) projects. Therefore, they concern the use of smart cards and contactless passes as a means of improving the ease by which an individual engages in ticketing/payment/toll collection tasks.

5.8.1 Design of smart cards/ contactless passes

Guidelines
A smart card used for ticketing/payment/toll collection (e.g. at car parks, for use of public transport services, road tolling) should contain information regarding whether the elderly or disabled traveller is entitled to a reduction in the fare.

A contactless pass can be very beneficial for the safety and comfort of elderly and disabled passengers, especially on certain modes of public transport, such as buses. However, more research is needed to ensure that contactless passes and their magnetic fields do not restrict accessibility for people with disabilities.

Rationale - Exposure to magnetic fields must be regulated for health reasons, and therefore contactless passes can impose certain restrictions. When the entrance to the vehicle is very narrow, some people with disabilities, e.g. those in wheelchairs, may not be able to pass close by. This would result in the contactless pass making such a mode of transport inaccessible to them.

In order that passengers can reach their seats as soon as possible, a badge can be carried by the traveller, which can be passed under the magnetic field of the system. If the badge were carried in a portable bag at the level of the magnetic field, then the passenger would not need to hold it and could more quickly be seated.
5.8 TICKETING/ PAYMENT/ TOLL COLLECTION: Design of smart cards/ contactless passes (Cont…)

Guidelines

Example - In TELSCAN’s collaborative testing with the ICARE and CALYPSO projects, the badge (see photo below) was found to be easily portable and to be well designed in terms of size, format, colour and weight. The badge has a small visual display that provides information about the validity of the pass in terms of transportation companies, areas and duration, as well as about the money available and other information such as the hour or date. A magnetic card, which can be credited at any Automatic Teller Machine (ATM), is inserted into the badge to make payment. This card is also expected to become a bank card for other small payments, such as parking, newspapers, coffee, etc.
PART 5: Guidelines for Specific Systems

5.8.1 TICKETING/ PAYMENT/ TOLL COLLECTION:
    Design of smart cards/ contactless passes (Cont…)

Guidelines
Inter-modal contactless passes require a coding system for any visual information (e.g. via a badge), its complexity depending on the complexity of the transportation network and the facilities offered to the traveller.

A character followed by 2 or 3 figures and the corresponding type can represent all the variability of the inter-modal pass system. However, support for remembering or accessing the code must be provided, especially for some elderly people or people with cognitive problems.

*Examples* –

The use of characters for coding is very limited as it can create some ambiguity; so, just uppercase characters and those distinct from numeric characters should be used. There are two possibilities:

If each square doesn’t have diagonals just 11 alphabetic characters can be used (A, C, E, F, G, H, I, J, L, P, U).

If each square has diagonals 18 alphabetic characters can be used (A, C, E, F, G, H, I, J, K, L, M, N, P, R, U, W, X, Y).

Using diagonals within a matrix system is recommended for information presentation. The use of lowercase characters can, however, create some confusion, (e.g., the `t` can be confused with an `E` having a system malfunction).

Relevant user groups
All

Cross Reference
Part 3.3  Smart cards
Part 4.4  Multi-Modes
5.8.2 TICKETING/ PAYMENT/ TOLL COLLECTION: Validators for contactless passes

Guidelines
Validators for passes should be located so as to ensure passengers’ ease of entry and validation, as well as ensuring passenger safety.

Validators for passes should be easily identified, e.g. in subway, railway or ferryboat stations, and the corresponding functions should be clearly signed.

*Examples* - Some modes of transportation, such as buses and trams, have two validators inside the vehicle. One is needed to confirm that a pass is valid in that area. The other is needed for non-valid passes, requiring the passenger to purchase a ticket, and displaying the price and validation details. The first validator for valid passes would be located at the entrance, and the second one should be located inside the vehicle in the seating area, allowing for validation in a seated and stable position.

Relevant user groups
All

Cross Reference
Part 3.3 Smart cards
Part 4.4 Multi-Modes
The following checklist is a summary of the most important guidelines contained within this handbook. If taken into consideration, it is expected that the usability of an ATT system for elderly and disabled would be significantly improved. Handbook references are provided, so that the reader can discover the rationale behind specific guidelines and observe relevant examples.

<table>
<thead>
<tr>
<th>General Issues</th>
<th>Tick if YES</th>
<th>Guidelines Handbook References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Included elderly and disabled travellers in the design and evaluation process?</td>
<td></td>
<td>2.2/2.9 (Usability principles)</td>
</tr>
<tr>
<td>Flexible and easy to adapt to individual’s requirements?</td>
<td></td>
<td>2.4 (Usability principles)</td>
</tr>
<tr>
<td>Easy to learn the system?</td>
<td></td>
<td>2.5 (Usability principles)</td>
</tr>
<tr>
<td>Comfortable to use the system?</td>
<td></td>
<td>2.7 (Usability principles)</td>
</tr>
<tr>
<td>Compatible with assistive devices?</td>
<td></td>
<td>2.8 (Usability principles)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.1.1/3.2.1/3.6 (General)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.4 (Web pages)</td>
</tr>
<tr>
<td>No electromagnetic interference between ATT system and any assistive devices?</td>
<td></td>
<td>3.6 (General)</td>
</tr>
<tr>
<td>Material of ATT system in contact with user’s skin unlikely to cause allergy?</td>
<td></td>
<td>3.6 (General)</td>
</tr>
<tr>
<td>Power overload unlikely, given that assistive device may use same power supply as ATT system?</td>
<td></td>
<td>3.6 (General)</td>
</tr>
<tr>
<td>System settings can be customised by driver, or if safety critical, by competent specialist?</td>
<td></td>
<td>4.3.2 (Driver Systems)</td>
</tr>
<tr>
<td>Non-threatening environment for using system?</td>
<td></td>
<td>4.1.1 (Kiosks)</td>
</tr>
<tr>
<td>Easy to locate system, especially for visually impaired traveller?</td>
<td></td>
<td>4.1.1 (Kiosks)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.2.2 (Public transport display signs)</td>
</tr>
</tbody>
</table>

Designer Comments:
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
## PART 6: The TELSCAN Interface Design Checklist

### Displays

<table>
<thead>
<tr>
<th>Description</th>
<th>Tick if YES</th>
<th>Guidelines Handbook References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative means of output (e.g. visual/auditory/haptic)?</td>
<td></td>
<td>2.1 (Usability principles)</td>
</tr>
<tr>
<td>Displays conform to expectations?</td>
<td></td>
<td>2.6 (Usability principles)</td>
</tr>
<tr>
<td>Unrestricted access to displays (e.g. flexible locations, no obstacles/restraints)?</td>
<td></td>
<td>3.2.2 (General) 4.1.1 (Kiosks) 4.3.4 (Driver Systems)</td>
</tr>
<tr>
<td>Displays easily viewable by a wheelchair user?</td>
<td></td>
<td>3.2.2 (General) 4.1.2 (Kiosks)</td>
</tr>
<tr>
<td>No need to peer over glasses to view/read display?</td>
<td></td>
<td>4.3.5 (Driver Systems)</td>
</tr>
<tr>
<td>User can get face close to displays?</td>
<td></td>
<td>4.1.2 (Kiosks)</td>
</tr>
<tr>
<td>User can access displays without having to rotate upper body?</td>
<td></td>
<td>3.2.2 (General)</td>
</tr>
<tr>
<td>User can easily enlarge the size of a display/its image?</td>
<td></td>
<td>3.2.3.1 (General)</td>
</tr>
<tr>
<td>Displays protected from (or positioned to avoid) direct light sources (natural or artificial)?</td>
<td></td>
<td>3.2.2 (General) 4.1.1 (Kiosks)</td>
</tr>
<tr>
<td>Contrast/brightness easily adjustable?</td>
<td></td>
<td>3.2.3.1 (General)</td>
</tr>
<tr>
<td>Volume/balance easily adjustable/automatically adjusted according to ambient conditions?</td>
<td></td>
<td>3.2.4 (General)</td>
</tr>
<tr>
<td>Auditory output avoids high frequencies?</td>
<td></td>
<td>3.2.5 (General)</td>
</tr>
</tbody>
</table>

### Designer Comments:

..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
## PART 6: The TELSCAN Interface Design Checklist

<table>
<thead>
<tr>
<th>Controls</th>
<th>Tick if YES</th>
<th>Guidelines Handbook References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative control mechanisms?</td>
<td>2.1 (Usability principles) 3.1.2 (General) 4.3.3 (Driver Systems)</td>
<td></td>
</tr>
<tr>
<td>Controls conform to expectations?</td>
<td>2.6 (Usability principles)</td>
<td></td>
</tr>
<tr>
<td>Unrestricted access to all controls (e.g. flexible locations, no obstacles/restraints)?</td>
<td>3.1.1/3.1.4 (General) 4.3.4 (Driver Systems)</td>
<td></td>
</tr>
<tr>
<td>Controls easily reachable by everyone, e.g., someone using a wheelchair?</td>
<td>3.1.1 (General) 4.1.2 (Kiosks)</td>
<td></td>
</tr>
<tr>
<td>User can access controls without having to rotate their upper body?</td>
<td>3.1.1/3.1.4 (General)</td>
<td></td>
</tr>
<tr>
<td>Separate controls well spaced?</td>
<td>3.1.4 (General)</td>
<td></td>
</tr>
<tr>
<td>Controls are avoided which:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• require precision?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• require both hands for optimal performance?</td>
<td>3.1.1/3.1.2/</td>
<td></td>
</tr>
<tr>
<td>• have to be held down for more than an instant?</td>
<td>3.1.4/3.1.5</td>
<td></td>
</tr>
<tr>
<td>• require concurrent pushing/pulling and rotating?</td>
<td>(General)</td>
<td></td>
</tr>
<tr>
<td>• cannot be readily identified by touch alone?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Designer Comments:**

..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................

---

**TELSCAN Design Guidelines - Usable ATT systems for Elderly and Disabled Travellers**

December 1999

Copyright – European Commission

Page 118
### Information presentation

| Information can be presented via alternative modalities (e.g. visual and auditory) | 2.1 (Usability principles)  
3.2.1 (General)  
4.3.1 (Driver Systems) |
| System functions optimally as single modality system? | 4.3.1 (Driver Systems) |
| Size/contrast of text sufficient for travellers with impaired vision? | 3.2.3.1/3.2.3.3 (General)  
4.2.1/4.2.2 (Public transport display signs) |
| Symbols clear and unambiguous? | 3.2.6 (General)  
4.2.2 (Public transport display signs) |
| Limited number of information units presented to user? | 2.3 (Usability principles)  
4.3.5 (Driver Systems) |
| Information remains on display for sufficient time? | 4.2.1 (Public transport display signs)  
4.3.7 (Driver Systems) |
| Timing of information presentation accounts for reaction times of older/disabled travellers? | 4.3.7 (Driver Systems) |
| Repeat mechanism, especially for time-critical information? | 4.3.7 (Driver Systems) |

**Designer Comments:**

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
## Training/Documentation

<table>
<thead>
<tr>
<th>Training needs considered for elderly/disabled travellers?</th>
<th>Tick if YES</th>
<th>Guidelines Handbook References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy to understand language for documentation?</td>
<td>3.5 (General)</td>
<td></td>
</tr>
<tr>
<td>Clear, concise and simple on-line help?</td>
<td>3.5 (General)</td>
<td></td>
</tr>
<tr>
<td>Personal service available (if required) at no extra cost?</td>
<td>4.1.6 (Kiosks)</td>
<td></td>
</tr>
<tr>
<td>Documentation specifies skills/capabilities required?</td>
<td>3.5 (General)</td>
<td></td>
</tr>
<tr>
<td>Instructions available in different modes (e.g., on audio tape)?</td>
<td>3.5 (General)</td>
<td></td>
</tr>
<tr>
<td>Pages of documentation can be turned with one hand?</td>
<td>3.5 (General)</td>
<td></td>
</tr>
<tr>
<td>Reference card provided (where applicable)?</td>
<td>3.5 (General)</td>
<td></td>
</tr>
</tbody>
</table>

### Designer Comments:

<table>
<thead>
<tr>
<th>Designer Comments:</th>
</tr>
</thead>
<tbody>
<tr>
<td>..................................................................................................................................................</td>
</tr>
<tr>
<td>..................................................................................................................................................</td>
</tr>
<tr>
<td>..................................................................................................................................................</td>
</tr>
<tr>
<td>..................................................................................................................................................</td>
</tr>
<tr>
<td>..................................................................................................................................................</td>
</tr>
<tr>
<td>..................................................................................................................................................</td>
</tr>
<tr>
<td>..................................................................................................................................................</td>
</tr>
</tbody>
</table>

---
## Smart Cards

<table>
<thead>
<tr>
<th>Tactile marking on card (e.g. notch for orientation, embossing for identification)?</th>
<th>Tick if YES</th>
<th>Guidelines Handbook References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of use for someone with poor manual dexterity?</td>
<td>3.3.2 (General)</td>
<td></td>
</tr>
<tr>
<td>Contactless card system?</td>
<td>3.3.2 (General)</td>
<td></td>
</tr>
<tr>
<td>Card contains information which may aid elderly/disabled travellers?</td>
<td>3.3.3 (General)</td>
<td></td>
</tr>
</tbody>
</table>

**Designer Comments:**

..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................
### For Specific System Functions,

Followed advice on

<table>
<thead>
<tr>
<th>System Function</th>
<th>Tick if YES</th>
<th>Guidelines Handbook References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-trip planning?</td>
<td></td>
<td>5.1</td>
</tr>
<tr>
<td>Trip information?</td>
<td></td>
<td>5.2</td>
</tr>
<tr>
<td>Access to vehicle?</td>
<td></td>
<td>5.3</td>
</tr>
<tr>
<td>Vehicle control?</td>
<td></td>
<td>5.4</td>
</tr>
<tr>
<td>Parking?</td>
<td></td>
<td>5.5</td>
</tr>
<tr>
<td>Dealing with weather and environment?</td>
<td></td>
<td>5.6</td>
</tr>
<tr>
<td>Emergency warning and traveller support?</td>
<td></td>
<td>5.7</td>
</tr>
<tr>
<td>Ticketing/Payment/Toll collection?</td>
<td></td>
<td>5.8</td>
</tr>
</tbody>
</table>

### Designer Comments:

<table>
<thead>
<tr>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>……………………………………………………………………………………...</td>
</tr>
<tr>
<td>……………………………………………………………………………………...</td>
</tr>
<tr>
<td>……………………………………………………………………………………...</td>
</tr>
<tr>
<td>……………………………………………………………………………………...</td>
</tr>
<tr>
<td>……………………………………………………………………………………...</td>
</tr>
<tr>
<td>……………………………………………………………………………………...</td>
</tr>
<tr>
<td>……………………………………………………………………………………...</td>
</tr>
<tr>
<td>……………………………………………………………………………………...</td>
</tr>
<tr>
<td>……………………………………………………………………………………...</td>
</tr>
</tbody>
</table>
References and bibliography

CEC project deliverables listed below can be obtained at cost from European Commission Host Organisation, CORDIS Customer Service, B.P. 2373, L-1023 Luxembourg.


Barham, P. and Alexander, J., (Jan. 1998), Evaluation of interactive information terminals (TRIPlanner Mk1) with respect to their use by the elderly and people with disabilities (For EUROSCOPE – ROMANSE II).


Bekiaris, E. and Mathiou, I., (1998a), Use of private data stored in a smart card, TELSCAN Project TAP 1108, Internal Report TRD2.5.

Bekiaris, E., and Mathiou, I., (1998b), ADEPT project smart card proposed fields in order to cover E&D needs, TELSCAN Project TAP 1108, Internal Report TRD7.2.
References and bibliography


Börjesson, M., Burnett, G., and Nicolle, C., (April 1998), ATT Systems and their relevance to Elderly and Disabled Travellers, TELSCAN Project TAP 1108, Deliverable 3.2.

Börjesson, M., Nicolle, C., and Burnett, G., (September 1999), Updating of user requirements of E&D drivers and travellers, TELSCAN Project TAP 1108, Deliverable 3.3.


Bruyas, M., and Marin-Lamellet, C., (1999), Accessibility of public transport Internet sites for the persons who are blind or poor sighted, TELSCAN Project TAP 1108, Internal Report ,INRETSINFOPOLIS2.


CEN TC293 Technical Aids, Ad hoc group on communication systems, including personal alarms.

CEN TC293 Technical Aids, Ad hoc group on wheelchair and occupant restraint systems.

Defence Standard 00-25, Human Factors for Designers of Equipment


EEC 77/649, Field of vision.

EEC 78/316, Identification of controls, tell-tales and indicators.


References and bibliography


ISO 3208, Road Vehicles - Evaluations of protrusions inside passenger cars.

ISO 3958, Road Vehicles - Passenger cars. Driver hand control reach.


ISO 4092, Road Vehicles - Diagnostic systems for motor vehicles.

ISO 4513, Road Vehicles - Methods for the establishment of eye ellipses for driver's eye location.

ISO 6385, Ergonomic principles in the design of work systems.

ISO 6549, Road Vehicles - Procedure for H-Point determination.

ISO 9241, Ergonomics requirements for office work with visual display terminals (VDTs), 17 parts.

ISO TC145 Graphical symbols, SC1 Public information symbols.

ISO TC159 Ergonomics, SC1 Ergonomic guiding principles - WG related to mental work.

ISO TC159 Ergonomics, SC4 Signals and controls -WG on visual display requirements.

ISO TC173 Technical Aids, SC4 Aids and adaptation for communication.
References and bibliography

ISO TC176 Quality Management & QA, SC12 Quality systems.

ISO TCI Information Technology, SC18 Text and Office Systems - WG on user requirements and user/systems interfaces and symbols.

ISO TR 12155, 1994, Commercial vehicles - Obstacle detection device during reversing - Requirements and tests.


Maguire, M., 1997, Usability Evaluation Methods within the design process, HUSAT Memo 1080, HUSAT Research Institute, The Elms, Elms Grove, Loughborough, Leics LE11 1RG, UK.


Marin-Lamellet, C., Burnett, G., and Nicolle, C., (July. 1999), A methodology for the assessment of telematics applications for travellers who are elderly or disabled. TELSCAN Project TAP 1108. Deliverable No. 4.2.


References and bibliography


Nicolle, C., Ross, T., Richardson, S.J., (eds.), (1992), Identification and Grouping of Requirements for Drivers with Special Needs, CEC DRIVE II Project V2032 TELAID Deliverable No. 3.


Oxley, P., Ayala, B., and Barham, P., (May, 1994), The Jaguar night vision trials: A report on the use of an infra-red based vision system by a sample of elderly drivers. CEC DRIVE II EDDIT Project V2031, Deliverable No. 22A.


References and bibliography


Chapter 1: Design Guidelines for Traffic and Road Information - including RDS-TMC
Chapter 2: Design Guidelines for Route Guidance and Navigation
Chapter 3: Design Guidelines for Collision Avoidance
Chapter 4: Design Guidelines for Autonomous Intelligent Cruise Control
Chapter 5: Design Guidelines for Variable Message Signs


Royal National Institute for the Blind, Making Equipment Accessible to Visually Impaired People. RNIB, Joint Mobility Unit, London.


Simões, A, Carvalhais, J, Trindade, C, Nunes, M & Santos, M (1999b), TELSCAN Assistance to INFOPOLIS 2 Project, TELSCAN Project TAP 1108.


TÜV Bayern, (1989), List of European Standards, CEC DRIVE I STAMMI Project V1037, Deliverable No. 2.1.
van Wimsum, W., 1998, Age-related differences in effects of drowsiness of measures of
driver behaviour and performance, Internal Report, TELSCAN Project TR1108.

Vaughan, G., Ross, T., Nicolle, C., Fuchs, M., Duncan, B., Eggerdinger, C., Pauzié, A. and
Vernet, M., (1993), Review of Existing Guidelines for Information Presentation in

Veenbaas, R., (1995), Inventory of controls used in ATT while driving. Proposal for DSN
MMI evaluation of controls. Delft, NL, TNO Road Vehicles Research Institute, in
Veenbaas, R., (ed.) (October 1995), Validation of ATT systems for DSN through
driving simulator tests. Test Report, CEC DRIVE II Project V2032 TELAID
Deliverable No. 9.

of Man-Machine Interface Standards and Legislation Requirements for Driver
Information. CEC DRIVE II HARDIE Project V2008, Deliverable No. 1.

common hand controls for accelerating and braking, Report IZF 1993 C-31,
Soesterberg, NL: TNO Human Factors Research Institute. Also Annex VI to Validation
of the identification of special needs of DSN - test report, CEC DRIVE II TELAID
project V2032, Deliverable No. 5.

Verwey, W.B., (1995), The control of input devices by people driving with and without
adaptations, Report TNO-TM 1995 B-9, Soesterberg, NL: TNO Human Factors
Research Institute, in Veenbaas, R., (ed.) (October 1995), Validation of ATT systems
for DSN through driving simulator tests. Test Report, CEC DRIVE II Project V2032
TELAID Deliverable No. 9.

Vienna Convention, 1969, United Nations, Conference on Road Traffic, 7 Oct-8 Nov 1968,
United Nations Publications.

overview of human factors issues affecting safety. Accident analysis and prevention,
26(6), 703-717.

of the Human Factors 33rd Annual Meeting, Denver, Colorado, 10, 16-20, Vol I, The
Human Factors Society.

Weintraub, D. J. and Ensing, M., (1992), Human Factors Issues in Head-Up
Display Design: The Book of HUD. CSERIAC 92-2. Wright-Patterson AFB, OH:
Crew Station Ergonomics Information Analysis Centre.

Westerlund, Y. and Stahl, A., (1999), Demand Responsive Transport (DRT) using advanced
Telematics, Internal Report, TELSCAN Project TR1108.

Whiteside, J., Bennett, J. and Hotsblatt, (1988), Usability Engineering: our experience and
evolution. In: Helander, M (Ed) Handbook of Human Computer Interaction, pp 791 -
817, Elsevier, Amsterdam.
References and bibliography


WWW Sites:

1. EC-funded TELSCAN project:
   http://hermes.civil.auth.gr/telscan/telsc.html

2. EC-funded INCLUDE project, providing general guidelines on designing accessible telematics systems:
   http://www.stakes.fi/include/

3. Guidelines for the design of accessible consumer products:
   http://tracecenter.org/docs/consumer_product_guidelines/toc.htm

4. Guidelines for computer accessibility:
   http://www.NSH.SE/IN_ENGLISH/PUBLICATIONS.htm

5. Royal National Institute for the Blind, UK:
   http://www.rnib.org.uk/

6. ‘Access Prohibited?’ – Guidelines for Smart cards and Public Access Information Kiosks:
   http://www.eyecue.co.uk/pats

7. Web Content Accessibility Guidelines:
   http://www.w3.org/TR/WD-WAI-PAGEAUTH
8. The BOBBY tool for assessing the accessibility of Web sites:

http://www.cast.org/bobby/
APPENDIX 1: Car Adaptations for Drivers with Disabilities

In the Guidelines for Driver Systems (Part 4.3) of the Handbook, some aids for drivers with disabilities are mentioned. These are explained briefly below. For further reference and information on specific systems in the market worldwide, one should refer to Bekiaris and Naniopoulos, 1992.

The aids mentioned below are simply indicative of a wide range of possible adaptations, which would include over 100 different types and 500 particular aids.

The diagram below illustrates three types of controls: a ring accelerator, a segment accelerator, and a manually operated brake (Veenbaas and Hekstra, 1993). Only one of these hand-controlled accelerators would be present at any one time:

**Ring accelerator**: the acceleration pedal is replaced by an acceleration ring of smaller radius, mounted on top of the steering wheel and operated by the thumbs or palms of the hands. This enables the driver to steer with both hands and operate switches on either side of the steering column.

**Segment accelerator**: the acceleration pedal is mechanically connected to a curved lever, as seen to the right of the steering wheel.

**Manual service brake**: The brake pedal is connected to an additional lever, as shown to the right of the segment accelerator.
Figure 2a below shows a single combined lever for accelerator and brake mounted on the floor between the front seats. This single lever could instead be placed to the side of the steering wheel. Figure 2b shows another system consisting of two separate levers for accelerator and brake placed on the right side of the steering wheel column (Peters, 1996; Nicolle and Peters, 1999).

Empty arrows show how to perform braking, and filled arrows show how to accelerate.

a) The single lever control from AMU/Kävlinge

b) The dual lever control from Handikappinstitutet (from Betjeningshjelpmidler i bil © RTF, OSLO)
APPENDIX 2: Descriptions of Field Trials/ Simulator Testing

Certain guidelines are based on simulator testing and field trials with elderly or disabled drivers, either conducted as part of TELSCAN’s collaborative testing with projects in the Transport Sector of the Telematics Applications Programme, or within the earlier TELAID and EDDIT projects. The TELAID and EDDIT testing has been described in sufficient detail so that you may not need to refer back to original documents. For detailed accounts of all of TELSCAN’s collaborative testing with other projects, see Deliverable No. 7.2, Report on the assessment of studies in city projects and advice set-ups relevant to E&D issues, to be available at the end of the project (Oxley, et al., 1999)

**AC-ASSIST** (Anti Collision Autonomous Support and Safety Intervention System)  
(Project No. 1004) and TELSCAN’s Collaborative testing  
The VTI driving simulator has been used for experiments, using volunteer elderly drivers. AC-ASSIST features the development of an anti-collision support and safety-intervention system for car drivers, and TELSCAN’s role has been to assess elderly drivers’ performance when driving with such a system.

**ADEPT II** (Automatic Debiting and Electronic Payment for Transport)  
(Project No. TR 1002) and TELSCAN’s Collaborative testing  
The ADEPT II project studied integrated smart card based payment systems and integrated information systems in Transport (Tolling systems, ticketing for Public Buses). TELSCAN suggested ways in which electronic payment systems for toll stations, buses and parking areas might better consider the needs of elderly and disabled travellers. The types of information that might be included within smart cards with respect to a person’s particular requirements was also established.

**CONCERT** (COoperation for Novel City Electronic Regulating Tools)  
(Project No. TR 1013) and TELSCAN’s Collaborative testing  
The objective of this testing is the evaluation of Variable Message Signs (VMS) in terms of information content and information presentation. TELSCAN’s aim is to improve the existing messages displayed, in order to meet the special needs of elderly and visually impaired drivers, by means of adequate font size and colour, and the introduction of various pictograms representing well-known traffic signs. It is also hoped that real-time information will soon be displayed on the VMS and through the INTERNET, for available parking sites reserved for disabled users.

**DISTINCT** (Deployment and Integration of Smartcard Technology and Information Networks for Cross-sector Telematics) (Project No. IA 1003) and TELSCAN’s Collaborative testing  
DISTINCT is a Cross-Sector project which aims to integrate a number of on-going telematics applications, such as the multi-purpose smart card, multi-media information services and integrated tourism. Co-operation is based on the development of a smart card access-control system for parking spots reserved for disabled drivers. This application will allow the provision of real-time information for parking through both existing VMS and the TELSCAN web-site.

**EDDIT** (Elderly and Disabled Drivers Information Telematics)  
(DRIVE II Project no. 110882)  
(Oxley, et al., Dec. 1994)  
Three Route Guidance Systems were evaluated on the open road in the vicinity of the Ford Design Centre at Laindon, Essex. These were a Bosch TravelPilot, a Philips CARIN device and a similar system provided by Motorola. All were installed in a Ford Scorpio, and were...
used by subjects on the same pre-set test route. In line with the common methodology of EDDIT, subjects’ performance and behaviour whilst executing a given driving task was measured and recorded both with and without electronic assistance. In the case of the Route Guidance Systems, the subjects’ task was to key in a given destination using the in-vehicle device provided, and then to follow the instructions given by the system to this destination. Test subjects were monitored in two ways: (i) a continuous log was kept of the time during which subjects were looking at the system’s screen and the time during which they were looking straight ahead (which provided data on the frequency of glances at this screen, glance duration and the proportion of driving time that was spent with the eyes off the road), and (ii) an (ex-Police) expert driving assessor sat in the front seat of the test car and evaluated subjects’ driving performance in terms of ten key driving parameters, including positioning, separation, use of gears, brakes etc. Problems and recommendations were made for each of the systems tested, including for example, timing of instructions; content and detail of map-based systems; operation of the systems while driving; and mode, quality, location, size and contrast of output.

**EDDIT** (Elderly and Disabled Drivers Information Telematics)  
(DRIVE II Project no. 110882)  
(Oxley et al., Jan. 1995)

One of the most common types of accident to befall elderly drivers is a collision at a road junction, particularly at a junction where the driver is required to manoeuvre into or across a stream of on-coming traffic. A test was designed, therefore, to assess the feasibility of a device that could act as a decision support mechanism for drivers in such situations. For obvious safety reasons, and because no technology currently exists to accurately measure the gap between successive cars in a stream of traffic, these evaluations were carried out on the driving simulator of the Transport Research Laboratory at Crowthorne. Two driving scenarios were simulated: a right turn from a major road into a minor road across on-coming traffic, and both a left- and right-turn at a T-junction. A device designed by GEC-Marconi Avionics was installed on the dashboard of the simulator’s car - this device consisted of a simple two-light display: a green light which was illuminated when the current gap in the stream of traffic was six seconds or longer, and a red light that was illuminated whenever a gap was less than six seconds. For the simulated T-junction scenario, there were two such displays installed; one to indicate when the gap in the traffic approaching from the left was “safe”, and one to perform the same rôle for traffic approaching from the right. A further advantage of using a driving simulator for this part of the evaluation was that data on minute aspects of subjects’ driving performance were able to be recorded in real time. Therefore, as well as being able to provide attitudinal information (i.e., subjects’ reaction to having such a device to help them make decisions, and their level of compliance with the system’s instructions), it was also possible to closely monitor subjects’ manoeuvring speed, instances of hesitation and any collisions/near misses with other vehicles, both with and without electronic assistance. Using the electronic device significantly increased the number of near misses experienced by subjects, which implies that some on-going indication of the proximity of a possible collision with an on-coming vehicle might be useful. It was found that for this equipment to enter the marketplace, the threshold for advising the driver to initiate a manoeuvre would need to be tailored to the requirements and capabilities of the individual.

**EDDIT** (Elderly and Disabled Drivers Information Telematics)  
(DRIVE II Project no. 110882)  
(Barham, et al., July and Dec. 1994)

Two types of reversing aid were evaluated by EDDIT:
APPENDIX 2: Descriptions of Field Trials/ Simulator Testing

a dashboard-mounted prototype based on infrared technology that gave precise positional information on the locations of objects to the rear of the vehicle (but no audible signal), and an ultrasound-based system which had its in-vehicle display positioned on the rear parcel shelf of the car and combined a light display and sound to convey information on the proximity of the nearest rearward object.

Both aids were evaluated using the off-road facilities of the Transport Research Laboratory, at Crowthorne. In both cases, a test-site was laid out, using poles, kerb stones and crowd control barriers, to simulate a number of common reversing scenarios, namely those of reversing in a straight line to an object (such as a lamp-post), reversing at a 90° angle into a simulated garage and reversing into a parking space between two parked cars parallel to a kerb. A comparison was made of subjects’ performance in these driving exercises both with and without each of the reversing aids, in terms of the accuracy of their manoeuvres, the time taken for each manoeuvre and the number of collisions that subjects had with kerbs and posts etc. A record was also made of subjects’ scanning behaviour whilst carrying out manoeuvres, with and without electronic assistance, in terms of the duration and direction of each glance made (i.e. whether it was made at the reversing aid’s display, the off-side wing-mirror etc.). This enabled an assessment to be made of the extent to which the presence of such in-car technology might impact on the driving task. Finally, to evaluate subjects’ ability to detect a moving object encroaching to the rear of the car whilst they were manoeuvring, a wheelchair was pushed, unannounced, into the path of the reversing test car - once when a reversing aid was in use, and once when no electronic assistance was available. The requirement of a sensing distance of 3m behind the vehicle is still believed to be reasonable for elderly or disabled drivers. The reversing aids enabled elderly drivers to park more accurately within confined spaces. Subjects preferred the provision of audible, as well as visual warnings.

The system mounted on the rear parcel-shelf of the car could be viewed using the rear view mirror. Subjects viewed this display almost exclusively through the rear-view mirror. In terms of the manoeuvring time spent glancing in each direction, the introduction of this system resulted in a substantial increase in the use of the rear-view mirror, and a marked decrease in glances over both shoulders and at both wing mirrors. This positioning was also preferable from the point of view of minimising the level of complexity of the driving task. The conclusion from the evaluations was that, whereas the dashboard-mounted display both increased the number of changes of glance made by subjects and increased manoeuvring time (indicating an increase in drivers’ visual and mental workload whilst manoeuvring), volunteers were not affected in either way when using the display positioned to the rear. (Barham et al., July and Dec 1994)

ELGAR (Environment - Led Guidance And Restraint) (Project No. TR 1013) and TELSCAN’s Collaborative testing

ELGAR is a project that followed CONCERT, a project funded jointly by the European Commission’s DGVII and DGXIII directorates. ELGAR is concerned with road pricing in Bristol; TELSCAN provided funding for Transport & Travel Research Ltd (the co-ordinators of ELGAR) to carry out additional attitudinal research to elicit the views of drivers with disabilities to road pricing and related transport issues. This was achieved by means of focus group discussions - supported by the Disabled Drivers Club and Bristol City Council’s Disability Equality Forum - which covered issues such as the current travel patterns of discussion group participants, attitudes to congestion, parking and environmental aspects of transport, knowledge of and attitudes towards road pricing, the potential effect of road
APPENDIX 2: Descriptions of Field Trials/ Simulator Testing

pricing on the mobility patterns of drivers with disabilities, and the issue of exemptions from road pricing charges.

**EUROSCOPE / ROMANSE II** (Efficient URban Transport Operation Services Co-Operation of Port Cities in Europe / ROad Traffic MANagement System for Europe) (Project No. TR 1023) and TELSCAN Collaborative testing

Collaborative evaluations with EUROSCOPE-ROMANSE II have focused on three telematic facilities, available in the city of Southampton: the TRIPlanner pre-trip planning terminal, the STOPWATCH real-time bus stop information system and the provision of trip planning information on an internet web-site. In each case, TELSCAN’s role has been to evaluate the usefulness and usability of the facilities for travellers who might be elderly and/or have a disability. Such evaluations were carried out by Cranfield University personnel using sub-groups of volunteers representing people with physical, visual and other sensory impairments. People who were both users and non-users of public transport were invited to take part in these evaluations, in order to assess the extent of the impact that these new facilities might have on the mobility of people with special needs throughout the community at large.

**ICARE** (Integration of Contactless CARd technologies into the public transport Environment) (Project No. 1029) / **CALYPSO** (Contact and contactless telemAtics pLatform Yielding a citizen Pass integrating urban Services and financial Operation) (Project No. 1001) and TELSCAN’s Collaborative testing

The ICARE project focussed on the integration of existing contactless technologies in the public transport environment. ICARE was succeeded by the CALYPSO project. TELSCAN’s involvement in the testing has been divided into 3 stages: a first stage consisted of an expert evaluation, a second stage consisted of tests carried out on a first prototype with samples of people who are elderly or who have disabilities, and a final stage involved the final prototype at EXPO98 and the World Cup. Advice given to CALYPSO has included guidance on the design of the pass itself, the validation device and users’ information requirements.

**IN-ARTE** (Integration of Navigation and Anticollision for Rural Traffic Environment) (Project No. TR 4014) and TELSCAN’s Collaborative testing

The co-operation provided assistance to the IN-ARTE project regarding its system development so as the needs of elderly users are met. The assistance wants to guarantee that the special needs of elderly car drivers are taken into consideration in the design process. IN-ARTE (Volvo) will perform a limited number of user tests in a driving simulator with older subjects. Joint analysis of the tests will be performed and recommendations for the special adaptations of the HMI of the IN-ARTE system will be given.

**IN-RESPONSE** (INcident Response detection with on-line innovative sensing) (Project No. TR 1030) and TELSCAN’s Collaborative testing

Specific fields for disabled users have been included in the IN-RESPONSE database. TELSCAN had originally proposed the identification of the international badge for people with disabilities placed on the windshield of the vehicle through the surveillance cameras of the system. An on-site visit to the IN-RESPONSE control center in Thessaloniki showed that the existing cameras provide a distant view of the roadway, allowing only designation of the type and number of the vehicle(s) involved in an incident but in no way a badge placed on the windshield. An alternative option was found interesting by using a GSM mobile phone modified so that it could be connected with the IN-RESPONSE database enabling the
APPENDIX 2: Descriptions of Field Trials/ Simulator Testing

disabled driver to send pre-determined messages to the control centre in case of an emergency.

QUARTET PLUS (Validation of a European Urban and Regional IRTE based on Open System Architectures) (Project No. TR 1044) and TELSCAN’s Collaborative testing
The overall objective of the QUARTET PLUS project was validation of a European urban and regional Integrated Road Transport Environment (IRTE) based on a consistent architecture. The participating sites (Athens, Birmingham, Gothenburg, Stuttgart, Torino and Toulouse) staged a series of extensive, long-term trials, permitting a definitive validation of inputs to be made. The results of these trials showed significant benefit for end users, authorities, operators and industry. As part of the work, a number of new information solutions were evaluated in order to assess user acceptance of traffic and transport information, the consequences for traffic and transport, and the quality of information.

SAMPLUS (System for Advanced Management of Public Transport Operations) (Project No. TR 3321) and TELSCAN’s Collaborative testing
The SAMPLUS project deals with Demand Responsive Transport (DRT) Systems for passengers in urban and rural areas. TELSCAN has assessed both the acceptance of, as well as the technical solution for, a return trip booking system for DRT. TELSCAN has also established cooperation on the following areas of common interest:
- Overview of the E&D user requirements regarding the Demand Responsive Transport Systems (DRTS) through a questionnaire survey (including 100 E&D travellers, users or non-users of public transport services)
- Evaluation study for the implementation of acoustic and visible signs at bus stops
- Evaluation study for electronic message devices in the main Florence railway station, which will include special information dedicated to disabled travellers
- Economic viability of the DRT System applied in Florence - economic impacts from the inclusion of the E&D users.

PROMISE II (Personal mobile Traveller and Traffic Information System) (Project No. TR1043) and TELSCAN’s Collaborative testing
PROMISE France is an Internet site that centralises services intended to facilitate urban transport in the Ile de France Region. The test version provided 5 services to users: search a public transport route, search a road route, user profiles, district plan, points of interest. TELSCAN’ ergonomic evaluation focused mainly on issues for people with hearing impairments and people who are elderly. The evaluation pointed out some interface problems specific to their needs, in particular problems with the terminology used in the system.

SAVE (System for effective Assessment of the driver state and vehicle control in emergency situations) (Project No. TR 1047) and TELSCAN’s Collaborative testing
A group of 13 patients with sleep apnea syndrome was tested in comparison with a group of matched sex and age control group. The main purpose of the study was to compare their respective driving characteristics in order to verify if they belong to a same category of drivers. Sleep apnea patients appear to constitute a separate population from controls of same age, not only for their electrophysiological characteristics and appreciation of their vigilance level, but also for their driving performance. Patients are characterized by poorer control of their trajectory and larger lateral deviations than controls. In addition, while the latter seem to be not sensitive to time on driving (although this time is quite short here), the former were very sensitive to driving time and showed a progressive increase in degraded driving. Subjective evaluations showed clear differences between groups for the global vigilance.
level. Patients generally overestimated their driving ability and were not aware of their poor performance. Therefore, it appears necessary to qualify this subgroup of the population (only a small portion of it has been diagnosed) and determine how IMU-SAVE system can take these characteristics into account and be specifically adapted to them.

**SIAMS** (Ship Information And Management System) (Project No. TR 4025) and TELSCAN’s Collaborative testing

The SIAMS project demonstrates an integrated system in the transportation chain of passengers’ sea lines, involving all relevant actors (shipping lines, port authorities, travel agencies and passengers). The system proposed makes use of various telematic applications (INTERNET, GIS, etc.) in order to assess the impact of such services in the field of information exchange, management and access of the trip process. TELSCAN has provided recommendations regarding information requirements of E&D passengers in every phase of the trip process (pre-trip, on-board, on-arrival), through an overview of SIAMS Del. 3.1, titled “Description of user requirements” together with a set of design guidelines for accessible Information Kiosks derived from this Handbook.

**TELAID** (Telematics Applications for the Integration of Drivers with Special Needs) (DRIVE II Project V2032)  **(Verwey, 1995)**

The possibility of drivers with no functional use of the lower parts of the body (i.e., people with paraplegia) to use various types of input devices while driving with adaptations was examined. From the controls currently used in ATT devices, a sample of controls varying in type, size and position were selected as well as an adapted control (head support switch) (Veenbaas, 1995). Subjects with paraplegia drove in a driving simulator on straight road sections and negotiated roundabouts, left turns, and curves. In these situations they performed a response task, using the selected buttons and switches. Their performance was compared with that of able-bodied drivers. The results indicate that a segment accelerator reduces the ability to operate buttons and switches more than a ring accelerator, but that even with a ring accelerator a disadvantage will remain for people with paraplegia. The study also supports the notion for all drivers that expectations or intentions to perform a certain task may affect driving performance and that the extent that driving is affected depends on the type of input device.

**TELAID** (Telematics Applications for the Integration of Drivers with Special Needs) (DRIVE II Project V2032)  **(Peters, 1996)**

A driving simulator study on ACC driving was performed with drivers with lower limb disabilities (Peters 1996). The subjects were accustomed to driving with hand controls for the accelerator and brakes, and the simulator was equipped with an ACC system. The purpose of the study was to investigate how ACC driving would influence workload, comfort and driving behaviour of drivers with lower limb disabilities, and also to see if ACC driving had a different influence on the driver depending on the type of hand control system being used. It was found that workload was lower and performance better for the ACC driving condition. The subjects also thought that they could control both speed and distance to leading vehicles better with the ACC system than when driving manually. Their variations in speed decreased when the ACC was available, but the system did not influence choice reaction time, speed level, lateral position or variation in lateral position. Mean time headway for the car following situations was shorter for the ACC condition compared to manual driving. The ACC system was well received, wanted and trusted by the subjects.

The study revealed that this group of drivers prefer a longer average headway than that which the system used. Therefore, it is important that the headway parameter of the ACC system is
individually adjustable according to these drivers’ needs and preferences. Drivers with different types of impairments should be included when the adjustable range of the headway is determined. As a starting point it is recommended that the ACC system use a headway which is 0.7 seconds longer compared to that used for able-bodied drivers. For example, an often-used headway value is 1.4 seconds in ACC systems. This value should be prolonged to 2.1 seconds. It is recommended, however, that testing in real traffic is undertaken to validate these guidelines.

**TELAID** *(Telematics Applications for the Integration of Drivers with Special Needs)* *(DRIVE II Project V2032)* *(Peters, 1995)*

The purpose of this field study in TELAID was to test parking behaviour and attitudes to two reversing aid systems, compared to an unsupported condition. Reversing into parking spaces often requires a precise control of the car. Drivers with physical disabilities, especially restricted flexibility in the neck region, find parking difficult as their direct view of the rear is limited. Reversing aids based on various ATT technologies have been developed mainly for trucks and buses. These aids could be used to alleviate the identified problems for this group of drivers with special needs.

Nine drivers with various physical impairments participated in a field test of two different reversing aids. One system used a video camera placed in the rear window and provided only visual feedback on the dashboard-mounted monitor. The other system consisted of ultrasonic sensors on the rear bumper and provided both auditory and visual feedback to the driver. It was found that the ultrasonic system gave better support to the drivers. A probable reason for this result is that this system provided redundant feedback and interfered less with the driving task. This system also informed the driver of the position of rear obstacles based on ISO defined warning zones.

Even though most of the differences between the systems were not significant, it seems likely that both systems can improve parking behaviour for drivers with special needs and that the systems will be accepted by the drivers. More testing of reversing aids is needed with elderly and disabled drivers in order to find out to what extent these systems will promote their independent mobility.