Overview of validated recommendations for evaluation of ATT system with respect to E & D: A methodology for travellers who are elderly and disabled.

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TELSCAN

TELematic Standards and Coordination of ATT systems in relation to elderly and disabled travellers

TRANSPORT TELEMATICS PROJECT N°.: TR 1108

Title
Overview of validated recommendations for evaluation of ATT systems with respect to E & D

A Methodology for the assessment of Telematic Applications for travellers who are elderly or disabled

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Executive summary

The specific objective in WP04 activity 4.1 is to provide help to Telematic Application designers to define and to complete assessment of the usability of systems with integration of potential users with disabilities or who are elderly. The first level of the assessment methodology framework is related to the definition of the users to be involved in the usability assessment. To this end TELSCAN proposed three indicators:

- The mobility indicator
- The problem indicator
- The extent indicator

These indicators have to be analysed and tailored according to different considerations best accomplished by way of a brainstorming session.

The second level of the framework is related to the choice of the testing environment and context, as some of them could be more suitable or unsuitable to persons with disability or who are elderly.

In the third level, the framework provided guidelines in order to choose the methods/tools which will be the more suitable for use with the persons with disability or who are elderly as well as protocols or ethical issues which need to be considered.

Some information are also provided on the analysis of the results procedure and two cases studies are given in order to illustrate the framework.
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1. Introduction

In TELSCAN wp04, Methodological framework for the usability of Telematic Applications by elderly or disabled travellers-Evaluation in controlled environments, the main objectives are:

- to define assessment aspects that are relevant for the assessment of the usability and the appropriateness of telematic applications for travellers with disabilities or who are elderly
- to develop criteria for the assessment of telematic applications with respect to the requirements of travellers with disabilities or who are elderly
- to ensure homogeneity of the assessments conducted by TELSCAN in terms of methods/assessment criteria and usability of results.

The specific objective in WP04 activity 4.1 is to provide help to Telematic Application designers to define and to complete assessment of the usability of systems with integration of potential users with disabilities or who are elderly.

The TELSCAN project makes this distinction in order to state that persons who are elderly should not necessarily be considered as persons with impairments.

It is important to recognise, however, that elderly people do not form a homogeneous group, and many elderly people have active and healthy lives, even though the natural process of ageing has reduced certain abilities. Chronological age is not a true indicator of deterred performance and increased disabilities, and variability also increases with age. Therefore, where we use the terms ‘elderly and disabled’, we do not imply that elderly people are disabled (Nicolle and Peters, 1999).

However, the project is very aware of all the changes in functional abilities due to the ageing process, but the impact on mobility cannot be compared with the situation of persons with medical impairments. When dealing with Telematic Applications, ageing is a process which can have a great influence on the usability of the device and its acceptance by the persons who are elderly; « user friendly interface » is a crucial issue for them. That is why TELSCAN recommend that in the design of an usability assessment plan, persons who are elderly should been included.

Even if it is well admitted that the chronological age is not really a true indicator of age, in most of the studies, persons are considered to be part of the elderly population between 60-65 and over. Depending of the goal of the study, it could be possible to find studies including persons over 50 years old but in this case, it is better not to classify them as person who are elderly but person in their fifties for instance.

This framework deals mainly with the human factors issues related to telematic applications, and does not cover the assessment of the economic or technical impact of a system.

The usability of a given device can be assessed by different ways, but the two mainly used are expert assessment and assessment using a sample of users. Annex 1 provide
some background information in relation to the human factors assessment of a device found in the literature.

In the framework of this work-package, the TELSCAN’s methodology guidelines are not directly concerned with expert assessment, even if some of the issues presented in this report can be useful for them.

TELSCAN support to the Transports Telematics projects is planned in three levels which are described in Table 1.

Table 1 - Levels of Support to Transport Telematics Projects

<table>
<thead>
<tr>
<th>Level</th>
<th>Support Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level A</td>
<td>Common assessment and development between TELSCAN and other projects</td>
</tr>
<tr>
<td>Level B</td>
<td>Continuous expert monitoring and support</td>
</tr>
<tr>
<td>Level C</td>
<td>Project expert advice upon request</td>
</tr>
</tbody>
</table>

Since many projects were already in their validation phases at the beginning of this workpackage task, collaborative testing took place at the same time as the framework for usability assessment was produced.

In the case of level A support, the assessment with respect to travellers with disabilities or who are elderly was conducted by the TELSCAN partner and, as they are specialists of this field, they did not need real guidance to conduct their usability assessment. For the other levels of support, the usability assessment was not supposed to be conducted by TELSCAN specialists. This is why the framework presented here gives very detailed information and tries to help the assessors as much as possible during the choice of their samples of subjects, the choice of their environment for testing and the choice of their methods and tools.

For Telematic Application projects, all the aspects concerning the evaluation of the application, which for us include the usability assessment, had to follow the guidelines provided by the horizontal project CONVERGE. To ensure that TELSCAN completed the work of this project, TELSCAN reviewed in detail the deliverables produced by CONVERGE and, in order to avoid duplication of information we chose not to repeat some elements and made cross reference to CONVERGE documents. The main difference between the CONVERGE and the TELSCAN approach in this activity is that CONVERGE covered all the aspects of the evaluation process and that TELSCAN focused, in this report, only on one of these aspects: the usability assessment. This was due to the act that many of the TELSCAN partners are human factors specialists and also because it appeared that this particular aspect was not very detailed in the CONVERGE documents.

Figure 1 describes the composition of a whole evaluation process according to CONVERGE and the main input that TELSCAN provide in this report. The input is on three levels

- Choice of assessment category
- Choice of evaluation methods
- Study design

Figure 1: Where TELSCAN’s Methodology fits into Evaluation Process as defined by CONVERGE

This chart is extracted from the CONVERGE Del5.2 « Model validation plans » and represents the TRACAR (TR1059) draft validation plan done according to CONVERGE guidelines
As a result of the review of the CONVERGE reports, TELSCAN suggests some improvements in the tables produced in the CONVERGE Deliverable 3.2. These tables are presented in annex 2.

Overview of Assessment Methodology (figure 2)

The first level of the assessment methodology framework is related to the definition of the users to be involved in the usability assessment. To this end TELSCAN (Burnett & Nicolle 1998) developed three indicators:

- The mobility indicator
- The problem indicator
- The extent indicator

These indicators have to be analysed and tailored according to different considerations best accomplished by way of a brainstorming session (see section 2.4).

The second level of the framework is related to the choice of the testing environment and context, as some of them could be more suitable or unsuitable to persons with disability or who are elderly.

In the third level, the framework provided guidelines in order to choose the methods/tools which will be the more suitable for use with the persons with disability or who are elderly as well as protocols or ethical issues which need to be considered.

Some information are also provided on the analysis of the results procedure and two cases studies are given in order to illustrate the framework.
Figure 2: Overview of TELSCAN assessment methodology
2. Definition of user groups to include in assessment

This part of the assessment methodology leads assessors to particular user groups in light of the following factors:

- Mobility indicator, i.e., the extent to which system functionality could help a particular group with impairment overcome their mobility problems
- Problem indicator, i.e., the difficulties that might be experienced by different groups with impairment when using the system
- Extent indicator, i.e., the number of people who could potentially benefit from such a system.

Figure 3 below illustrates the 3 indicators, their inputs and outputs. In general terms, a consideration of each of the indicators and their output will aid the assessor in making a decision as to which user groups are most relevant to their application. Some basic assumptions must be noted.

- The ordering of the indicators does not suggest that one indicator is more important than the other.

- The activities do not need to be performed in a prescribed order.

- The assessor must make the final decision regarding which user groups to include in their trials. This methodology does not make this choice for them, rather it highlights what the relevant issues are when making this decision.

- Since the needs of older people differ from younger people with the same functional impairments, a sample of persons who are elderly should always be included in the assessment as a matter of course, in addition to the other impairment groups chosen from the functional point of view.
Figure 3: Methodology - Choice of subjects for ATT assessment trials

Sections 2.1 to 2.3 below outline how the assessor can gain an understanding of each of the indicators.

2.1 Mobility Indicator

TELSCAN has identified the numerous difficulties experienced by persons with disability or who are elderly when travelling through 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 person in a wheelchair might benefit from increased knowledge to aid in trip planning, such as whether there are any lifts at the destination station (see annex 3 for more details).

Clearly, the provision of functionality within an ATT system can be considered to be important for all travellers. Nevertheless, as an aid to the assessor, table 2 below states...
which of the different user groups are **most likely** to benefit from the provision of certain high-level functionality within an ATT system - this serves as the **Mobility Indicator**.

The sections below the table (2.1.1 to 2.1.9) give in descriptive terms examples to illustrate some of the ticks put in the table.

**Table 2: Mobility indicator** : User groups who will potentially benefit most from system’s functionality-Classified as in TELSCAN Deliverable 3.2, Part 3-. (Remember always to include users who are elderly, as well as users from functional classification)

<table>
<thead>
<tr>
<th>System functionality</th>
<th>People who are elderly</th>
<th>People with disabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LL</td>
<td>UL</td>
</tr>
<tr>
<td>Pre-trip planning</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Trip information</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Access to vehicle/ service</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Vehicle control</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Parking</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Dealing with weather &amp; environment</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Emergency warning &amp; traveller support</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Ticketing /payment</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Toll collection</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

**Key to User Groups (from Functional Classification, TELSCAN Deliverable 3.1)**

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LL</td>
<td>Lower Limb</td>
<td>2</td>
<td>UL</td>
<td>Upper Limb</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>A</td>
<td>Anthropometrics</td>
<td>5</td>
<td>C/D</td>
<td>Co-ordination/Dexterity</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>SL</td>
<td>Sudden Loss of control (visceral)</td>
<td>8</td>
<td>V</td>
<td>Vision</td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td>L/S</td>
<td>Language and Speech</td>
<td>11</td>
<td>C</td>
<td>Cognitive</td>
<td></td>
</tr>
</tbody>
</table>

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In the first column persons who are elderly are included as an additional group, even though it is clear that when following a functional classification, they do not form a separate group for data capture or assessment. For example, the requirements of a person who is elderly with mobility problems are very different from a young person in a wheelchair. TELSCAN therefore recommend that travellers who are elderly shall be included in all assessments as a matter of course.

2.1.1 Pre-Trip Planning

The extent to which a trip-planning ATT system might improve the mobility of a person who is elderly or disabled depends largely on the information that is provided within the interface. Consequently, it is important that the assessor considers in detail the information that is available, and whether a particular group of persons who are elderly/disabled might benefit from the inclusion of such information.

By way of example, a person with mobility problems, whether a youth in a wheelchair or a person who is elderly with arthritis, would like to know how long they have to wait at a stop/station; a person with vision problems would benefit from a clear audible or tactile description of the layout of a station, the location of doors and the length of carriages; whilst a person with poor memory would benefit from regular reminders of the trip plan.

2.1.2 Trip Information

Again, it is primarily the nature of the information provided by an ATT system during a trip which may improve the mobility of persons who are elderly or disabled. In this respect, information relating to navigation (both for purposes of general orientation and route following/re-planning) is of particular importance for those with visual and cognitive impairments and travellers who are older. This is the case for private transport (e.g. reading and interpreting road signs) and public transport (e.g. identifying upcoming stops/stations).

Certain modes of transport may currently require travellers to utilise verbal information or to communicate with others during a journey, e.g. hearing airport/station announcements, or communicating with a driver/steward. In such cases, the visual display of equivalent information will be of considerable importance for those with hearing or language/speech impairments.

2.1.3 Access to Vehicle/Service

Physical access to a vehicle (whether a car or a public transport vehicle) is a particular problem for users of wheelchair, and those with impairments that mean that the use of doors is problematic (upper limb, force, co-ordination/dexterity). Therefore, the provision of any functionality within an ATT system that can aid in access tasks will be of considerable benefit to these groups of people.
In addition, any functionality within an ATT system that aids those with limited visual and/or cognitive functions (including persons who are elderly) to identify whether the correct bus/tram is approaching will be of significance.

### 2.1.4 Vehicle Control

Drivers with physical disabilities (lower/upper limb, upper body) may use a variety of different car adaptations in order to control their vehicle. As a result, the workload (both physical and mental) associated with primary control of the vehicle can be extremely high, and thus any ATT functionality which might reduce the difficulties encountered in carrying out secondary tasks (e.g. navigation, accessing in-vehicle controls) will be of benefit to these individuals.

Given that driving is predominately a visual task, functionality which can assist those drivers with visual impairments (e.g. reduced visual acuity/field of view) is of fundamental importance. Particular tasks where new functionality may be of benefit include: choosing a correct lane; estimating driving distances and vehicle speeds; indication of traffic light status; and using roads signs (particularly at night). In addition, many drivers who are elderly or disabled (particularly those with visual impairments, or those who cannot easily turn their body) experience difficulties in judging gaps in traffic, and would benefit from functionality to assist in this task.

An individual who experiences sudden loss of control (e.g. a heart attack) is evidently a major safety risk to other road users in the driving situation, and functionality with assists in the control of the vehicle in these situations may save lives.

### 2.1.5 Parking

Parking is a task which currently requires considerable rotation and concurrent balancing of the body, and hence is a major problem for drivers with lower limb and upper body impairments. Drivers with visual impairments and poor spatial awareness (cognitive) also experience difficulties in parking at present, and hence will benefit from functionality to assist in this task.

### 2.1.6 Dealing with weather and environment

People with visual impairments (including drivers who are elderly) can experience considerable difficulties in degraded driving conditions (e.g. poor weather and night-time), for instance due to headlight glare. ATT functionality which can support drivers in these conditions (e.g. vision enhancement) will particularly benefit these individuals.

The acoustic environment within bus/train stations and airports can be such that those with hearing impairments currently experience difficulties with spoken announcements. ATT systems which provide this information via other means (e.g. visually) will be important to these people.
2.1.7 Emergency warning and traveller support

Support during emergency situations (e.g. an evacuation of an airport) will be of particular benefit to all groups of people who are elderly or disabled, due to possible fear, lack of confidence and/or physical ability to cope with the circumstances. Nevertheless, it can be argued that certain people might be expected to benefit more from ATT functionality relating to emergency warning and traveller support.

For instance, given that many emergency warnings are auditory (to attract attention), those with hearing and language/speech impairments may currently be left unaware of the predicament. Travellers with cognitive impairments would be expected to experience considerable difficulties in emergency situations, and ATT functionality of this kind could be of considerable benefit.

In the driving situation, it can be difficult for those with lower limb impairments to quickly get out of the car and then access an emergency phone. Therefore, ATT functionality which provides the means of contacting emergency services from within the car would be important to these individuals.

2.1.8 Ticketing/payment

Many current ticket machines, whether relating to public transport or car parks, require physical interaction (e.g. pressing buttons, reaching controls). As such, users of wheelchair, travellers with upper limb impairments or those with limited strength or co-ordination in their hands will experience difficulties in using these machines. ATT functionality which aids in user-ticket machine interaction (e.g. smart/contactless cards), will be extremely important to such people.

Ticket machines generally require a number of steps to be followed. As a result, tasks associated with them (e.g. understanding and remembering instructions, calculating costs) can be excessively demanding for those with cognitive impairments. Furthermore, locating the machine in the first instance and reading any visual instructions will evidently be a problem for those with limited sight.

In the absence of ticket machines, ticketing/payment can require communication with staff, and hence will be problematic for those with language/speech impairments. ATT systems which assist in these aspects of the travelling task will be valuable aids to an individual’s mobility.

2.1.9 Toll collection

Currently, many drivers with upper body/limb impairments experience difficulties in passing money through car windows at toll plazas. Drivers with visual impairments can also experience some difficulties in locating which toll booth is appropriate for them. ATT functionality to assist in these tasks will be of considerable benefit to these individuals.
Information provided in annex 2 could also be helpful to complete the mobility indicator and more detailed information can be found in TELSCAN Deliverable 3.1 and 3.2.

2.2 Problem Indicator

The interface to an ATT system will possess a number of characteristics that could lead to difficulties for particular persons who are elderly or disabled. 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, it will be critical that an assessor considers the relevant attributes of their system interface against the Functional Classification for Elderly and Disabled Travellers (TELSCAN Deliverable 3.1) - this is what is termed the Problem Indicator. Such a mapping process will lead the assessor to those groups who might experience greatest problems, and, hence should be considered for inclusion within any assessment trials. Notice again that people who are elderly are recommended for inclusion in the assessment as a matter of course.

Evidently, there are many characteristics of system interfaces that could potentially cause problems for different persons who are elderly or disabled. Table 3 serves as a starting point, by listing questions that the assessor should consider regarding their interface, and the corresponding user groups that are most likely to experience difficulties as a result of a ‘yes’ answer. It is evident that such questions will also point towards design guidelines for that system, for example using simple symbols to assist people with cognitive impairments, providing alternative output in both visual and audio modes, or ensuring that the device is light and easy to carry (See TELSCAN Deliverable 5.3).

At first glance, an assessor might think that the Sensory Modalities below would point toward the only user groups to include in the assessment. Indeed, these groups are the most obvious (e.g. if the system has visual output, a person with a visual impairment is likely to have problems). However, if the system has a socket for an assistive device to provide speech output, or if the system has a font enlargement facility, then the user is unlikely to experience problems with the visual interface. Once user groups have been identified through the Sensory Modality questions, it is still necessary to investigate the interface to a finer level of detail. Hence, it is important to answer all the questions in the Problem Indicator to identify less obvious user problems (e.g. other user groups who might have difficulty with visual output because they cannot understand text or symbols).
Table 3: Problem indicator
User groups for which particular system interface characteristics could cause problems

<table>
<thead>
<tr>
<th>Sensory modality</th>
<th>People who are elderly</th>
<th>People with disabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tick if</td>
<td>LL</td>
<td>UL</td>
</tr>
<tr>
<td>Is input required with hands/fingers?</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>Is input required with feet/lower limbs?</td>
<td></td>
<td>YES</td>
</tr>
<tr>
<td>Is input required with speech?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is there any visual output?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is there any auditory tone output?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is there any auditory speech output?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is there any output given to hands/fingers?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is there any output given to feet/lower limbs?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is the system incompatible with assistive devices which can provide alternative input/output modes?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Question</th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Is access to any displays/controls restricted (e.g. fixed locations)?</td>
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<td></td>
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<tr>
<td>Is a user prevented from getting his or her face close to any displays?</td>
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<td></td>
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</tr>
<tr>
<td>Does the user have to rotate their upper body in order to view/access any displays/controls?</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Are there separate controls which are close together (i.e. controls which may be inadvertently activated)?</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Visual display</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Is glare/reflection a potential problem on the display?</td>
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<tr>
<td>Is contrast/brightness not adjustable or not easily adjustable?</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Is the default contrast/brightness of the display low?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does the display have to be used in conditions of low light (e.g. night-time)?</td>
<td></td>
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<tr>
<td>Is there any text to be read?</td>
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<tr>
<td>Is coding used to provide information to the user?</td>
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<tr>
<td>Are there any symbols/icons to interpret (in particular those which are not commonly encountered)?</td>
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<tr>
<td>Are colours used to code information?</td>
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<tr>
<td>Is there any visual information requiring decision making?</td>
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<tr>
<td>Would a user have difficulty enlarging the size of a display or its image?</td>
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<tr>
<td><strong>Auditory output</strong></td>
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<tr>
<td>Does auditory information have to be used in a variety of different acoustic environments?</td>
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<tr>
<td>Is volume/balance <strong>not</strong> easily adjustable?</td>
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<tr>
<td>Is there any auditory information requiring decision making?</td>
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<tr>
<td>Is volume/balance <strong>not</strong> automatically adjusted according to ambient conditions (i.e. controls are required)?</td>
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<tr>
<td>Is there any auditory output which use high frequencies?</td>
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<table>
<thead>
<tr>
<th><strong>Controls</strong></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>Are there any obstacles nearby preventing user from making easy contact with controls</td>
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<tr>
<td>Is precision required in the use of controls (e.g. small buttons or a continuous rotary knob)?</td>
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<tr>
<td>For optimal control performance, are both hands required?</td>
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<tr>
<td>Is a pushing/pulling/rotating force required (in particular, controls which need holding down or those which require concurrent pushing/pulling and rotating)?</td>
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<tr>
<td>Are there any controls which cannot be readily identified by touch alone (e.g. by shape, size, type)?</td>
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</tbody>
</table>
### General

Does the user have to remain vigilant when using the ATT system (i.e. the consequences of lack of attention are high)?

<p>| | |</p>
<table>
<thead>
<tr>
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</table>

### Key to User Groups (from Functional Classification, TELSCAN Deliv. 3.1)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LL  Lower Limb</td>
</tr>
<tr>
<td>2</td>
<td>UL  Upper Limb</td>
</tr>
<tr>
<td>3</td>
<td>UB  Upper Body</td>
</tr>
<tr>
<td>4</td>
<td>A   Anthropometrics</td>
</tr>
<tr>
<td>5</td>
<td>C/D Co-ordination/Dexterity</td>
</tr>
<tr>
<td>6</td>
<td>F   Force</td>
</tr>
<tr>
<td>7</td>
<td>SL  Sudden Loss of control (visceral)</td>
</tr>
<tr>
<td>8</td>
<td>V   Vision</td>
</tr>
<tr>
<td>9</td>
<td>H   Hearing</td>
</tr>
<tr>
<td>10</td>
<td>L/S Language and Speech</td>
</tr>
<tr>
<td>11</td>
<td>C   Cognitive</td>
</tr>
</tbody>
</table>
2.3 Extent Indicator

Finally, the demographics of each impairment group will help to assess the number of people who will be affected by the use of the system, or who could benefit in some way. This is the Extent Indicator. In Europe, the estimated number of people with impairments is given in Table 4 that follows (Gill, 1997). Unfortunately, this table does not include any figures for those with upper body impairments, individuals who are short in stature, or people who are prone to sudden loss of control.

In addition, people who are elderly represent a significant proportion of the European population and the numbers are still rising. Many of these people will also have disabilities, which will be included in Table 4 below.

Table 4: Number of people with physical disabilities in Europe, out of geographic population of about 800 million (Gill, 1997):

<table>
<thead>
<tr>
<th>Impairment Type</th>
<th>Description</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>LL Lower Limb</td>
<td>Wheelchair users</td>
<td>3 million</td>
<td>(0.4%)</td>
</tr>
<tr>
<td></td>
<td>Cannot walk without aid</td>
<td>45 million</td>
<td>(5.6%)</td>
</tr>
<tr>
<td>UL Upper Limb</td>
<td>Cannot use fingers</td>
<td>1 million</td>
<td>(0.1%)</td>
</tr>
<tr>
<td></td>
<td>Cannot use one arm</td>
<td>1 million</td>
<td>(0.1%)</td>
</tr>
<tr>
<td>F Force</td>
<td>Reduced strength</td>
<td>22 million</td>
<td>(2.8%)</td>
</tr>
<tr>
<td>C/D Co-ordination/Dexterity</td>
<td>Reduced co-ordination</td>
<td>11 million</td>
<td>(1.4%)</td>
</tr>
<tr>
<td>L/S Language and Speech</td>
<td>Speech impaired</td>
<td>2 million</td>
<td>(0.3%)</td>
</tr>
<tr>
<td></td>
<td>Language impaired</td>
<td>5 million</td>
<td>(0.6%)</td>
</tr>
<tr>
<td></td>
<td>Dyslexia</td>
<td>25 million</td>
<td>(3.1%)</td>
</tr>
<tr>
<td>C Cognitive</td>
<td>Intellectually impaired</td>
<td>30 million</td>
<td>(3.8%)</td>
</tr>
<tr>
<td>H Hearing</td>
<td>Deaf</td>
<td>1 million</td>
<td>(0.1%)</td>
</tr>
<tr>
<td></td>
<td>Hard of hearing</td>
<td>80 million</td>
<td>(10.0%)</td>
</tr>
<tr>
<td>V Vision</td>
<td>Blind</td>
<td>1 million</td>
<td>(0.1%)</td>
</tr>
<tr>
<td></td>
<td>Low vision</td>
<td>11 million</td>
<td>(1.4%)</td>
</tr>
</tbody>
</table>

Some relevant statistics on the ageing population are given below:

- 15.5% of the population in the EU are over 65 (Demographic Statistics, 1997)

- The proportion of over 50s in the UK is projected to reach 48% of the population by 2021 (Coleman, 1993)

- Aged population will increase from its current level of 10-15% to around 20-30% in 2047 (Frye, 1997).

- Disabilities increase with age. 2/3 of disabled people are elderly (Kumar). 1997
• By the year 2021, a significant increase in proportion of people beyond age 80, and a reduction in the young adult population (Kumar, 1997)

Of course, even though we can estimate the number of people in the majority of the impairment groups, this does not mean that these figures will reflect the number of potential users of the system in question. To illustrate, when TELSCAN identified the requirements of travellers with visual impairments, many users with visual impairments mentioned that no difficulties were experienced because they usually travelled with friends if at all possible. However, would the availability of an easy-to-use, hand-held device enable the person to travel on his/her own, without reliance on another person? This would in fact impact on mobility, leading to more independence and quality of life for the traveller who is elderly or disabled.

It is very important to assess the likelihood of people actually using or wanting to use the system. If this market-related information is available to the assessor, it should be used in conjunction with table 4. In summary, we recommend that projects/assessors consider and discuss this difficult issue, and not just look at the numbers in each impairment group as an indicator of the true numbers involved.

2.4 Brainstorming process

The Mobility Indicator, the Problem Indicator and the Extent Indicator described above will produce a qualitative/quantitative listing of priorities and issues for consideration. This will lead the project team towards an informed choice of subjects to include in the assessment trials.

Ideally, no user groups should be excluded, but with resource constraints it is always necessary to make certain difficult decisions and trade-offs. This methodology does not suggest that the difficulties of certain impairment groups are not severe enough to include them in the assessment process. It just attempts to assist designers/assessors in making realistic and cost-effective plans to ensure that the system is more usable by more people, within the resource constraints of the project. We recommend that the assessment team conduct a brainstorming session to interpret the data derived from the 3 indicators in order to arrive at their best possible choice of user groups.

Brainstorming is a technique by which people from different backgrounds (e.g. the members of a multi-disciplinary design team) come together to inspire each other and generate new ideas (Poulson, et al., 1996). The more creative people, the more variety of experiences, the better the result should be. Ideally, 5-12 people may participate, one of whom will be group leader, and a session need not take more than one hour.

The starting point of brainstorming is important, and the group leader must present the issue or question to the others, giving them a few minutes to think about it before the session begins. Each participant can then present his or her ideas, each person
building on others’ ideas and trying to take them further. We recommend that the focus of this brainstorming session is:

“How do we interpret the data derived from the 3 indicators in order to arrive at the best possible choice of user groups to be involved in the system’s assessment?”

Some key issues which members of the team ought to consider are listed below, and these could be presented by the group leader before the session. However, these issues are in no way meant to limit the opinions or creativity of the participants.

1. With regard to the Mobility Indicator, it is necessary to consider whether the transport system being assessed is both accessible to the user groups in question, and also whether it contains relevant information to that user group. For example, even though people with lower limb impairments were selected by the Mobility Indicator because they could benefit from a particular trip information system, it may not be possible to include them in the assessment if the transport is not accessible. Using the Mobility Indicator, therefore, highlights the importance of accessibility.

2. It is necessary to consider the adverse effects and consequences that a system may have on one group, which might at the same time be benefiting another group. For example, mobile telephones are wonderful for people using wheelchairs, but for people using hearing aids, mobile telephones are not acceptable because they cause interference.

3. In choosing user groups for assessment, it is also necessary to consider the type of travelling tasks that may be problematic for persons with different levels of visual acuity. For example, in the UK, a driver must be able to read a standard number plate (containing letters and figures 79.4 millimetres high) in good daylight from 20.5m (67 feet), using glasses if necessary. If glasses or contact lenses are needed to do this, the driver must wear them every time he or she drives. And so, if a user group does not have the required level of visual acuity to drive, they need not be included in testing for vehicle control systems. On the other hand, a person with other forms of visual impairment, e.g. colour blindness, may have problems if the system’s display relies on colour coding.

4. It is important to consider user groups with multiple impairments, which might make the use of the system that much more problematic. Examples where combinations of impairments are likely to occur are:
   - Lower limb and upper limb
   - Visual and hearing
   - Cognitive and mobility
Therefore, if the Problem Indicator identifies people with, for example, visual and hearing impairments, consider trying to include users with not only these individual impairments, but also a combination of these.

5. When the safety of travellers is an issue (e.g. for people who have visual difficulties but still meet the requirement to drive) then the Problem Indicator becomes even more important. It would then be necessary to investigate the displays and controls that might cause particular problems for that user group. Issues identified through the Problem Indicator will often help to identify not only the experimental design and scenarios for testing, but also the need to consider re-designing the system's interface, using the design guidelines developed by TELSCAN.

Discussing issues such as these will help to choose the most relevant groups to include in the assessment strategy. It is necessary to stress that the team must make the final decision, and these are only tools to highlight important issues. Furthermore, in order to implement these decisions, it is necessary for assessors to know how to find people who have different types of impairments. More work is needed to extend this methodology to include a list of contacts to help designers find the right organisations and individuals.
3. Testing Environments / Context

When including people who are elderly or disabled in the assessment process, the environment for testing may need to be different or need to be adapted to suit particular needs. Once the most relevant user groups have been chosen for testing, they may need special consideration to accommodate their physical, communication, visual or cognitive requirements. For example, assessments including people with lower limb impairments must consider ease of ingress/egress and whether the test vehicle has wheelchair restraints. Certain environments may exclude certain user groups simply because they are not accessible, for example the moving base simulator may be impossible to climb into unless the funds can be found to install a lift.

The environments have been drawn from the HARDIE Evaluation Database (Ross et al., 1993), which identifies possible environments for testing systems in cars. These test environments and contexts also draw from those developed by the DRIVE Safety Task Force (1991), which distinguishes between real environment test trials at micro (single vehicle) and macro (fleet) levels.

TELSCAN expanded HARDIE’s list of environments to include those that can be used for testing other systems for travellers, for example in the railway station or in the home. These have been classified according to their correspondence to the real or artificial world, as shown below:

<table>
<thead>
<tr>
<th>Real World</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real vehicle in real environment</td>
</tr>
<tr>
<td>Test vehicle in real environment</td>
</tr>
<tr>
<td>Real vehicle in test environment</td>
</tr>
<tr>
<td>Test vehicle in test environment</td>
</tr>
<tr>
<td>Moving base simulator</td>
</tr>
<tr>
<td>Static simulator</td>
</tr>
<tr>
<td>Usability laboratory</td>
</tr>
<tr>
<td>Laboratory</td>
</tr>
<tr>
<td>Specific test environment (e.g. at home or other familiar place)</td>
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</tbody>
</table>

| Artificial World              |

This section begins with the general considerations needed to enable people with a particular type of disability (whether it be physical, communication, visual or cognitive) to
take part in any kind of experimental work (Section 3.1). Suggestions are made to overcome some of the difficulties, but further protocols are also recommended in the Methods/Tools section in Part 4.

The specific advantages and disadvantages of each environment are then discussed in Sections 3.2 to 3.11. Provided that the correct arrangements have been made for people with disabilities, these advantages and disadvantages will apply equally well to volunteers who are either able-bodied or disabled. In some cases, specific issues need to be considered, and these are listed where appropriate.

3.1 General Issues

3.1.1 Issues for all people with disabilities and people who are elderly

The first thing that should be recommended is to put people first, not their disabilities: for example, in terms of wording "people with disabilities" is more adapted than 'the disabled', or "a person who has cerebral palsy", instead of "a cerebral palsy sufferer" etc. It is important to emphasise people's abilities, not their limitations.

The assessors should understand the issues concerning people with disabilities, and should be either thoroughly experienced in the field, or if newcomers to the field, thoroughly briefed. Although it is true that common-sense and courtesy go a long way, it is also true that one ignorant mistake can cause the volunteer to put up a barrier fairly quickly.

Take sufficient time before the testing to understand the traveller’s abilities, needs and preferences. If a vehicle is used, allow plenty of time for volunteers, especially those who are elderly, to become familiarised with it. This is particularly important when a car with an automatic transmission is used if the volunteer is used to a manual gearbox (and vice versa). A person who is elderly might also be generally inexperienced with modern cars.

It is also of first interest to establish the degree of familiarity the persons have with technological devices. As a matter of fact, some persons who are elderly are even afraid of new technological system but on the contrary, a person with physical or sensory impairments can be an expert in using a computer for example. All the research protocol to be used in the assessment will have to be design with this issues in mind.

If uncertain on any aspect, seek professional advice to ensure safety and acceptability. Ethical guidelines must be adhered to, with testing procedures approved by an appropriate research ethics committee.

Safety is always of paramount importance when using members of the public for assessments. The should be covered by an insurance policy, just in case there is an accident during the course of the assessment.
In most cases, it is necessary to rely on various organisations for people with disabilities distributing invitations, on our behalf, for people to take part in tests. For example, the Data Protection Act in the UK gives guidelines for obtaining the names and addresses of potential volunteers; although this appears to be quite acceptable to most people, many volunteers appreciate being told how their names and addresses were obtained.

### 3.1.2 Issues for Travellers with Physical Impairments

As these travellers may tire easily, the testing time should be limited. The assessor should consider the distance that the subject may have to travel to the test site, as this may have implications for either the choice of volunteers or the choice of test site.

Private and public transport vehicles, their environment, simulators, laboratories, nearby toilets and other facilities must all be accessible to people with lower limb impairments. This includes people in wheelchairs and also people who would find stairs difficult or tiring.

As safety should be of paramount importance, there are some things to bear in mind when volunteers are using wheelchairs, particularly when they are being asked to go up ramps, down slopes and over kerbs, etc.:

1. Don't underestimate how easy it is for a wheelchair to tip over, or for the user to fall out, especially when the volunteer has limited strength and/or control in the torso. The user might also be unaware of the instability of the chair that they are using, so there must be at least one person in very close attendance when they are asked to perform anything that might have the remotest possibility of danger.

2. Before you invite a volunteer to perform any task or manoeuvre, be sure to ask them whether they can carry it out safely and without causing themselves any distress or anxiety.

3. Having asked them, continue to be cautious because for a number of reasons, they may be too cavalier with their own safety, or simply not wish to appear weak by shying away from what they might see as a challenge. It doesn't hurt to err on the side of caution - ie. better safe than sorry!

### 3.1.3 Issues for Travellers with Communication Impairments

It may be difficult to communicate instructions or collect verbal protocols from people with hearing or speech impairments; clear instructions should be provided on printed
sheets. Consider use of a sign interpreter and sit in a position which would make lip-reading possible, and establish before the trial any particular protocols for issuing further instructions or warnings.

3.1.4 Issues for Travellers with Visual Impairments

Arrangements to accommodate carers or guide dogs shall be provided.

Few people with visual impairments really use Braille, so it is not absolutely necessary to convert text to that format. Size 16 point font can be read by many people with visual impairments.

Ensure that lighting levels are high and good contrast is used on all materials.

3.1.5 Issues for Travellers with Cognitive Impairments

There may be uncertainty over the traveller's decision-making and awareness capabilities, and also they may have difficulty distinguishing between the real and simulated world. Assessor should take time with the volunteer to discuss the purpose of the trial, and describe the test environment, for example, what is meant by a simulator or test track.

People with cognitive impairments and some persons who are elderly may find it difficult to learn new tasks, so sufficient time must be allowed, with clear simple instructions.

Ensure that safety backup procedures are available, e.g., dual controls or mobile phones.

3.2 Real vehicle in real environment

This refers to a non-instrumented vehicle operated in its actual environment, whether it be a car on the road, or a public transport vehicle on road, rail, or in the air. The traveller is usually unaware of observation and the vehicle is therefore normally their own or used regularly by them. Usually this type of environment is used to collect more descriptive metrics, although road sensors can sometimes be used to gather objective metrics from drivers such as speed. The HARDIE project identified the advantages and disadvantages of using a real car in a real environment, and these have been adapted to meet the needs of TELSCAN, including all forms of transport, as follows:

Advantages:
- Results likely to represent real world phenomena.
- Low equipment cost if observation only.
- Travellers likely to be familiar with vehicle (usually own car) or with the context

Disadvantages:
• (Usually) observational data only = less accurate measurement of micro level data.
• Limited control over variables.
• Can be high labour cost if time consuming data collection methods are used.
• Higher accident risk than in more controlled conditions.

Special consideration must be given when testing systems in real vehicles in real environments:

For People with Physical Impairments
If not driver’s own car, it may be necessary to install specific and possibly expensive car adaptations. Therefore, driver’s own car shall be used, if at all possible, with its appropriate controls. Otherwise, the assessor shall investigate well in advance what car adaptations may be necessary and discuss type/costs of car adaptations with experts to see if feasible.

3.3 At station/airport/other public sites

Some systems for travellers can be evaluated at rail or bus stations, or at an airport. However, kiosks can be found in other public places, such as libraries and in shopping precincts, and hand-held systems can be used whilst walking down the street. TELSCAN would suggest that the general advantages and disadvantages of testing at stations, airports or other public sites are as follows:

Advantages:
• Results likely to represent real world phenomena.
• Low equipment cost if observation only.
• Travellers likely to be familiar with the travelling environment.

Disadvantages:
• (Usually) observational data only = less accurate measurement of micro level data.
• Limited control over variables.
• Can be high labour cost if time consuming data collection methods are used.

3.4 Specific test environment

Systems tested in a person’s home may resemble use in either the real or artificial world. Using the example of a hand-held trip planning system, a person with mobility impairment may prefer or find it easier to conduct an assessment in his/her own home for any number of reasons: lack of accessible transport to get to another assessment site, fatigue in travelling long distances, etc. Such a trip-planning system could be used in the home, but also whilst walking down the street, so the home may or may not be a realistic testing environment. TELSCAN would suggest that the general advantages and disadvantages of testing a system at a person’s home are as follows:
Advantages:
- Results can represent either real or artificial world phenomena, depending on where the system is likely to be used.
- Low equipment cost if observation only.
- Travellers likely to feel comfortable with their own environment.
- May be more suitable for people who are susceptible to fatigue or pain when travelling.

Disadvantages:
- (Usually) observational data only = less accurate measurement of micro level data.
- Limited control over variables.
- Can be high labour cost if time consuming data collection methods are used.

Special consideration must be given when testing is done in the home of a person with a disability:

For all Volunteers
Send suitable, simple introductory material before the home visit, and talk through the material on arrival. The assessor should consider the subject’s possible fatigue or other commitments, and not overstay his/her welcome.

3.5 Test vehicle in real environment

This is a vehicle which is usually instrumented in some way and often has an experimenter present, used in a real road or travelling environment. The HARDIE project identified the advantages and disadvantages of using a test car in a real environment, and these have been adapted to meet the needs of TELSCAN, including all forms of transport, as follows:

Advantages:
- Results more likely to match real world phenomena (than a simulator).
- Accurate measurement of micro level data.

Disadvantages:
- Little or no control over many variables.
- Accident risk in cars, therefore, no testing to the limits of ability.
- High initial financial outlay for equipment.
- Traveller likely to be unfamiliar with vehicle.

Special consideration must be given when using test vehicles in real environments:

For People with Physical Impairments
If not driver’s own car, it may be necessary to install specific and possibly expensive car adaptations. Otherwise, the assessor shall investigate well in advance what car
adaptations may be necessary and discuss type/costs of car adaptations with experts to see if feasible. Sufficient time for driver to become accustomed to car shall be provided, as it is highly likely that the car adaptations, if installed, have been configured differently to driver’s own. This may affect performance if driving controls interfere with ATT controls (or vice versa).

For People with Cognitive Impairments
Learning even minor changes/adjustments to driving controls may cause problems, so ensure plenty of learning time, simple clear instructions, and back-up safety procedures (like dual controls).

3.6 Real vehicle in test environment

A test environment encompasses all possibilities, from a dis-used airfield to a section of real road or public transport network dedicated to the trial (i.e. closed to public traffic). Test vehicles are normally employed in such a test environment, very rarely are real vehicles used, but examples do exist. The HARDIE project identified the advantages and disadvantages of using a real car in a test environment, and these have been adapted to meet the needs of TELSCAN, including all forms of transport, as follows:

Advantages:
• Results more likely to match real world phenomena (than a simulator).
• Control over most variables.
• Low equipment cost if observation only.
• Traveller likely to be familiar with the vehicle.
• Accident risk reduced, and therefore, can test more closely to limits of ability.

Disadvantages:
• Results less likely to represent real world phenomena (than real environment).
• (Usually) observational data only = less accurate measurement of micro level data.
• Cost of hiring test environment.

Special consideration must be given when testing systems in real vehicles in test environments:

For People with Physical Impairments
If not driver’s own car, car adaptations may need to be installed, and may need to be different, or configured differently, for different drivers. Otherwise, the assessor shall investigate well in advance what car adaptations may be necessary and discuss type/costs of car adaptations with experts to see if feasible.

Provide sufficient time for driver to become accustomed to car, as it is highly likely that the car adaptations have been configured differently to driver’s own. This may affect performance when driving controls interact with ATT controls.
**For People with Cognitive Impairments**
This testing environment may be especially suitable, as there may be uncertainty over the traveller’s decision-making and awareness capabilities. Learning even minor changes/adjustments to driving controls may cause problems, so ensure plenty of learning time, simple clear instructions, and back-up safety procedures (like dual controls).

### 3.7 Test vehicle in test environment

This situation is a combination of the situations describe in 3.5 and 3.6 and the advantages/disadvantages of using a test car in a test environment, as stated by HARDIE and adapted by TELSCAN including all forms of transport, can be describe as follows:

**Advantages:**
- Results more likely to match real world phenomena than using a simulator.
- Control over most variables.
- Accurate measurement of micro level data.
- Accident risk reduced, and therefore, can test more closely to limits of ability.

**Disadvantages:**
- Results less likely to represent real world phenomena than in a real environment.
- Cost of hiring test environment.
- High initial financial outlay for equipment.
- Traveller likely to be unfamiliar with vehicle.

Special consideration must be given when using test vehicles in test environments, and these issues are listed below:

**People with Physical Impairments**
Car adaptations may need to be installed, and may need to be different, or configured differently, for different drivers. The assessor shall investigate well in advance what car adaptations may be necessary and discuss type/costs of car adaptations with experts to see if feasible.

Provide sufficient time for driver to become accustomed to car, as it is highly likely that the car adaptations have been configured differently to driver’s own. This may affect performance when driving controls interact with ATT controls.

**People with Cognitive Impairments**
This testing environment may be especially suitable, as there may be uncertainty over the traveller’s decision-making and awareness capabilities. Learning even minor changes/adjustments to driving controls may cause problems, so ensure plenty of learning time, simple clear instructions, and back-up safety procedures (like dual controls).
3.8 Moving base simulator

A moving base simulator consists of a driving simulation (video or computer generated), usually with a sophisticated steering buck, which gives the traveller realistic movement in all directions. The HARDIE project identified the advantages and disadvantages of using a dynamic simulator:

Advantages:
- High level of control over variables.
- Accurate measurement of micro level data.
- No accident risk, therefore, possible to test to limits of ability.

Disadvantages:
- Results less likely to represent real world phenomena (than real environment).
- High equipment cost.
- Traveller may need training.
- Risk of motion sickness problems.

Special consideration must be given when using moving base simulators to test systems with people with disabilities:

For all Volunteers
As noted in Section 3.1, it is necessary to allow plenty of time for familiarisation. The main problem, however, is the risk of the volunteers feeling ill as a result of motion sickness. This can be tackled in three ways:

1. Pre-screening. Anyone who suffers from motion sickness, vertigo, dizziness, etc. should not take part in the tests.

2. Piloting. A very successful measure can be to invite people, in small groups, to come and have a drive on the simulator before the assessment, so that they can see what they might be letting themselves in for. Having a "drive" in relaxed circumstances can help to relax volunteers on the day - and can also weed out those who are likely to feel sick on the day. The opportunity of a sneak preview of the simulator - without giving them knowledge of the test procedure itself, which might bias results - can reduce anxiety and nervousness about being in unfamiliar surroundings and circumstances, putting them in a more relaxed frame of mind for the actual assessments.

Specifically for People with Physical Impairments
Car adaptations may need to be installed or simulated, and may need to be different, or configured differently, for different drivers. The assessor shall investigate well in advance what car adaptations may be necessary and discuss type/costs of car adaptations with experts to see if feasible. Provide sufficient time for driver to become accustomed to vehicle, as it is highly likely that the car adaptations, if installed, have been configured differently to driver’s own.
This may affect performance if driving controls interfere with ATT controls (or vice versa).

It may be necessary to install a lift to enable people to climb into the simulator. The resource implications of this should be investigated and confirmed early in the design process.

### 3.9 Static simulator

A static simulator is a driving set up, where the subject normally has a version of a steering buck with which to control a video or computer generated driving task. The steering buck does not give the driver any realistic movement. This type of simulator is much more common than the moving base type described above. The HARDIE project identified the advantages and disadvantages of using a static simulator:

**Advantages:**
- High level of control over variables.
- Accurate measurement of micro level data.
- No accident risk, and therefore, possible to test to limits of ability.

**Disadvantages:**
- Results less likely to represent real world phenomena (than real environment).
- Medium to high equipment cost.
- Traveller may need training.
- Risk of motion sickness problems.

For special considerations when using static simulators to test systems with people with disabilities, see Moving base simulators above.

### 3.10 Usability laboratory

This is an environment where the subject is required to perform a number of related tasks representing travelling and using ATT systems, while being observed by the assessor and data is being collected. The HARDIE project identified the advantages and disadvantages of testing systems through laboratory part-tasks, and these are relevant for usability laboratories, as follows:

**Advantages:**
- High level of control over variables.
- Accurate measurement of micro level data.
- No accident risk, therefore, possible to test to limits of ability.
- Low to medium equipment cost, depending on whether the usability laboratory has already been established for earlier studies.

**Disadvantages:**
• Results unlikely to represent real world phenomena for most aspects of the travelling task.

Special consideration must be given when testing systems with people with disability in a usability laboratory:

**For People with Physical Impairments**
Car adaptations may need to be simulated, and may need to be different, or configured differently, for different drivers. Ensure that the assessor investigates well in advance what types of car adaptations may need to be simulated and what range of configurations may be necessary.

### 3.11 Laboratory

This is an environment where the subject is not required to perform any task which represents/replaces travelling, but is required to complete relevant tasks, e.g. to determine reading times using a tachistoscope. The HARDIE project identified the advantages and disadvantages of testing systems through laboratory part-tasks, as follows:

**Advantages:**
- High level of control over variables.
- Accurate measurement of micro level data.
- No accident risk, and therefore, possible to test to limits of ability.
- Low equipment cost.

**Disadvantages:**
- Results unlikely to represent real world phenomena for most aspects of the travelling task.
4. Methods/Tools to be used

This part presents the various methods and tools that can be used when assessing the usability of a telematic application taking into account characteristics of users with disability or who are elderly. This part used some element from the TIDE USER Project (Usability Requirements Elaboration for Rehabilitation Technology), as this project has published a Handbook and Toolkit called USERfit (Richardson et al., 1995), which was identified as relevant to TELSCAN’s usability assessment framework. Protocols in the use of these methods and tools are recommended for the particular groups of persons with disability or who are elderly. Refer also to Section 3.1, General Issues to be considered in various testing environments, as they are also relevant here.

Most of the methods classically used for usability assessment are also suitable for users with disability or who are elderly, but in some cases, dedicated methods or adaptations will have to be considered.

Assessors should be trained on issues related to people with disabilities or who are elderly. In the same way, it could be possible that the assessment will be conducted by a person who has a disability. In this case, training in the methodological issues related to human factors may be necessary.

Methods are usually classified according to their objective or subjective aspects.

Table 5:

<table>
<thead>
<tr>
<th>Subjective</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Questionnaire</td>
<td>Observation by the assessor</td>
</tr>
<tr>
<td>Interviews (Individual or Group)</td>
<td>Observation through devices</td>
</tr>
<tr>
<td>Activity diaries</td>
<td></td>
</tr>
</tbody>
</table>

The issues to be considered for each of the above methods are described in Sections 4.1-4.5

4.1 Questionnaires

In the context of usability assessment, questionnaires can be used in different circumstances, depending on whether they are a complement to other assessment methods. In most cases, questionnaires are used in association with objective methods.

Different use of questionnaires:
• pre trial: usually used to get information concerning the user, e.g., driving habits, use of public transport, understanding and use of new technologies, medical treatment, etc.

• post trial questionnaire: usually used to get complementary information for the assessment, e.g., difficulties encountered when using the device, satisfaction, interest for the services, willingness to pay, etc.

• survey questionnaires: in some cases, questionnaires are the only source of information available; completed by the user without the presence of an assessor (most frequently done this way), usually postal and requiring closed questions, rather than open-ended ones.

Questionnaires are interesting when considering users with disability or who are elderly because they can be used to obtain the opinion of people who have difficulties with mobility and who might find it difficult to come to assessment sites for interviews. Moreover, postal surveys which can guarantee anonymity of the respondents, make it easier for the respondents to answer personal or embarrassing questions; however, in this case, no postage costs should be supported by the respondent when returning the questionnaire.

Questionnaires can vary in their degree of structure depending on whether they are self-administered or administered by an assessor. Highly structured questionnaires are recommended for postal surveys, while less structured questionnaires could be more appropriate for addressing complex issues, through the use of open-ended questions in face-to-face situations.

Special types of questionnaire are the subjective workload assessment questionnaire used in research in the field of driving like the NASA TLX or the SWAT (Hart & Staveland 1988).

Ideally the elaboration of a questionnaire should follow a number of steps:

- Construction of the questionnaire: one of the better ways to proceed should be to organise a focus group of potential end users in order to highlight the main issue related to the application to assess. It is recommended not to start with highly personal questions (as this may lead to the rejection of the questionnaire) and to structure the questionnaire in topics in order to help the respondent to be focused on the right context.

- Writing the questions: different types of questions are possible such as multiple choice items, rating scale (difficult to interpret and require a great number of subjects), paired comparisons, ranking (no more than ten alternative to rank) and open ended questions (rich but require a lot of effort for the respondent and the assessor for processing).

- Testing the draft questionnaire: should be done with representatives of the final population who will answer the questionnaire, should be completed by interviews in order to check any difficulties in understanding the questions or other problems (such as
the time needed to complete the questionnaire which should not be too long for certain categories of respondent).

-Revision and final questionnaire
-Administration

4.1.1 Protocols with respect to persons with disabilities or persons who are elderly

General issues: Persons with disability or who are elderly may possibly have a lower education level, or may have difficulty reading or understanding or possibly communicating or documenting their views. Consider their particular needs beforehand and who should complete the questionnaire; use simple and clear wording (see also Section 3.1.1).

Due to the fact that answering the questionnaire could be longer with these persons, it is strongly suggest to focus on the main issues under consideration and to avoid question with low relevance.

Issues for people with physical impairment: If writing is difficult, provide a helper to complete it, or provide an on-line computer questionnaire, which could be completed through the use of assistive input devices. See also Section 3.1.2.

Issues for people with communication impairment: Many native people with hearing impairment could also have problems regarding reading and writing, so avoid postal survey or self completion. Provide an interpreter to help. See also Section 3.1.3.

Issues for people with visual impairment: Translation into Braille is possible but braille is not used by the majority of persons who are visually impaired. Remember that size 16 point font can be read by many people with visual impairments (See Section 3.1.4). Completion could be made by a third person, or the questionnaire could be read out during a face to face interview or over the telephone. See also Section 3.1.4.

Issues for people with cognitive impairment: It is better to use a face to face interview, with the interviewer making notes onto the questionnaire. See also Section 3.1.5.

4.2 Interviews (individual and group)

In the context of usability assessment, interviews are usually used in conjunction with other methods, e.g., with a structured or semi-structured questionnaire. This technique is mainly used during the definition of user requirements, but can be used later to evaluate subjective opinion of the system.

Interviews are defined as face to face interviews or group interviews. Face to face interviews are appropriate for some sensitive questions or some complex information, but on the other hand, they are more time consuming, due to the time needed for data
processing. As a consequence, individual interviews are not appropriate for large samples, and group interviews should be considered if a wide range of views is sought.

The focus group, or roundtable discussion, is a type of group interview used in order to quickly obtain opinions on a certain topic, which can then often be employed as the basis for further analysis (e.g. in-depth individual interviews). The size of the group usually varies from 5 to 10 people. The presumption is that in a group of this size there are usually a couple of people who express themselves easily and can talk in a group, thereby inspiring the other participants to speak up. The interviewers should be aware however, that some opposition can also appear in such a group.

The focus group can be conducted in various ways, from the very structured, in which everyone, in a designated order, expresses themselves on a well-formulated issue, to the very open, where only one clue is provided (certain main points) and the discussion is allowed to take its own course.

The preparation of interviews is to some extent similar to the questionnaire preparation; the precise themes of the interview should be determined, questions written and their order defined. It seems better to have the set of questions ordered and written, in order to be sure that the interview will not deviate from the topic of interest.

For administration, the interviewer should not be embarrassed by respondent’s specificity, and must be sure that the questions are well understood. The data could be recorded by audio tape but it takes a lot of time to transcribe. Another solution is to have two persons during the interviews, one putting questions to the subjects and the other taking notes.

4.2.1 Protocols with respect to persons with disabilities or persons who are elderly

General issues: In all types of interviews, caution is needed so that the interviewer does not influence the answers, especially with some persons with disabilities or who are elderly who may find it difficult to communicate their views. See also Section 3.1.1.

Issues for people with physical impairment: See Section 3.1.2.

Issues for people with communication impairment: Provide possibilities to make the questions understandable for the persons interviewed, speaking slowly, facing the volunteer (See also Section 3.1.3). Opinions held by persons with severe communication problems may be better recorded by other methods, but in any case training of the interviewers is essential.

Issues for people with visual impairment: See Section 3.1.4.

Issues for people with cognitive impairment: Interviews are well suited for getting information, but usually an individual face to face interview is best. Questions should be specific, simple, using examples and comparisons. See also Section 3.1.5.
4.3 Activity diaries

This technique consists of recording activities by the users throughout a normal day or a given time period. Various tools can be used, from paper-pencil to video or on-line questionnaires. The design of an activity diary could be a complex task.

In the preparation phase, the choice will have to be between a structured or an unstructured approach. Both present advantages and drawbacks, for example, a structured approach facilitates the processing of the data while an unstructured approach leads the participant to use his own language to report his activity but complicates the processing of the data.

Completing the diary can be after each use of the device, or at a precise time of the day or at the end of the day; it is important that users are reminded to complete the diary (especially for persons with memory impairments).

4.3.1 Protocol with respect to persons with disabilities or persons who are elderly

**General issues:** See Section 3.1.1.

**Issues for people with physical impairment:** It is better to use a computerised interface or a verbal report. See also Section 3.1.2.

**Issues for people with communication impairment:** See Section 3.1.3.

**Issues for people with visual impairment:** It is better to use a verbal report. See also Section 3.1.4.

**Issues for people with cognitive impairment:** Use the simplest diary possible with pictorial representation and standardised procedures to complete the diary. See also Section 3.1.5.

4.4 Direct observation by the assessor

This technique has a very high external validity, as the users are observed while interacting with the application. Direct observation can be conducted on prototype or on end products. It can be realised in different environments and the great difference will be between provoked (the task given to the user is to get information from an info-kiosk for example) or non-provoked use (the user is in the public transport area and sees a new device and decides by him/herself to use it).

One or more observers are present with the user when s/he interacts with the device, but they have to be as passive and discrete as possible. In the case of the assessment of a prototype, it could be necessary that one of the observers needs to be more active.
It is recommended to develop a framework for recording the observation. This structure will define the objectivity of the technique, as without a precise framework, observations may relate more to the observer's subjective point of view than to objective assessment.

The observation period needs to be similar to that of actual use of the device and not atypical. Caution is also necessary that the Hawthorne effect may influence behaviour, i.e., that people tend to perform better under observation because of the attention they get. It must be clearly stated to the volunteer that the assessment concerns the device and not user's capacity.

For ethical reasons, the users need to be informed of the presence of the observers.

4.4.1 Protocols with respect to persons with disabilities or persons who are elderly

**General issues:** For in-home assessments, the observer may have to come one day before the test to assess the layout, space available for equipment, etc. See also Section 3.1.1.

**Issues for people with physical impairment:** See Section 3.1.2.

**Issues for people with communication impairment:** The observer should be able to communicate, using language familiar to the subject to explain the activity to perform, the goal of the test and how output will be obtained from the subject. See also Section 3.1.3.

**Issues for people with visual impairment:** The observer must present himself, give his location to the subjects and explain what he will do during the test. See also Section 3.1.4.

**Issues for people with cognitive impairment:** Direct observation will not be very different from observing members of other user groups; however, the way the observer is introduced is crucial, as some persons may be uneasy, frightened or distrustful if they feel observed by a stranger. Carefully explain the presence of the observer. See also Section 3.1.5.

4.5 Observation through devices

These methods would include video recording, computer logging, vehicle controls measure or the use of psycho-physiological techniques.

**Video recording** can be used in a broad variety of situations in order to give data for the assessment of the usability of a given telematic application. Using video recording poses many ethical and legal questions, which must be considered before use. See especially the protocols for people with cognitive impairments below. The position of the camera
may also have to be different than for other subjects due to the characteristics of persons with disabilities. For example, in a car, driving adaptations can mask the field of view of the video-camera.

**Computer logging of actions:** this technique can be used for the assessment of telematic applications such as Internet services, public transport information kiosks or in-vehicles systems. Using this technique, it is possible to record all the actions performed by the users at a given time; it gives very detailed information, but usually require a high work for processing the data.

**Vehicle controls measure:** this technique use different kind of captors; with it, it is possible to record information such as the use of the gear shift, accelerator or brake pedals, lane keeping. It gives very detailed information, but usually require a high work for processing the data.

**Psycho-physiological** techniques are considered as the intrusive methods of getting information concerning the users. In most cases, captors are used for example to obtain heart rate, sinus arrhythmia, EEG, etc.

Some metrics can be obtained by using different techniques. For example, eye movements can be obtained by video recording or by electro-oculography with users equipped with electrodes around the eyes.

### 4.5.1 Protocols with respect to persons with disabilities or persons who are elderly

**General issues:** Even if non-intrusive methods are sometimes less accurate, it could be recommended to avoid intrusive devices with some volunteers who are elderly or with disability as they can be scared about being equipped with electrodes for instance. See also Section 3.1.1.

**Issues for people with physical impairment:** See Section 3.1.2.

**Issues for people with communication impairment:** See Section 3.1.3.

**Issues for people with visual impairment:** As all the other participant in an assessment trial, people with visual impairments must be informed of the presence of a video camera. See also Section 3.1.4.

**Issues for people with cognitive impairment:** Assessors must seek the consent of all subjects. Although some people might have difficulty communicating, hearing, or understanding, this does not lessen the professional’s obligation to ensure consent. When people with cognitive impairment are not able to give their consent (e.g., someone with Alzheimer’s Disease), then it is possible to involve those close to the subject to help
indicate what the person would have wanted, if the person had been competent to decide. See also Section 3.1.5.

NB: UK law does not recognise consent by the next-of-kin (British Medical Association and the Royal College of Nursing, 1995).

### 4.6 Assessment procedure and scenarios of use

Depending of the context of testing and the degree of development of the Telematic Application, the task that the subjects will be asked to do can be very different. In case of non natural use of one Telematic Application, the assessors will have to design scenarios of use which will integrate most of the actions that a user would do when the system is completed.

*Example of a procedure used (Galinier & Marin-Lamellet 1998)*: The subject was given a series of tasks to carry out such as interrogating the waiting time for stop X on line Z of the network. The subject was invited to speak his or her thoughts and reactions aloud as the scenario progressed.

For developing scenarios, the INFOPOLIS project proposed the following guidelines:
- Provide realistic scenarios, complete with motivation to perform. The closer the scenarios represent reality, the more reliable the test results.
- Sequence the task scenarios in the order in which they are most likely to be performed.
- Avoid using jargon and cues.
- Try to provide a substantial amount of work in each scenario. Provide a goal, clearly stated in simple language and let the participants do the rest.

For persons who are elderly, the absence of a concrete goal in the exercise of using a device often results in difficulties of understanding the usefulness of the system tested, of grasping what they should do and of the procedures to be implemented. Contextualisation shows itself to be a particularly important factor in the usability assessment of a system with an ageing population. Contextualising instructions permits subjects to conceptualise and assign a certain usefulness to what is demanded of them, since they can identify the task with an approach familiar to them. The recommendation is therefore to use realistic, everyday usage scenarios to ensure that the users understand the context in which the system will be used.
5. Results analysis procedures

In this part, the question to answer is: to what extent will the strategy for processing data from a usability assessment test with persons with disabilities or who are elderly differ from overall assessment with users considered as «able bodied»?

In theory, it can be said that there will be no big differences.

However, from TELSCAN point of view and according to the experience of most of the project participants, assessors have to be aware of the following points:

- Often they could have used small samples due to the difficulties to get persons who are elderly or with disabilities to participate in the assessment.
- Depending of the research protocol used, it could be difficult to conduct statistical tests: subjects can tire more quickly than others and may not be able to perform the entire experiment if there are many sessions.
- Often persons with disabilities or who are elderly introduce variability in the results: an increase in standard deviation and variance should be expected; then the use of statistical tests has to be considered carefully (Anova for example)

Table 6: Example of Types of data processing according to methods used

<table>
<thead>
<tr>
<th>Type of methods</th>
<th>Type of data processing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Questionnaires</td>
<td>Closed questions can be processed easily, open questions are more time consuming to process</td>
</tr>
<tr>
<td>Interviews (individual and group)</td>
<td>Verbal reports analysis has to be performed</td>
</tr>
<tr>
<td>Activity diaries</td>
<td>Possibility to reconstruct the activity of the subjects</td>
</tr>
<tr>
<td>Direct observation by the assessor</td>
<td>Allows a very detailed analysis of the user activity, but brief events could be missed by the assessors (example: visual activity) Example: frequency of use of a specific key, time to complete a task, ....</td>
</tr>
<tr>
<td>Observation through devices</td>
<td>Allows a very detailed analysis of the user activity, but the processing of all the data could be very time consuming Example: reaction time, glance duration, time to complete a task, frequency of errors .....</td>
</tr>
</tbody>
</table>

Statistical tests allow the assessor to predict that the results found with the test sample will be generalised to the population from which the sample is coming. This issue could be complicated by the difference between the characteristics of people with disability (cf TELSCAN functional classification). In order to take into account all the categories of impairment with sufficient subjects to perform statistical comparison, then it will result in a very big sample of subjects. This is why it is very important to concentrate on travellers who emerge from the use of the three indicators in the design of the usability assessment plans (as described in section 2).
The data processing strategy will depend on the type of data and the number of subjects:

- Objective data and big sample: descriptive statistical analysis (mean, standard deviation, variance, mode ...), and statistical test (analysis of variance......)
- Objective data and small sample: descriptive statistical analysis (mean, standard deviation, variance, mode ...), statistical test is possible if non parametric or if high number of trials per subjects
- Subjective data and big sample: descriptive statistical analysis (% of answer, mode ...), and statistical test (factorial analysis, ...)
- Subjective data and small sample: descriptive statistical analysis (number of answer, of errors ...), statistical test is possible if non parametric but the validity of these tests could be questionable.

The principal statistical tests are described in the CONVERGE Del n°5.1 and will not be repeated here.
6. Case study

In this part, two examples will be described in relation to the TELSCAN methodological framework. These two examples are representative of the Level A support to other projects: common testing with different samples of users.

6.1. PROMISE French application Case Study

The PROMISE2 project is concerned with the development of Advanced Transport Telematics services on hand held and in-car terminals. The basic concept of PROMISE is that travelers could be assisted by a PROMISE terminal with interactive access to real time travel and traffic information.

PROMISE FRANCE is an Internet site that centralises services intended to facilitate urban transport in the Ile de France Region. The test version makes available four essential services to users:

- Trip planning using public transport; real time information about underground lines in Paris and near suburbs;
- Map request: maps around any road or underground station in Paris and near suburbs;
- Places of interest: information on museums and monuments near any road or underground station in Paris and near suburbs;
- Route request: traffic information and car itinerary.

The PROMISE concept is planned to be accessible by various media such as PC, mobile telephone or in-car devices. However, at the time of the assessment period, PROMISE was available only on PC.

The full report of the work undertaken by TELSCAN in this context can be found in the TELSCAN internal report: TELSCAN ergonomic evaluation of the French PROMISE internet site; Guyot L & Marin-Lamellet C, November 1998.

Application of the TELSCAN methodological framework

Mobility Indicator

The first step is to identify those user groups who will potentially benefit most from the PROMISE system’s functionality. The mobility indicator below highlights pre trip planning and trip information as the two relevant functionality.
<table>
<thead>
<tr>
<th>System functionality</th>
<th>People who are elderly</th>
<th>People with disabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LL</td>
<td>UL</td>
</tr>
<tr>
<td>Pre-trip planning</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Trip information</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Access to vehicle/</td>
<td>The application does not give information on access to vehicle to persons with disabilities or who are elderly</td>
<td></td>
</tr>
<tr>
<td>service</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle control</td>
<td>Not relevant</td>
<td></td>
</tr>
<tr>
<td>Parking</td>
<td>The application could give this information but it was not the case at this stage of development</td>
<td></td>
</tr>
<tr>
<td>Dealing with weather &amp; environment</td>
<td>The application could give this information but it was not the case at this stage of development</td>
<td></td>
</tr>
<tr>
<td>Emergency warning &amp; traveller support</td>
<td>Not relevant</td>
<td></td>
</tr>
<tr>
<td>Ticketing/payment</td>
<td>Not relevant</td>
<td></td>
</tr>
<tr>
<td>Toll collection</td>
<td>Not relevant</td>
<td></td>
</tr>
</tbody>
</table>

The PROMISE service added value is to combine on a same web site route traffic information and public transport information; so the population who will be more interested by the service will be the drivers population. For the other users who are not drivers, they will be interested only by the public transport information and these kind of information can be found on the web site of public transport operators.

As the assessment needed to focus on drivers it was necessary to include in the sample for the assessment only the persons who will meet the requirement to drive, and particularly on the visual aspects; so the persons with visual impairments that cannot be corrected with glasses or contact lenses can not be included.

Next, the problem indicator is completed to identify those groups who are most likely to experience problems with the user interface.

**Problem Indicator**

The answers given for this indicators referred of course only to the PC version of the PROMISE application.
<table>
<thead>
<tr>
<th>Sensory modality</th>
<th>People who are elderly</th>
<th>People with disabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is input required with hands/fingers?</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Is input required with feet/lower limbs?</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Is input required with speech?</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Is there any visual output?</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Is there any auditory tone output?</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Is there any auditory speech output?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is there any output given to hands/fingers?</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Is there any output given to feet/lower limbs?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is the system incompatible with assistive devices which can provide alternative input/output modes?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location of displays/controls</th>
<th>In home or office use, not relevant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual display</td>
<td></td>
</tr>
<tr>
<td>Is glare/reflection a potential problem on the display?</td>
<td>✓</td>
</tr>
<tr>
<td>Question</td>
<td>Yes</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>-----</td>
</tr>
<tr>
<td>Is contrast/brightness <strong>not</strong> adjustable or <strong>not</strong> easily adjustable?</td>
<td></td>
</tr>
<tr>
<td>Is the default contrast/brightness of the display low?</td>
<td></td>
</tr>
<tr>
<td>Does the display have to be used in conditions of low light (e.g. night-time)?</td>
<td></td>
</tr>
<tr>
<td>Is there any text to be read?</td>
<td>✓</td>
</tr>
<tr>
<td>Is coding used to provide information to the user?</td>
<td>✓</td>
</tr>
<tr>
<td>Are there any symbols/icons to interpret (in particular those which are not commonly encountered)?</td>
<td>✓</td>
</tr>
<tr>
<td>Are colours used to code information?</td>
<td>✓</td>
</tr>
<tr>
<td>Is there any visual information requiring decision making?</td>
<td>✓</td>
</tr>
<tr>
<td>Would a user have difficulty enlarging the size of a display or its image?</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Auditory output</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Controls</strong></td>
<td></td>
</tr>
<tr>
<td><strong>General</strong></td>
<td></td>
</tr>
<tr>
<td>Does the user have to remain vigilant when using the ATT system (i.e. the consequences of lack of attention are high)?</td>
<td>✓</td>
</tr>
</tbody>
</table>
The relevant groups identified with the Mobility Indicator were:
- LL: Lower Limb
- V: Vision
- H: Hearing
- L/S: Language and Speech
- C: Cognitive
- Elderly

and with the Problem Indicator:
- UL: Upper Limb
- C/D: Co-ordination/Dexterity
- F: Force
- V: Vision
- L/S: Language and Speech
- Elderly

Then, using the Extent Indicator, it is possible to gain a better understanding of the number of people across Europe who have these types of impairments. It is clear that elderly people form a large user group, and those with hearing impairments represent 10% of the European population, many of them elderly. So people who are elderly and people with hearing impairments are very important to consider.

Examination of each one of the groups:
- Persons who are elderly: TELSCAN promote the inclusion of users who are elderly in each usability assessment
- Persons with visual impairment: as said before, the added value of the PROMISE application is to touch people who are both drivers and users of public transport
- Persons with impairment related to language and speech: these users can have great difficulties to have access to the kind of information provided by PROMISE as these are generally given by vocal output
- Persons with impairment related to lower limb: information on the accessibility to the network are not provided by the PROMISE service and there are no reason for specific needs when using the service in terms of man machine interaction
- Persons with impairment related to upper limb: the PROMISE service is used with a computer and is compatible with the adaptative devices as it is an internet application available trough classical browsers
- Persons with impairment related to co-ordination/dexterity: the PROMISE service is used with a computer and do not induce particularity
- Persons with impairment related to force: idem
- Persons with hearing impairment: vocabulary problems can be expected
- Persons with cognitive impairment: navigating in menus can be difficult
As this is the PC version being tested, assistive devices can be used as input/output modes by people with many types of disabilities. Therefore, sensory modality should not be a problem for this version under assessment. Also, even though text needs to be read, a PC version can enlarge text font or substitute text by speech, and so people with visual impairments should not be a priority in this case. When the hand-held device is assessed later, however, another screening of the Problem Indicator will be needed to decide if there are any particular problems relating to controls or displays.

It was then decided that V, LL, UL, C/D and F were not relevant in the context of this assessment and the users chosen were:
- three persons with hearing/language speech impairment
- one person who was elderly (over 65 years old)

**Choice of the methodology**

The PROMISE demonstration phase in France will last one month; as the other users of the PROMISE service, TELSCAN users will be asked to use frequently the service during the period of a month. Therefore direct observation, or video observation would not be possible. The method used was then:
- face to face interviews before and after the period of use
- interventions by the experimenter following requests for aid, consisting of explaining certain icons, certain terms, ‘why hasn’t it found this place’, ‘why doesn’t it work’, ‘I can’t do a certain thing’, etc.
- activity diary, site interrogation sheets (by services) completed by the users as they progressed through the experiment, and sometimes comments on copies of screens.

**Results analysis**

Due to the small number of subjects (4 in total), qualitative analysis of results will be performed.

**6.2 EUROSCOPE / ROMANSE II Case study**

Collaborative assessments with 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) focused on three telematic facilities, available in the city of Southampton: the TRIPlanner pre-trip planning terminal (located in railway stations and other public places), the STOPWATCH real-time bus stop information system and the provision of trip planning information on an internet web-site. The purpose of this assessment was to evaluate the usefulness and usability of the TRIPlanner for travellers who might be elderly and/or have a disability. The assessment would be conducted by Cranfield University personnel using sub-groups of volunteers.
representing people with physical, visual and other sensory impairments. The TELSCAN Assessment Methodology was consulted to identify the MOST relevant user groups, given resource constraints, that should be included in the trials.

Application of the assessment framework

Mobility Indicator

The first step is to identify those user groups who will potentially benefit most from the TRIPlanner’s functionality. The mobility indicator below highlights pre trip planning and trip information as the two relevant functionality.

<table>
<thead>
<tr>
<th>System functionality</th>
<th>People who are elderly</th>
<th>People with disabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-trip planning</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Trip information</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Access to vehicle/service</td>
<td>The application does not give information on access to vehicle to persons with disabilities or elderly</td>
<td></td>
</tr>
<tr>
<td>Vehicle control</td>
<td>Not relevant</td>
<td></td>
</tr>
<tr>
<td>Parking</td>
<td>The part of the service that gives information for tourists and other visitors indicates whether hotels have parking facilities suitable for drivers with disabilities.</td>
<td></td>
</tr>
<tr>
<td>Dealing with weather &amp; environment</td>
<td>Not relevant</td>
<td></td>
</tr>
<tr>
<td>Emergency warning &amp; traveller support</td>
<td>Not relevant</td>
<td></td>
</tr>
<tr>
<td>Ticketing/payment</td>
<td>Not relevant</td>
<td></td>
</tr>
<tr>
<td>Toll collection</td>
<td>Not relevant</td>
<td></td>
</tr>
</tbody>
</table>

Next, the problem indicator is completed to identify those groups who are most likely to experience problems with the user interface.
## Problem Indicator

<table>
<thead>
<tr>
<th>Sensory modality</th>
<th>User groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is input required with hands/fingers?</td>
<td>✔ ✔ ✔ ✔ ✔</td>
</tr>
<tr>
<td>Is input required with feet/lower limbs?</td>
<td>✔ ✔ ✔</td>
</tr>
<tr>
<td>Is input required with speech?</td>
<td>✔ ✔ ✔ ✔</td>
</tr>
<tr>
<td>Is there any visual output?</td>
<td>✔ ✔ ✔ ✔</td>
</tr>
<tr>
<td>Is there any auditory tone output?</td>
<td>✔ ✔ ✔ ✔</td>
</tr>
<tr>
<td>Is there any auditory speech output?</td>
<td>✔ ✔ ✔ ✔</td>
</tr>
<tr>
<td>Is there any output given to hands/fingers?</td>
<td>✔ ✔ ✔ ✔</td>
</tr>
<tr>
<td>Is there any output given to feet/lower limbs?</td>
<td>✔ ✔ ✔ ✔</td>
</tr>
<tr>
<td>Is the system incompatible with assistive devices which can provide alternative input/output modes?</td>
<td>Not relevant</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location of displays/controls</th>
<th>User groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is access to any displays/controls restricted (e.g. fixed locations)?</td>
<td>✔ ✔ ✔ ✔ ✔ ✔</td>
</tr>
<tr>
<td>Is a user prevented from getting his or her face close to any displays?</td>
<td>May be ✔ ✔</td>
</tr>
</tbody>
</table>

---
Does the user have to rotate their upper body in order to view/access any displays/controls? | May be | ✓ | ✓ | ✓ |

Are there separate controls which are close together (i.e. controls which may be inadvertently activated)? | ✓ | ✓ | ✓ | ✓ |

**Visual display**

Is glare/reflection a potential problem on the display? | ✓ | | | ✓ |

Is contrast/brightness not adjustable or not easily adjustable? | ✓ | | | ✓ |

Is the default contrast/brightness of the display low? | | | | |

Does the display have to be used in conditions of low light (e.g. night-time)? | | | | |

Is there any text to be read? | ✓ | ✓ | ✓ |

Is coding used to provide information to the user? | | | | |

Are there any symbols/icons to interpret (in particular those which are not commonly encountered)? | | | | |

Are colours used to code information? | | | | |

Is there any visual information requiring decision making? | ✓ | | | ✓ |

Would a user have difficulty enlarging the size of a display or its image? | ✓ | | | ✓ |

**Auditory output**

Does auditory information have to be used in a variety of different acoustic environments? | ✓ | ✓ | | ✓ |

Is volume/balance not easily adjustable? | ✓ | ✓ | | ✓ |
<table>
<thead>
<tr>
<th>Question</th>
<th>✓</th>
<th>✓</th>
<th>✓</th>
<th>✓</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is there any auditory information requiring decision making?</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Is volume/balance <strong>not</strong> automatically adjusted according to ambient conditions (i.e. controls are required)?</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Is there any auditory output which use high frequencies?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Controls</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are there any obstacles nearby preventing user from making easy contact with controls</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Is precision required in the use of controls (e.g. small buttons or a continuous rotary knob)?</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>For optimal control performance, are both hands required?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is a pushing/pulling/rotating force required (in particular, controls which need holding down or those which require concurrent pushing/pulling and rotating)?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are there any controls which cannot be readily identified by touch alone (e.g. by shape, size, type)?</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>General</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does the user have to remain vigilant when using the ATT system (i.e. the consequences of lack of attention are high)?</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Using the Extent Indicator, it was possible to gain a better understanding of the number of people across Europe who have these types of impairments. However, it was clear by looking at the wide range of impairment groups identified as relevant to TRIPlanner, that we wanted to include as many impairments as possible within our limited resource constraints.

Choice of methodology

The terminal was set up in Resource Centres for people with disabilities, on the premise that this would give access to as many people as possible with a variety of impairments, age groups, etc. However, in order to ensure that many types of disability would be represented, a number of local groups representing people with different disabilities were contacted in order to encourage them to visit the Resource Centre. Once set up in a Centre, the recruitment of volunteers was then done on a necessarily informal basis, while at the same time considering the key user groups as identified above.

The 56 people who were actually recruited in this way declared the following disabilities:

- lower limb(s) impairment (33 persons)
- upper limb(s) impairment (7 persons)
- hand co-ordination impairment (10 persons)
- problems exerting force (1 persons)
- back problems (6 persons)
- visual impairment (13 persons)
- hearing impairment deaf (8 persons)

with some persons declaring more than one disability.

Altogether, 38 of the 56 respondents had a physical impairment of some kind, with 13 being wheelchair users. Ten people said that they were limited in the length of time for which they could stand.

Concerning age, 9 respondent were over 70 years old and 7 between 60 and 70 years old.

The key method used was observation; subjects were set two route planning tasks and were observed in their efforts to complete them. No prior instructions or information about the terminals was given, and volunteers were told that they were to proceed as far as possible without help from a researcher, but that help would be available if and when absolutely necessary. The rationale behind this method was that it was important to simulate, as faithfully as possible, the situation of approaching the terminal in the street “from cold”.

Results analysis

The analysis of the results of this observation was to be based on answering the following research questions,
Was there any aspect of the terminal or its functionality that totally prevented the subject from successfully planning a route?

What aspects of the system presented particular difficulties for the subject?

Did the subject succeed in completing the route planning task?

What particular errors did the subject make during the route planning exercise?

With which aspects of the task did the subject request help from the researcher in attendance?

How much use did the subject make of particular features of the system, such as the “Help” function, scrolling mechanisms, the “delete” button etc.?

Direct observation of subjects’ actions was followed by an after-trial questionnaire that sought to elicit their views on the ease of use of the system, the potential usefulness of the system, particular aspects of the terminal’s functionality that they had found difficult, suggested improvements to the system etc.. Questions were also asked as to whether subjects thought that the TRIPlanner system would encourage them to travel more often, and whether the system would make travelling easier and more convenient.
7. References

Barham, P A J and Alexander. J J. (1997) Evaluation of interactive information terminals (TRIPlanner Mk I) with respect to their use by the elderly and people with disabilities; for the ROMANSE Project, on behalf of Transport Telematics Project TR 1108 TELSCAN.


TELSCAN ergonomic evaluation of the French PROMISE internet site; Transport Telematics Project TR 1108, TELSCAN internal report.


INFOPOLIS (1996) Synthesis on Ergonomics Approaches; Telematics; Applications Programme TR 1031 Infopolis Deliverables N°4


Nicolle, C. and Burnett, G. (eds.) (V3, May 1998) TELSCAN Handbook of Design Guidelines for Usability of Systems by Elderly and Disabled Drivers and Travellers, Transport Telematics Project TR 1108, TELSCAN Deliverable No. 5.3.

Opperman & Reiterer (1997)
Software evaluation using the 9241 evaluator; Behaviour & Information technology, vol16, n°4/5, pp235-245.


Scapin & Bastien (1997)
Ergonomic criteria for evaluating the ergonomic quality of interactive systems; Behaviour & Information technology, vol16, n°4/5, pp220-231.

Guidebook for assessment of Transport Telematics Applications; Transport Telematics Project TR 1101 CONVERGE deliverable 5.1 final version.
8. Annex 1: Background information

8.1 Review of Methods

According to ISO DIS 9241-11, **usability** is defined as 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 context of use is also defined as the nature of the users, task and physical and social environment.

These definitions are for software but they are still valid for the telematic information system considered in TELSCAN. The following review of literature indicates how system usability can be assessed, but clearly shows the need for more guidance in including the needs of elderly and disabled travellers, precisely what the TELSCAN project proposes in this deliverable.

According to Opperman & Reiterer (1997), general evaluation methods can be classified as:

- **subjective**: based on user' judgement, after use
  - questionnaires: care needs to be taken in selecting sample
  - interviews: more time-consuming than questionnaires, results sometimes difficult to synthesise and to analyse

- **objective**: observational methods of users interacting with the system
  - direct observation
  - video recording: data analysis after observation, increases the cost and the time but richer data
  - interaction monitoring: reconstruct how users interact with the system, can be replay based or logging based
  - co-operative evaluation: observer asks questions, video confrontation, constructive interactive method (two users work together)

- **expert evaluation method**
  - expert evaluation reports and expert walkthrough
  - cognitive walkthrough: based on learning by exploration and on research on problem solving
  - checklists, guidelines

- **experimental evaluation method**: usually conducted in controlled conditions with precise hypothesis, sometimes difficult to find theoretical framework with man machine interaction.

All methods involve users with the exception of expert evaluation and so most are relevant to TELSCAN’s framework.

Scapin & Bastien (1997) adopted a guideline based approach (as opposed to a theory-based approach). They used a large set of experimental results and available guidelines which were iteratively grouped into sets that were characterised by specific usability dimensions they called Ergonomic criteria. They are:
• guidance: means available to advise, orient, inform, instruct, and guide the users throughout their interactions with a computer, including language issues

• workload: concerns all interface elements that play a role in reducing the users’ perceptual or cognitive load, and in increasing the dialogue efficiency.

• explicit control: concerns both the system processing of explicit user actions and the control users have on the processing of their actions by the system.

• adaptability (of the system): refers to its capacity to behave contextually and according to the users’ needs and preferences.

• error management: refers to the means available to prevent or reduce errors and to recover from them when they occur (include invalid data entry, invalid format for data entry, incorrect command syntax).

• consistency: refers to the way interface design choices are maintained in similar contexts, and are different when applied to different contexts.

• significance of codes: codes and names are significant to the users when there is a strong semantic relationship between such codes and the items or actions they refer to.

• compatibility: refers to the match between users’ characteristics and task characteristics on the one hand, and the organisation of the output, input, and dialogue for a given application, on the other hand.

These ergonomic criteria were designed first for expert evaluation use, but tests showed that there were also robust with non experts (end user).


• Performance setting refers to the definition of the users to be include in evaluation.

• Method selection is divided into different parts:
  - goal: can be prescriptive (explicit, direct support) and leads to heuristics/rules of thumb; or descriptive (implicit, indirect support) and leads to guidelines.
  - output: can be quantitative or qualitative
  - input: personnel available (HMI specialist, domain expert), system available (system to evaluate), users available (final users)
  - mapping output/input: can be qualitative or quantitative
  - system development stage: user requirements, specification, implementation, evaluation
• Methods configuration: this step tries to formalise how evaluation methods chosen could be configured in order to meet the desired quality and acceptable costs. This stage leads to the production of the draft evaluation plan.

UMTRI (University of Michigan, Transportation Research Institute) reviewed the methods and measures for assessing safety and ease of use of IVHS-related driver information systems (Green, 1995). The report concerns in-car systems that may be used to present navigation, hazard warning, vehicle monitoring, traffic, and other information to drivers in cars of the future. It does not specifically refer to testing systems with elderly and disabled drivers, except with regard to other documents which have mentioned it, for example the ICE Code of Practice. The report provides further insight into the selection of methods and measures for the evaluation of the driver interface and demonstrates there is still clearly a need for guidance on the inclusion of elderly and disabled people in the process.

8.2 ISO/TC 22/SC 13/WG 8 New Work Item

A new work item has recently been approved by ISO/TC22/SC 13/WG8 on Suitability of TICS (Transport information and control systems) for use while driving. This standard is related to in-vehicle TICS and whether their specific design, or in combination with other TICS, is suitable for use by drivers while driving. The ISO definition of ‘Suitability’ focuses on 3 aspects of usability most related to the driving task: controllability, compatibility (with the driving task) and efficiency. However, it does not cover other aspects of usability which are considered specific to individual manufacturers and products.

This standard recommends a detailed definition of the tasks that the driver is required or likely to perform when interacting with the TICS. These tasks should be listed in sufficient detail so that they can be used as a basis for assessment. These tasks and the goals of the driver will all be the same for able-bodied, disabled, and elderly drivers. The ultimate goal is to get from A to B, but that might be more difficult for some people who have even a small degree of functional impairment, and they might need to perform that task with either a car adaptation or a different user interface to the telematic system.

The standard also recommends a number of stages that can be used to develop an assessment process:

Stage 1 - Definition of the assessment plan
Stage 2 - Selection of the assessment scheme
Stage 3 - Definition of the assessment criteria
Stage 4 - Definition of assessment context
Stage 5 - Selection of assessment methodology
Stage 6 - Performing the assessment and analysing the data
Stage 7 - Interpretation of results
TELSCAN’s usability assessment framework does not attempt to repeat all the above stages, but instead provides further input to the process, in particular within Stage 4 where the user population for the assessment is defined and how it is selected, and Stage 5 where the assessment methodology, techniques and tools are selected.

8.3 GEM

The EC funded DRIVE II project GEM developed a generic evaluation process model for the assessment of integrated driver systems (Melchior et al., 1995). In all, nine sequential stages are described in which the assessor is required to answer numerous questions and fill in forms. For instance, under the stage, "Definition of the context of use", the assessor is expected to provide details regarding the characteristics of the system’s users and customers, the tasks to be performed, the likely traffic scenarios in which the system will be used, and any requirements for using the system.

The GEM methodology does not provide the means for considering evaluation issues specific to the use of systems by elderly and disabled people - the focus was on the needs of the driving population as a whole. Nevertheless, it does include a 'tick box' section for noting any particular impairments of the intended population. Unfortunately, it is not clear how this section affects later stages of the process, such as the selection of evaluation methods.

8.4 USER Project (TP 1062)

The TIDE USER Project (Usability Requirements Elaboration for Rehabilitation Technology) has published a Handbook and Toolkit called USERfit, which can contribute to TELSCAN’s Assessment Methodology (Richardson et al., 1995). USERfit provides basic user-centred design tools and development approaches like user involvement, usability specification, usability assessment and evaluation. Even though the Handbook is aimed at the rehabilitation and assistive technology sector, the methodology is applicable on a much wider scale, and can be used in the design, development and evaluation of ATT.

At the heart of USERfit is the concept of usability - we say that a product is usable if it can effectively, efficiently, safely and comfortably perform the function for which it is being designed. Technical evaluations, however, are not specifically included within USERfit. The Handbook contains 6 parts:

1. A guide on the subject of user centred design, usability, the principles of user involvement and the significance of user, activity and context characteristics for assistive technology design.
2. The USERfit Methodology: a set of summary tools to collate, analyse, evaluate and develop information to build the specification.
3. A collection of descriptions for when and how to use different methods for gathering information at different stages of the design process.
4. A collection of design prescriptions and recommendations concerning the design of assistive technology drawn from the scientific and technical literature on the subject.
5. A general information section containing a bibliography and information on useful sources like standards organisations.
6. An introductory video which graphically depicts some of the challenges that can be faced in the development of assistive technologies.

USERfit suggests that the following methods and tools are most likely to be used in the evaluation phase, although some may be used at different phases of design:

- User trials
- Direct observation
- Questionnaires
- Interviews
- Group discussions
- Field trials
- Expert opinion

Some techniques or tools may be used at different phases, for example, interviews may be used for both identifying users’ requirements, but may also be used as part of the evaluation process.

As well as recommending various data collection methods and tools, USER also provides its own Usability Evaluation Tools, which assist in the planning of testing activities, in summarising the results of such testing and in recording any actions needed in the form of design modifications. These tools are:

- Overall Evaluation Strategy
- Evaluation Planning
- Usability Evaluation Summary

The evaluation of a hand-held trip planning system is used as an example below.

### 8. 4.1 Overall Evaluation Strategy

The Overall Evaluation Strategy can help to formulate general ideas for the evaluation, including both the usability evaluation with users, as well as a functional evaluation in the laboratory. For example,

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Type of Evaluation Planned</th>
<th>Details of Plan</th>
</tr>
</thead>
</table>
8. 4.2 Evaluation Planning

The Evaluation Planning tool details the usability goals that the product must satisfy to test each system feature, along with the activities that need to be performed to test those goals, how they will be measured, and against which usability evaluation criteria.

For example,

<table>
<thead>
<tr>
<th>Feature</th>
<th>Product Usability Goals</th>
<th>Activities</th>
<th>Type of Study</th>
<th>Measurement Procedures</th>
<th>Pass/Fail Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of sound as well as visual indications for display</td>
<td>Whether elderly, hard of hearing and visually impaired can change mode of output to suit requirements</td>
<td>Scenarios set for finding trip information</td>
<td>User trials in real environment.</td>
<td>Time to successfully perform task Type, description &amp; no. of errors Subjective opinion</td>
<td>To be decided.</td>
</tr>
</tbody>
</table>

8. 4.3 Usability Evaluation Summary

The Usability Evaluation Summary is used after the evaluation to record how well the technology has satisfied the usability goals, and what changes might be needed as a result of the evaluation.

<table>
<thead>
<tr>
<th>Product's Usability Goals</th>
<th>Have the criteria been satisfied?</th>
<th>Actions Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>e.g., Easy to change parameters.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
9. Annex 2 : TELSCAN suggested improvements to CONVERGE tables

CONVERGE original table

<table>
<thead>
<tr>
<th>Category of Assessment</th>
<th>Assessment Objectives</th>
<th>User Groups Involved in Validation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testing Physical Functioning of System</td>
<td>1.</td>
<td></td>
</tr>
<tr>
<td>User Acceptance</td>
<td>1.</td>
<td></td>
</tr>
<tr>
<td>Impact Analysis</td>
<td>1.</td>
<td></td>
</tr>
</tbody>
</table>

Table C2 modified : Definition of assessment objectives with respect to categories of assessment and to user groups involved in validation

<table>
<thead>
<tr>
<th>Problem indicator</th>
<th>Users less than 60 years old</th>
<th>Users more than 60 years old</th>
<th>Users with special needs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testing physical functioning of the system</td>
<td>Physical access</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usability</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mobility indicator</th>
<th>User acceptance</th>
<th></th>
<th></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Extent indicator</th>
<th>Impact analysis</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Social cost benefits analysis</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CONVERGE original table

<table>
<thead>
<tr>
<th>Category of Assessment</th>
<th>Assessment Objective</th>
<th>Indicators</th>
<th>Reference Case</th>
<th>Methods of Measurement or Simulation</th>
<th>Measurement Conditions or Conditions to be Simulated</th>
<th>Statistical Considerations</th>
<th>Measurement Plan</th>
<th>Integrity of Measurement or Simulation</th>
</tr>
</thead>
<tbody>
<tr>
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</table>

Table C3 modified : definition of validation methods for each objectives and category assessment

<table>
<thead>
<tr>
<th>Category of assessment</th>
<th>Assessment objective</th>
<th>Indicators</th>
<th>Reference case</th>
<th>Evaluation condition (real case, simulation...)</th>
<th>Measurement conditions (scenario, tasks...)</th>
<th>Research protocol</th>
<th>User groups (1=less than 60 ; 2=over than 60 ; 3= with special needs*)</th>
<th>Result analysis procedure (1=general case ; 2=case study)</th>
<th>Integrity of measure</th>
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</thead>
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</table>
10. Annex 3 : Overview of the TELSCAN E&D Functional Classification
(from TELSCAN Del 3.2: ATT Systems and their relevance to E&D travellers, Börjesson M., Burnett G., Nicolle N., May 1998, p27)

Here we describe in greater detail what makes an ATT system relevant for each impairment group. In most cases the description concerns how a particular part of the system makes things easier for a certain kind of functional impairment, because passengers' descriptions of user needs are based on problems encountered in today's traffic systems. New ATT systems, however, have a great potential for integrated alternatives to existing traffic systems, thus providing solutions for additional user needs. One notable part of this development is systems that replace travelling with an entirely different solution. One example is replacing a trip to the movies with a system providing video-on-demand at home. In this case, the new system quite simply eliminates the need to travel. For people with functional impairments, such solutions can imply improved opportunities to participate in various activities, but they are not the subject of this report. The integrated solutions dealt with here concern new systems that can simultaneously simplify several stages in the passenger's travelling task. For everyone who has any kind of functional impairment, systems are of great value if they can show the location of people who can help if a problem arises, and an easy procedure for contacting such people. Another common interest is having information about frequently asked questions provided to the operators so that they can become aware of the questions and travel needs of functionally impaired travellers.

Lower limb mobility
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 kiosk or other building, or inside vehicles, the buildings and vehicles must of course be accessible. It must also be accessible considering the risk of overload on upper limbs. But otherwise, impairments of lower limb mobility cause no problems for using the information system. The same is valid for ticketing, parking and 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. Example of possible problems are height and location of controls and screen whether wheelchair users can get close enough.
The greatest problem for this group is that transport systems are 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. This 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 ADL and other services.
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.
Many of the measures that must be applied in the traffic system to make it accessible to people with mobility impairments are very costly. To establish priorities and the order of precedence for new measures, a feedback system informing operators about common problems can be very useful.

**Upper limb mobility**
Using 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 be 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.
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 transports 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 such obstacles as 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.

**Upper body mobility**
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, information can be reflected in the windshield. Keypads and keyboards for communicating with traffic information office, for example, should be placed where they
are easy to reach. 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. Good ATT systems can permit seat selection and a certain choice of seat design when making reservations.

**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. The problem of not being able to reach keypad/keyboard 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 people during a trip. It should also pinpoint vehicles that may be difficult for short people to board or disembark. An ATT system can be useful when driving by replacing the need to physically reach different controls, e.g. via voice activation.

**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.

**Force / Strength**

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 in case of accidents that require strength.

**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.

**Vision**

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

Relevant ATT systems contain information about the physical accessibility of parking places, stations and bus stops, and whether there are passageways or other assistance in getting oriented at bus stops and stations and when approaching or leaving them.

People with seeing eye dogs need to know about possible restrictions on having animals on various modes of transport.

Written information is provided during a trip, and 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.

**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 non-existent 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 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 communicate with one another by blinking their lights and blowing their horns. People with impaired hearing can benefit from aids that translate acoustic signals into another medium. Similar systems can help in knowing when some part of the vehicle is making unusual or alarming noises.
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. Such people 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.

Intellectual/ psychological
People with impaired intellectual, psychological or cognitive functions have difficulties orienting themselves, absorbing new information and encountering unfamiliar situations. For these people, advanced new 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.

Elderly
Elderly people often have several different functional impairments. It is 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.

Integrated solutions
For people with functional impairments, anxiety about inadequate accessibility during a trip is often as great a problem as the possible deficiencies themselves. An integrated system in which a person planning a trip can see how parking places, service facilities, bus stops, stations and vehicles look in advance can help reduce this anxiety. A system is maximally user friendly if it can provide information related to a person's specific disability.
An example of such a solution can be a smart card for paying parking fees or travelling on public transportation which also contains user data. Entitlement to use a parking place or to receive a refund can be checked when paying. The same smart card can be used in systems for pre-trip planning or trip information to have the information presented in a mode appropriate for the needs of the individual, and to contain the information the card owner needs for a particular trip. With additional development, the data on the smart card can also control the setting of assistance systems in the car, and inform public transport personnel about the passenger's specific needs, e.g. in an emergency situation.
Demand responsive door-to-door travel is one example of an integrated traffic solution that makes travelling easier for people with functional impairments. Demand responsive transport requires booking a trip in advance. Reservation, confirmation and payment for such trips can be simplified with new integrated ATT systems.
## 11. Annex 4: Mobility indicator form

<table>
<thead>
<tr>
<th>User groups</th>
<th>People who are elderly</th>
<th>People with disabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>System functionality</td>
<td>LL</td>
<td>UL</td>
</tr>
<tr>
<td>Pre-trip planning</td>
<td></td>
<td></td>
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<tr>
<td>Trip information</td>
<td></td>
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<tr>
<td>Access to vehicle/service</td>
<td></td>
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<tr>
<td>Vehicle control</td>
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<tr>
<td>Parking</td>
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<tr>
<td>Dealing with weather &amp; environment</td>
<td></td>
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<tr>
<td>Emergency warning &amp; traveller support</td>
<td></td>
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<tr>
<td>Ticketing /payment</td>
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<tr>
<td>Toll collection</td>
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</tbody>
</table>
### 12. Annex 5: Problem indicator form

<table>
<thead>
<tr>
<th>Sensory modality</th>
<th>LL</th>
<th>UL</th>
<th>UB</th>
<th>A</th>
<th>C/D</th>
<th>F</th>
<th>SL</th>
<th>V</th>
<th>H</th>
<th>L/S</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is input required with hands/fingers?</td>
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<td>Is input required with feet/lower limbs?</td>
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<tr>
<td>Is input required with speech?</td>
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<td>Is there any visual output?</td>
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<td>Is there any auditory tone output?</td>
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<tr>
<td>Is there any auditory speech output?</td>
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<tr>
<td>Is there any output given to hands/fingers?</td>
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<tr>
<td>Is there any output given to feet/lower limbs?</td>
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<tr>
<td>Is the system incompatible with assistive devices which can provide alternative input/output modes?</td>
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<table>
<thead>
<tr>
<th>Location of displays/controls</th>
<th>YES</th>
<th>LL</th>
<th>UL</th>
<th>UB</th>
<th>A</th>
<th>C/D</th>
<th>F</th>
<th>SL</th>
<th>V</th>
<th>H</th>
<th>L/S</th>
<th>C</th>
</tr>
</thead>
</table>

Copyright TELSCAN Consortium 1999
<table>
<thead>
<tr>
<th>Is access to any displays/controls restricted (e.g. fixed locations)?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is a user prevented from getting his or her face close to any displays?</td>
</tr>
<tr>
<td>Does the user have to rotate their upper body in order to view/access any displays/controls?</td>
</tr>
<tr>
<td>Are there separate controls which are close together (i.e. controls which may be inadvertently activated)?</td>
</tr>
</tbody>
</table>

**Visual display**

<table>
<thead>
<tr>
<th>Is glare/reflection a potential problem on the display?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is contrast/brightness <strong>not</strong> adjustable or <strong>not</strong> easily adjustable?</td>
</tr>
<tr>
<td>Is the default contrast/brightness of the display low?</td>
</tr>
<tr>
<td>Does the display have to be used in conditions of low light (e.g. night-time)?</td>
</tr>
<tr>
<td>Is there any text to be read?</td>
</tr>
<tr>
<td>Is coding used to provide information to the user?</td>
</tr>
<tr>
<td>Are there any symbols/icons to interpret (in particular those which are not commonly encountered)?</td>
</tr>
<tr>
<td>Are colours used to code information?</td>
</tr>
<tr>
<td>Is there any visual information requiring decision making?</td>
</tr>
<tr>
<td>Would a user have difficulty enlarging the size of a display or its image?</td>
</tr>
</tbody>
</table>
### Auditory output

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does auditory information have to be used in a variety of different acoustic environments?</td>
<td></td>
</tr>
<tr>
<td>Is volume/balance <strong>not</strong> easily adjustable?</td>
<td></td>
</tr>
<tr>
<td>Is there any auditory information requiring decision making?</td>
<td></td>
</tr>
<tr>
<td>Is volume/balance <strong>not</strong> automatically adjusted according to ambient conditions (i.e. controls are required)?</td>
<td></td>
</tr>
<tr>
<td>Is there any auditory output which use high frequencies?</td>
<td></td>
</tr>
</tbody>
</table>

### Controls

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are there any obstacles nearby preventing user from making easy contact with controls</td>
<td></td>
</tr>
<tr>
<td>Is precision required in the use of controls (e.g. small buttons or a continuous rotary knob)?</td>
<td></td>
</tr>
<tr>
<td>For optimal control performance, are both hands required?</td>
<td></td>
</tr>
<tr>
<td>Is a pushing/pulling/rotating force required (in particular, controls which need holding down or those which require concurrent pushing/pulling and rotating)?</td>
<td></td>
</tr>
<tr>
<td>Are there any controls which cannot be readily identified by touch alone (e.g. by shape, size, type)?</td>
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</tbody>
</table>
### General

Does the user have to remain vigilant when using the ATT system (i.e. the consequences of lack of attention are high)?

<p>| | | | | | | | | | | |</p>
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</tbody>
</table>

### Key to User Groups

(from Functional Classification, TELSCAN Deliv. 3.1)

<table>
<thead>
<tr>
<th></th>
<th>LL Lower Limb</th>
<th></th>
<th>UL Upper Limb</th>
<th></th>
<th>UB Upper Body</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>2</td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>A Anthropometrics</td>
<td>5</td>
<td>C/D Co-ordination/Dexterity</td>
<td>6</td>
<td>F Force</td>
</tr>
<tr>
<td>7</td>
<td>SL Sudden Loss of control (visceral)</td>
<td>8</td>
<td>V Vision</td>
<td>9</td>
<td>H Hearing</td>
</tr>
<tr>
<td>10</td>
<td>L/S Language and Speech</td>
<td>11</td>
<td>C Cognitive</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>