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Guide to in-vehicle information systems

Committees responsible for this Draft for Development

The preparation of this Draft for Development was entrusted to Technical Committee EPL/278, Road transport informatics, upon which the following bodies were represented:

- Automatic Identification Manufacturers' Association (AIM UK)
- British Telecommunications plc
- Consumer Policy Committee of BSI
- Department of Transport
- GAMBICA (BEAMA Ltd.)
- Institution of Civil Engineers
- Institution of Electrical Engineers
- Institution of Highways and Transportation
- Road Signalling Development Association
- Society of Motor Manufacturers and Traders Limited

The following body was also represented in the drafting of the Draft for Development, through subcommittees and panels:

Institute of Trading Standards Administration

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Foreword

This Draft for Development has been prepared by Technical Committee EPL/278 and is based on a code of practice and design guidelines prepared for the Department of Transport.

It is being issued in the Draft for Development series of publications and is of a provisional nature because the subject matter is in the process of development by CEN Technical Committee 278, Road Transport and Traffic Telematics (RTTT). It should be applied on this provisional basis, so that information and experience of its practical application may be obtained.

Observations on this code should be sent to the Secretary of BSI Technical Committee EPL/278, at the BSI Head Office address as shown on the back cover. Any comments received will be considered by the responsible BSI committee for submission to CEN as a UK proposal for inclusion in the appropriate European Standard. It is anticipated that when the text of the European Standard is available, it will be published as a British Standard and that this Draft for Development will be withdrawn.

Annex D is an extract from the European Conference of Ministers of Transport (ECMT) document entitled *New Information Technologies in the Road Transport Sector — Policy Issues, Ergonomics and Safety* [1].

This publication is not to be regarded as a British Standard

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 34, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Introduction

Over the past two to three years there has been a rapid growth in the number of driver information systems on the market or at the prototype stage. Many products use an in-vehicle display and there is increasing concern about the potential impact of these systems on driver behaviour, and thus road safety, and traffic management. In addition, many items of business equipment are now available as portable units which can be adapted for in-car use.

In general, a licence may be needed under the provisions of the 1989 Road Traffic (Driver Licensing and Information Systems) Act [2] if the system needs roadside equipment to communicate with equipped vehicles or if it gives real-time and detailed route guidance information to drivers.

This Draft for Development is intended to fulfil the need of manufacturers, suppliers and users for a document covering the design, installation and use of driver information systems. It is divided into three sections. Section 2 gives recommendations on the key issues to be considered if a product is to achieve the highest levels of efficiency, effectiveness and safety when it is used. Section 3 is an introduction to ergonomics best practice. It incorporates research results and expert opinion to help designers who are new to working with in-vehicle systems to achieve good ergonomic system design.

BSI recognizes that this is an interim document because in a number of areas there is insufficient underpinning research to be able to specify clearly and unambiguously what constitutes a safe in-vehicle system. Many research establishments are studying this issue and several EC research projects, to which the United Kingdom is contributing, are aiming to produce objective results needed for performance-based standards. The Comité Européen de Normalisation (CEN) has begun work to develop such performance standards for the man-machine interface (MMI) aspects of road transport telematics which is expected to take until 1998 to complete. Section 2 represents an initial UK contribution to this work. However, in some areas the need for advice is pressing. As there is much material and a large body of expert knowledge to contribute to descriptions of what makes for safer systems, the BSI believes it is sensible to make this Draft for Development available now as a compendium of what can be achieved and a contribution to the general effort.

This Draft for Development:

- a) is intended to minimize distraction of the driver caused by information systems;
- b) only applies to systems that will be used by the driver while driving;
- c) is intended to supplement, not replace, British, European or International Standards, directives or regulations;
- d) is for guidance only.

This document is in three sections:

Section 2 sets out the objectives to be achieved in order to maximize the safety of driver information systems. This includes ensuring that they do not distract the driver and that they do not pose a hazard in the event of an accident.

Section 3 provides advice and data to help the designer, manufacturer, installer and user achieve the objectives set out in the Draft for Development. This summarizes current ergonomics knowledge and provide sources for further information.

Achieving the objectives recommended in section 2 is not necessarily dependent upon implementation of the detail in the guidelines. There is much research currently being undertaken in this area and new data and information are becoming available. Alternative means of achieving the objectives of section 2 may be found and used so long as these can be demonstrated by means of valid and reliable evaluation techniques to be at least as safe.

If you have any queries about this Draft for Development, please write to the secretary of Technical Committee EPL/278.

Section 1. General

1.1 Scope

This Draft for Development gives recommendations for important safety related issues that should be addressed by the designers, manufacturers, suppliers and installers of in-vehicle information systems that could conceivably be used by drivers while driving.

NOTE 1 Use of in-vehicle equipment while stationary presents less of a safety concern, although some of the driver's attention has still to be reserved to monitor external events whilst stopped in traffic.

It applies to all information systems except those solely giving information about the state of the vehicle or its equipment (e.g. speedometer, fuel gauges, etc.) Such systems include communications systems (such as telephones and radios), entertainment systems, traffic information systems, navigation systems, mobile data terminals, portable personal computers and fax machines.

NOTE 2 With the rapid growth in new technologies at this time it is not feasible to list all the equipment to which this Draft for Development is applicable and so this list should not be viewed as exhaustive.

This Draft for Development applies to equipment which may be used by the driver whilst the vehicle is being driven. It applies whether one or more driver information system is fitted, and it applies to equipment capable of multiple applications and multifunction displays.

1.2 References

1.2.1 Normative references

This Draft for Development incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on the inside back cover. For dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publication apply to this Draft for Development only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

1.2.1 Informative references

This Draft for Development refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

1.3 Definitions

For the purposes of this Draft for Development, the following definitions apply.

1.3.1 driving

when the vehicle is moving

1.3.2 H-point

point about which the upper legs and trunk pivot when seated

NOTE The H-point varies with seat position.

1.3.3 R-point

lowest rearmost fixed point of reference which relates the human body to the vehicle

NOTE Also known as the seating reference point and manufacturer's design H-point.

1.3.4 eyellipse

design tool which represents the range of eye positions for a given population range and seating design

1.3.5 accommodation

ability of the eye to sharply focus on objects at varying distances from infinity down to the near point

1.3.6 near point

nearest point of distinct vision

1.3.7 ergonomics

study of the interaction between people and the machines, tools and environments they use or come into contact with

NOTE In relation to these design guidelines, ergonomics is particularly concerned with optimizing the driver's performance, while both driving and using an information system.

1.3.8 function keys

keys that allow the user to perform a series of actions through one, or a limited number, of key entries

1.3.9 contrast

luminance ratio between character and background

1.3.10**resolution**

smallest measurable detail in a visual display

1.3.11**percent active area**

proportion of a symbol or character that is actually emitting light

1.3.12**stroke width**

thickness of the lines which form a character in a visual display

1.3.13**glare**

discomfort or impairment of vision experienced when parts of the visual field are excessively bright in relation to the general surroundings

1.3.14**head-up display (HUD)**

originally referred to a particular display technology which presented images which could be viewed through the windscreen. May sometimes be used to describe any display which does not require the driver to look down from the view ahead

1.3.15**head-down display (HDD)**

displays which the driver has to look down from the view through the windscreen to view. Conventional instruments are examples of HDDs

1.3.16**menu**

list of options, frequently presented on a computer screen to a computer user in the form of a small table

1.3.17**phoneme**

basic speech sounds from which syllables and words are constructed. Each phoneme has a phonetic symbol in a phonetic alphabet. Not all phonemes can be pronounced in isolation

1.3.18**raster**

pattern of horizontal scanning lines traced by an electron beam on a cathode ray tube (CRT) screen

1.3.19**spectrum**

graphical presentation of a quality (e.g. sound or colour) across a range (of frequencies or wavelengths for instance)

1.3.20**system**

in-vehicle information system

1.3.21**synthesized speech**

speech produced from inputted speech phonemes, or text in a text-to-phoneme system

1.3.22**digitized speech**

pre-recorded natural speech

1.4 Responsibility

Designers, manufacturers, suppliers and installers all have some responsibility for safety in relation to the construction and installation of in-vehicle information systems. Companies promoting any system, employers, hire companies and drivers all have some responsibility for the way in which the equipment is used.

Section 2. Manufacture, installation and use

2.1 General

2.1.1 System controls should be designed to be securely fixed to the vehicle's interior in a place where they can be safely used.

2.1.2 The system should be designed so that it does not unduly distract the driver, nor give rise to potentially hazardous driving behaviour by the driver or other road users.

2.1.3 Information systems should be compatible and consistent with existing vehicle equipment.

2.1.4 It should not be possible to activate system functions designed to be used only while the vehicle is stationary, while the vehicle is being driven.

2.1.5 Use or misuse of the system should not result in the vehicle becoming unsafe to drive during normal use or during total or partial failure of the system.

2.1.6 The system should not present an electrical, electromagnetic, chemical or mechanical hazard to vehicle occupants or other road users during normal use and reasonably foreseeable misuse and should not increase risk of injury in the event of an accident.

2.2 Driver/system interaction

2.2.1 Displays should not aim to visually entertain the driver.

2.2.2 Displays should not interfere with the driver's central or peripheral view.

2.2.3 The system should not produce patterns or sounds liable to startle the driver.

2.2.4 The system should be easy to use and able to be switched off without adversely affecting the control of the vehicle.

2.2.5 Drivers should be able to control the volume of sounds generated by the system.

2.2.6 Audible information should not prevent reception of external warning sounds.

2.2.7 The system should not require the driver to make time-critical responses when providing inputs to the system. The driver should be able to dictate the pace of interaction with the system.

2.2.8 The system should not provide information which is likely to adversely affect appropriate reactions by the driver in critical situations, e.g. by diverting the driver's attention from a hazardous situation.

2.2.9 Information provided should, as far as reasonably practicable, be sufficiently timely and accurate to assist the driver. Route information should be given sufficiently in advance of the manoeuvre for it to be accomplished safely.

2.2.10 Nationally and/or internationally agreed standards for icons, symbols, words, acronyms or abbreviations should be used wherever possible.

2.2.11 Visually displayed information should be such that driver can assimilate it at a glance which is brief enough not to affect driving, see Figure 6. For example a glance lasting not more than 2 s has been proposed as a reference in less visually demanding driving conditions (e.g. a straight motorway with little traffic and good visibility).

2.2.12 Text messages should be relevant to the driving situation, easily readable, and limited in length. Message signs should not exceed seven words.

2.2.13 Text input by keyboard should be minimized while driving. Long and repetitive sequences of actions should be avoided.

2.3 System instructions

2.3.1 The system should have written instructions for use. These should cover all aspects of installation, use and maintenance.

2.3.2 Instructions should be correct, simple and clear and in the user's native language.

2.3.3 The system instructions should clearly state the intended user groups and the intended use of the system.

2.3.4 The system instructions should clearly state if specific skills or capabilities are required to use the system.

2.3.5 Instructions should be durable so that future owners will be able to learn about the system. Ideally they should be integrated into the system, for example as a programmed tutorial.

2.4 Responsibilities of the supplier

2.4.1 Suppliers should ensure that any promotion (e.g. advertising) does not encourage unsafe use.

2.4.2 Suppliers should be sufficiently familiar with equipment offered in order to assist buyers at the time of purchase and to provide after-sales support.

2.5 Responsibilities of the installer

2.5.1 The installer should install the system in such a manner that it does not obstruct or interfere with existing vehicle controls or instrumentation, especially those required for safe driving.

2.5.2 The installer should ensure that the system does not obscure the driver's view out of the vehicle.

2.5.3 The system should be located and fitted in accordance with the relevant standards for installing equipment in vehicles. The system should be easily usable from the driver's preferred seating position while wearing a seat belt.

2.5.4 If the system is intended for use by front seat passengers as well as the driver, the installer should ensure that it is located such that reasonable use by the passenger does not interfere with the driver in any way.

2.5.5 The installation should be performed in accordance with the manufacturer's instructions.

2.5.6 Where more than one information system is installed within a vehicle the installer should assess the complete installation for safety and usability in realistic situations. Expert help should be sought where necessary.

2.5.7 Installers should be sufficiently familiar with both the system to be installed and the vehicle in which it is to be installed to enable them to carry out the installation competently.

2.6 Responsibilities of an employer

2.6.1 Employers requiring staff using an information system or systems in a vehicle to follow specific procedures should ensure that these procedures do not reduce the safety of the vehicle. Expert help should be sought where necessary.

2.6.2 Employers should ensure that anyone required to use the in-vehicle system whilst driving is capable of doing so without endangering themselves or other road users.

2.6.3 Adequate training should be provided on all installed systems that drivers are required to use. A record of training should be retained and methods of assessing the effectiveness of the training should be considered.

2.6.4 A copy of the manufacturer's user instructions should be provided in every equipped vehicle.

NOTE It is preferable that these be passed to the next owner of the system.

2.6.5 The employer should ensure that the system is maintained in accordance with the manufacturer's instructions.

2.7 Responsibilities of vehicle hire companies

2.7.1 Vehicle hire companies should inform drivers of the purpose of all information systems installed in the vehicle and should offer instruction in their safe use.

2.7.2 A copy of the manufacturer's instructions for use should be provided in every equipped vehicle.

NOTE It is preferable that these be passed to the next owner of the system.

2.7.3 The company should ensure that the system is maintained according to the manufacturer's instructions.

2.8 Responsibilities of the driver

2.8.1 Ultimate responsibility for safe control of the vehicle rests with the driver. Drivers should only use in-vehicle information systems when it is safe to do so.

2.8.2 Drivers should ensure that they have access to the manufacturer's instructions and should follow these instructions. Drivers should not use a system until they are content that they can do safely. This may mean a period of training or familiarization is required.

2.8.3 Information systems with controls which are hand-held or placed on a seat should not be used while driving.

2.8.4 Communications equipment, even with hands-free operation, should be used with care. Drivers should warn conversants that they are driving and may break off conversation to attend to driving tasks.

2.8.5 All instructions associated with the in-vehicle equipment should be retained with the vehicle and passed to the next vehicle owner or user.

Section 3. Design guidelines

3.1 The design process

3.1.1 General

These design guidelines are an introduction to ergonomics best practice and introduce the important issues to consider when designing in-vehicle information systems in order to meet the needs of the driver when using a system while the vehicle is in motion.

It is good policy to document all information collected and its sources for future reference.

Assessed capability. Users of this Draft for Development are advised to consider the desirability of quality system assessment and registration against BS EN 9000 *Quality management and quality assurance standards* by a third party certification body.

Figure 1 outlines the most important factors that the designer should consider from the start of the design process, i.e.:

- what the system will do and why it is needed;
- what the driver does now to obtain the same, or similar, information;
- who will use the system;
- define when the system will be used, including the traffic conditions and, if appropriate, the weather conditions.

The success of the system will be measured by the extent to which it meets the real needs of the driver. In addition to its specific benefits, for safety the system should have minimal “eyes off the road” and “hand off the wheel” times.

3.1.2 System requirements

Figure 1 shows some examples of different systems and the factors which should be considered in their design. These factors are important. Various questions should be asked at this early stage, for instance:

- Is the system needed?
- How does the driver now obtain the information the new system will provide?
- Will the system conflict with other tasks undertaken by the driver?
- Will the system conflict with other systems already in use?

Help in answering these questions is available from such sources as sales and marketing information relating to existing systems and from ergonomics and transport research organizations. In addition, vehicle manufacturers should be consulted to ensure that the proposed system is compatible with their existing systems.

3.1.3 System users

Information about the drivers who will use the system should be taken into account during the design process. It should be recognized that drivers vary widely in their physical, intellectual and perceptual abilities.

This information, examples of which are given in Figure 1, should include visual capabilities such as colour blindness and whether or not spectacles are worn, size, age and mobility, and less tangible factors such as previous experience with in-vehicle information systems and any tendencies to take risks. Other matters which should be taken into account include a knowledge of the vehicles to which the systems will be fitted, the presence of passengers, especially children, and other more general questions affecting safe design.

If there are difficulties in defining the characteristics of the driver, as may happen when systems are designed for use by the general driving public, then the system should be designed for the least able, for instance for older drivers, and for drivers with varying degrees of visual impairment, limited mobility, hearing loss and slowing of recognition and co-ordination.

If the system is intended solely for use by a specific market, such as firemen, ambulance or taxi drivers, the type of driver can be defined more easily.

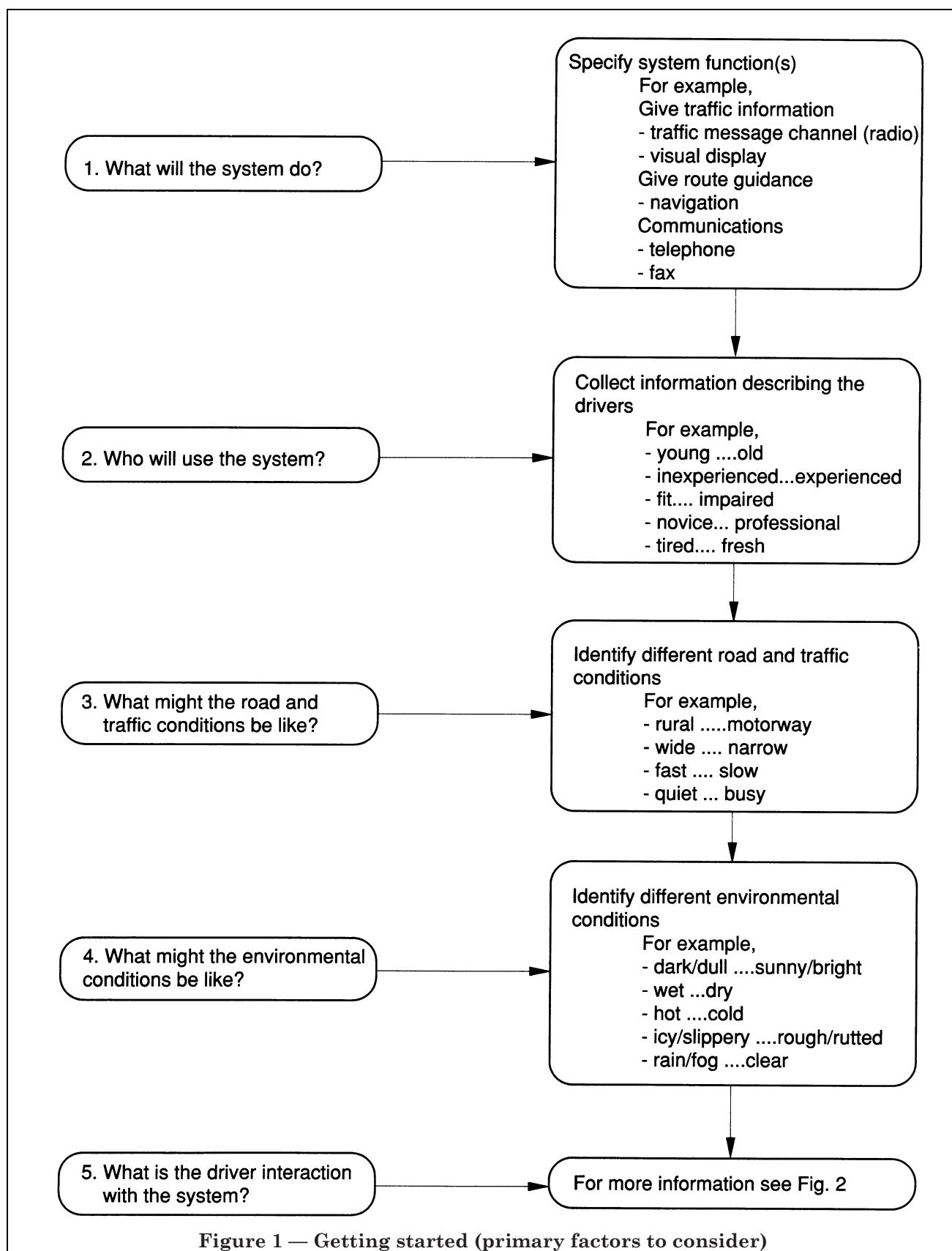
However, the effect of other issues such as those detailed in Table 1, should be considered.

Table 1 — Examples of issues and effects

Issue	Effect
Potential stress level	Lack of concentration
Personal distraction	Lack of concentration
Clothing	Gloves and protective clothing might affect the selection and spacing of controls

3.1.4 Road and traffic conditions

Traffic conditions are variable and difficult to define in advance. The designer should take this into account and should also recognize that a system might not always be used solely in the conditions for which it was originally designed. For instance, a system intended for use by drivers covering long distances with consequently high motorway mileage might also be used on short, local runs such as taking children to school. The former will require traffic information over a large geographic area whereas the latter will require detailed local information.



Alternatively, a system may be intended for use within a tightly constrained environment where the likely conditions of use can be closely defined in advance and will not change. An example of such a system would be a mobile data terminal for motorway police.

3.1.5 Environmental conditions

Environmental conditions are very variable and difficult to define in advance. Most drivers will experience all the conditions shown in Figure 1 during an average year and the system should be designed to take account of these variations since they can have a considerable effect on usability.

A close examination of the system, drivers, traffic and environment should be carried out to help to clarify the benefits and any disadvantages that are expected from the development of the system and will provide valuable input to the design specification.

3.1.6 System and driver interaction

All system actions and logic should be considered in relation to the driver's abilities and limitations in defining detailed information about system and driver interaction. A system for use by a specific market should be provided with adequate instructions or tutorials. A system for use by the general public should not be designed with a complex driver interface unless additional training and instruction, perhaps involving simulated use, can be made available.

Figure 2 outlines what a driver would need to do to operate a hypothetical, simple information system. It is recommended that expectations of driver and system actions and reactions are mapped out as in Figure 2 for detailed system specification and for planning system evaluations. It will also enable the interaction between driver and system to be monitored so that expectations and actuality can be compared.

The designer should also determine whether changing vehicle characteristics will affect functioning of the system. For instance, if the vehicle is towing a caravan or carrying a boat on the roof, will this affect a navigation system in any way? Would a bag of golf clubs placed in the boot interfere with compass directions in any way?

NOTE A primer called "QED" (quick ergonomic design) was specifically developed by the HUSAT Research Institute, Loughborough University of Technology, Loughborough with the intention of advising on the incorporation of ergonomics into the design of computer products and systems. Although it was not developed to assist with the design of in-vehicle information systems, there is considerable information within it which can be applied successfully.

3.1.7 System hardware

Once information has been collected defining the characteristics of the drivers who will use the system, the tasks associated with using it and the environment and context in which it will be used, a decision should be made about the most appropriate input and output technology to use.

Information is input into a system using controls. These may be conventional, such as switches, pushbuttons and sliders, or they may involve the use of touchscreen technology.

The output can be presented visually using cathode ray tubes (CRT's), liquid crystal displays (LCD's) and plasma displays for example, or aurally using tone or speech.

All of these technologies have advantages and disadvantages according to where the system will be used and who will use it.

3.2 Information presentation

3.2.1 General

Good, effective information presentation is the key to developing an effective and usable system. The driver's response to the information presented should be the response intended and this will be affected by existing knowledge, expectations of the system, attitude to technology and motivation.

There are several reasons why driver response may not be that anticipated by the designer and all should be accounted for in this safety critical environment. These reasons include the following.

- a) The driver may be unaware that the system is trying to present information (see 3.3).
- b) Information may be inaudible, illegible or in some other way unintelligible (see 3.3).
- c) Information may be ignored. Why information is ignored can be difficult to ascertain, although good ergonomic system and software design and accompanying instructions may minimize this likelihood. The driver may, for example, be busy attending to other tasks at the time. If he cannot follow the advice at that moment in time then further advice or information should be given later.
- d) The system presents information either too late or too early to be useful.

The penalty for the driver failing to respond should not be such as to force the driver to change priorities. The design of the system should enable the driver to obtain information quickly and easily.