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# Human Factors (HF); Human factors guidelines for ISDN Terminal equipment design

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ETSI

# ISDN TERMINAL DESIGN

## Human Factors Guidelines

June 94

## Foreword

This ETSI Technical Report (ETR) has been produced by the Human Factors (HF) Technical Committee of the European Telecommunications Standards Institute (ETSI).

ETRs are informative documents resulting from ETSI studies which are not appropriate for European Telecommunication Standard (ETS) or Interim European Telecommunication Standard (I-ETS) status. An ETR may be used to publish material which is either of an informative nature, relating to the use or the application of ETSs or I-ETSs, or which is immature and not yet suitable for formal adoption as an ETS or an I-ETS.

ETR 116, containing Human Factors guidelines relating to the provision of pan-European Integrated Services Digital Network (ISDN) telecommunications services, is presented in a different manner to other ETSI publications. However, ETSI endorses these guidelines as an ETR.

# Contents

# 1 Scope

The European Telecommunications Standards Institute (ETSI) has produced this ETSI Technical Report (ETR) to help terminal equipment suppliers to maximize the level of usability on the systems and equipments they design, develop and/or supply; through a comprehensive set of Human Factors design guidelines that relate to the provision of Pan-European Integrated Services Digital Network (ISDN) telecommunications services.

The ETR is intended to provide guidance to ISDN terminal equipment designers on the human factors issues, good human factors design practice, international and national standards that relate to the product they are designing.

This ETR addresses the design issues and provides guidelines for a limited set of products. It is hoped that future versions will address other products as the information becomes available.

This version looks at:

Telephones, principally for fixed, private and business use;
Facsimiles, principally for fixed, private and business use;
Videotelephones, principally for fixed, private and business use;
Integrated multimedia terminals, principally for fixed business use.

Future versions may look at:

Telephones, mobile and public;
Facsimiles, mobile and public;
Videotelephones, public;
Mobile terminals, e.g. pagers, radio data terminals, etc.

# 2 Introduction

The integration of digital technology within telecommunications has led to many significant changes in the design of both the network and the terminals that access it. The improvements made in quality and reliability have been overtaken by a phenomenal growth in services. Services which have broadened the range of media carried (voice, data, image, etc.), multiplied the types of terminals served and exploded the variety of facilities offered.

This ETR is an attempt to make sure that designers do not lose sight of people's basic requirements in this massive technology push, and that simple needs do not get lost in the rapid growth of complexity.

This introduction to the ETR touches on three points:

**How to use these guidelines:**
Identifies who we think might use the ETR, and gives suggestions on how to get started.

**Why human factors:**
Presents the business case for human factors. The short answer is, it can save money, yours and your customers.

**Human factors in the product design process:**
Presents some ideas on how Product Design Managers can make use of human factors expertise.

## 2.1 How to use these Guidelines

This ETR is targeted to provide information to two different audiences, the members of other ETSI Technical Committees and ISDN Terminal Equipment Designers, from Design Managers to Design Engineers, although it is recognized that frequently these may be the same person.

Whichever you are, standards creator or product designer, it is expected that you may have one of three possible uses:

- you have a specific design (or standards) question or problem in mind, which seems to be related to human factors,
- you have a specific product in mind and need to know which issues are important for human factors, or
- you have a more general interest, and may be looking for future reference, or to get a better idea of where and when to apply human factors.

With these uses in mind we have divided the document into the following Clauses:

Contents

### 2.1.1 If you have a specific question

For the user with a specific question or problem, start with the Index or Contents List. From here, we hope we have provided enough clues for you to quickly target a likely subclause, within the Design Guidelines Clause. Otherwise, we suggest you look in the Design Issues Clause where we hope you can get a feel for possible related areas.

### 2.1.2 If you have a product in mind

For the user with a specific product or project in mind, four key telecommunications product areas are offered in this issue. We recommend you start with Design Issues: Telephones, Facsimiles, Videotelephones or Integrated Multimedia Terminals. Each of these presents a series of questions and keywords that relate to some of the relevant guidelines subclauses. Unfortunately it is not possible to offer specific design guidance for each issue or question raised as the information is not available; but by asking the question of the user, we hope there is a chance that it will be addressed.

### 2.1.3 If you have general interest

For the user without a specific question or project in mind, but who may have a general interest and may be looking at how to integrate human factors requirements into a product, we recommend starting with the introduction, and in particular the subclauses on "Why Human Factors?" and "Human Factors in the Design Process".

### 2.1.4 For all readers

For all readers, if you do not find what you are looking for, please do not give up. We would like you to do two things:

1 talk to a professional Ergonomist or Human Factors specialist. They will be able to find the information you are seeking, or know how to find the answer.

2 talk to your ETSI representative and ask them to pass on your requirements to the Technical Committee for Human Factors (TCHF), then we can consider the point for future releases.

## 2.2 Why Human Factors?

To answer the question "Why should human factors be integrated into ISDN product design?", we look first at what has been happening to products over the last decade or so - The usability gap. Secondly, we look at the cost benefits available from human factors design inputs - Price, performance and preference.

### 2.2.1 The usability gap

Over the past 20 years or so, technical advances and market pressures have made telecommunications products and systems increasingly complex and feature rich. At the same time, because of customer demand and the reduced cost of technology, products and services that people used to be trained for, are now available to all, the users have become less and less specialized. For example, in the early seventies, the user facilities on a Private Automatic Branch Exchange (PABX) were principally for the operator to help them assist their extension users. At that time, nobody handled call transfers or multiparty calls without the operators assistance. Since then, PABX features have been down loaded to the extension user who can: Hold, Transfer, Shuttle, Conference, Divert, Follow me, etc. etc. all from the comfort of the basic telephone. What happened, has occurred all too often in other technologies, an increase in product complexity has been paralled with a decrease in user specialization, and the problems that are created in the middle can be considered a gap in product usability.

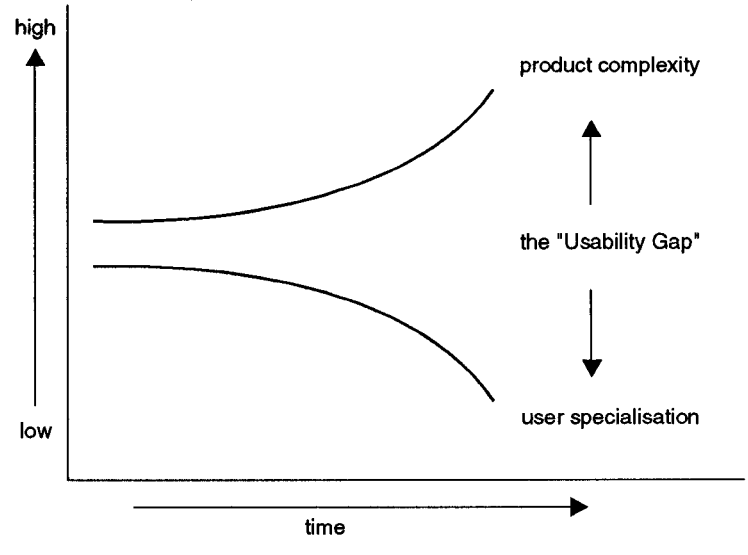



**Figure 1: The usability gap**

The same graphical demonstration can be used to consider what happens if the design of the user interface is kept the same whilst the complexity of the product increases which is what happened with the introduction of PABX extension user features, when the extension user only had a basic 12 key telephone.

The user interface remained the same and did not keep pace with the increased product complexity, so the usability gap increased. The only solution is to upgrade the user interface so that the user has better access to the increased product complexity.

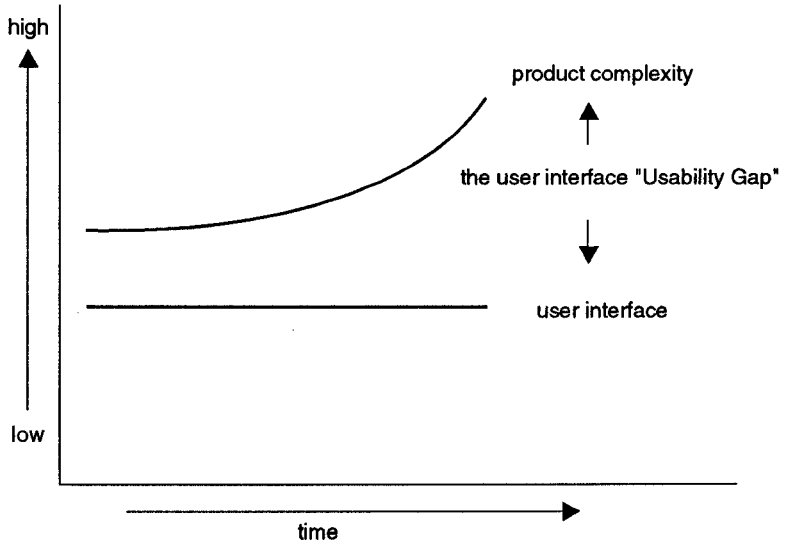



**Figure 2: The user interface - usability gap**

The parallels in the software industry are many, but one example is worth quoting. The first commercial spreadsheet "Visicalc™", was command based and provided a functionality not realized before. However, the command language necessary was extensive and complex, and thereby limited the user's capability. "Lotus 123™" took the opportunity and reduced the user's memory load with a menu based system. Now, the product complexity has been raised again, with the need to cut and paste between spreadsheets, documents and charts. Consequently, the point and select graphical user interface of "Excel™" and others, is in demand. Each time there has been an increase in complexity, it has been matched by improvements in the user interface.

The challenge then, for human factors in the product design process, is to bridge the usability gap and help keep the user interface in line with the product's complexity.

### 2.2.2 Price, performance and preference

There are three key elements that can contribute to the customer's buying decision: Price, Performance and Preference.

#### 2.2.2.1 Price

The Price for any product or system is a function of the initial purchase price and the progressive cost of ownership. Human factors may make an impact on both of these.

##### 2.2.2.1.1 Purchase price

The impact on the initial purchase price can arise from a comparison, for example, between two display solutions. Both may offer similar functional capabilities, but one may be significantly more expensive and offer, say 10% gains in resolution. A simple experiment could determine the effect of the increased resolution on the critical tasks that the product is aimed at, and

analyse the users subjective assessment of the better resolution. The question then becomes: is there a significant improvement on the tasks and/or on the users assessment of the higher resolution display to justify the cost increase? Similar trade-offs between purchase price differences may also be made, for example, to decide whether a full alphabetic keyboard or a particular dialogue style is necessary or beneficial.

#### 2.2.2.1.2 Cost of ownership

The impact on the cost of ownership can arise from several sources. Human factors may help reduce training or learning costs, maintenance or service costs, or operational costs.

**Cost of ownership = Training + Operational + Maintenance Costs**

**Training costs**

Following the introduction of a new PABX, a telecommunications operating company looked again at the way they trained their users. An human factors study concluded that feature uptake and user performance would not be significantly reduced if they stopped "hands on" training as part of their support to new PABX end users. The inclusion of "hands on" training was significantly more expensive in time and effort. The reported "saving" was $2,5 million in the first year (Karlin, 1977). A subsequent study also showed a pay-off in concentrating on "concept training" rather than the more expected "procedure training".

**Operational performance**

A software and systems company compared users performance on two versions of a software programme, the original and the human factors re-design. The human factors exercise had made changes in screen formats, screen contents, abbreviations, error correction and feedback messages. The results showed a consistent improvement of 25% in transaction time and a similar 25% drop in errors. The cost savings of such improvements are self-evident. (Keister and Gallaway, 1983)

**Maintenance costs**

With the introduction of stand-alone photocopiers, a copier company specialising in leasing, saw a large increase in service call outs. The majority of these were for handling simple problems, like clearing paper jams and toner spills. The human factors analysis showed the need for user instructions to be integrated onto the copiers (not hidden in a user guide) and for changes in the design of the paper path. The result was a significant saving in service call outs as the simple maintenance was transferred to the end users. From the customer's perspective, a small increase in the user's work load made a major difference to the availability of the copier.

### 2.2.2.2 Performance

The performance of a product or system is a function of the capability of the hardware and software components and the efficiency of the human operator.

The failure rates of hardware components are typically between 1 in $10^3$ and 1 in $10^6$. Pushbuttons, for example, are frequently better than $10^6$. At present, software companies do not publish reliability figures for their programmes. However, given the numbers of lines of code even moderate applications require and the extensive use now made of software based products, the failure rates are probably similar to hardware, between 1 in $10^3$ and 1 in $10^6$. Both of these far exceed the typical human error rates, which are more normally between 1 in 10 and 1 in $10^2$ for infrequent tasks, but can reach 1 in $10^3$ or better for highly practised tasks. For example: a recent series of trials on a new ISDN service showed errors ranging from around 6 in 10 (60%) to better than 1 in $10^2$, depending on the task being considered.

Quite obviously the limiting factor for any product or system performance is the user.

| **Total Performance =** | **Hardware +** | **Software +** | **Live-ware** |
|---|---|---|---|
| | **1 in $10^3$-$10^6$** | **1 in $10^3$-$10^6$** | **1 in 10-$10^2$** |

The impact that human factors can have on the total product or system performance is to reduce human error and improve user efficiency.

**Human error**
The earlier examples affecting the price all had elements of human performance. The example now is related to human error.

A telecommunications company compared user performance across sixteen different activation procedures for a single PABX feature. Each procedure had been genuinely proposed by professional systems designers and others, and would have been intended to be easy to use. The results are stark. They show a significant difference in the fatal error rates between the best and the worst. Procedure P has a 550% increase in errors over procedure A. The likely effect on customer acceptance, if procedure P had been implemented, can only be guessed at. (Dooling and Klemmer, 1982)

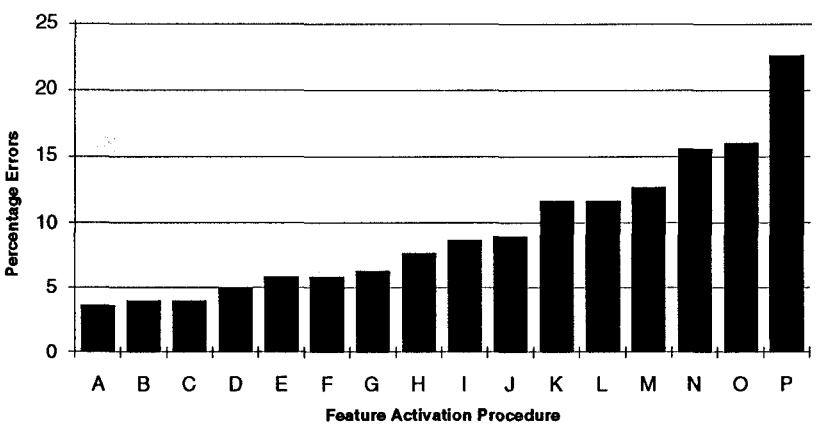



**Figure 3: Error data for 16 different activation procedures for a single PABX feature**

The results also showed that fatal errors (losing one of the called parties) was not the only measure to be considered. Coincidentally, procedure A also had a rather high incidence of non-fatal errors. The final design chose one of the second best procedures e.g. D-H with a low non-fatal error rates, in order to minimize the difficulties and frustrations that otherwise would be experienced in normal use.

#### 2.2.2.3 Preference

The third element to the buying decision which human factors can affect, is less tangible than the Price and Performance elements. For simplicity, it is called here User Preference, but it can include a number of psychological components, e.g. Product aesthetics, Consumer confidence (in the manufacturer or supplier), Customer stereotypes or habits, User acceptance etc. In some respects, preference is the strongest of the three elements. One example will suffice to demonstrate how it can affect performance.

Maclean et al, 1985, reported a comparison between performance and preference trade-offs in a data entry task. Subjects completed the data entry exercise in three blocks. On the first two blocks, they used the mouse then the menu based method of data entry (or vice versa). On the last block the subjects chose which method they preferred, and could change as they wished throughout the block. The argument was, that if preference reflected performance perfectly, the faster method would be chosen every time, or at least the slower one would be chosen only when there were small time differences. However, the data showed a considerable bias.

| **Preference vs. Performance** | Menu Chosen | Menu Chosen | Total |
|---|---|---|---|
| Menu Faster | 36% | 2% | 38% |
| Mouse Faster | 40% | 22% | 63% |

The subjects tended to chose the menu method even when the mouse was significantly faster. The fact that this was a distinct preference is confirmed by the high score for Menu choices, when the mouse is fastest. The efficiency level, Mouse or Menu faster, was established in the results from the first two blocks of data.

The impact on price/performance-only assessment is certain, sometimes at least, user preference decides the contest.

### 2.2.3 The human factors role

Quite clearly, from the examples given and others (Chapanis, 1991; Klemmer and Dooling, 1983), human factors can contribute towards and significantly effect three crucial elements of the buying decision: the price, the performance and the customer's preference. In having this effect human factors can meet the challenge and help bridge the Usability Gap.

It should, therefore, have a significant role in the Product Design Process.

## 2.3 Human Factors in the Product Design Process

### 2.3.1 The design process

Product or system design methods and procedures are often as individual as the company or people involved, but underlying these there is usually a common theme. An initial idea or market requirement is converted into an initial design concept. The concept may then go through a series of revisions, refinements or transformations, until finally a product is launched. For simplicity the process can be described sequentially, together with the documents and prototypes produced, as in the figure below.

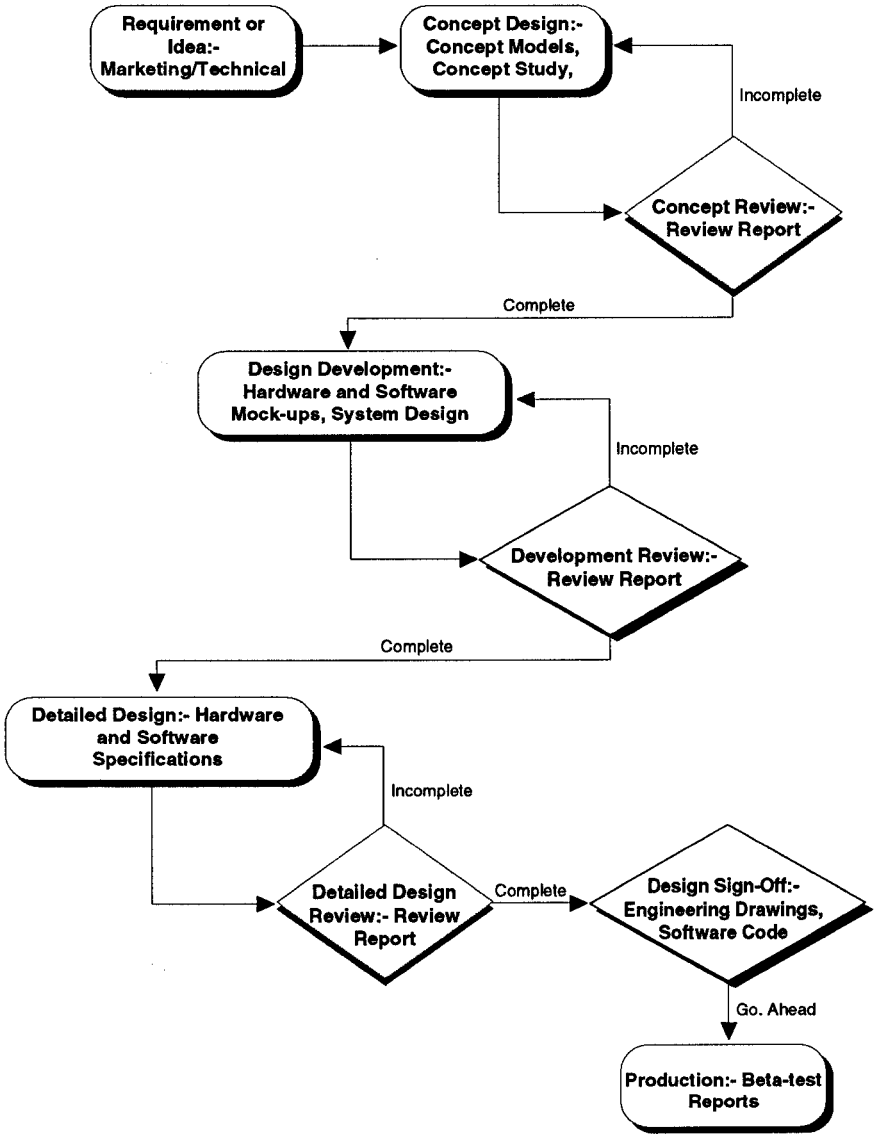



**Figure 4: Generic design process**

### 2.3.2 The contribution of human factors

The contribution of human factors within the design process is towards the design of the User Interface of the product. For human factors, the User Interface includes everything the users are likely to come in contact with, the exterior hardware (casework, controls and displays) the software dialogues (display contents and user procedures) and the product documentation (user guide, training manual, etc.). As the user is the limiting component in the total performance of the product, the design of the user interface (the user's access route to the product) requires the same dedication as the design of any other part of the system.

The contribution then, to be expected from human factors, should be like that expected of any other design engineer: to analyse requirements, to design and develop solutions and to test the design against the requirements.

**Analysing requirements**
The essential first step for human factors is to know the users and to know the tasks, and usually to document the requirements of both in some way (See Clause 3 "Users and Tasks"). The human factors jargon term is usually "Task Analysis". The purpose is to have a clear perspective of who the users are and what range of tasks they have to perform and to what criteria.

**Design**
For some, human factors is more about requirements analysis and specifying the user needs. For others, the real challenge is in design, to see the problem and to seek a solution.

**Test and evaluate**
The essential final step for human factors is to assess the chosen design(s) against the requirements of the users and the tasks. One of the problems in the past was the late stage at which testing could be accomplished. Now, with the range of rapid prototyping tools and advanced research techniques, human factors testing can be done earlier and cheaper.

#### 2.3.2.1 Levels of human factors involvement

The actual level of involvement that human factors (HF) may have within any particular product development will depend upon the needs and objectives of the Product Design Manager. In practice three levels can be described: Qualification, Design Support, and Design Responsibility. These are briefly outlined below. A Design Manager's checklist is also presented, which gives a review of what the manager might expect from each of the three levels of involvement.

**Qualification**
The involvement of human factors within Qualification (Quality Assurance) is where there is minimum involvement with the design activity. The role is more to provide initial guidance or specifications on the human factors requirements, and then to use design review and other test points within the process to check how well the requirements are being met.

**Design support**
The involvement at the design support level provides a higher degree of contact within the design activity. Here the human factors specialists are providing design support to the main design engineers. They may be giving specific advice: for example, on the points to watch for in selecting a suitable display, i.e. legibility, brightness/contrast, resolution, etc., or they may be

offering help with design reviews with respect to the users needs. As well as maintaining an advisory role they may also maintain the qualification role.

**Design responsibility**
This gives a specific responsibility for a distinct part of the overall design to human factors. The two key areas are: the Hardware and Software User Interface, and the User Guide (or handbook). In this case the human factors specialist needs to create the necessary requirements statements or specifications, and then to propose solutions which take account of the hardware and software capabilities and the market and user needs. These solutions will progress through the usual revisions and refinements until a final specification is signed off. At the same time other human factors specialists may be maintaining the qualification role checking the user/task requirements are being met.

**Table 1: The design manager's checklist**

| The Design Phase | Qualification | Design Support | Design Responsibility |
|---|---|---|---|
| **Concept Design** | Is the User/Task Requirements Analysis complete, and is there a detailed User/Task Requirements Statement? | | |
| | Is there a Usability Specification giving performance targets for the Product/System's critical tasks? | | |
| | | Is HF making an input to the Hardware, Software, Industrial and System Design programmes? | Is HF developing a User Interface concept, and is HF liaising with Hardware and Software people? |
| | | | Is HF preparing a visible format of the User Interface design concept (Demo or Simulation)? |
| | Is there an HF report reviewing the concept design? | Is there an HF input to the Design Concept review? | Is HF critically reviewing the User Interface design concept against the User/Task Requirements ans the Usability Spec.? |
| **Design Development** | | Is HF making an input to Hardware, Software, Industrial and System Design, re: controls, displays, display layouts, casework, user procedures, etc.? | Is HF developing the User Interface Design, and revising the User Interface demo or simulation?<br><br>Is HF liaising with the other design team members?<br><br>Is there a Graphics Design input to the User Interface? |
| | | Is HF making an input to the contents and format of the User Guide, Handbook or Training programmes? | Is HF preparing a draft specification of the control layouts, display layouts, user procedures, help procedures and displays, etc.? |
| | Is there an HF report reviewing the latest design solutions? | Is HF making an input to the design review on the current prototype, engineering drawings or specifications? | Is HF testing the User Interface against the Usability Specification with representatibe users role-playing on the demo or simulation? |

**Table 1: The design manager's checklist.... concluded**

| The Design Phase | Qualification | Design Support | Design Responsibility |
|---|---|---|---|
| **Detailed Design** | | Is HF making an input to Hardware, Software, Industrial and System Design, re: control labels, display messages, casework legends, user procedures, etc.? | Is HF refining the User Interface Design, and revising the User Interface demo or simulation?<br><br>Is HF updating the specification of the control layouts, display layouts, user procedures, help procedures and displays, etc.? |
| | | Is HF reviewing the draft user guide in relation to the critical tasks? | Is the User Interface demo or simulation being integrated into the full prototype?<br><br>Is the Graphics Design of the user interface complete? |
| | Is there an HF report reviewing the final design proposals, including user trials with the prototype and the draft user guide? | Is HF making an input to the review of the Detailed Design, including using the draft user guide with the latest prototype? | Is the User Interface and the rest of the prototype being trialed with representative users, including the draft user guide?<br><br>Does the prototype's performance match the Usability Specification? |
| **Pre-production and Production** | Is HF assessing the product's usability against the original specification and Market requirements with representative users in the Beta Trials? | | |
| | Is HF re-assessing the user interface and the product's usability against the original specification and Market requirements with representative users in the Field Trials? | | |

# 3 Users and Tasks

## 3.1 Introduction

"Users and Tasks" examines some of the issues concerned with who will be using the ISDN terminal, for what purpose and why. In Human Factors, the term "user" refers to any person who uses, maintains or is affected by the use of the system under consideration. For example, in a normal telephone call, there are usually two users: the initiator of the call, and the person affected, the receiver of the call. The term "task" refers to the purposes for which the terminal is designed to be used, such as making and receiving calls or transferring data. It includes the primary goals, e.g. the need to talk to person A, the primary tasks, e.g. the need to set up a call, and the subsidiary tasks, such as setting up a personal telephone directory.

Whatever the role of Human Factors within the overall design process (Qualification, Design Support, Design Responsibility), knowing the users and their tasks is perceived as being central to the design process. A proper analysis and record of the user and task requirements is considered essential and should be included in the initial requirements specification.

Within this User Centred Design Process, there are two main elements to consider:

- user populations and their characteristics - who are the users, what is their variability and individual differences?
- task requirements - what are the users' jobs or tasks? Are there any special needs in relation to where the terminal will be used: noise, light levels, etc. What are the technical constraints - the current state of technological development, reliability and cost.

The aims of the User Centred approach are:

- to ensure all user and task requirements are addressed in the design process.
- to broaden market availability of ISDN products.
- to give positive support towards integrating the requirements of children, the elderly and other people with special needs.

## 3.2 User Populations and their Characteristics

### 3.2.1 What is the market?

A key question that ought to be answered before a product is developed and released is "What is the market?". As far as telecommunications is concerned, the answer ranges from all members of a local, national or international population for public services to selected groups within these populations that can be characterized by a particular requirement or activity, be it vocational, occupational, medical, recreational or social. These user groups will vary in size and in the characteristics that can be used to describe them.

### 3.2.2 User characteristics

There are a large number of attributes that can be used to distinguish between people in a population. The ones that have direct impact on the successful use of telecommunications include:

- sight;
- speech;
- hearing;
- memory;
- cognitive processing skills;
- manual dexterity;
- motivation;
- familiarity with technology;
- familiarity with the topic of the communication;
- need to communicate, etc.

The individual user ability may be high in some areas and low in others. For the population as a whole there is wide variability in any one attribute, which increases dramatically as more are considered.

### 3.2.3 Distribution of characteristics

Consider just one variable, "height", as an example of the range and variability of the so called "normal" population.

In an average UK adult population:

- more than 50% of males are between 1700 to 1780 mm tall.
- more than 50% of females are between 1570 and 1650 mm tall.
- more than 94% of males are between 1620 and 1870 mm tall.
- more than 94% of females are between 1500 and 1740 mm tall. (There is a 15 - 16% difference in height between the tallest and shortest people in this group).
- the remaining 6% of the population, or about 3,5 million people in the UK alone, may be as short as 1400 mm for males and 1300 mm for females, or as tall as 2200 mm for males and 1800 mm for females.

Some people outside the 94% range of height have no identifiable clinical reason to be outside of this range. Many people within the 94%, and even the majority 50%, ranges do have growth disorders without which their height would have been quite different, e.g. due to hormone related growth disorders or stunted growth as a result of smoking as a child. (Tanner and Whitehouse, 1982).

The importance of this data is:

- that the range of variability is an important factor. Differences of 250 mm between a tall and short male is about the height of a head. This suggests that if a public notice is inappropriately placed, it is conceivable that more than 15 million adults across the European Community will have difficulty reading the information.
- that it challenges intuitive concepts of normality and abnormality. When there are some people who lie outside a statistical normal distribution who may have no other clinical symptoms that would explain short or tall stature. Are they therefore non-normal or abnormal? Some who are within the statistically normal part of the population distribution do in fact

have a clinical condition, but one that does not manifest itself in short or tall stature as one of its symptoms, which would suggest that they should be considered as normal. The conclusion is that the concept of normality is a very difficult one to define.

- that the need to allow for a wide range of abilities applies to all user characteristics whether in the general public or in a specialist sector of the market.

### 3.2.4 Changes of relevant characteristics with age

Ageing of the population is another important factor to consider. The current and projected distribution of ages within the European Community are shown here as percentages of the total population:

**Table 2: Predicted distribution of ages within the European population**

| AGE | 1980 | 1990 | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|---|---|
| **0-14** | 22,6 | 19,6 | 18,8 | 17,1 | 16,6 | 17,2 | 17,5 | 18,0 |
| **15-64** | 64,3 | 66,8 | 66,5 | 67,0 | 65,3 | 62,0 | 60,1 | 60,5 |
| **65+** | 13,0 | 13,6 | 14,7 | 16,0 | 18,1 | 20,8 | 22,4 | 21,5 |

The elderly can clearly be seen as a significant proportion of people within the population of those likely to be using telecommunications facilities. It is forecast they are likely to be more affluent than in the past, making them a valuable marketing opportunity. If this opportunity is to be realized, the particular characteristics of the elderly need to be understood. (Collins & Rabbitt, 1990).

Elderly people generally widen the distribution of a given human characteristic, as some of them will experience a change or degradation of that characteristic. In general, most functional abilities will change. For example, hearing will often become less acute, sight will need more refractive correction (generally for "long sight"), manual dexterity and mobility will reduce. This is often accompanied by a slowing of the brain's ability to process information, particularly information received simultaneously from a number of sensors. This has the effect of causing an overall slowing of "behaviour" and the phenomenon which is generally called "loss of memory".

This has relevance for telecommunications in areas such as reaction times and speed and accuracy of movements in addition to the obvious sensory input and output issues. A study performed by Welford, Norris and Shock (1969), illustrated this with a set of measurements relating accuracy of movements to speed of movements and distance of movements. By relating these elements in various ways, different properties emerge. The general conclusions are:

- accurate movement depends on a complex relationship between hand/eye co-ordination, absolute positioning skills, control skills, kinaesthetic feedback and decision skills.
- it is predictable that older people will have problems where a complex relationship exists between a number of processes being applied simultaneously. This is indeed the case, as shown in figure 5 below, with significant loss of accuracy occurring even within the working age range.

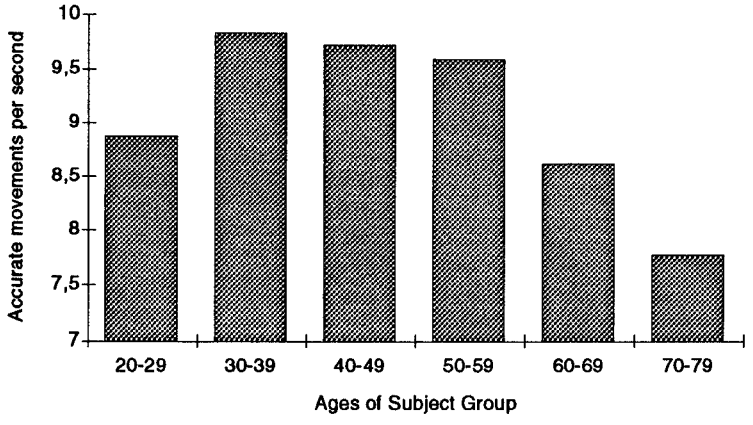



**Figure 5: Accuracy of movement compared across various age groups**

### 3.2.5 Disability and ability

Recognising the variance in ability across a sample of population, there is clearly a point at which ability becomes so far from the expected range for the population that it has to be considered outside (above or below) the expected range. Disability, by its definition, occurs where an ability falls below the expected range. Population figures are, however, very difficult to collect because of difference between a clinical impairment threshold and a disability in a given context. As an example, television companies will reject over 10% of the male population as potential engineers because of colour discrimination problems, whereas the best estimate revealed by standard clinical measurement thresholds is around 8% of males, and software engineers are probably never tested for this ability. In addition, gathering clinical data is very difficult, (as current attempts to monitor the spread of Aids illustrates). The consequence of this, particularly when interpreting pan-European data, is that any quoted figure is probably lower than the true situation. The following table (from Sandhu and Wood, 1990) gives some recent figures on disabilities in Europe as a whole, although organizations with responsibility for particular groups have suggested figures an order of magnitude higher. Whatever the method of compiling the statistics, there is little disagreement that between 10 and 20% of the European Population have a significant impairment.

The figures also indicate the potential size of this market as a proportion of the entire market for telecommunications facilities. They were also a significant motivator for RACE project 1066 IPSNI, which looked specifically at the user requirements people with special needs introduce to the design of integrated broadband communications systems (RACE Project 1066 IPSNI, 1991a, b & c).

**Table 3: Percentage of people with a disability in European member states**

| Type of Impairment | | % of Population | Number (Millions) |
|---|---|---|---|
| Physical | Lower Limb | 5,8 | 18,7 |
| | Upper Limb | 1,9 | 6,1 |
| Visual | | 2,0 | 6,5 |
| Hearing | | 2,7 | 8,7 |
| Mental | | 2,3 | 7,4 |
| Verbal Communications | | 1,1 | 3,6 |
| Total European Population | | 100,0 | 332,4 |
| Total Disabled Population | | 11,3 - 15,1 | 37,6 - 50,2 |

### 3.2.6 Attributes of a given selected population

Having considered the various characteristics of the potential telecommunications user group, it would be instructive to consider the group of users that is all too often the apparent model user for equipment and service designers. This user is likely to be male, late 20's to late 40's, an engineer or at least a university graduate, and familiar with technology and its potential benefits.

In order to have achieved this status, it is likely that they will have average hearing, sight and manual dexterity, as all education systems unfortunately tend to select, by default, in these areas. They will, however, have a 1 in 6 chance of being red green colour blind.

This somewhat extreme model is, however, quite obviously faulty. It fails to recognize the differences even within the business community. For example, in respect of the female members of this group, the movement of labour within the European Community, and the changes that occur with age. Further, since age changes begin to take effect even from the mid 40's, so assumptions of ability at age 30 may not apply so readily at 48.

This illustrates the care that needs to be taken in making assumptions about the full set of characteristics of a group that have been selected as a potential market from within a population, and even the validity of this selection at all.

### 3.2.7 Designing for variability

The potential user population for telecommunications services and facilities is enormous. In addition, however, there are significant variances in the abilities of the users, resulting from natural ageing processes, trauma induced impairment or health induced impairment. The design process should recognize that even a narrowly selected market will contain significant variances in characteristics other than those used in the selection. This variance can be accommodated by employing human factors knowledge and methods in the design cycle.

For those groups requiring particular considerations, because their abilities are further outside the range of performance than can be accommodated within

basic good design practice, special measures will need to be employed. These may require the assistance of rehabilitation engineering professionals. The local ministry of employment or ministry of health officer responsible for measures for the disabled, or the technical officer for the most appropriate charity may be the best place to begin to find the necessary information.

The importance of considering people with special needs has been made particularly pertinent recently with the changes taking place in the United States of America caused by legislation which essentially requires computer systems used by government departments to be accessible to all potential employees. The effects of this ruling will no doubt permeate into the world of telecommunications, so there will be a window of opportunity for European manufacturers to follow this lead. Those seeking accessible systems should find that they can source products from Europe as well as the USA. Where such solutions are unavailable, uptake by some users will be reduced and the potential market will remain untapped.

**Table 4 : Summary of user characteristics and requirements**

| User Variable | Design impact |
|---|---|
| Physical size | Affects casework design position and design of displays and input controls. Design for minimum access to accommodate largest user, limit design reach and weight for smallest user. Overlay the needs of children, elderly, disabled. Refer to published anthropometric data and agreed standards. |
| Sensory perception | Affects terminal and system output. Research for optimum levels of auditory and optical signals, legibility of text, intelligibility of speech, etc. Provide redundancy for the sensory impaired, and for use in noisy/dark environments. |
| Aptitude | Affects user-interface, user guidance, reaction time. Design for least able technical skill, memory capacity, information processing, and technophobia. Remember, reduced complexity makes it easier for everyone. |
| Skills | Affects user-interface, user guidance, training. Design for least able where largest market base is for novice and unskilled user in public domain. |
| Expertise | Affects user-interface, and user guidance. Skilled and expert users may have specific requirements in terms of efficiency, language, operational requirements. Some users may have expertise in their own field, but no technical expertise. Simplicity of the interface will still be essential even though the application demands may be complex. |

## 3.3 Task Requirements

### 3.3.1 Analysing the users' tasks

A User Centred Design Process defines that a full examination of the users' tasks is essential to ensure that ISDN products and services meet the users' operational and functional needs. One of the newest approaches subdivides the users' tasks into Goal Tasks and Enabling Tasks. The users' prime communication needs are defined as the Goal Tasks. To facilitate a goal task, the user must complete one or more enabling tasks to progress the equipment to the correct Enabling State for the particular Goal Task (Byerley et al, 1990; Voigt et al, 1993). Both the goal and enabling tasks may be further subdivided into primary and subsidiary tasks (there may be more than one level of subsidiary task). These tasks should be considered for each of the relevant users.

**Table 5: Simplified example of goal and enabling tasks**

| **Primary End User** | **Primary Tasks** | **Subsidiary Tasks 1** | **Sub-tasks 2** |
|---|---|---|---|
| Goal Tasks | Communicating with the other party. | Getting and recording a telecomms address for future use. | Etc. |
| Enabling Tasks | Call Set-up.<br>Call Termination. | Setting up the terminal.<br>Storing numbers in the directory. | Etc. |

| **Secondary End User** | **Primary Tasks** | **Subsidiary Tasks 1** | **Sub-tasks 2** |
|---|---|---|---|
| Goal Tasks | Communicating with the other party. | Recognize who is calling. | Etc. |
| Enabling Task | Perceive incoming call.<br>Accept incoming call. | Capture call address for future use. | Etc. |

| **Maintenance Engineer** | **Primary Tasks** | **Subsidiary Tasks 1** | **Sub-tasks 2** |
|---|---|---|---|
| Goal Tasks | Correct existing fault. | Detect likely future faults. | Etc. |
| Enabling Task | Diagnose and identify fault.<br>Disassemble and reassemble terminal to access fault. | Diagnose for possible future faults. | Etc. |

### 3.3.2 How will the ISDN terminal be used?

The task analysis can be developed by examining current working practices with existing technology and by developing scenarios or models of how the new product or service might be used. It is important to look at both the frequently occurring tasks, such as basic call set-up, and the infrequent tasks, such as installation or emergency situations. It is also important to look beyond the best case where everything goes according to plan, towards a number of worse case scenarios, where if it can go wrong it will.

The level of complexity reflected in many user tasks is unique within the communications environment, as there is more than one user interacting simultaneously with the equipment and with each other. The potential sources of error increase exponentially as the communication enriches to include more users and more types of media. There are, for example, five possible sources of error, even within a simple communication link, i.e. User A, Terminal A, Network, Terminal B, and User B.

### 3.3.3 Where and when will the terminal be used?

Not all terminals will be used in the comfort of a home or office environment. Noise may affect listening levels for speech as well as telephone tones and signals, while in a quiet open plan office audible feedback, or loudspeakers or handsfree operation may annoy others and reduce privacy. Bright direct sunlight can cause a complete loss of contrast for LED and CRT displays, whereas LCDs can only be used in low light levels if backlighting is provided.

Terminals designed for use in public locations may need to take account of adverse weather conditions, including extremes of temperature and humidity, as well as misuse and vandalism. Similarly, mobile terminals by their nature will be used out of doors and in potentially very dirty environments. Even terminals designed for the home or office can be open to accidents and abuse, from simple spillages, to using the handset as a hammer.

Not all terminals will be used during the hours of daylight or within well lit offices. Not all terminals will be used occasionally, some are in constant use all day and everyday, whereas others are not used for months. Finally, what is true for the terminals may also be true for the facilities and services, whether they are available in the network or the terminal.

Consequently, in addition to the descriptions of the raw tasks that can be extrapolated for each user group from the task analysis, there should also be information about some of the characteristics that specific tasks demonstrate, or about the situation within which specific tasks might have to be completed. For example, the user at home and in the office needs to accept incoming calls and so does the switchboard or emergency operator. However, the latter two also have the additional possibilities of working under very heavy traffic levels and significant time pressures, i.e. the need to accept the next call immediately on release of the previous one. Therefore, for the task analysis to be complete, the characteristics and working environment of the task needs to be understood. Table 6 presents a summary of some of the key task variables that can impact the design of the terminal.

**Table 6 : Summary of task characteristics and requirements**

| Task Variable | Design impact |
|---|---|
| Task complexity | Affects interface design, choice of dialogue design, and user guidance. Develop working scenarios for sample procedures for frequent and important tasks, and worst case infrequent events. |
| Task frequency | Affects the layout of controls, screen layout, user interface design and user guidance. Group controls, displays. Offer most support to infrequent and once only use. Offer short cuts for frequent use where user becomes skilled. |
| Multi-tasking | Affects user interface and input and output demands. Offer alternative outputs such as tone plus visual message to catch the users attention. Allow system to monitor long duration activities such as file transfer in background. |
| Time pressure | Affects user interface. If time is critical minimize keystrokes and response times, offer user definable defaults, and short cuts. If time is not critical beware of excessively fast response times pressurising the user. |
| Fail safe | Affects all aspects of the design. Include cancel and undo features and error checking to minimize impact of human error. For critical usage, for example, where using ISDN terminal to monitor control room safety, some form of expert risk analysis may be required in order to fully optimize the design. Include prototype evaluation to highlight sources of errors. |
| Security hazards | Affects user interface and communications design. Keep log-on procedures as brief as possible, balancing the everyday needs of the legitimate user against the need for security from unauthorized access. |
| Unusual conditions | Consider whether there are any aspects of the task or job that put special demands on the design specification. For example, having to wear protective clothing, competing demands such as using the telephone when driving, or noise. |

### 3.3.4 The impact of task analysis

By completing a thorough task analysis covering each of the user groups the terminal will impact, the designers will obtain a detailed description of the product's requirements from the users' perspective. There are four ways in which a task analysis can make a user centred impact within a design process:

1 By affecting the designers' understanding of the users' task requirements.

The process of collating and analysing user and task data usually takes the terminal development team into close contact with current users of similar products and their marketing colleagues. There is a subtle but very significant difference between designing a product with its essential functionality and designing for the experience of using that product. Collating user/task information gives designers the opportunity of learning about that experience at first hand and of seeing their work through another pair of eyes.

2 By indicating a framework for the design of the user interface based on the structure and logical grouping of users' tasks and sub-tasks.

The grouping of tasks and sub-tasks helps the user to breakdown complex tasks into more manageable logically related groups. The relationships of task frequency, task importance, operational sequence, task similarity, etc., can all be applied to the way control keys are organized, or the way menu items are linked and structured hierarchically, or the way the display screen is laid out.

3 By establishing user performance criteria to specific key tasks which can be used to evaluate the product concepts and prototypes during the development.

The application of user performance criteria to specific key tasks that have been defined, leads directly to the production of a Usability Specification for the terminal being designed. Where, for example, it could be specified that:

*95% of a representative sample of users can achieve task A successfully at the first attempt, within X seconds; and,*

*80% of a representative sample of users can achieve task B successfully at the first attempt, within Y seconds; and,*

*95% of the same sample of users can subjectively rate the terminal on task A and or B, as good as or better than a similar sample rated a competitive product, on a similar task or set of tasks.*

The existence of a usability specification of this sort can act as a strong focal point for all aspects of the design by setting clear objectives by which the design solutions can be tested. The earlier in the design process such a specification is made, the earlier prototype solutions can be tested and the easier design changes can be implemented.

4 By providing formal methods for the elicitation and assessment of user and task requirements, e.g. User/Task Requirements Specification, Functionality Matrix.

**Table 7: Simplified example of HUFIT's Functionality Matrix**

| **HUFIT - Functionality Matrix** | | Terminal Functionality | | | | | | |
|---|---|---|---|---|---|---|---|---|
| User and Task Requirements | | A | B | C | D | E | F | Etc. |
| | 1 | | | | | | | |
| | 2 | | | | | | | |
| | 3 | | | | | | | |
| | 4 | | | | | | | |
| | 5 | | | | | | | |
| | 6 | | | | | | | |
| | 7, Etc. | | | | | | | |

A Functionality Matrix (HUFIT, 1989) can be used to cross reference the user and task requirements defined during the task analysis, with the prospective terminals planned functionality. The concept is that, to meet the users requirements, there should be an element within the terminals functionality which can be simply matched against each stated requirement.

By looking along the rows of the matrix the specified requirements can be checked to see that they are all being accommodated. Additional functionality may then be required to cover any missing elements. Similarly, by looking along the columns of the matrix, the functionality can be checked to see if any unnecessary provision is being made, that is, not being balanced by a user or task requirement. By introducing a five point scale to assess each cell of the matrix, a rough comparison can be made between columns or rows when design trade-off decisions might be necessary.

RACE project 1077 Usage Reference Model has collated a broad range of general and specific data on the usage implications for broadband ISDN terminals and their functions (RACE Project 1077 URM, 1990). Race project 1067 GUIDANCE developed the concept of goal and enabling tasks into a method for extrapolating specifications for IBC systems (Voigt et al, 1993). For more general information on other tools and methods available within human

# 4 Design Issues

## 4.1 Introduction

The purpose of this Clause is to introduce design issues as they relate to real products, systems and applications. Four types of ISDN terminal are considered: telephones, facsimiles, videotelephones, and integrated multimedia terminals.

The design issues are raised in the form of questions to the people involved in the design process. The questions are addressed to all the members of the product design team, including the Product Design Manager, Industrial Designers, Hardware Engineers, Software and User Interface Developers, Marketing and Quality Assurance. Finding the answers to the questions and issues raised is part of the designers' challenge. Hopefully some of the answers may be found in the Design Guidelines Clause. To highlight each of the product areas and to help focus ideas. Illustrated examples are shown for each product type. The illustrations are annotated with relevant topics. Each topic can be referenced in the Design Guidelines Clause.

### 4.1.1 Caveat

The illustrations given in this Clause are intended to be generic for the product type. Any similarity to any current or future products is purely coincidental. By including these drawings, ETSI is referencing a product type; it is not endorsing any particular product style or feature.

## 4.2 Telephones - Fixed, Private

The design issues in this subclause relate to ISDN telephone design.

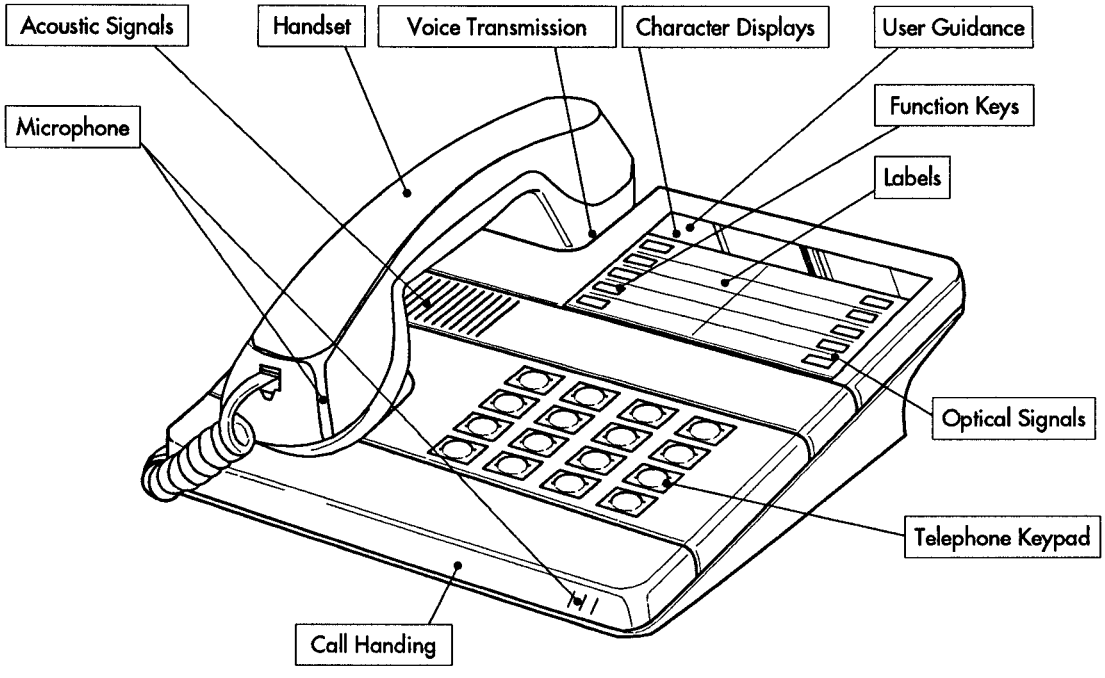



**Figure 6: Generic telephone (fixed, private)**

**Marketing/Design Managers**
What range of people is the telephone to be used by?
- market sector
- physical size and abilities
- experience, skill, technical ability
- cultural background
- first language

What provisions are planned to accommodate people with special needs?
- visual, hearing, motor and intellectual impairment
- modularity, to allow input/output technologies to be changed
- choice and usage of controls and indications
- children and elderly

What key tasks will people need to do to make the telephone work best for them?
- set up, install and learn how to make and receive calls
- make and receive telephone calls, handle multi-party calls
- set and use the telephone facilities
- use the telephone to access network-provided Supplementary Services

Where will the telephone be used?
- indoors, desk top or wall mounted, office, factory or home
- outdoors, exposed to weather or sheltered

**Industrial/Hardware Designers**

What are the requirements on the casework construction?

- materials, strength and durability
- fluid, dust hazards
- maintenance, e.g. battery exchange
- modularity
- electrical and thermal safety

What are the requirements on the shape and colour?

- desk top, wall mounted and portable usage
- reflections, legibility
- cleaning and hygiene

What arrangement of the major units is appropriate?

- provision and location of handset
- keyboard and/or other controls
- visual and auditory displays
- connector cables and battery housing
- labels, prompts

**Hardware/Software Engineers**

How will people input and remember telephone addresses?

- dialling key pad, alphanumeric keyboard, other controls
- abbreviated dialling, e.g. redial, direct dial keys, short code dialling, alphabetic directories, etc.
- alpha-mnemonic dialling, short code lists, paper directory
- overlap and/or en bloc dialling (with editing)

How will people access and control terminal, transmission and network-provided facilities?

- choice of ring signals, ring signal volume, speech volume, microphone on/off, handsfree/handset
- ISDN capabilities, two call handling, terminal identity/sub-addressing, etc.
- ISDN access to supplementary services, changes of teleservice
- keys, soft keys, selector switches, rotary knobs, pointers etc.
- ISDN switching orders for multiple calls, seamlessness between local and network services

How will the controls be laid out and grouped?

- primary, secondary control areas
- control/display relationship, control actuation directions
- keypad/keyboard separation, function key groups

How will people monitor and progress the set up and reception of calls?

- auditory displays: ringers, tones, synthetic speech, operational noises
- visual displays: alphanumeric and symbol displays (small and large), status light displays, printed paper, control labels
- tactile displays: vibratory keys, Braille pads
- how will people monitor and progress terminal, transmission and network provided facilities
- ISDN Supplementary Services, e.g. CLIP, CW, CF, CCBS, etc.
- terminal services for abbreviated dialling etc.
- local ISDN required capabilities, e.g. second call arriving, terminal identity changes, etc.
- changes of teleservice or service quality

How will the displays be laid out and positioned?

- visual displays: LCDs, CRTs, LEDs and other technologies
- printed displays: control labels, prompting graphics, warning labels
- auditory displays: speech path loudspeakers, ringers and buzzers
- tactile displays

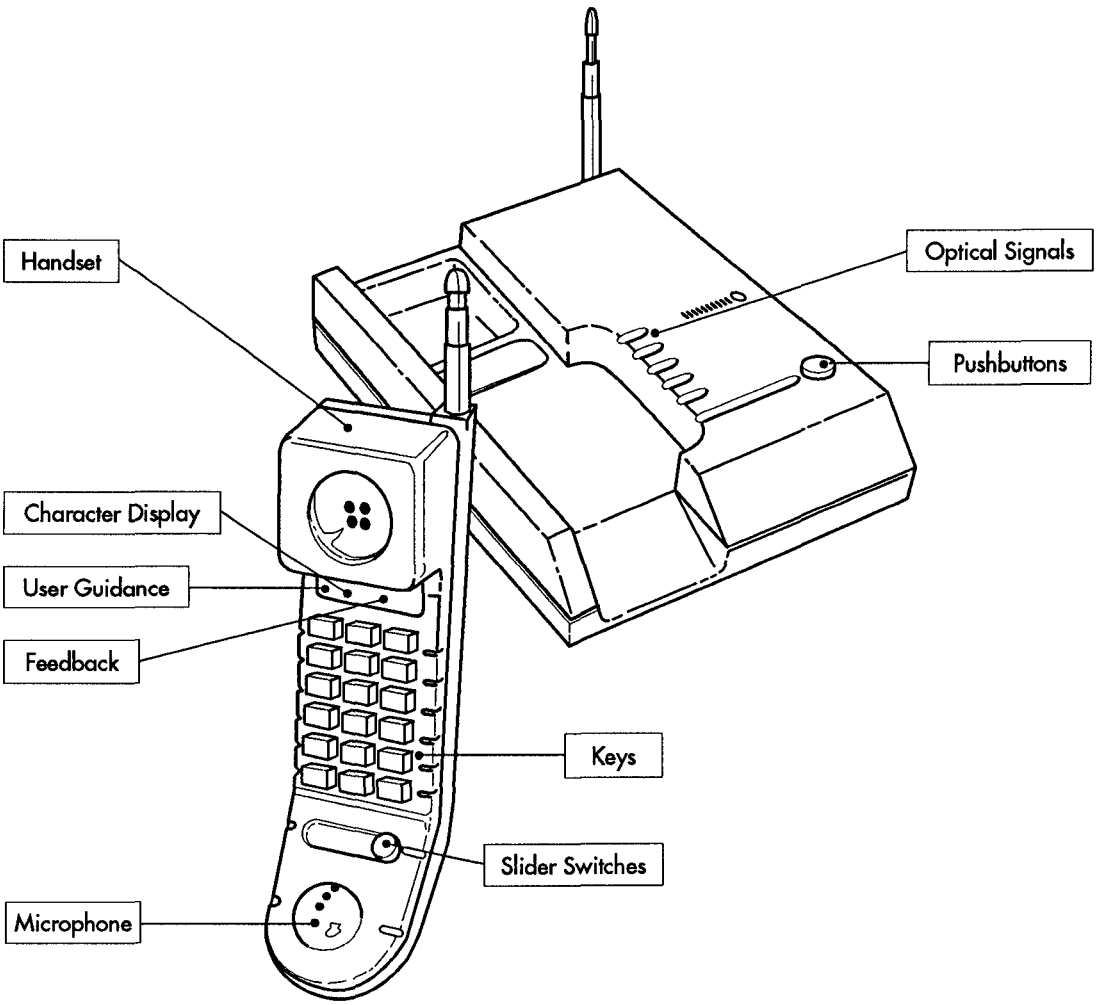



**Figure 7: Generic cordless telephone (fixed, private)**

**Software/User Interface Developers**

How will the user dialogue support the user and the tasks?

- user stereotypes and expectations, particularly for call set up, receive and terminate
- domestic, business, European languages
- user guidance

What features are supported

- set up of user programmable features
- flexibility, defaults, personalization

What information will the user receive from the system?

- status and warning
- feedback on actions numeric, alpha-numeric, speech messages, tones
- instructions as auditory menus, prompts, visual display

What control information will the user send to the system?

- telephone numbers
- feature commands
- alpha codes and text

What dialogue style, and characteristics?
- phone based interfaces, feature keys, soft-keys programmable keys
- response time to inputs and execution
- consistency of syntax, procedures

**Quality Assurance Manager**
What are the usability design goals?
- learn-ability, efficiency, effectiveness, flexibility
- user preference, acceptance

How can usability be assessed and measured?
- user performance and errors
- test frequent, critical, worst case user tasks
- low fidelity prototypes, mock-ups, field trials
- interviews, questionnaires, observation

How will usability be applied?
- initial specification, design review, modification
- expert validation
- quality assurance, sign off

## 4.3 Facsimile - Fixed, Private

The design issues highlighted in this subclause principally relate to private facsimile equipments. However, many of the issues will probably be directly relevant to public terminals.

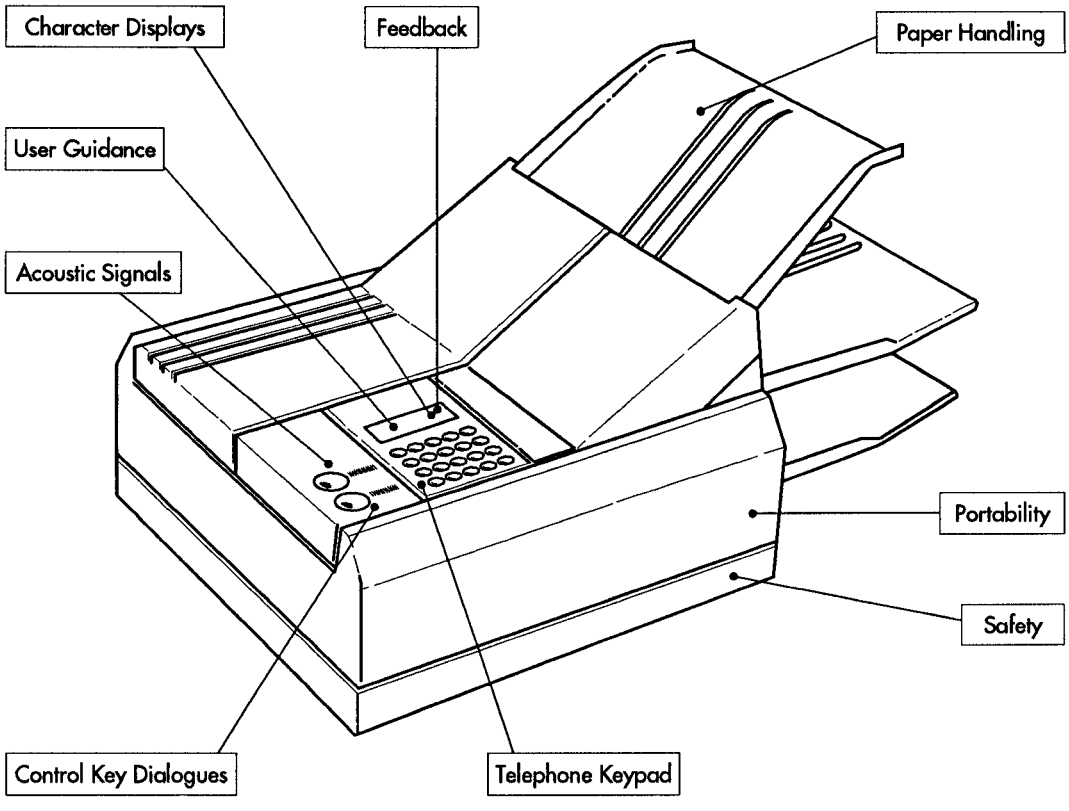



**Figure 8: Generic facsimile terminal (fixed, private)**

**Marketing/Design Managers**
What range of people is the facsimile to be used by?
- market sector
- physical size and ability
- experience, skill, technical ability
- culture, first language

What provisions are planned to accommodate people with special needs?
- visual, hearing, motor and intellectual impairment
- modularity, to allow input/output technologies to be changed
- choice and usage of controls and indications

What key tasks will people need to do to make the facsimile work best for them?
- set up and learn how to send and receive faxes
- send and receive facsimile, handle multiple sends
- send at pre-set times
- monitor and maintain paper supplies for received faxes

Where will the facsimile be used?
- indoors, desk top or wall mounted (office, factory or home)
- outdoors, in sheltered accommodation

**Industrial/Hardware Designers**

What are the requirements on the casework construction?
- to simplify installation and connection to network
- routine maintenance, paper supply, paper jam
- durability
- electrical and thermal safety

What are the requirements on the shape and colour?
- desk top usage
- portability/adjustability
- paper transport and collection
- reflections
- cleaning

What layout is appropriate?
- location and orientation of paper feeds and collection
- keys and other controls
- visual and auditory displays
- connector cables and power support
- labels, on-product instructions

**Hardware/Software Engineers**

How will people input and remember facsimile addresses?
- dialling keypad, alphanumeric keyboard, other controls
- dial features such as abbreviated dialling, redial, direct dial short code dialling, electronic directory, etc.
- overlap and/or en bloc dialling (with editing)

How will people access and control facsimile terminal, transmission and network-provided facilities?
- ISDN capabilities, terminal identity for local bus, changes of teleservice
- ISDN Supplementary Services, CLIP, CUG; changes of service quality
- choice of ring signal, volume, time to answer, change of fax header, etc.
- alphanumeric and feature keys, soft keys, selector switches, knobs, pointers etc.

How will controls be laid out and grouped?
- facsimile send and receive controls (off-hook, keypad etc.)
- paper handling and paper path access controls
- abbreviated dialling facilities
- operational sequence, functional relationship

How will people monitor and progress the call set up and transmission and reception of documents?
- auditory displays: tones, ringers, fax handshake signals, volume control
- operational noise (paper feed, reading and printing mechanisms)
- visual displays: alphanumeric/symbol displays, status lights, on product graphics, operational changes (paper feedings, paper output)
- tactile displays: control feedback, Braille displays, operational vibration

How will the displays be laid out and positioned?
- visual displays: electronic (CRT, LCD, VFD, LED etc.) printed (symbols, pictograms, on product instructions, labels)
- auditory displays: call progress loudspeakers/ringer

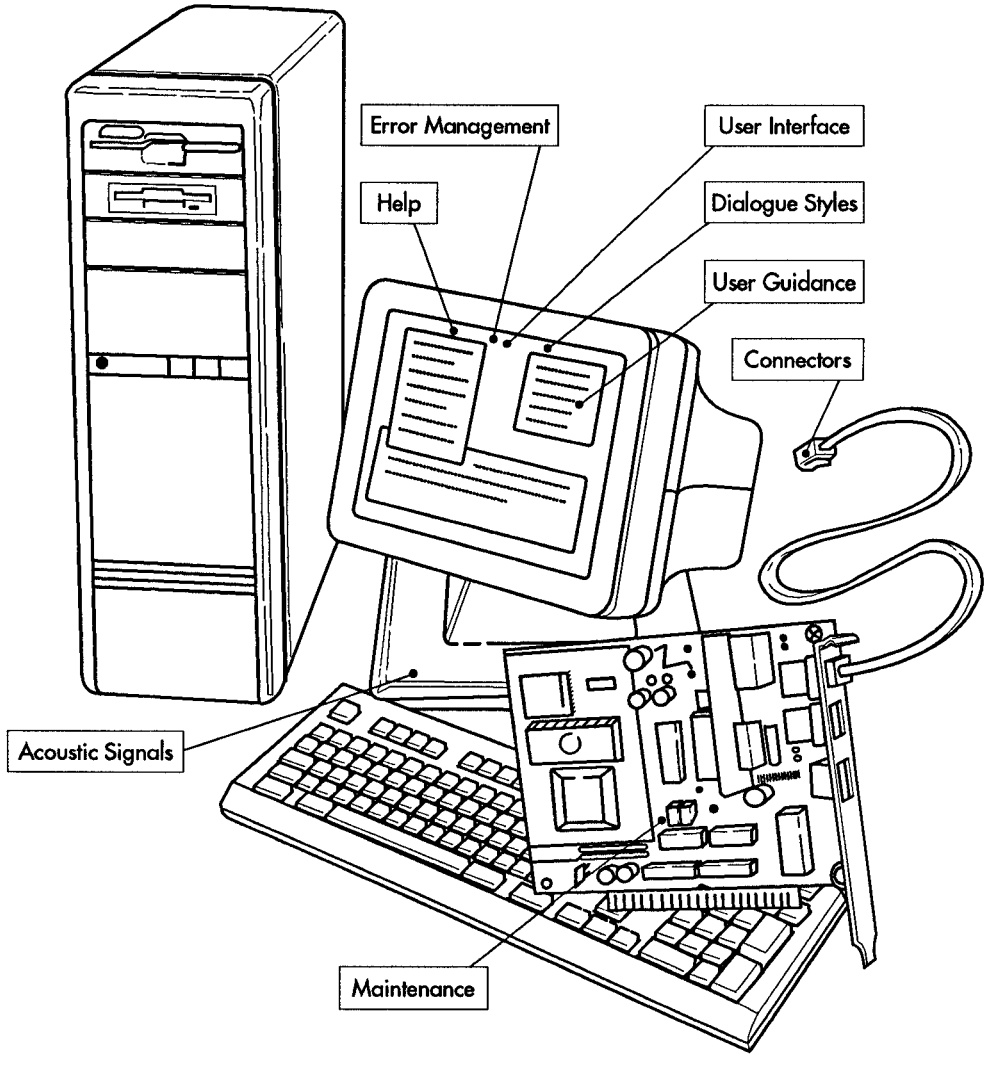



**Figure 9: Generic fax/modem (fixed, private)**

**Software/User Interface Developers**

How will the user dialogue support the user and the tasks?

- user stereotypes and expectations, particularly for call set up, receive and terminate
- domestic, business, European language variants
- text prompts, help, user guidance

What information will the user receive from the system?

- status and warning
- feedback on actions numeric, alpha numeric, speech messages, tones
- instructions as auditory menus, prompts, visual display
- records of calls made, faxes sent and received

What control information will the user send to system?
- fax phone numbers
- feature commands
- alpha codes and text

What dialogue style, and characteristics?
- phone based interfaces, feature keys, soft-keys, programmable keys
- screen based application, menus, forms, object manipulation
- response time to inputs and execution
- consistency of syntax, procedures, language

What features are supported
- set up of user programmable features
- flexibility, defaults, personalization

**Quality Assurance Manager**
What are the usability design goals?
- learn-ability, efficiency, effectiveness, flexibility
- user preference, acceptance

How can usability be assessed and measured?
- user performance and errors
- comparison with performance on similar, or previous versions
- test basic procedures for fax set up, transmission, receive
- test frequent, critical, worst case user tasks
- low fidelity prototypes, mock-ups, field trials
- interviews, questionnaires, observation

How will usability be applied?
- initial specification, design review, modification
- expert validation
- quality assurance and conformance with human factors recommendations, sign off

## 4.4 Videotelephones - Fixed, Private

The design issues highlighted in this subclause principally relate to private fixed videotelephone equipments.

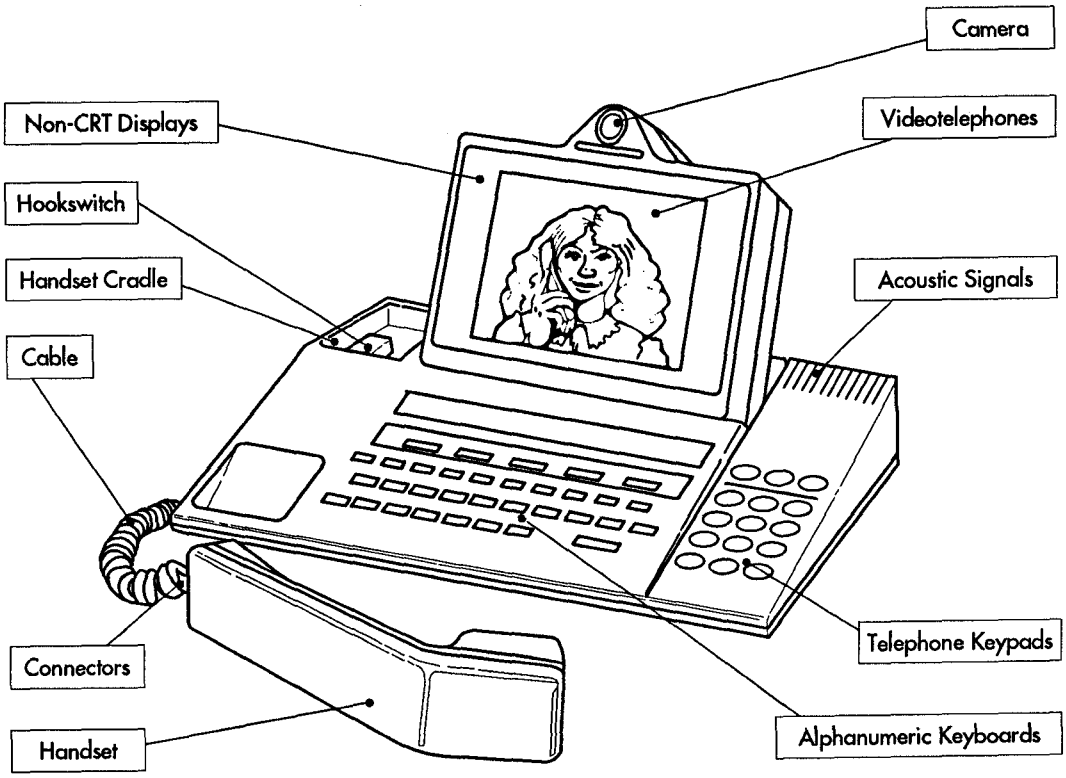



**Figure 10: Generic small screen videotelephone, e.g. QCIF (fixed, private)**

**Marketing/Design Managers**

What range of people is the videotelephone to be used by?

- market sector
- physical size and capabilities
- experience, technical ability
- cultural and language

What provisions are planned to accommodate people with special needs?

- visual, hearing, motor and intellectual impairment
- modularity, to allow input/output technologies to be changed
- choice and usage of controls and indications
- children and elderly

What key tasks will people need to do to use the videotelephone effectively?

- install, set up and learn how to make and receive videotelephone calls
- make and receive telephone and videotelephone calls and change between them
- access and control ISDN terminal, network and supplementary services
- monitor and maintain videotelephone capabilities and facilities

Where will the videotelephone be used?

- indoors, office desk-top, home table top, wall mounted

**Industrial/Hardware Designers**

What are the requirements on the casework construction?

- installation and connection to the network
- rough handling and potential contaminants
- electrical and thermal safety
- user control over privacy

What are the requirements on the shape and colour?

- desk top or wall mounting and occasional portability/adjustability
- access and control by the expected user population
- reflections, reduction of glare, optimum contrast
- cleaning, hygiene

What arrangements of the major elements is appropriate?

- camera/screen for head/shoulders view
- keys and other controls
- visual and auditory displays
- loudspeaker, microphone
- connector cables and power support for codec, display, camera(s), etc.
- labels, on product instructions

**Hardware/Software Engineers**

How will people input and remember video and telephone addresses?

- dialling keypad, alphanumeric keyboard, other controls
- dialling features abbreviated dialling, redial, direct dial, short codes, alphabetic directory
- alpha-mnemonic dialling, overlap and/or en bloc dialling
- variations in procedure for video and telephone call set up/receive
- handset, handsfree and/or loudspeech

How will people access and control videotelephone terminal, transmission and network-provided facilities?

- videotelephone special functions (self view, camera off, picture freeze, etc.)
- exchanging between videotelephony and telephony before/during calls
- maintaining privacy on incoming video calls
- ISDN capabilities, terminal identity re telephony/videotelephony calls
- ISDN supplementary services (call forward for telephony/videotelephony)
- ISDN switching orders for multiple calls

How will controls be laid out and grouped?

- videotelephone/telephone call set up and control functions
- display control facilities (brightness, contrast, etc.)
- control/display relationship, control actuation directions
- primary, secondary control areas, functional and sequential relationships

How will people monitor and progress the set up and reception of calls?

- auditory displays: ringers, tones, synthetic speech, operational noises
- visual displays: video display, alphanumeric and symbol displays, status lights, control labels and on-product graphics
- tactile displays: control action feedback

How will people monitor and progress terminal, transmission and network-provided facilities?

- ISDN supplementary services: CLIP, CW, CFU, etc.
- ISDN switching orders for multiparty calls
- local ISDN required capabilities, e.g. second call arriving, terminal identity
- changes between videotelephony and telephony teleservices and/or service quality
- terminal services for abbreviated dialling, video control, privacy, etc.

How will the displays be laid out and positioned?

- visual display format, LCDs, CRTs, LEDs, and other technologies
- printed displays: control labels, prompting graphics, etc.
- auditory output: loudspeakers, ringers,

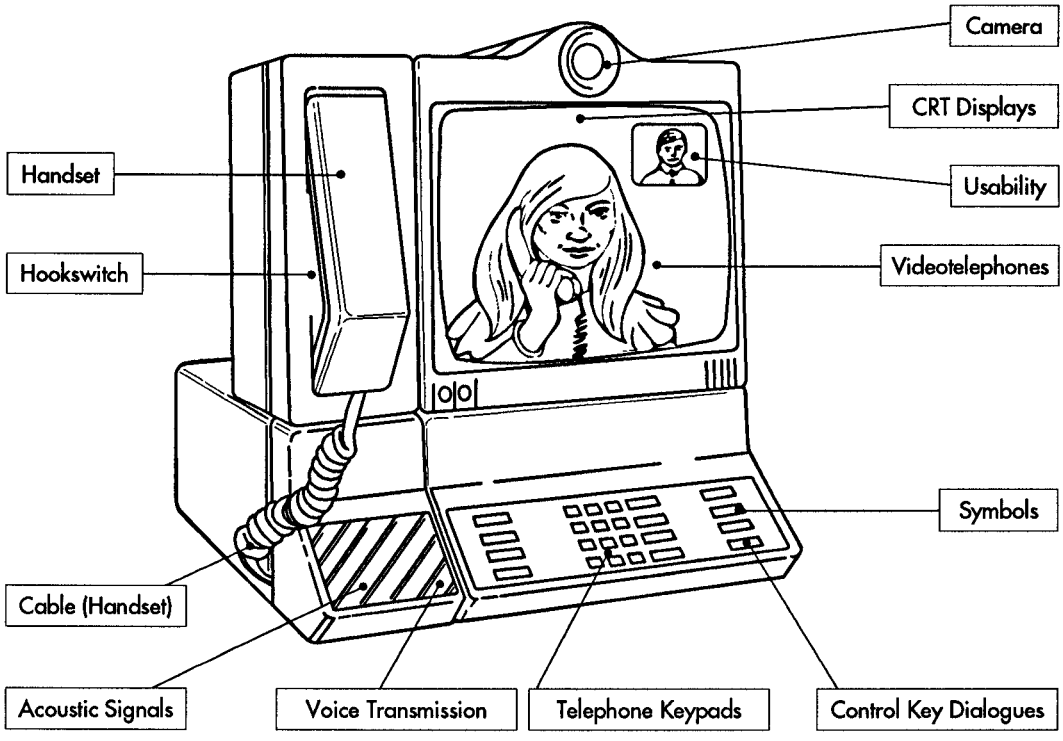



**Figure 11: Generic full screen videotelephone, e.g. CIF (fixed, private)**

**Software/User Interface Developers**

How will the user dialogue support the user and the tasks?

- user stereotypes and expectations, particularly for call set up, receive and terminate
- domestic, business use
- international call handling

What information will the user receive from the system?

- status and warning lights and tones
- feedback on actions as alpha numeric, voice, tones
- instructions as auditory menus, screen based messages, prompts

What control information will the user send to the system?

- alpha and numeric entries
- feature set up and control of camera, screen, microphone

What dialogue style, and characteristics?

- phone based interfaces, feature keys, programmable keys
- screen based interface, soft-keys, menus, forms
- response time to inputs and execution
- consistency of syntax, procedures
- error checking, error correction

**Quality Assurance Manager**

What are the usability design goals?

- user performance, learn-ability, efficiency, effectiveness, flexibility
- user preference, acceptance

How can usability be assessed and measured?

- user performance tests, time and errors
- test: call set up and answer procedures
- test: frequent, critical, user tasks
- use: low fidelity prototypes, mock-ups, field trials
- interviews, questionnaires, observation

How will usability be applied?

- specifications, design review, modification
- expert validation, conformance to human factors recommendations
- quality assurance sign off

## 4.5 Integrated Multimedia Terminals - Fixed, Private

The design issues highlighted in this subclause relate to the range of terminal equipments which integrate some or all of the communications media: voice telephony, facsimile, videotelephony and data.

The relevance of any particular issue may depend on the media to be integrated, e.g. voice/fax, voice/data, voice/image/data.

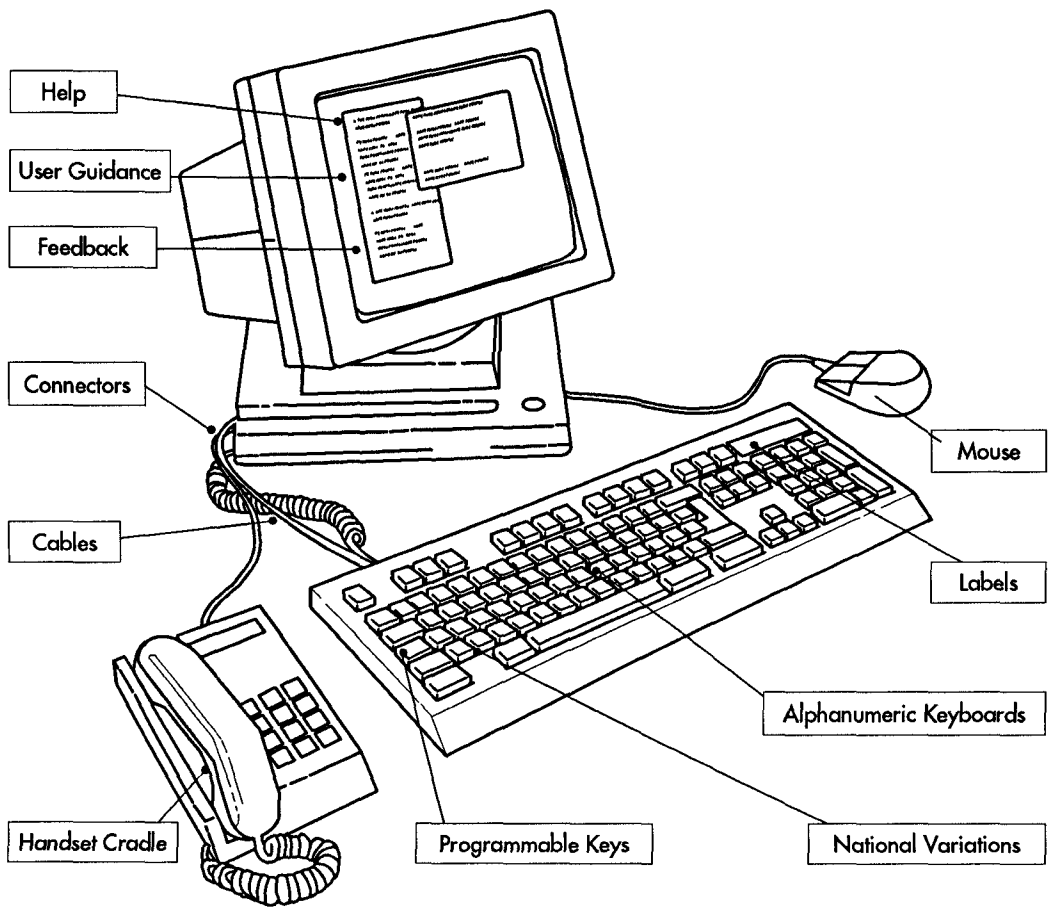



**Figure 12: Generic voice/data terminal (fixed, private)**

**Marketing/Design Managers**

What range of people is the integrated multimedia terminal to be used by?

- physical size ability and variability
- intellectual capacity, memory, learning ability
- cultural background, first language

What provisions are planned to accommodate people with special needs?

- visual, hearing, motor and intellectual impairment
- modularity, to allow input/output technologies to be changed
- choice and usage of controls and indications

What key tasks will people need to do to use the terminal effectively?
- install, set up and learn how to make and receive the basic range of calls (telephone, facsimile, video, data, etc.)
- make and receive any of the possible range of single media and multi-media calls and to change between them (e.g. voice/data to videotelephony)
- access and control ISDN terminal, network and supplementary services
- monitor and maintain the integrated media capabilities and functions

**Industrial/Hardware Designers**
What are the requirements on the casework construction?
- support the target range of media
- installation and connection to the network
- modularity and choice of control and display elements for people with special needs
- electrical and thermal safety
- rough handling and potential contaminants

What are the requirements of the shape and finish of the terminal?
- desk top mounting of terminal and sub-units
- reflections, optimize contrasts
- cleaning and hygiene
- terminals functionality
- paper handling, paper transport and storage

What arrangements of the major units is appropriate?
- keys, keyboards and other control: visual, auditory and tactile displays, voice units (handsets, headsets), printed paper units (scanner, printer)
- connectors, cables and power support for individual units
- relationships between different units: (camera/display relationship for showing head and shoulders image)
- on product graphics, labels

**Hardware/Software Engineers**
How will people access and control call set up, acceptance and termination?
- dial keypad, alphanumeric keyboard, point and select, handset/handsfree controls (alpha-mnemonic or numeric, overlap or en bloc dialling)
- dialling features, redial, direct dial, short code, alphabetic directory
- teleservice selection and changes (telephony to videotelephony to voice/data, etc.) before and during calls
- congruency across call set up and acceptance procedures between the provided media

How will people access and control the supporting services provided by the terminal, transmission and network?
- particular media special functions, e.g. videotelephone self view, picture freeze
- opportunities provided for shared media functions
- ISDN capabilities (terminal identity for separate media) and switching orders for multi-point calls
- ISDN supplementary services (especially call forwarding for individual media)
- offer one control strategy for all supported media

How will controls be laid out and grouped?
- call set up and control functions
- display and paper handling control functions
- control-display relationship, control actuation direction
- primary, secondary control, functional sequential relationships
- microphones and pointing devices

How will people monitor and progress call set up, acceptance and termination?

- auditory displays: ringers, tones, synthetic speech, operational noises
- visual displays: video display, alphanumeric and symbol displays, status lights, control labels and on-product graphics, printed material
- tactile displays: control action feedback, operational vibration, vibratory keys, Braille pads

How will people monitor and progress the supporting integrated media provided by the terminal, transmission and network?

- ISDN supplementary services: CLIP, call waiting, call forwarding, etc.
- ISDN capabilities (terminal identity etc.) and switching order control
- terminal facilities (abbreviated number stores, default parameters, etc.)
- service particular functions (e.g. videotelephone camera off, alternative cameras)
- display space and windowing to support the range of media offered

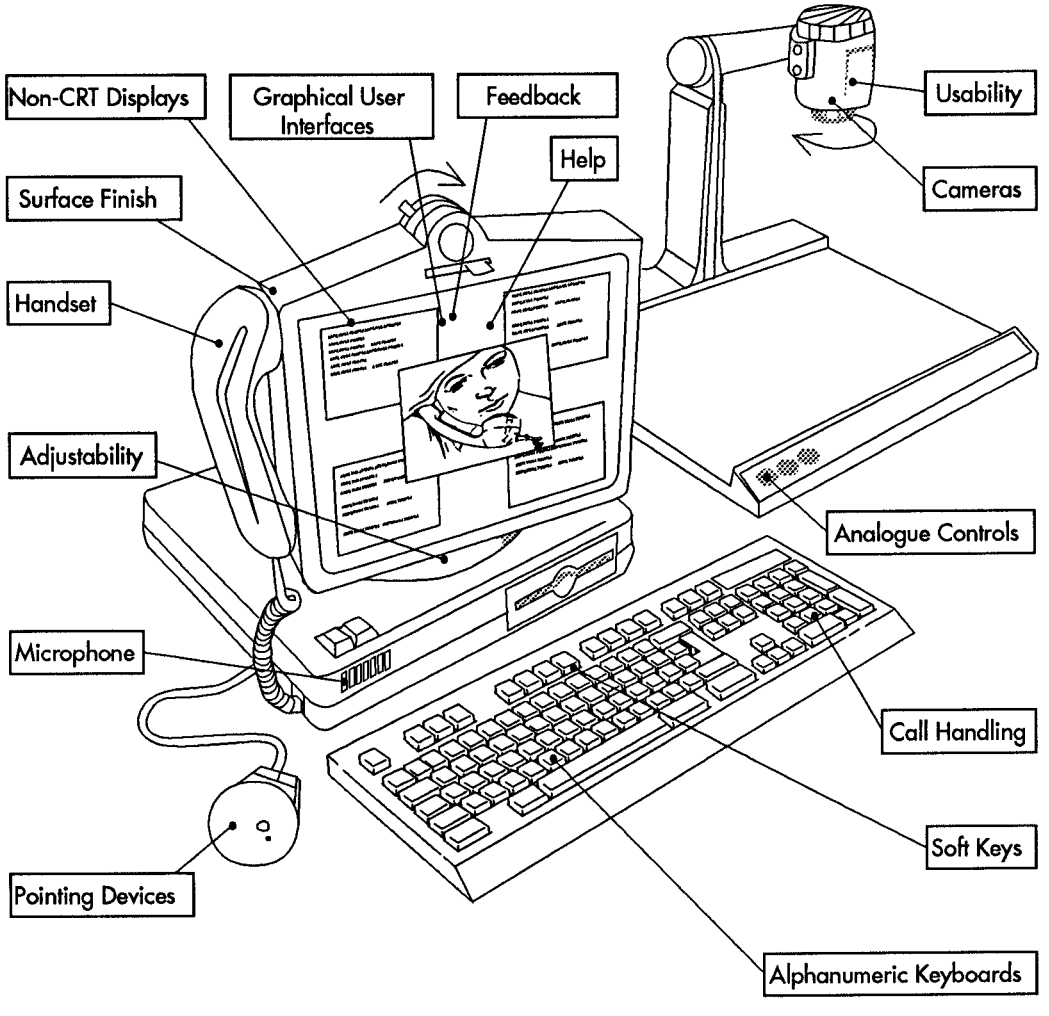



**Figure 13: Generic integrated multimedia terminal**

How will displays be laid and grouped?
- visual displays: LCDs, CRTs, LEDs and other technologies
- printed displays: control labels, on-product graphics, etc.
- auditory displays: loudspeakers, ringers
- tactile displays: keys, Braille pads
- opportunities for sharing or providing independent displays for separate media

**Software/User Interface Developers**

How will the user dialogue support the user and the tasks?
- user stereotypes and expectations, particularly for call set up, receive and terminate, and for individual modules of fax or videotelephone, computer applications
- international applications
- consistency and compatibility between applications, systems
- user guidance, on-line help

What information will the user receive from the system?
- status and warning
- feedback on actions numeric, alpha-numeric, speech messages, tones
- instructions as auditory menus, prompts, visual display

What control information will the user send to the system?
- telephone numbers
- feature commands
- alpha codes and text

What dialogue style, and characteristics?
- phone based interfaces, feature keys, soft-keys programmable keys
- screen based interface, object manipulation, WIMPS
- response time to inputs and execution
- consistency of syntax, procedures
- error checking, error correction, defaults

**Quality Assurance Manager**

What are the usability design goals?
- learn-ability, efficiency, effectiveness, flexibility
- user preference, acceptance

How can usability be assessed and measured?
- user performance, time and errors
- test basic tasks for individual modules
- test basic and frequent multi-function tasks
- test critical and worst case multi-function tasks
- use low fidelity prototypes, mock-ups, field trials
- interviews, questionnaires, observation

How will usability be applied?
- initial specification, design review, modification
- sign off, conformance testing to human factors recommendations
- expert validation

# 5 Design Guidelines

## 5.1 Introduction

This Clause contains the Human Factors Design Guidelines. The guidelines are arranged alphabetically, with no indication of importance intended.

Each guideline entry has six components:

1 Title
2 Alternative titles (shown in italics in brackets)
3 Definition
4 Cross references (other guideline entries that should also be considered)
5 Recommendations (the preferred human factors design points)
6 Additional comments (additional points and usability factors worth considering)

The guidelines offered can be considered under the following general topics:

**Communication and Transmission**
Addresses, Call Handling, Data Transmission, Dialling, Facsimile Machine, Multimedia Terminal, Security, Supplementary Services, Voice Transmission

**Casework**
Adjustability, Cables, Casework Colour, Connectors, Handset, Handset Cradle, Hand Sizes, Hookswitch, Maintenance, Paper Handling, Portability, Safety, Surface Finish, Videotelephones

**Input Hardware**
Analogue Controls (Linear Sliders, Rotary Controls, Thumb/Finger Wheels)
Keyboards (Alphanumeric Keyboards, Keys, Telephone Keypads)
Non-tactile Inputs (Bar-code Readers, Cameras, Card Readers, Microphones)
Pointing Devices (Cursor Keys, Data Glove, Eye/Head Movement, Foot Mouse, Graphics Tablet, Joysticks - Finger/Hand, Light Pens, Mouse, Roll Balls, Stylus/Pen Computer, Touch Screens)
Speech Recognition
Switches (Key Operated Switches, Pushbuttons, Rocker Switches, Rotary Switches, Slider Switches, Toggle Switches)

**Output Hardware**
Auditory Displays (Acoustic Signals, Music, Speech Output)
Tactile Displays
Visual Displays (Character Displays, Graphic Displays, CRT Displays, Non-CRT Displays, Optical Signals)
Printed Displays (Handbooks, Labels, Symbols)

**Software User Interface**
Auditory Menus, Command Language Style, Consistency, Control Key Dialogues, Dialogue Style, Error Management, Evaluation, Feedback, Flexibility, Function Keys, Graphical User Interface, Help, Menu Dialogues, National Variations, Phone-based Interfaces, Response Times, Screen Formatting, Screen Messages, Standardization, Usability, User Guidance, User Interface Design Principles

# Acoustic Signals

### *(Auditory Tones, Earcons, Ring Signals, Warning Tones)*

Acoustic signals and auditory tones are intended to provide information to the user of the status of terminals, systems and networks. For clarification, acoustic signals include: the ringing signals, equipment warning signals, e.g. error "bleep", and also incidental noises such as the sound of a cooling fan or disc-drive. Auditory tones include: the ring tone (the other terminal is ringing), busy tone, call waiting, fax answerback, etc.

### *Cross references:*

Call Handling; Feedback; Music; National Variations; Response Times; Voice Transmission

### *Recommendations:*

- use acoustic signals to attract attention, for example, as the ring signal and as a warning signal where immediate action is needed.
- use auditory tones to provide feedback on the current state of a call, and as a prompt for action within call set-up/handling.
- for signals or tones, use a very limited number of easily recognized codes using rhythm (cadence) and pitch (frequency) variations; preferably less than 7 in any single context. For example, keep the total number of tones possible within call set-up to less than 7 (Miller, 1956).
- use tones having a frequency (pitch) between 300Hz and 3000Hz where the human ear is most sensitive irrespective of the auditory channel's bandwidth (3,1 kHz, 7 kHz, 15 kHz, etc.).
- ensure the time delay between terminal, system or network changes and the corresponding signal or tone is minimal; a desirable maximum would be 0,5 seconds (See Response Times).
- ensure the sound level of tones provided by the terminal independently, or in response to network prompts, meets the CCITT recommended levels shown in figure 16 (CCITT Recommendation E.180).
- where possible provide a volume control so that users can adjust the loudness of signals and tones for personal preference and relative to any ambient noise.
- where tones are generated independently by the ISDN terminal in response to signalling from the network, the terminal generated tones should copy the local PSTN generated tones in frequencies, cadence and meaning.
- in general, ISDN terminals should not generate new tones. If the terminal provides services which require feedback, it is preferred that the terminal makes use only of the minimum set of PSTN tones (dial tone, special dial tone, ring tone, busy tone, congestion tone, special information tone, call waiting tone and warning tone); these may be supplemented by other auditory or visual announcements.

- make use of users stereotypes, use accepted telephony tone codes, e.g. for ringing and busy tones. (CCITT Recommendations E.180, E.181, E.184, ETSI ETS 300 295).

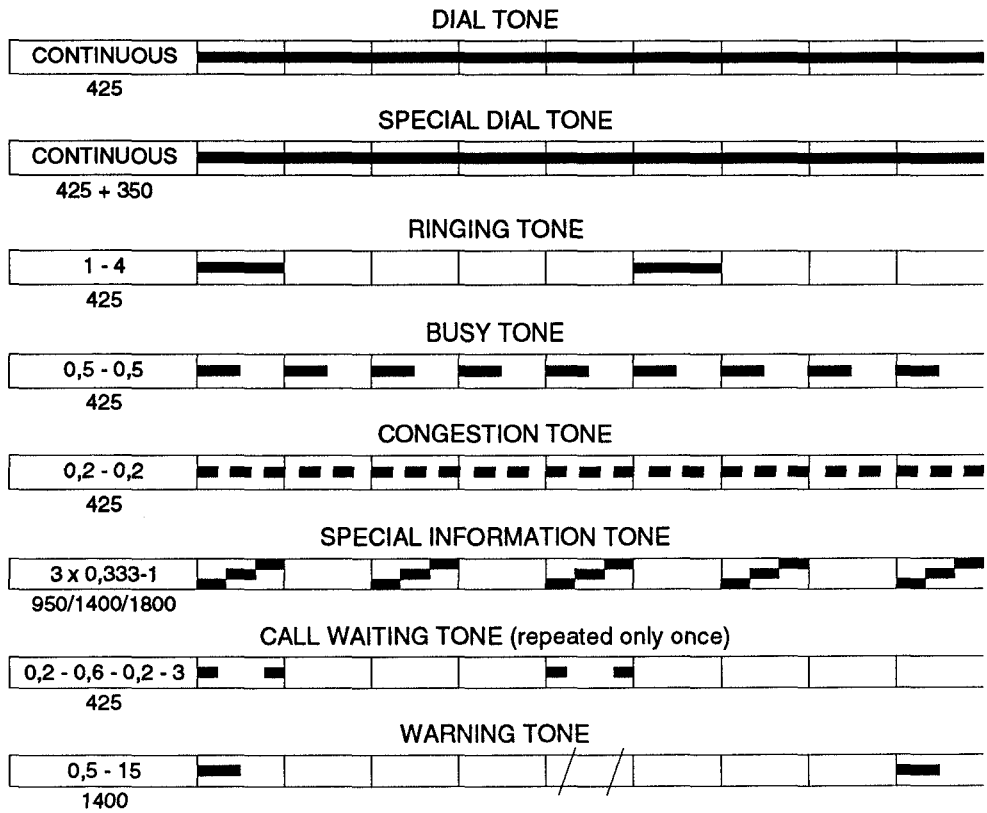



**Figure 14: ETSI recommendations for terminal generated tones**

- for signals, use complex (multi/variable frequency) sounds, variations in cadence (rhythm) and combinations of sounds to make two to four note patterns as these are easier to identify than single frequency pure tones.
- in general, aim to support signals and tones with confirmatory and supplementary visual information, e.g. a lamp signal in response to a ring signal and an indication who is calling, helps both the people with special needs and the untrained user.
- if possible allow users to control or switch off acoustic signals where they might cause annoyance in quiet or crowded environments.
- peripheral sounds such as a disc-drive operating may provide important feedback cues, if these are lost due to technological improvements consider providing alternative auditory or visual signals.
- although often useful information, try to keep the pitch of continuous operating noises as low as possible, and ensure they are within the relevant noise criterion curves. Some EC countries have a required target level for areas where "intellectual" work is being done (i.e. Offices) e.g. Great Britain 55dBA. (BS 7179) Ensure that operational noise has minimum impact on and does not mask signals and tones. (Clark, 1987).

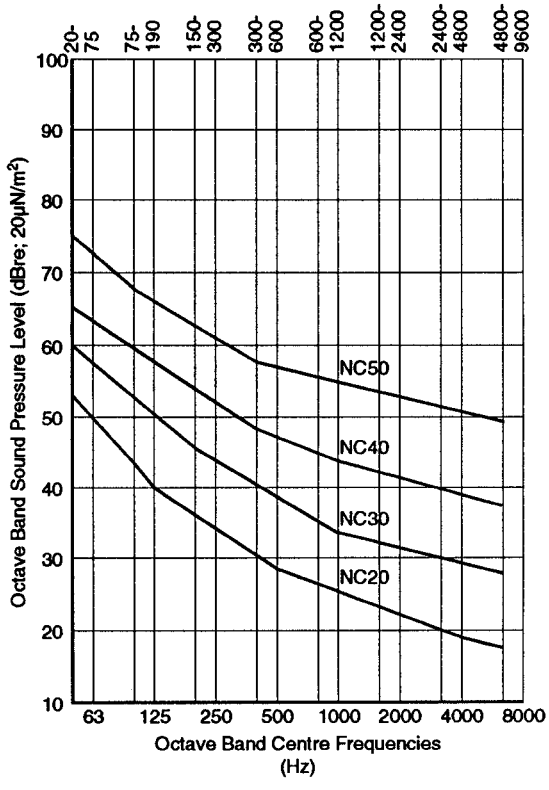



**Figure 15: Noise criterion curves**

- where security requirements prevent the giving of auditory feedback, e.g. for PIN numbers, etc.; ensure the user can still receive visual and/or auditory feedback on the other elements of the dialogue, e.g. the dialled out number.

## *Additional comments:*

Audio icons (earcons), coded signals or auditory information tones which the user has to interpret and to respond to differently, should be made as different as possible.

Auditory signals are particularly valuable for attracting attention, and giving warnings. However, the information content of a "ring or beep" is very low and may need to be supplemented by further visual or speech outputs. (CCITT Recommendations E.182, E.183).

It is useful in many environments, if users are able to adapt or modify the ring signal, for example, so that they can differentiate between several terminals in close proximity. Where ring signals can be customized, it is desirable for the user to be able to test the changes without having to make or request a call.

Environmental constraints need also to be considered since signals and tones may not be heard in noisy conditions, or may be annoying or embarrassing in quiet or crowded conditions. For example, the usability of the basic ring signal can be improved by providing a supplementary lamp signal, which enables the sound to be minimized and incidentally helps people with hearing difficulties.

At the time of going to press, the recommended figure for acoustic signal sound pressure level is subject to further study within ITU-T. One proposal suggests: when measured by an artificial ear, the acoustic sound pressure level is recommended to be -5 ± 4 dBPa (each sine wave) for a handset terminal when the Received Loudness Rating (RLR) is at the nominal value.

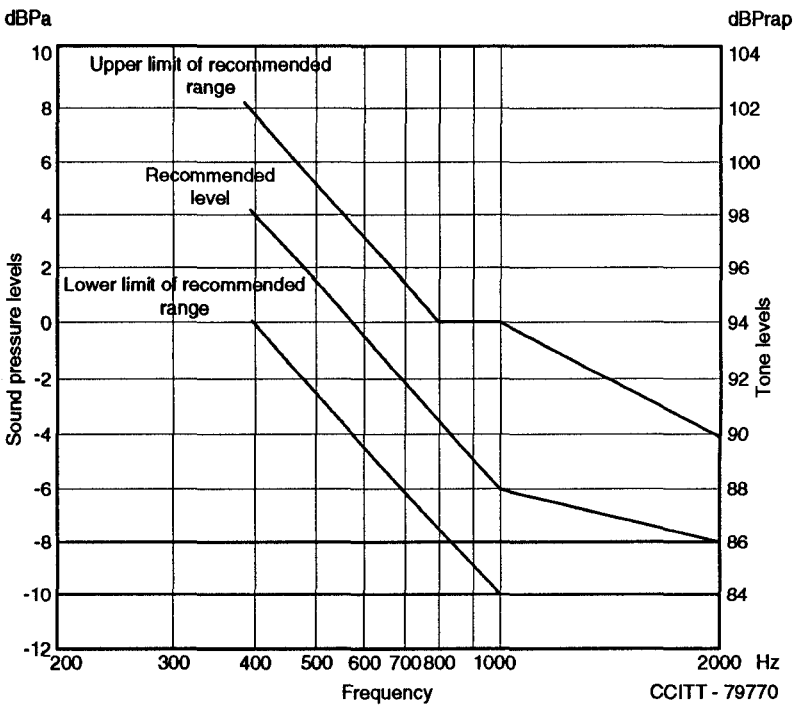



**Figure 16: CCITT recommended listening level limits for tones**

For further information on preferred listening levels, see Coleman (1980), and on audio icons (earcons), see Jones and Furner (1989).

# Addresses

## *(Telephone Numbers)*

The expression used to describe the string of alphanumeric characters and symbols required to dial a call, or refer to a subscriber number. Addresses used for a wide range of telecommunications services (voice, facsimile, telex, videotelephony) are principally numeric, whereas data communications addresses, e.g. electronic mail boxes are invariably alphanumeric, and may include other conventional keyboard symbols.

## *Cross references:*

Call Handling; Dialling

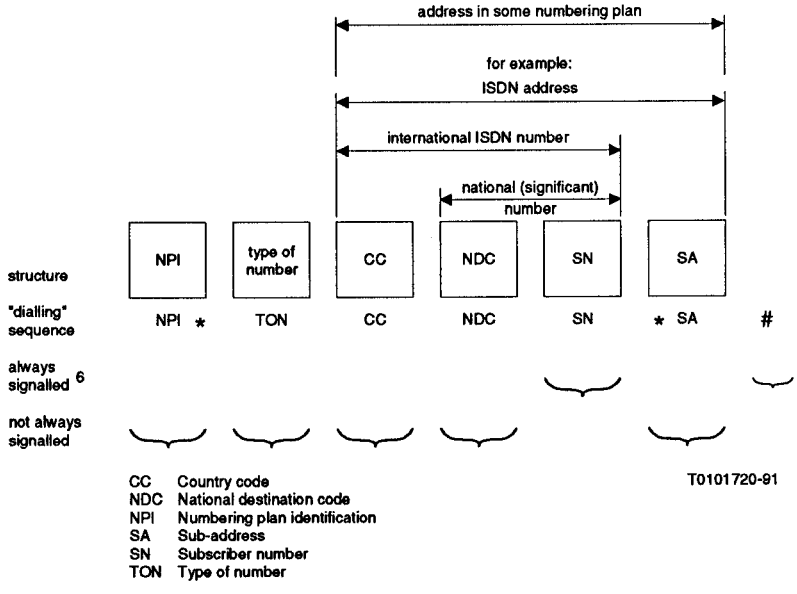
## *Recommendations:*

- use the CCITT preferred format for all printed forms of national and international numbers (CCITT Recommendation E.123).

| | |
|---|---|
| National | (0123) 456 789 |
| International | +123 456 789 |

## *Additional comments:*

Consideration may also be necessary of ITU-T Recommendation E.331 - "Minimum user-terminal interface for a human user entering address information into an ISDN terminal"; if the terminal may be used within a private or similar numbering plan environment (See figure 17).




Note: It would be seldom, if ever, that every part of this sequence were input for a single connection.

**Figure 17: ITU-T recommended ISDN address format**

# Adjustability

## *(Repetitive Strain Injury (RSI), Swivel and Tilt)*

This is the facility to position and re-position a module or a complete terminal to meet the specific personal requirements of the user.

## *Cross references:*

Casework; CRT Displays; Flexibility; Portability; Safety

## *Recommendations:*

- give consideration in the construction of all single unit terminals to aspects that will facilitate the adjustment of the terminal to optimize the orientation of user critical elements (e.g. bring it closer to read the display or avoid specular reflections).
- if the terminal integrates Visual Display Terminal and Keyboard, the keyboard should be separate from the display unit, and the keyboard and display unit flexible enough to allow a range of working arrangements (ISO DIS 9241). The display unit should also enable the following range of adjustments:

  - Screen tilt -5° to +20° (from vertical) (DIN 66 234 Part- 6).

  - Screen height adjustment range 110mm (minimum, if provided) (DIN 66 234 Part- 6).
- if the keyboard is also adjustable, at least one position within the range of adjustment should meet the 30mm height requirements on the "C" row - A, S, D, F, G, H, etc. (ISO DIS 9241 Part 4).

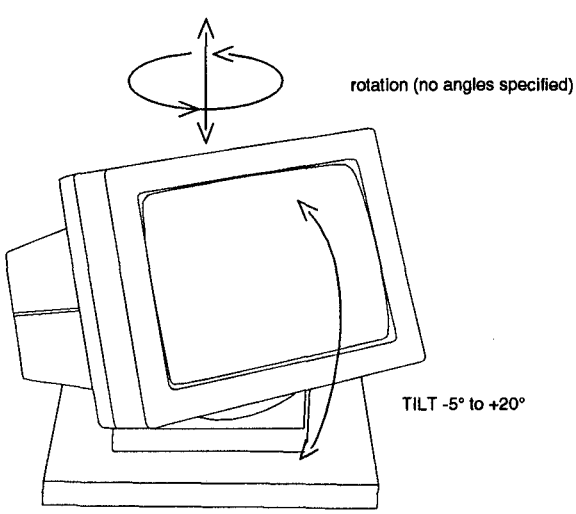



**Figure 18: Visual display adjustability (swivel and tilt)**

- when an item is being adjusted, enable the item to remain stable while the adjustment is locked. If possible the whole procedure should be capable of being completed one-handed.
- give consideration in the construction of the terminal for the replacement or parallel operation of control and display areas, to maximize the opportunity for people with special needs to use alternative input and output technologies to the standard fit.
- when terminals or terminal modules are adjustable provide adequate hand positioning points with suitable friction surfaces to assist in making the adjustments. Ensure the item is adjustable by people with 5th percentile push/pull capability (maximum push/pull forces of 75 N, based on 67% of 5th percentile male capacity with non-preferred hand/arm at least effective angle of elbow flexion, 90° - Mil Std 1472 C) and reach (650mm, based on functional reach of 5th percentile females). (CEN TC122) (Pheasant, 1986).

## *Additional comments:*

It is a physiological requirement that people adjust their posture to release stresses on the body. Therefore it is essential that equipment designs should not constrain people to work in fixed or cramped postures, especially when the equipment has to be used over extended periods. This applies equally to the end-users and maintainers of the equipment.

# Alphanumeric Keyboards

## *(Alphabetic Layouts, QWERTY/QWERTZ/AZERTY Keyboards, Repetitive Strain Injury)*

An alphanumeric keyboard contains keys bearing letters of the alphabet as well as numbers (and possibly function keys), usually in separate blocks.

## *Cross references:*

Control Key Dialogues; Keyboards; Keys; Pushbuttons; Safety; Switches; Telephone Keypads

## *Recommendations:*

- the preferred key pitch (key centre to centre) for professional level alphanumeric data entry is 19mm ± 1mm, vertically and horizontally irrespective of key cap style. (DIN 2139, ECMA-110, ECMA-126).
- the preferred arrangement of letters, digits and symbols is the accepted "QWERTY" layout, with national variations. (ISO 2530 and ISO 3243; scheduled to be replaced by ISO/IEC DIS 9995) (See figure 19).

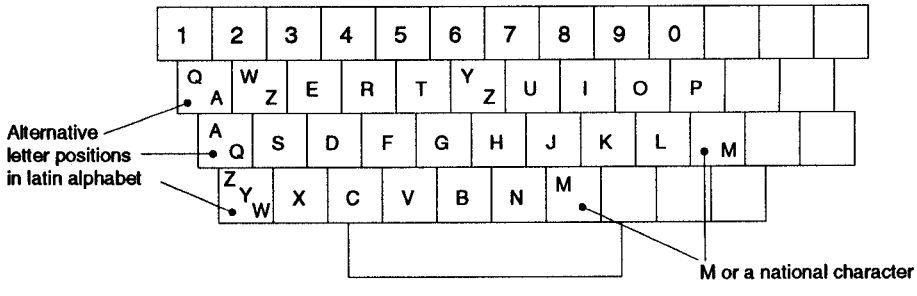



**Figure 19: ISO/IEC recommended arrangement of letters**

- consider providing raised dots or lines on the touched surface of the respective keys in the C-row, "F" and "J", to help unsighted navigation of the keyboard.
- the preferred keyboard height at the Home row (A, S, D, F, etc.) is 30mm or less. (German Gepruefte Sicherheit (G.S.) -VBG). Alternatively 35mm is the maximum for the lowest setting (ECMA-110, ECMA-126) (See figure 20).
- the preferred keyboard angle is less than 15° (German Gepruefte Sicherheit (G.S.) VBG), or between 5° - 18° (ECMA-110, ECMA-126).

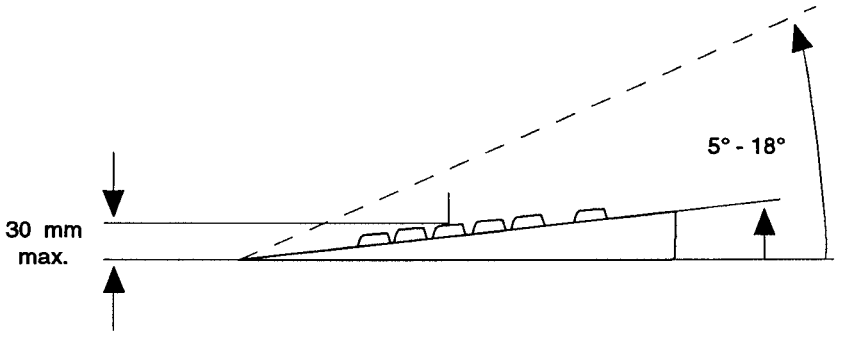



**Figure 20: Preferred keyboard angles**

- where the alphanumeric keyboard is part of display screen equipment that is to be used for a significant part of the working day, the design needs to meet Health and Safety regulations under the European Council Directive 90/270/EEC.
- for VDU workstations, ensure the keyboard is separable from the screen unit by at least 300mm (ECMA-110, ECMA-126). This may be desirable, but is not mandatory, for portable terminals or compact systems for specific applications.
- if a compact keyboard is essential (less than 18mm key pitch) there is evidence that "QWERTY" layouts perform better than Alphabetic (Francas, 1983 (9mm pitch, 6mm clearance radius)).
- alphabetic layouts are only recommended if space precludes the 4 x 10 key matrix necessary for a "QWERTY" layout, where the increase in key size for a 5 x 6 versus a 4 x 10 layout can be traded with the benefit of "QWERTY" over alphabetic.

| | | | | | |
|---|---|---|---|---|---|
| A | B | C | D | | |
| E | F | G | H | | |
| I | J | K | L | M | N |
| O | P | Q | R | S | T |
| U | V | W | X | Y | Z |

**Figure 21: Alphabetic (5 x 6) keyboard layout**

- use conventional keys with 1-8mm travel for alphanumeric keyboards, if membrane keyboards have to be used, be aware that data entry performance is reduced (increased keying times and errors) (Cohen Loeb, 1983).
- use conventional keys with 0,25 - 1,5 N force for alphanumeric keyboards, be aware that "snap-action" tactile feedback may slow professional typists, use "ramp/continuous force" keys for main keyboard and "snap-action" for function keys (Alexander, 1974).

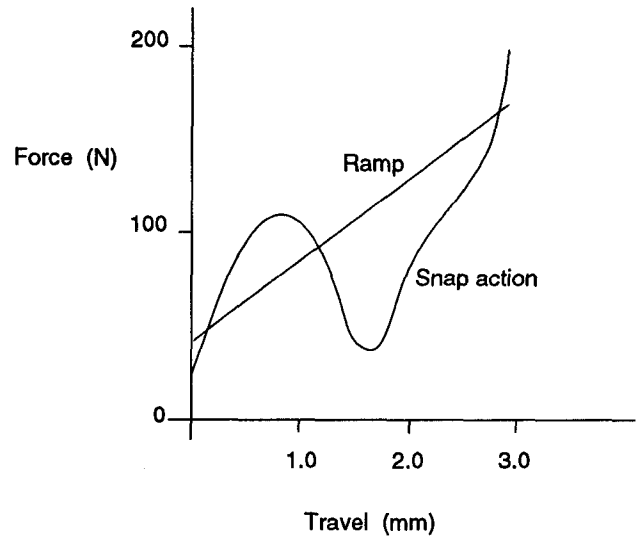



**Figure 22: Force travel characteristics**

- make use of enlarged keycaps for critical functions, e.g. space, enter, tab, backspace, and the shift keys (shift, alt and control), avoid the use of keycaps which include a standard size finger pad on top of the main key body (See figure 23).

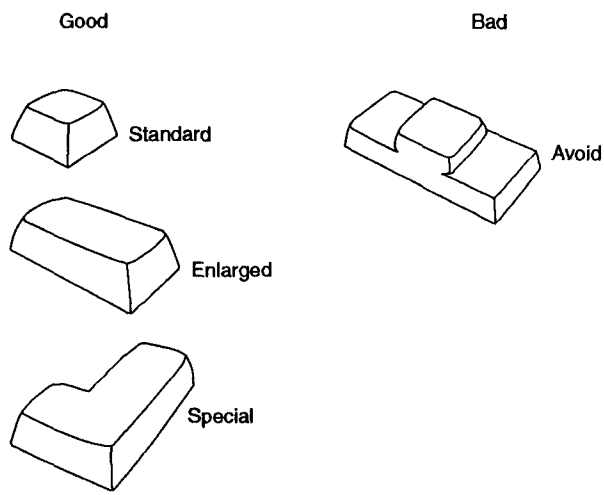



**Figure 23: Example of enlarged keycaps**

## *Additional comments:*

As a matter of good design practice, the electrical and terminal interfaces characteristics of detachable keyboards should conform to recognized standards. This is one way to maximize the opportunity to offer alternative keyboards and other input devices for users with special needs.

There is some evidence that keyboards that will be used for prolonged data entry should be designed at different inclines to those recommended in the standards. See Zipp (1983) and Ilg (1987) for more detailed information. For more general background on the development of alphanumeric keyboards, see Klemmer (1971).

# Analogue Controls

## *(Continuous Controls, Controls, Knobs, Sliders, User Stereotypes)*

A control input device for selecting the chosen level of a continuous analogue variable, e.g. audio volume. Analogue controls are usually operated in a linear (slider) or circular motion (rotary control, thumb/finger wheel).

## *Cross references:*

Graphical User Interfaces; Linear Sliders; Rotary Controls; Thumb/Finger Wheels

## *Recommendations:*

- take advantage of people's stereotypes for the direction of motion used to increase the setting of the variable:
  - for linear sliders - to the right, back or top.
  - for rotary knobs - to the right, clockwise.
  - for thumb, finger wheels - to the right, back or top.
- provide labels, legends and/or markings to:
  - identify the function of the continuous control.
  - identify the direction and function of the variable.
  - indicate the current setting of the control and of the controlled variable.
- analogue controls may be implemented in hardware, or in software as part of a screen based application. The analogue controls on the screen exhibit the same functionality as the hardware implementation. The screen based control will require a pointing device to change its setting, and cannot provide direct tactile feedback to the degree of change chosen.

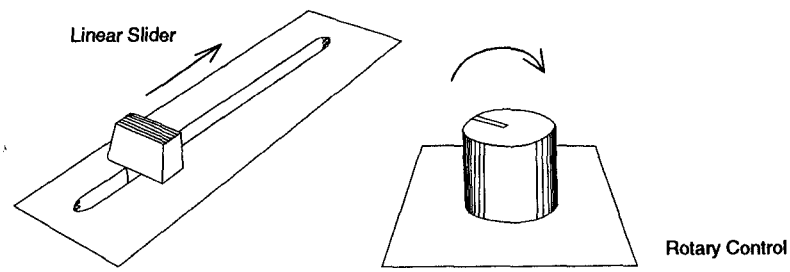



**Figure 24: Example of analogue controls**

## *Additional comments:*

The table below gives some user/task related guidance on the different types of analogue controls (DOI, 1977).

**Table 8: Comparison of analogue controls**

| | Sliders | Rotary Controls | Thumb wheels |
|---|---|---|---|
| Size of scale | Limited to length of slide | Multiple turns are possible | Multiple turns are impractical |
| Precision of setting fine tuning | Moderate | Good with large knob | Poor |
| Speed to approximate position | Good | Good with scale limited to 270° maximum | Poor |
| Ease for visual check of control setting | Good | Good with limited scale. Poor with multiple rotation | Poor |
| Ease for non-visual check of control setting | Good | Moderate with distinct pointer and limited scale | Poor |
| Ease of operating simultaneously with array of similar controls | Good | Poor | Moderate |
| Space requirements | Large | Moderate | Smallish |

It may be appropriate to consider (perhaps as a switchable option) auditory as well as visual feedback for analogue controls. For example, a rising tone or

of a screen based application. The analogue controls on the screen exhibit the same functionality as the hardware implementation. The screen based control will require a pointing device to change its setting, and cannot provide direct tactile feedback to the degree of change chosen.

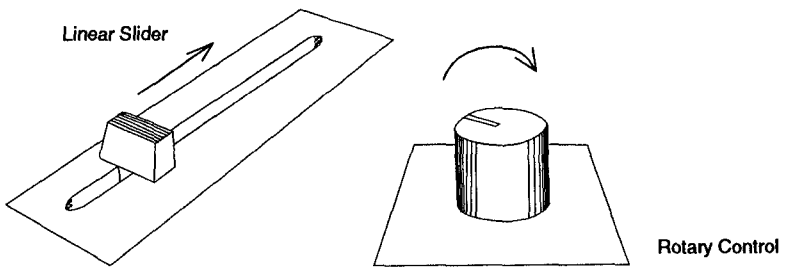



**Figure 24: Example of analogue controls**

## *Additional comments:*

The table below gives some user/task related guidance on the different types of analogue controls (DOI, 1977).

# Auditory Displays

### *(Displays, Sounds)*

The group of information displays that rely on the user hearing the information.

### *Cross-reference:*

Acoustic Signals; Auditory Menus; Music; Speech Output

### *Recommendations:*

- use auditory displays (acoustic signals, speech output, etc.) to complement visual information, to assist some categories of people with special needs, such as the visually impaired.
- use auditory displays when users are unlikely to be attending to, or facing a visual display.
- use speech output when more message flexibility is necessary, when specific data has to be conveyed, when there is a need for two way exchange of information, when listeners cannot be trained in the meaning of acoustic signals.
- use acoustic signals: where immediate action is required, when a point in time (but not a value) has to be indicated, to override speech communication.

### *Additional Comments:*

Review the individual guideline entries for specific recommendations on each type of auditory display.

# Auditory Menus

Auditory menus are spoken using recorded real speech or synthetic speech. Menu choices are made using key input, sound or speech.

### *Cross-references:*

Menu Dialogues; Speech Output

### *Recommendations:*

- develop the menu specifically for speech output. Avoid the use of homonyms (words which sound similar). Use single words, or common (perhaps also jargon) word pairs. Maintain a good rhythm and a near constant speech rate, keep the gap between menu items fairly short (0,5-1,0 second). Use the female voice. Limit the number of choices in any one menu presentation to a maximum of six.
- ensure the quality and intelligibility of the speech output by testing on a representative sample of users. Set the necessary success rate quite high, e.g. 95% correct recognitions on the first exposure.
- avoid developing a hierarchy; if it is necessary, keep the number of levels to a maximum of two.
- minimize the memory load by allowing the user to select an option immediately. Enable interrupts or "typeover".
- provide the facility to allow the user to hear the choices repeated.
- allow short cuts for expert users. Enable users to interrupt and type ahead, i.e. interrupt with one or more known inputs.

### *Additional comments:*

Research has shown that the requirements for auditory menus are more complex than for visually displayed menus. At this time it is particularly important to evaluate and optimize the content and format of the menu during the design stage.

# Bar-code Readers

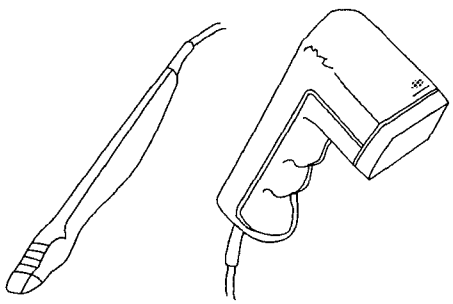
An input device for accessing alphanumeric data codes presented in the standard format of printed lines of varying thickness and spacing.

## *Cross references:*

Input Hardware; Non-tactile Inputs

## *Recommendations:*

- ensure the bar-code is sited on a flattish surface.
- avoid covering the bar-code with any opaque or semi-transparent material, or transparent material which can ruck or crinkle.
- provide a clean flat surface for scanning bar-codes with the stylus scanner.



Example Bar-code

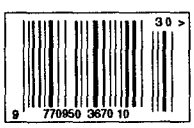



**Figure 25: Example of bar-code readers and bar-code**

- ensure the bar-code reader gives a clear indication as to which part is the sensor, when it is active and clear feedback when a code has been read correctly or if needs a second scan.

## *Additional comments:*

No real guidance is currently available from the human factors literature. Therefore, if a bar-code reader is a key element of the terminal design, it is imperative to do prototype testing early in the design process to ensure the user's needs are being accommodated.

# Cables

## *(Connecting Cables, Cords, Equipment Practice, Handset Cables, Vandalism, Wires)*

Cables are used to provide a physical interconnection between ISDN terminal modules to connect to the ISDN, PSTN or other network, and to connect to power sources. Typically they terminate in connectors, plugs or sockets.

## *Cross references:*

Casework; Connectors

## *Recommendations:*

- use flexible coiled handset cables, to connect a handset to a terminal base unit, to prevent the cable pulling or moving a free-standing base unit. The cable length coiled should be in the range 0,3 - 0,5m; and fully extended in the range 1,0 - 2,0m.

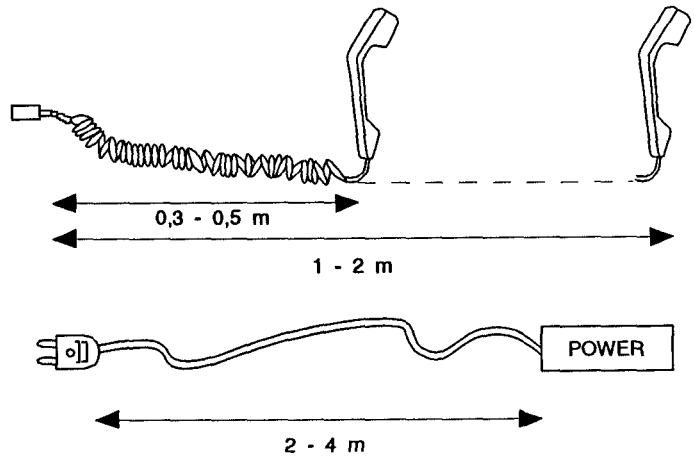



**Figure 26: Recommended cable lengths**

- provide flexible cables to connect base units to the network and power sources. The length will depend on the expected location of the base unit and the resource outlets, usually a length in the range 2,0 - 4,0m is sufficient.
- use flexible cables to interconnect between terminal modules. The type and length should be determined by communication needs and the likely range of terminal installation arrangements that users might consider. For example, keyboard to base unit cables for integrated terminals may need to be of the flexible coil type to meet the adjustability requirements, and allow users to position the keyboard where they will.

- consider the need to provide cable storage facilities on terminal modules to keep excess cable safely stowed.
- consider the need to provide labels or other visual and tactile identifiers to enable users to distinguish between different cables used on the same terminal modules, e.g. use connectors of different shapes and sizes.
- ensure that all necessary cables are supplied and packaged with the terminal before release to the customer, and identify and illustrate the interconnection of modules in the customer documentation.

### *Additional comments:*

There are often specific requirements for all forms of cables used with public terminals. These include: the style/construction of protective sheathing, the length and the design of the mounting points. In general, terminals sited in insecure public areas use short stainless steel reinforced handset cable and stainless steel cable mounting points.

# Call Handling

## *Call Set-up, Call Terminate, General Rules, Generic Procedures (Call Set-up, Incoming Call, Change, Identification, Payment, Termination, Outgoing Call, User Procedures)*

Call handling refers particularly to the procedures which the user needs to complete in order to set up, control and terminate a call from his (or her) terminal via the ISDN network to another terminal.

### *Cross references:*

Acoustic Signals; Addresses; Communication and Transmission; Feedback

### *Recommendations:*

- the call set-up, control and termination dialogues should require the minimum possible user actions and the minimal memory load.
- basic call handling procedures for voice calls should support user stereotypes and expectations by remaining consistent to existing user models of telephone operation.

**Table 9: Basic call handling examples**

| **Outgoing Calls** | |
|---|---|
| State | Idle |
| Control action | Go off-hook |
| Indication | Dial tone |
| Control action | Dial number |
| Indication | Dialled number |
| Indication | Ring tone |
| State | Connection |

| **Incoming Calls** | |
|---|---|
| State | Idle |
| Indication | Ring signal |
| Control action | Go off-hook |
| Indication | Connection |
| State | Connection |

| **Terminating Calls** | |
|---|---|
| State | Connection |
| Control action | Go on-hook |
| Indication | Idle |
| State | Idle |

- novice and casual users should be guided through the basic level of call control using visual display, voice or on-product graphics.
- enable users to dial during call set-up using the standard "overlap" or the newer "en bloc" dialling. Ensure the "en bloc" dialling is supported with a basic numeric display and last digit editing facilities.
- prevent time-outs at the start of dialling and/or at inter-digit intervals from affecting people who key slowly (because of motor or cognitive impairment). This will include the accessing of secondary networks.
- in applications where some users may be frequent or skilled, the interaction should allow for time-saving short-cuts, e.g. programmable direct dial keys (with auto off-hook), short code dialling or alphabetic directory.
- the terminal and network should provide clear feedback on the progress of the call, through the use of auditory and visual displays. (See Acoustic Signals).
- call failure due to user error, terminal and system faults, or congestion should be clearly indicated and options for error recovery or indication of duration of fault condition should be provided.

### *Additional comments:*

Users need to be able to make, receive and terminate calls with minimum training and without making errors, especially for voice communications (telephony), but preferably irrespective of the communication media. (van Hardeveld and Mierop, 1988).

Recent research has shown that users often have incomplete and inaccurate models of how the telephone and the telephone network operates (Bennett and Klinger, 1990; Chin, 1993). These limitations in user models lead to confusions and errors with more complex procedures such as multi-party calls, e.g. call waiting, call transfer, hold and enquiry, etc.; and also in more ordinary scenarios, e.g. loss of dial tone. The design of call procedures needs to offer support and guidance to direct the user towards the correct procedure, and to reduce the risk of errors that lead to rejection of all or parts of the system capabilities. Suppliers should test their chosen procedures with representative users, and should consider a stringent success criteria, e.g. 80% success on the first exposure, 90% on the second. (See subclause 2.2 "Why Human Factors?"). (Ferris, 1986).

To give guidance to the developers of call handling procedures for new services, a set of twelve General Rules for User Control Procedures and a set of six Generic User Procedures have been developed by ETSI and are reproduced below (ETSI DTR/HF-01021, ETSI DTR/HF-01022). User procedures designers should also consider CCITT Recommendation Q.931, ITU-T Recommendation E.134 and Deutsche Bundespost FTZ 1 TR3 and FTZ 121 TR10.

**Table 10: Twelve general rules for user control procedures**

| | |
|---|---|
| 1 | A user procedure comprises a sequence of user control actions and equipment display indications targeted to enable completion of a user's task or sub-task |
| 2 | Every control action requires a clear indication of the status of the system and of the control before the action, and a clear indication (feedback) of the change in status of the control and the system after the action. |
| 3 | A user control action is necessary to initiate and complete any task or sub-task. A single action may complete one task and initiate a new task, if the action is explicit in both tasks. Similary, a single action may complete a number of nested or parallel tasks, if the action and the corresponding indication explicity confirms the multiple effect. |
| 4 | Any change of status of the system (terminal, network, remote terminal) that affects the user's interaction with the system shall be indicated to the user. Interruptions to a user's task that are initiated by the system (including a remote user's actions) should accommodate the current task, and facilitate the user's choice over the available options. |
| 5 | All indications to the user whether static or transitory, shall be appropriate, discriminable, comprehensible and timely, within the range of physical and mental capabilities of the possible user population (with due reference to people with special needs). |
| 6 | All control actions required to operate the system shall be within the range of the physical and mental capabilities of the possible user population (with due reference to people with special needs). |
| 7 | No indication, control action or status of the system should threaten the physical or mental well-being of the possible user population. |
| 8 | Any procedure necessary to complete a task (or sub-task) should be concise, consistent, comprehensible and complete; commensurate with minimum user errors and congruent with targeted user preference levels. |
| 9 | Any set of procedures which relate to a set of tasks (or sub-tasks) shall demonstrate the qualities of consistency, flexibility, compatibility, self-explanation and user task orientation, to support the user's modelling or comprehension of the tasks and the system. |
| 10 | All procedures should support a simple and comprehensive error recovery strategy to enable the user to backtrack and/or exit from erroneous control actions. As far as possible, error recovery should not be penalized by any loss of data or of the communication path. |
| 11 | New procedures should be tested by a representative sample of people drawn from the possible user population (with reference to people with special needs) and evaluated against previously established criteria of usability. |
| 12 | Disregard any or all of the above rules in the interests of developing user control procedures and user interfaces which have a proven higher level of usability. |

Figures 28 - 34 present seven Generic User Control Procedures developed by ETSI TCHF. They comprise: Call Set-up, Incoming calls, Payment, Identification, Change, Call In Progress and Call Termination.

- Generic Call Set-up is intended to accommodate both single and multi-service terminals (public or private).
- Generic Incoming Call is intended to accommodate all possible incoming call options including Network Determined User Busy (NDUB), User Determined User Busy (UDUB) and Call Waiting, at both network and terminal level.
- Generic Payment is intended to enable a range of possible payment options for use with public terminals.
- Generic Identification is intended to enable a range of possible options for verification of the identity of the user.
- Generic Change is intended to enable any status change the user may require, e.g. Change of Teleservice.
- Generic Call In Progress is included for completeness. It enables the user to access most of the other procedures: Generic Incoming Call, Change, Payment and Call Termination.
- Generic Termination is intended to enable the user to complete a call.

All seven Generic procedures are described as flow charts using the CCITT approved SDL chart symbols (CCITT Recommendation Z.100):

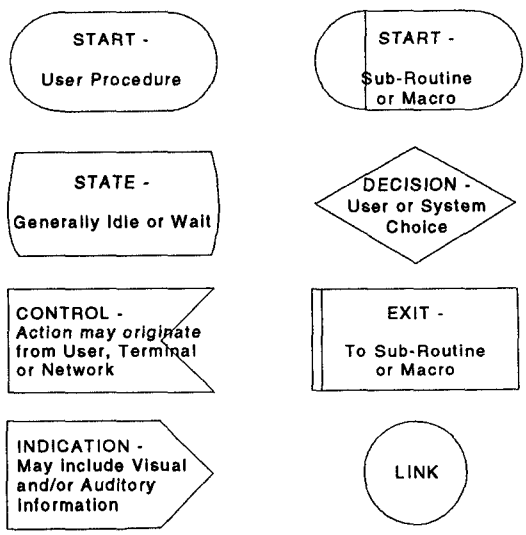



**Figure 27: SDL diagram symbols used in the generic user procedures**

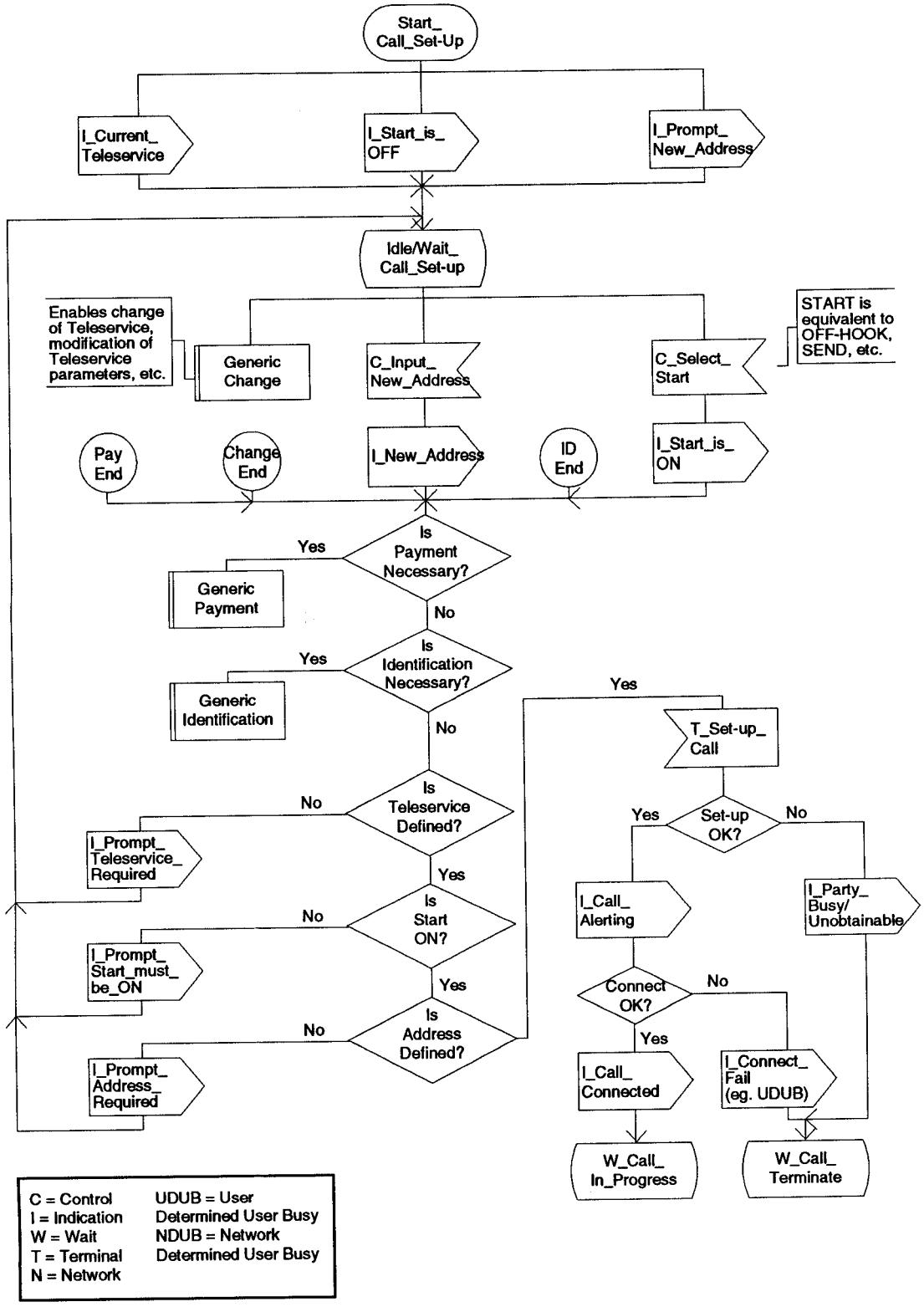



**Figure 28: Generic call set-up**

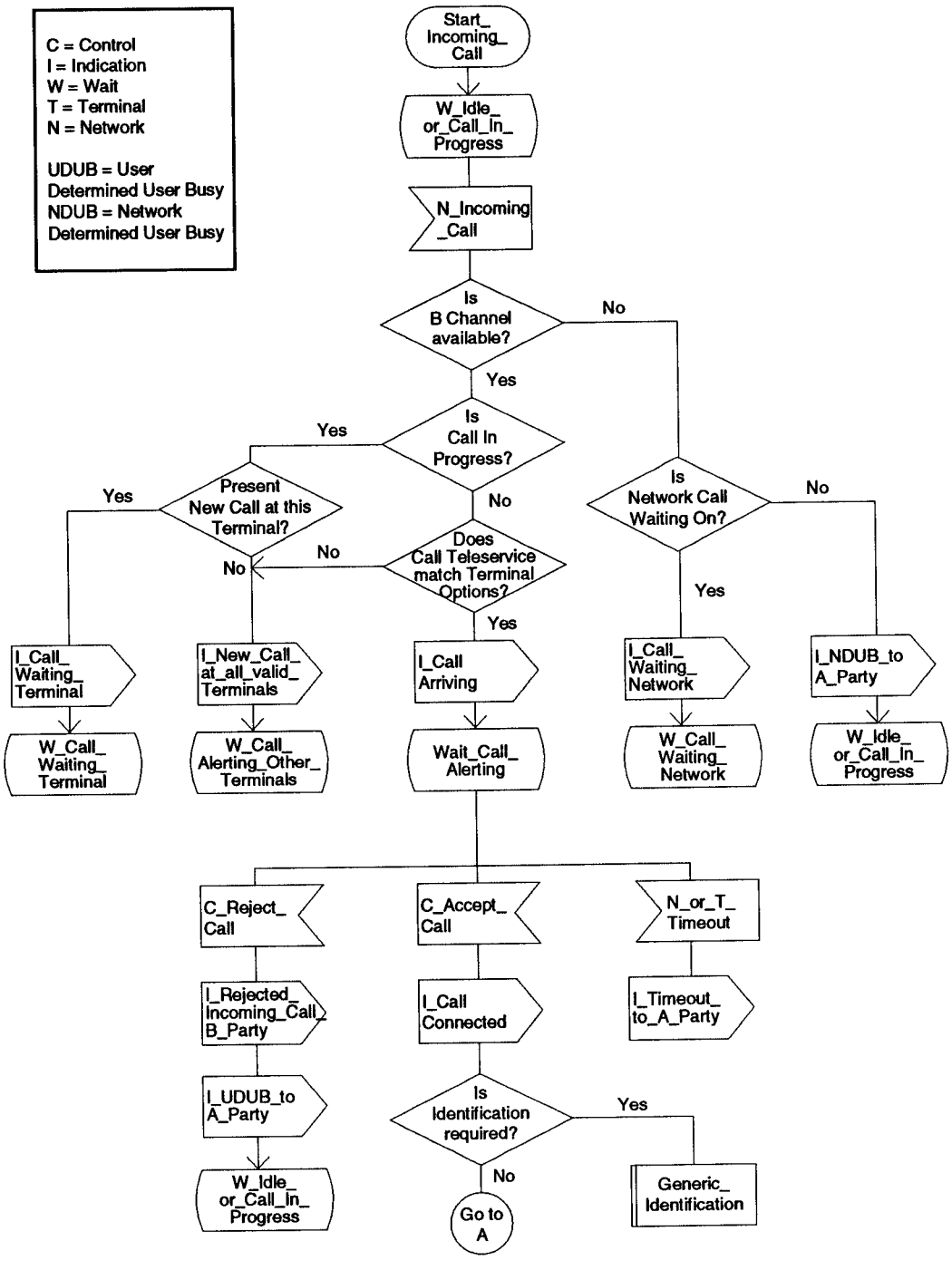



**Figure 29: Generic incoming call**

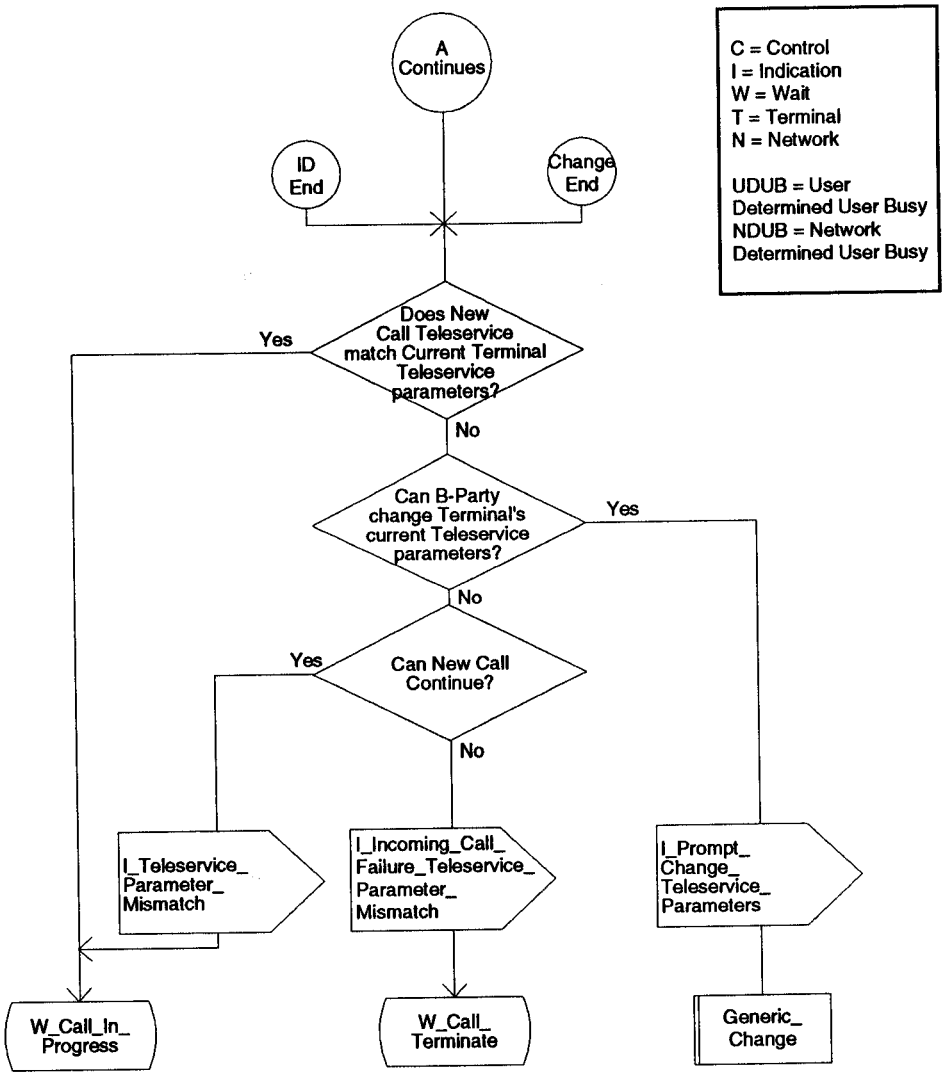



**Figure 29: Generic incoming call.... concluded**

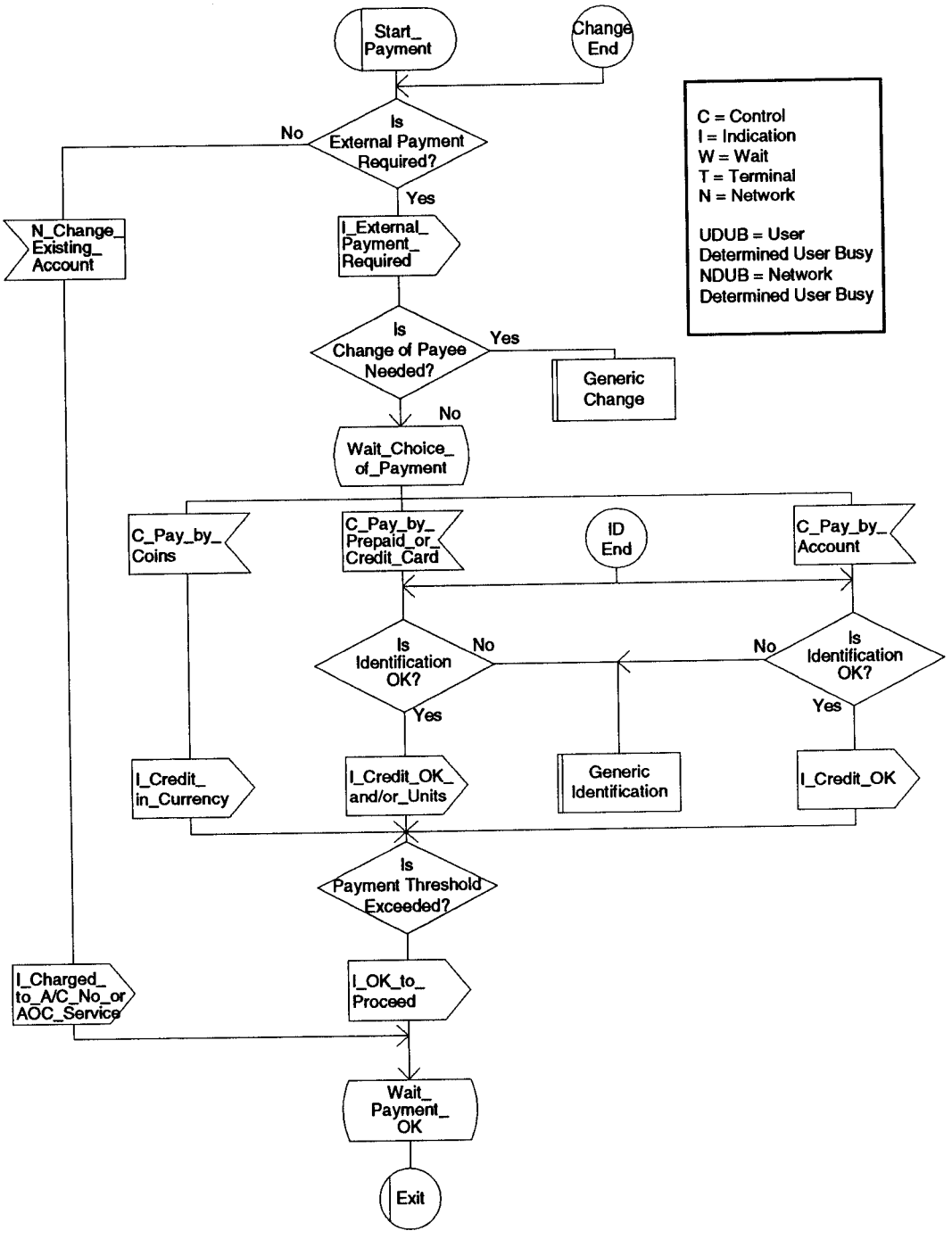



**Figure 30: Generic payment**

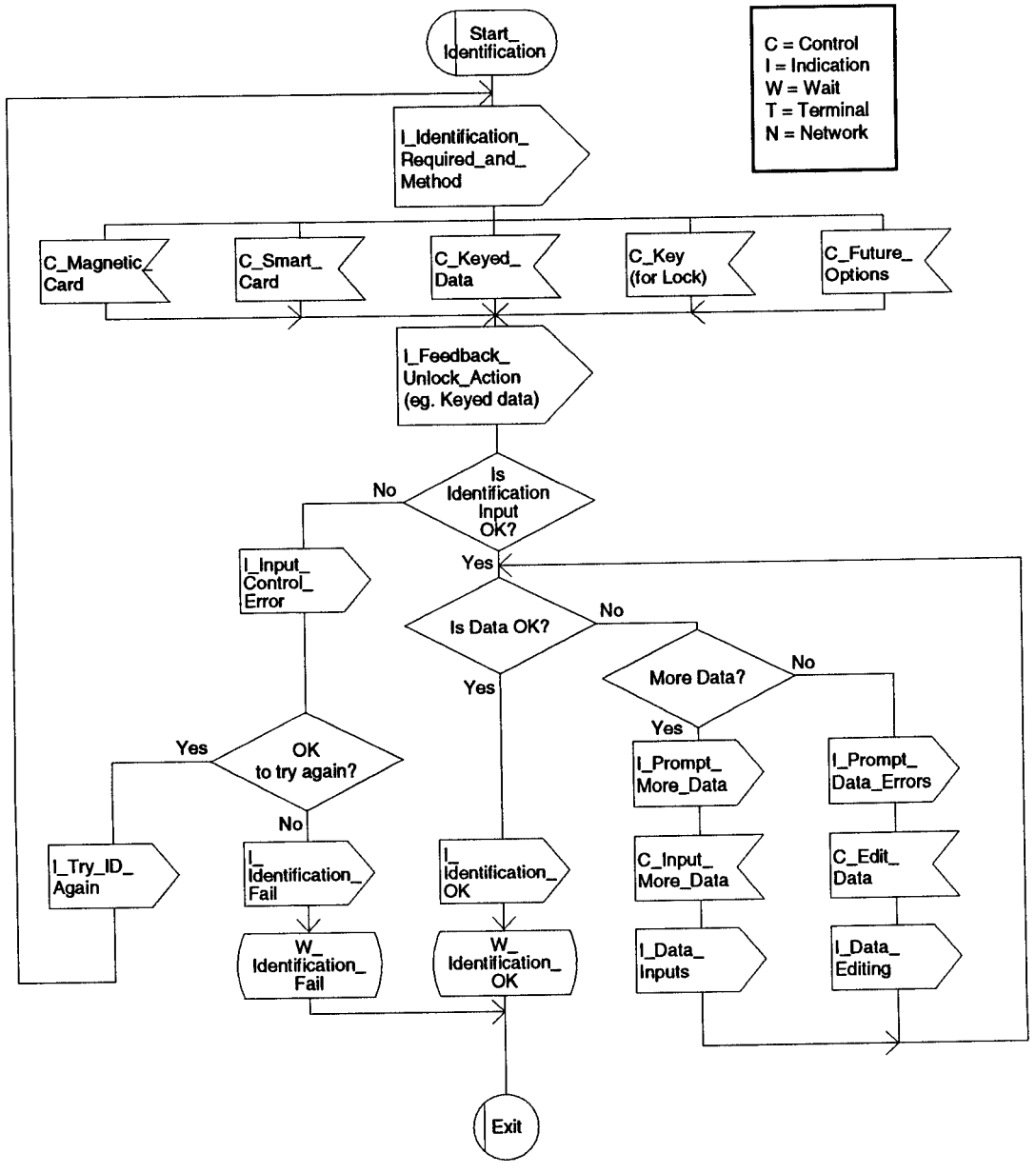



**Figure 31: Generic identification**

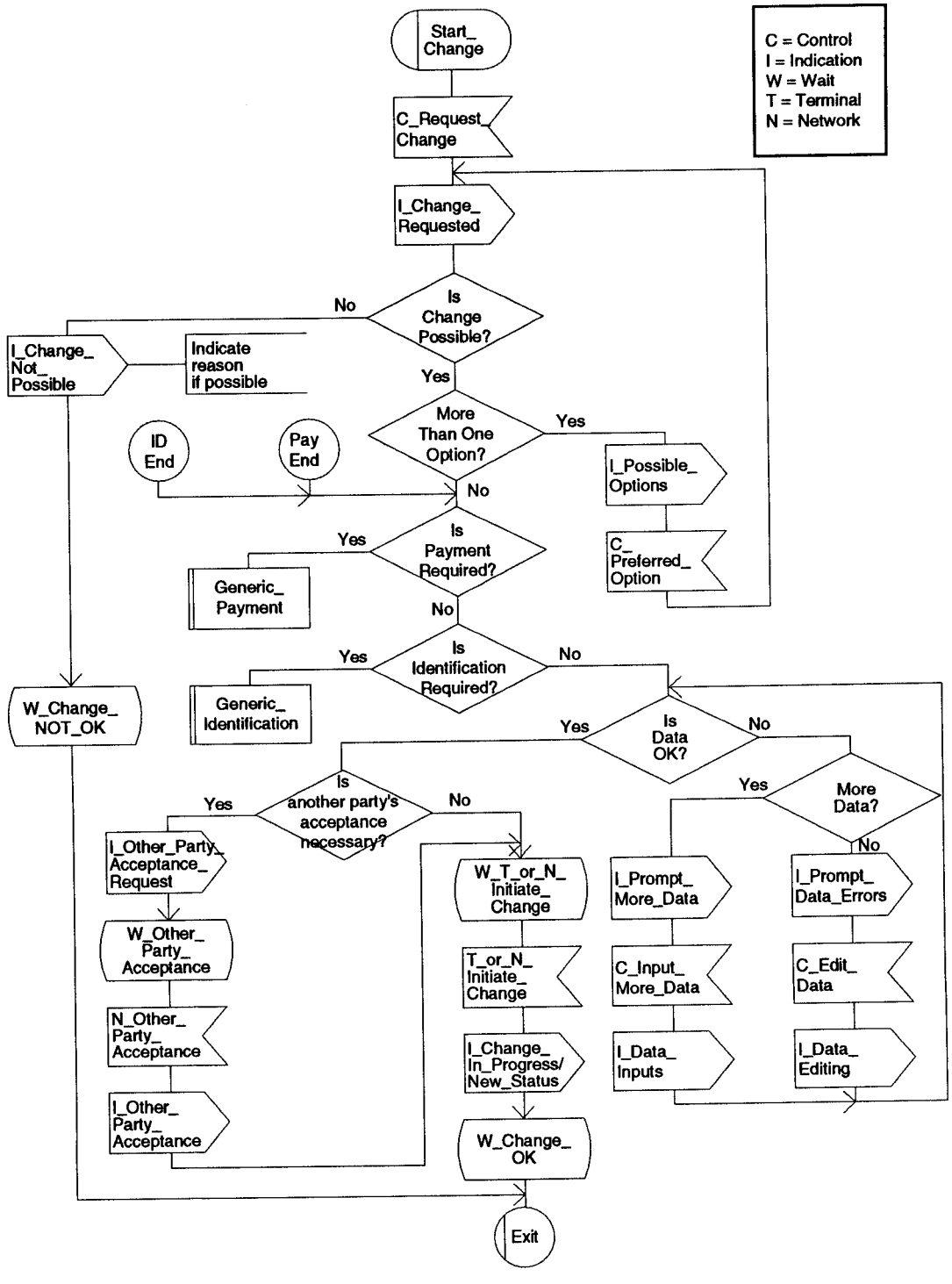



**Figure 32: Generic change**

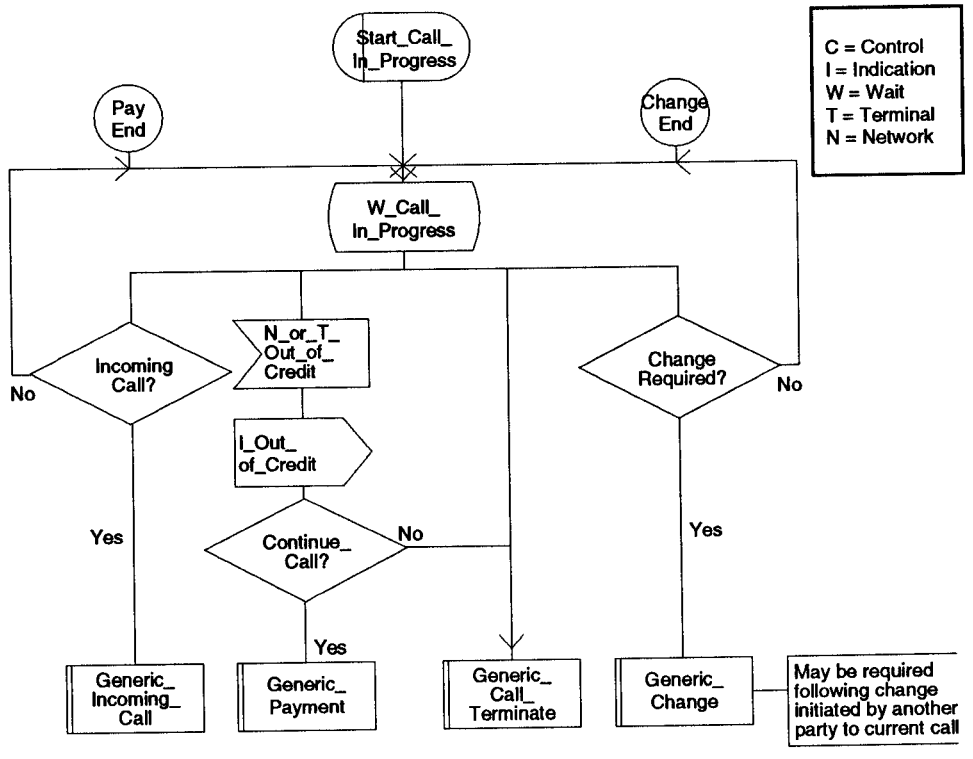



**Figure 33: Generic call in progress**

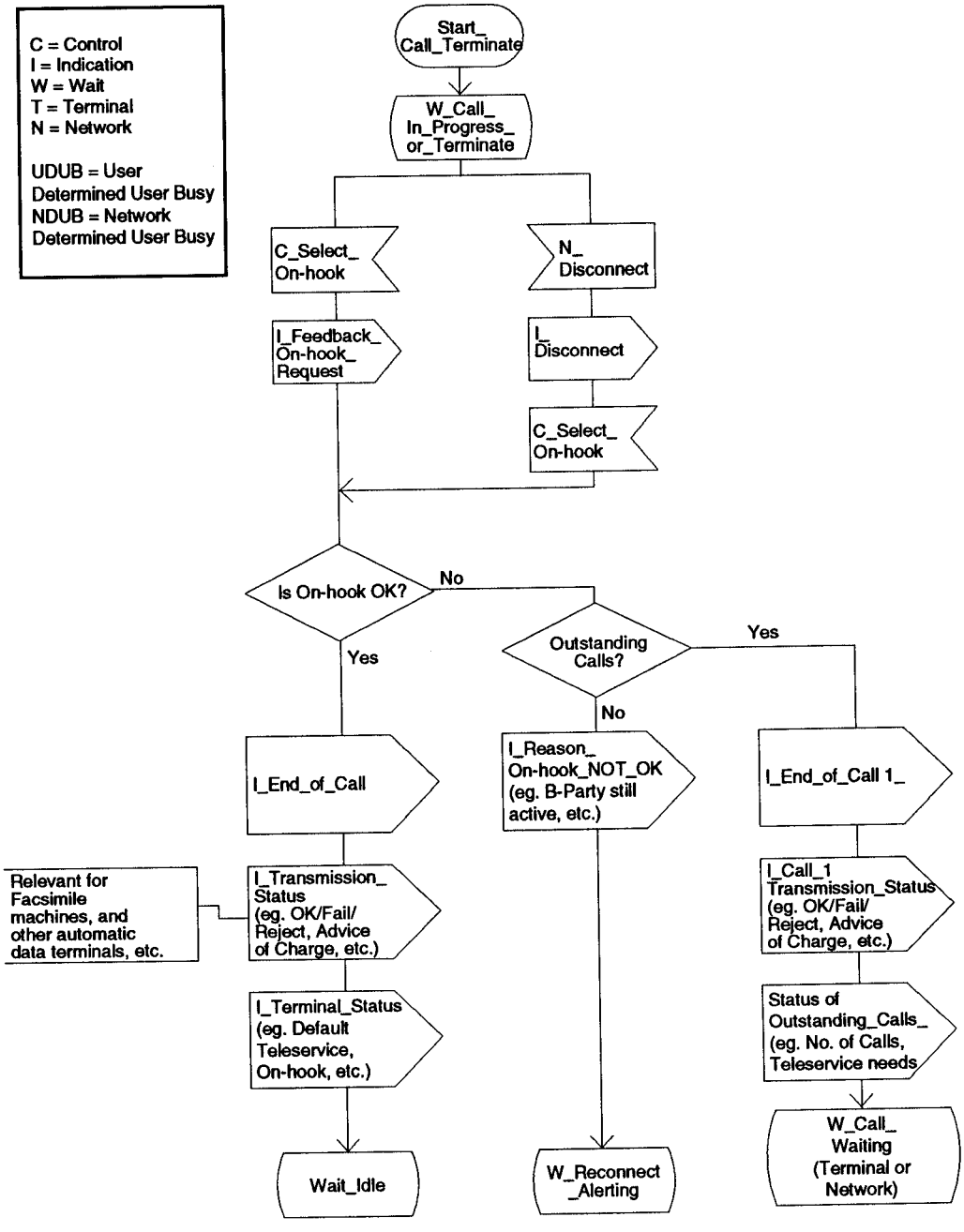



**Figure 34: Generic call terminate**

# Cameras

The lens, aperture, light sensitive surface and electronics to convert visual images or pictures into electronic format. It may be coupled to electronic circuits or codecs for conversion into standard digitized formats to enable transmission. The camera may capture still, slow scan or real-time live images.

## *Cross references:*

Analogue Controls; Data Transmission; Videotelephones

## *Recommendations:*

- provide any user controls for the camera in an accessible form. Comply with the users stereotypes for the direction of movements.

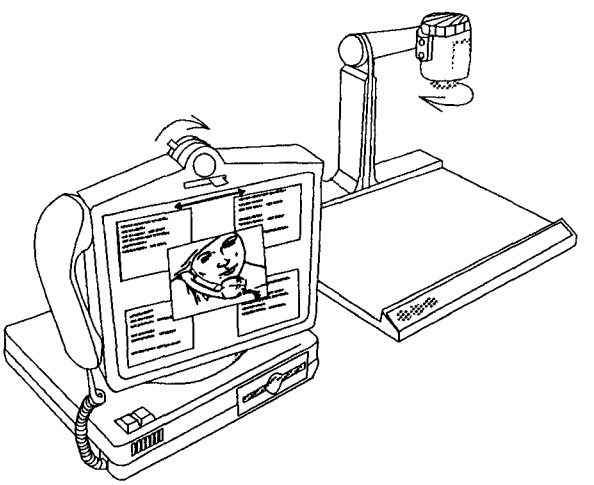


**Figure 35: Example camera controls**

- if multiple cameras are provided to work through the same interface, ensure there is clear visual indication at the control and on the camera to show which is currently live.
- cameras used for videotelephone applications should be positioned to provide a basic head and shoulders image. It is desirable for good face to face communications for the camera systems focal plane to be coincidental to the eyes on the imaged face. If parallax differences are unavoidable, ensure the camera's focal plane is situated centrally above the display, and the difference does not exceed 8° at the furthest point of the preferred viewing distance.
- provide cameras used for videotelephone applications with automatic iris control and automatic "white balance" adjustment. If additional manual control is also provided, ensure there is a clear quick control action that will return the camera to the pre-set default settings.

- for cameras used for videotelephone applications focus control, if provided, should be available from the normal viewing position.
  If automatic focusing is provided, then it should be activated for only one focusing action at a time. There should also be some indication to the user that the camera is auto-focusing and of the field of view it is using to focus.

### *Additional comments:*

There are few relevant guidelines in the available human factors literature relating to cameras, therefore it will be even more appropriate to test the system with representative users, before hardware design decisions are fixed.

# Card Readers

## *(Credit Cards, Identification Cards, Phone Cards, Smart-cards)*

An input device for accessing alphanumeric and/or coded data stored electronically in standard formats on or in plastic or paper-based cards, usually of credit card dimensions.

### *Cross references:*

Hand Sizes; Non-tactile Inputs; Tactile Displays.

### *Recommendations:*

- ensure the siting of card readers in public terminals takes account of wheelchair users and children.
- in preference allow users to retain hold of the card throughout the transaction exchange, particularly for high value credit or prepaid cards.
- for card readers that require a swipe action to enter the data consider the following user requirements:
  - horizontal swipes, available in either direction with either hand.
  - vertical swipes, ensure swipe is downwards and available to either hand.
  - provide space to access the swipe channel, and use guiding grooves or sculpting on the insert and retrieve ends of the channel.
  - ensure there is sufficient space for at least 95th percentile fingers to grip the card, when it is inserted for swiping.
  - ensure the channel edges are smooth and robust to withstand wear, and protect against skin or finger nail damage.
  - provide clear indication to show the required orientation of the card and the direction of travel, and test this with a representative sample of users.
  - ensure that the pull forces required to swipe the card are possible across 99% of the possible user population.

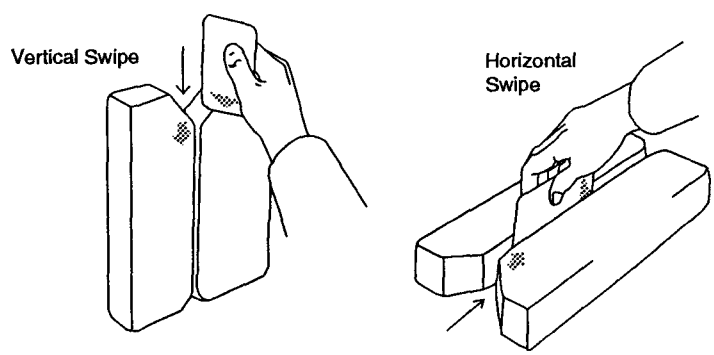



**Figure 36: Example of swipe card readers**

- for card readers that require an insert and retrieve action to enter the data consider the following user requirements:

  - in preference use card readers that accept cards with the short edge leading, it allows the user better grip with the card, and prevents accidental insertion with the wrong longer edge.
  - provide clear indication to show any required orientation of the card, and test this on a sample of representative users.
  - provide smooth sculpted grooves to aid correct insertion, and provide sufficient space for at least 95th percentile fingers to retrieve the card with an adequate finger grip on the card.
  - ensure that the push/pull forces required to insert and retrieve the card are less than 25N (based on 67% of 5th percentile male sustained thumb/finger grip - Mil Std 1472 C), such that they are possible across 99% of the possible user population.

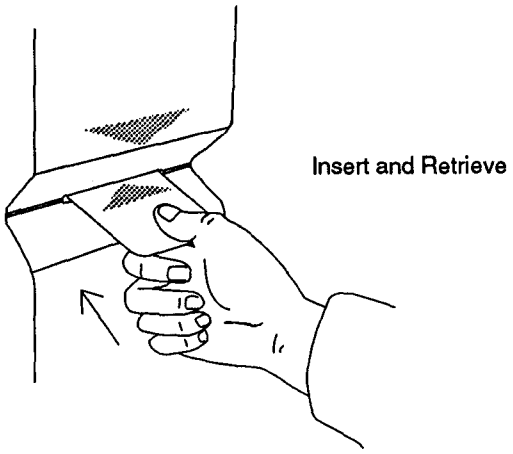



**Figure 37: Example of insert card readers**

## *Additional comments:*

None

# Casework

## *(Console, Equipment Practice, Housing, Product Semantics)*

The box or boxes that contain the electronics and/or mechanical components that constitute the product. The casework gives the product its distinctive shape and appearance. The casework provides an integral part of the user interface of the product, from the positioning of controls and displays (heights, angles, separation, etc.) to the presentation of on-product graphics (labels, user guidance), and the provisions to assist maintenance, ensure safety and minimize the effects of vandalism.

## *Cross references:*

Adjustability; Casework Colour; Connectors; CRT Displays; Character Displays; Handset; Handset Cradles; Hookswitch; Labels; Maintenance; Paper Handling; Portability; Safety; Surface Finish; Videotelephones

## *Recommendations:*

- the primary concern, in the design of the casework, should be for the users safety, and for the users functional requirements of the terminal, based on a thorough knowledge of the users tasks and capabilities.
- the secondary concern, should be for the requirements of people with special needs, as invariably this makes products more accessible to all users.
- the third concern is for general aesthetics, adjustability, portability, etc.

## *Additional comments:*

There is a general rule for most product design that the shape and appearance of the product should give good indications about both its purpose and the way the user is expected to operate it. This sometimes goes under the generic name of "Product Semantics", and it includes ideas like "Don't make a phone look like a can of Cola, and then expect people to be able to use it first time", or "If a door just needs to be pulled to open, use a handle which is obviously for pulling, don't use one which suggests the door needs unlatching or pushing". (Norman, 1988).

Form can be used to help identify the function of a new and unfamiliar product. There are opportunities to visually identify and clarify the purpose and operational procedure of a product by the sculptural elements of its shape:

- use integrated instructions which go beyond the application of symbols and labels.
- borrow descriptive functional details from diverse but well established intrinsic and learned functional stereotypes, to help instil a sense of familiar on the unfamiliar.
- work towards a catalogue of broad and unambiguous forms that would comfortably "migrate" across product ranges without losing their functional meaning, e.g. paper handling elements, like insert slots, for photocopiers

# Casework Colour

### *(Surface Colour)*

The colour of all external surfaces and controls that the user will see during their normal operation of the product.

### *Cross references:*

Casework; Surface Finish

### *Recommendations:*

- in general, avoid using highly saturated colours across the majority of the casework (Brigham, 1986).
- avoid using bright red and blue close together in an area of high visual work loads, these colours have slightly different focal lengths.
- avoid using very dark or very bright colours, keep the difference in average luminance between different visual task areas within a ratio of 10:1 (ISO DIS 9241 Part 3).
- if colour is used to code different areas of the casework, or controls etc., avoid using colours too close together in the visual spectrum. (Three subtle shades of a pastel colour may simply blur into one for many users) (Brigham, 1986).
- use matt rather than high gloss finishes that cause glare.

### *Additional comments:*

Colour and finish are typically highly subjective issues of aesthetics and fashion.

The human factors usual role is not to stipulate specific casework colours, or state which are best, but rather to point out some potential problems to be avoided. In general, where the casework is continually in the line of sight - as for example, with the casework surrounding a CRT screen, it is best to use light neutral colours which are restful to the eye. Very bright, saturated colours, and ones that clash can be both visually and psychologically disturbing. Bright colours can be used most effectively to provide highlighting, or when there is a need to attract attention as part of the task requirement e.g. to identify an emergency control, or emergency telephone.

# Character Displays

## *(Display Size, LCDs {Liquid Crystal Displays}, LEDs {Light Emitting Diodes}, Line Display, Small Display Panels, VFDs {Vacuum Fluorescent Displays})*

Single line and small panel displays typically from 1 to 8 lines by 24 characters are usually LCD, LED, VFD, or plasma displays. They may be used to provide numeric or alphanumeric outputs on a variety of products, from basic facsimile terminals to mobile and advanced feature telephones.

### *Cross references:*

Control Key Dialogues; Non-CRT Displays; Output Hardware; Screen Messages; Visual Displays

### *Recommendations:*

- there should be sufficient display space for the amount of information required and the demands of the task, as the size of the display may otherwise cause problems and constrain the dialogue design and the information presentation.
- specification of size and legibility of displayed characters should take account of the viewing distance. Recommended minimum character height is 2,9mm (ECMA-136). If the display is likely to be read at a distance greater than 500mm, character height should be increased.

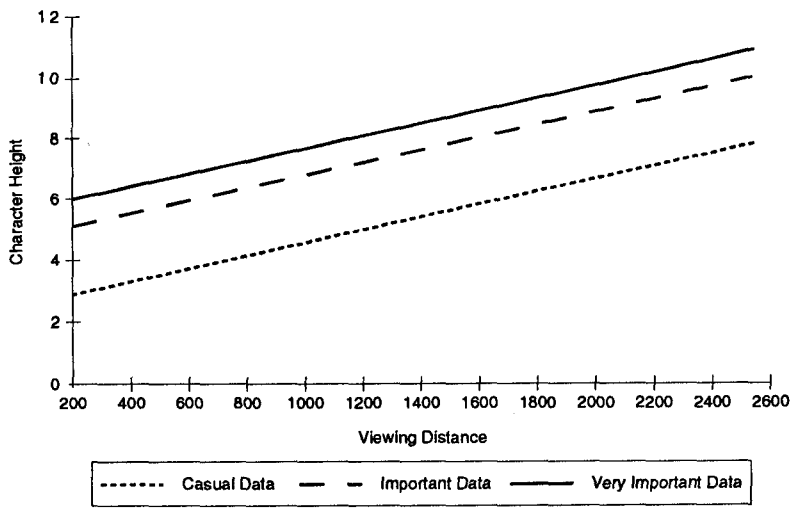



**Figure 38: Character height vs. viewing distance**

- the simplest 7 or 9 segment displays are acceptable for display of numeric information. They are not recommended for alpha information since legibility is severely compromised by the bit format, resulting in an unsatisfactory mix of upper and lower case letter shapes.

- use a dot matrix where alpha-numeric information is required. As a minimum, use matrix of 7 x 5 for capitals. Preferably use a matrix of 9 x 7 with additional dots, i.e. 14 x 7 to provide for ascenders and descenders of lower case letters, accents.
- characters should be clear and legible. Text should use lower case lettering, with capitals used for the beginning of sentences and in accordance with National language conventions.
- character/background contrast ratio should be 3:1 minimum (ECMA-136), 10:1 recommended. Character line thickness should be comparable to bold typeface.
- the display should be mounted in or on the product to allow for an optimum viewing angle of 90° to the plane of the display. On a desk mounted display a visual angle of 65° to the horizontal is preferred. This assumes that the user is sitting in a relaxed, slightly slumped posture. Allow for a hand-held device to be held in a similarly relaxed posture.
- protect from glare and reflections. Mounting the display with a glass or transparent cover at an angle of 750 helps to minimize reflected glare from overhead lights.
- where the message to be displayed is greater than the display space, provide scrolling, preferably under the user's control, and an indication that there is more information.
- if automatic scrolling is necessary, scroll line by line, or page by page, in preference to character by character. When providing automatic scrolling allow sufficient time for slow reading, e.g. minimum 3 seconds for 24 characters, 5 seconds for 40 characters.
- to gain attention flash only one character cell (e.g. an asterisk ✳), do not flash the whole display or message as this makes it difficult to read. Use a flash rate 1 second on, 0,5 second off, or for an urgent indication 0,25 second on, 0,25 second off. For urgent attention offer a complementary auditory signal.
- LEDs may become illegible in very bright conditions such as full sunlight, with green and yellow LEDs being worst affected. If necessary some form of shading should be provided.
- LCD displays may have a limited viewing angle, beyond which the display appears blank, or black. The screen needs to be positioned to take account of the known range of viewing angles, and provide for some level of adjustability. In low ambient light provide back-lighting to maintain contrast.

### *Additional comments:*

Character displays can improve the usability of a product by providing feedback and prompts to guide the user and support error recovery. The messages need to be clear, legible and concise. (See Screen Messages).

Studies have shown that the smaller the screen size, the greater the time the user may take to respond. Reading rates for 1 and 2 line displays can be slower than those for 20 line displays. The cut off point seems to be about 4 lines. Small screens may also necessitate greater use of abbreviations, or deeper menu hierarchies, both of which increase the time taken to interpret the display. For ISDN terminals, Bellcore® in the U.S.A., recommend screens larger than 2x40 characters, whenever feasible (Perris, 1993)

# Command Language Style

## *(Code Schemes, Command Strings, Stimulus Protocols)*

A Command Language requires the user to initiate and control procedures by entering a series of alphanumeric characters, to create command strings (groups of command language words). The software then executes the command, and may provide feedback on its execution. Typically command languages require very precise inputs, and provide minimum user prompts.

## *Cross references:*

Control Key Dialogues; Phone-based Interfaces; Supplementary Services; User Interface Design Principles

## *Recommendations:*

- command language styles are more suited for skilled and expert users, and preferably as a duplicate method of interaction.
- develop command names and mnemonics that are meaningful within the task, user experience or application.
- limit the use of numeric codes, using single digit access for the most frequently used commands or features.
- improve memory of numeric codes by arranging meaningful groups beginning with the same initial digit, for example, all call diversion codes could start with 5, and all mailbox entries begin with 6, followed by one more digit to allow up to 10 options, or (only if essential) two digits to allow for up to 100 options.
- offer user guidance in the form of on-line help, on-product graphics, prompt cards and reference documentation.

## *Additional comments:*

Command languages require the user to remember the commands and features. For highly skilled users this dialogue style is fast and powerful. Novice and casual users are at a disadvantage and need alternative support to develop a level of skill.

Studies show that users with a reasonable level of skill are usually only able to remember a small set of frequently used command names and numbers.

No one person should be expected to be an expert in all aspects of a complex user interface, and in practice they may prefer to swap between interaction styles depending on their familiarity with the task and the procedures necessary at any point in the interaction.

See also: ISO DIS 9241 Part 15 and Smith and Mosier (1986) for more information on the design of command languages.

# Communication and Transmission

## *(Bearer Services, Teleservices)*

The technical facility to transmit and receive voice, data, pictures and images between terminals across the ISDN, PSTN or other networks.

## *Cross references:*

Call Handling; Data Transmission; Facsimile Machine; Security; Supplementary Services; Voice Transmission

## *Recommendations:*

- maximize the quality of all transmissions, commensurate with human perceptual limitations.
- aim to provide all transmissions within "real" time, i.e. minimize transmission delays which interfere with "natural" communication.
- provide feedback on the reasons, time to correct, and other alternatives for breakdowns in transmission, or network failures and errors.

## *Additional comments:*

The purpose of ISDN and the associated terminals, products and applications is to allow people to communicate with each other by voice, data and images. Each media may be used independently, but increasingly it is expected that users will want to take advantage of the richness of integrated multimedia communication sessions, e.g. videotelephony, or integrated voice and dynamic images. ISDN will also enable users to explore a vast range of supplementary, local and remote, services and applications.

The recommendations given in the cross referenced entries aim to:

- ensure current communication and transmission quality standards for voice, data and images or pictures are maintained and improved upon.
- give an acceptable minimum standard of procedural compatibility to allow users to set up and release calls with minimal training, irrespective of the media of communication.
- encourage optimal (user-task related) new developments, including video-conferencing, and multimedia terminals.
- improve the acceptance and usability of supplementary, local and remote services and applications.

# Connectors

## *(Plugs, Sockets, Equipment Practice)*

The plugs and sockets that enable sub-units and modules to be connected to provide full operation of the terminals in all their variants.

## *Cross references*

Cables, Casework

## *Recommendations:*

- fixed terminals should be able to be fully operational with no more than two connections to external services; one to the network and one, if required, to a power source, unless this recommendation will compromise electrical or network safety standards.
- the user must always be given adequate protection against electrical voltages. The live part of a coupling should always be the socket. In general, connector contacts which cannot be touched with the test probe (CENELEC EN 41003) may be electrically live. Exposed plug terminals should always be electrically neutral until connected.

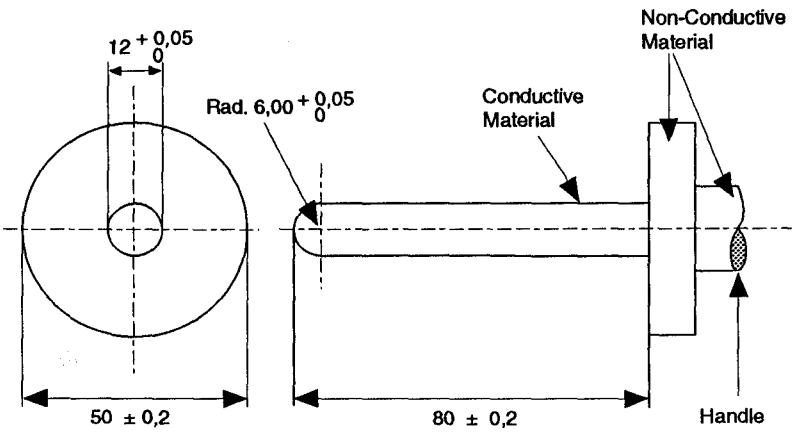



**Figure 39: CENELEC EN 41003 recommended test probe**

- the plug or socket shall be provided with aligning pins or equivalent devices to aid in correct alignment and to prevent insertions in other than the correct position. Any alignment pins shall extend beyond the plugs electrical pins to ensure that alignment is correct before electrical connection is made (Mil-Std-1472C).
- all plugs should be capable of connection and disconnection without the need for special tools, unless the connection should only be available to specified maintenance personnel.

- for all critical connections it ought to be impossible to connect a plug and socket incorrectly, indeed, it is good practice for all connections. Within a terminal with several connectors it should be impossible to connect the wrong plug and socket together, or to interconnect two modules the wrong way. (DOI, 1977).
- use connectors that enable a good finger/thumb grip for connection/ disconnection forces of 25N (67% of 5th percentile male sustained thumb/finger grip strength - Mil Std 1472 C); or good finger wrap grip if these forces are exceeded.
- ensure the connector area provides enough space so that 95th percentile males can grasp each connector firmly for connecting and disconnecting. Space between adjacent connectors or any adjacent obstruction shall be compatible with the size and shape of the plug and the necessary handling configuration. As guidance, the space around any plug should not be less than 25mm (See figure 39), except where connectors can be removed in sequence, then the space can be restricted to 25mm around 270° of the surround. (Mil-Std-1472C).

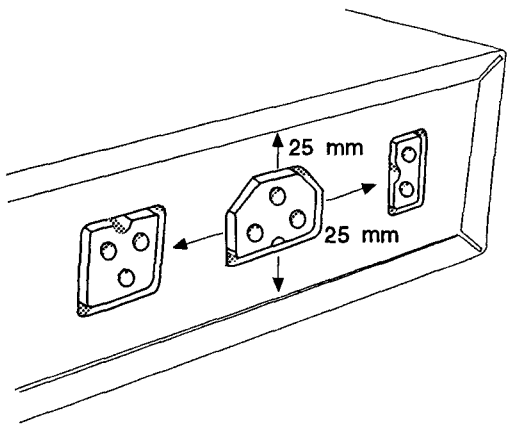



**Figure 40: Recommended connector space**

- in general, bayonet or clip type locking plugs are preferred to captive screw or screw thread types that require a tool or precise manipulation.
- it is a good practice to label plugs and their corresponding sockets (with text or recognizable symbols) and to co-ordinate the labelling to assist users in matching the required connections.
- where sub-assemblies have to be removed for maintenance or exchange, these should plug in and not require hard wiring.

## *Additional comments:*

There is an obvious opportunity to use shape and feel in connector design to differentiate between different plugs and their connectors. This becomes particularly important in the inter-connectability of different modules in a multimedia terminal, or in exchange modules for people with special needs.

# Consistency

Consistency within the way a terminal operates allows the users to improve their skills and predict the effects of their actions.

### *Cross references:*

User Interface Design Principles

### *Recommendations:*

- consistency of language should be applied so that the terms or labels used on the display, keyboard or control panel and any documentation are the same.

  *Example:*
  A key labelled CANCEL (or DELETE, or CLEAR, etc.) may be used to undo the last action. Whichever the choice always use the same word (in this example CANCEL) whenever it is referred to throughout the dialogue and the supporting documentation. Avoid introducing synonyms, such as clear, undo, erase, etc.

- consistency of effect should be applied so that the user perceives an action as having the same outcome regardless of mode or level within the system.

  *Example:*
  A simple way of switching a feature on and off is to press the feature key. The user may predict that this simple strategy applies to all feature keys and will make errors if sometimes two presses of one key leads to a different feature, or that one feature has to be cancelled with the cancel key.

- apply a consistent syntax and logic to procedures and sequences so that frequent users of the system can develop their skill and speed.

  *Example:*
  LOG ON can be consistently "User-Name, Password, Enter";
  HELP can be consistently available via the function key "F1";
  COMMANDS can be written "Verb, Separator, Noun 1, Separator, Noun 2", etc.

- structure the visual display layout so that the user can predict where to find required information.

  *Example:*
  Top Line - Screen title, application and file names.
  Second Line - Pull down menu bar.
  Bottom Line - Status information and low level messages.

### *Additional comments:*

Most people have a well developed skill in detecting patterns and developing hypotheses and rules about how things behave. Consistency within the design exploits this human capability and allows the users to improve their performance and minimize errors. Inconsistencies which break the overall pattern are a source of error which can lead to frustration, loss of confidence and rejection of the system.

Terminal designers should also be aware that there can be a trade-off between consistency and other user interface principles, like customization, flexibility, etc. For example, one consistency rule could suggest that a menu always has the same default item highlighted; whereas a contrary consistency or flexibility rule might suggest the highlight is always on the most recently selected item, as that may be the most likely next selection. The existence of such trade-offs makes the requirement for a thorough understanding of the user's tasks much more important, the provision of easy to modify software prudent and the need of usability trials essential (Grundin, 1989).

# Control Key Dialogues

## *(Programmable Keys, Soft-keys)*

Control key dialogues are interactions which are based on dedicated or programmable function keys. The feature or facility assigned to a function key may be fixed by the hardware design (e.g. Handsfree key), determined by the dedicated software and the current position in the dialogue (e.g. Soft-keys) or determined by the application software currently running on the terminal (e.g. PC Function keys).

## *Cross references:*

Dialogue Style; Function Keys; Keyboards; Labels; User Interface Design Principles

## *Recommendations:*

- use dedicated control keys to support casual and novice users.
- select meaningful labels and avoid abbreviations.
- group keys by task function, task sequence, frequency of use or importance (See Function Keys).
- use soft key dialogues to reduce the numbers of function keys, when the functions available depend on the current state of the dialogue, or to enable a number of menu choices to be offered on a small display.

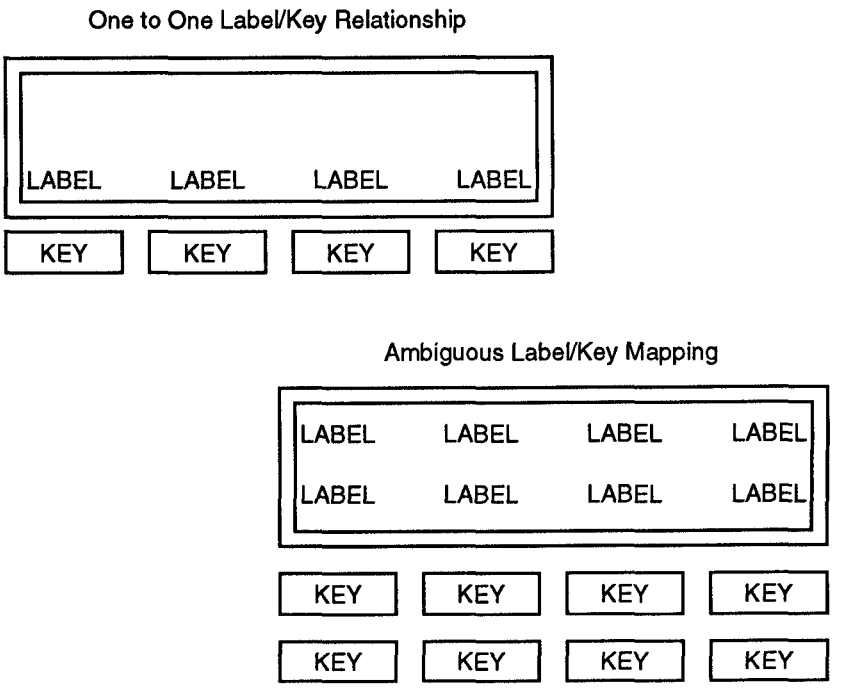



**Figure 41: Example of soft key arrangements**

- when soft-keys are used ensure there is a close one to one spatial relationship between each key and its displayed label. The best relationship is where the key and displayed label occupy the same space, e.g. transparent membrane overlay.
- use clear, obvious mappings, e.g. three keys underneath three labels. Avoid ambiguous mappings, e.g. 2 rows of 4 labels and 2 rows of 4 keys underneath display, (the user is confused about the control/display relationship, proximity vs. layout map).
- if the number of soft-keys is greater than 5 in any row or column, consider grouping the keys (and labels) into 2 or more groups (in the same row or column) to help the user see which label goes with each key.
- ensure soft key labels are as physically close to the key as possible (Character Displays), use graphic techniques to confirm a label relates to a specific key (Screen Formats).
- provide full word labels (or symbols). If abbreviation is necessary, use a consistent rule for creating all the abbreviations and provide a printed key in the user documentation.
- ensure a minimum separation of one character space (horizontal) or one row (vertical) between adjacent soft key labels on Character displays.
- when soft-keys access menus, ensure the menu hierarchy is shallow, not more than three levels (preferred), unless an audit trail or some other technique is available to help the user's navigation.
- keep the number of items in a soft key menu equal to the number of keys, avoid having more menu items at the same level.
- provide a facility for the user to return quickly to the top level (or another anchor point) from any point in a soft key menu hierarchy.

## *Additional comments:*

Dedicated control keys give users a clear visual reminder of the features, but too many can become confusing. See Smith and Mosier (1986) for more detailed recommendations on control key dialogues.

There is some evidence (Damay and Poulain, 1985) that a soft key dialogue has a higher usability than a fixed function key dialogue. However, it also depends on other factors within the overall dialogue design, e.g. quality of prompts and feedback, comprehension of key labels, complexity of dialogue etc. Simple analysis demonstrates the savings in terms of numbers of keystrokes, and the reduction on memory load when a user is only presented with valid choices.

# CRT Displays

***(Display (Brightness, Colour, Contrast), European Directives, Full Dot Matrix Displays, Legibility, Repetitive Strain Injury (RSI), VDUs, Visual Display Units)***

The CRT display continues to be the most popular large display medium for high resolution needs. It can be used to display text, graphics and still and moving pictures in either monochrome or full colour.

## *Cross reference:*

Adjustability; Character Displays; Graphic Displays; Non-CRT Displays; Safety; Visual Displays

## *Recommendations:*

- text and graphic CRT displays that are intended for frequent communications, transaction handling or data entry should meet the requirements of the European Directive 90/270 EEC, ISO DIS 9241 Parts 3, 7 & 8, ECMA-110 and ECMA-126. Display screens intended for other purposes are not subject to such stringent requirements, however, it is a matter of good design practice. The key points are:
  - the screen should be free of noticeable flicker.
  - the screen should offer positive contrast (dark characters on a light background) with a refresh rate preferably between 70 - 80Hz.
  - contrast and brightness should be adjustable by the user.
  - the characters should appear clear and sharp in all parts of the screen, including the corners and edges, as well as the centre.
  - the characters should be well defined and easily distinguishable.
  - character height, for a capital letter may be calculated as subtending 20 - 22 minutes of arc at the required reading distance. Some sources suggest that for a typical reading distance to a CRT display of 400 - 600mm, the letter height should be a minimum of 2,9mm, with one source suggesting an optimum range of 3,8 - 4,5mm. This larger character size benefits the young and old and also improves legibility of the less high quality screens.
  - character width should be 50 - 80% of character height, and stroke width should be 8 - 20% of character height. Within dot matrix screens the required minimum character cell for a capital "M" is 7 x 5 dots (DIN 66 234 Part 1), however, the preferred minimum is a 9 x 7 dot cell.
  - text lines should be separated so that there is at least a 1 stroke width separation between the top of diacritical marks (accents) on upper case letters (e.g. the top of the umlaut on "ä") and the bottom of descenders (e.g. the downward stroke of "g"). Increased separation improves reading speed. Based on the preferred minimum dot matrix cell of 9 x 7 for the capital "M", the preferred full cell size including diacritical marks is 14 x 7, with a 1 dot text line separation.

**Table 11: Character size and viewing distance (BS 7179 Part 3)**

| Character size | Preferred viewing distance (20' to 22' of arc) | Minimum acceptable viewing distance (16' of arc) |
|---|---|---|
| mm | mm | mm |
| 2,4 | 375-413 | 516 |
| 2,6 | 406-447 | 559 |
| 2,8 | 438-481 | 602 |
| 3,0 | 469-516 | 645 |
| 3,2 | 500-550 | 688 |
| 3,4 | 532-585 | 731 |
| 3,6 | 563-619 | 774 |
| 3,8 | 594-654 | 817 |
| 4,0 | 625-688 | 860 |
| 4,2 | 657-722 | 903 |
| 4,4 | 688-757 | 946 |
| 4,6 | 719-791 | 989 |
| 4,8 | 750-825 | 1032 |
| 5,0 | 782-860 | 1075 |

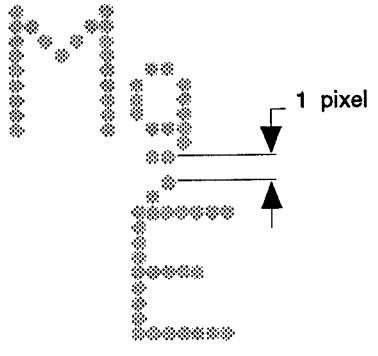



**Figure 42: Preferred full size character cell**

- the screen should be free of glare and reflections.
- speed of the screen update should be fast enough to avoid ghosting as text fades and if required, to support rapid changes as part of the interface design.
- the user should be able to swivel and tilt the screen to adjust the angle of view, to avoid reflections (See Adjustability).
- if the screen is to be used with a keyboard, the screen and the keyboard should be separable.
- the controls provided to switch on the screen and adjust the display attributes should be available from the front of the screen.

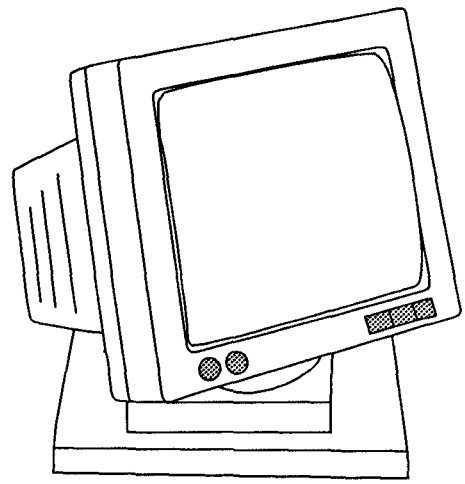


**Figure 43: Example of CRT with front controls**

### *Additional comments:*

The European Community Council Directive 90/270 EEC on "Minimum safety and health requirements for work with display screen equipment" is one response to a growing concern with Repetitive Strain Injuries (RSI) potentially related to working with VDUs. The directive requires that work stations first put into service after 31st December 1992 must meet the minimum requirements of the technical annex. For work stations already in use, compliance must be achieved within four years, i.e. by 31st December 1996.

The requirements for display layouts are covered in the recommendations for Screen Formatting and Screen Messages, and under the different Dialogue Styles. See also: Travis (1991) for general information on electronic displays: Biberman (1973) for aspects on perception of displayed images; ISO DIS 9241 Part 7 for guidance related to reflections; and ISO DIS 9241 Part 8, IBM (1991a & b), BT (1991), Matthews (1987) and Brigham (1986) for help on the use of displayed colours.

# Cursor Keys

## *(Arrow Keys)*

The simplest pointing device, with four keys representing the standard directions of up, down, left, right; usually used to control screen based cursors or pointers.

## *Cross references:*

Function Keys; Joystick; Light Pens; Mouse; Pointing Devices

## *Recommendations:*

- provide cursor keys as basic cursor controls to supplement any other chosen device used with the system, unless space specifically precludes it.
- choose a layout of keys which complements the users expectations for the relative positions of the four directional keys, i.e. up above down, left to left of right. Use the standard inverted T or cruciform layouts. (See figure 44) (ISO/IEC DIS 9995).

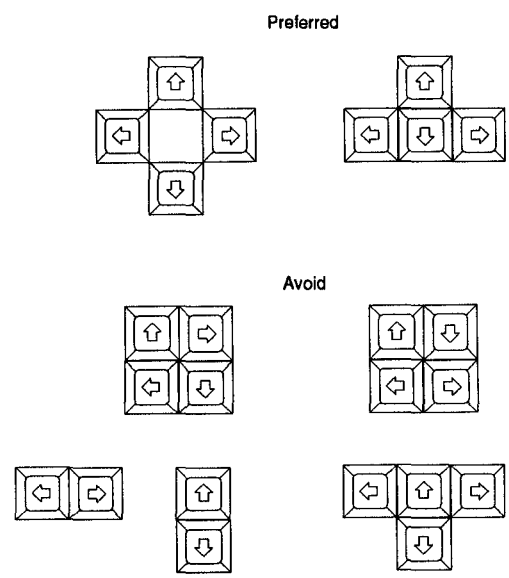



**Figure 44: Example cursor key arrangements**

- label the keys with arrow symbols which clearly indicate the direction of operation (ISO/IEC DIS 9995, defines the symbols).
- use the same minimum dimensions for the cursor keys as for the rest of the keys on the keyboard i.e. minimum key cap area 113mm$^2$, minimum dimension 12mm, minimum centre to centre spacing 19mm, minimum key clearance 9mm radius, travel 1,8mm, force 0,25-1,5N.
- the basic four cursor keys may be supported with two more keys, frequently labelled Home (move cursor to top left position of document, data-block or screen) and End (move cursor to bottom right position of document, data-block or screen). (ISO/IEC DIS 9995).
- use only to move pointers or cursors across a regular grid. Avoid using for full two dimensional movements.
- do not use for drawing on the screen, except perhaps for rectilinear objects.

### *Additional comments:*

None

# Data Glove

A recently introduced device for pointing, gesturing and manipulating software objects by means of the user inserting a hand into a glove fitted with sensors to digitize manipulative movements in three dimensions.

## *Cross references*

Pointing Devices

## *Recommendations:*

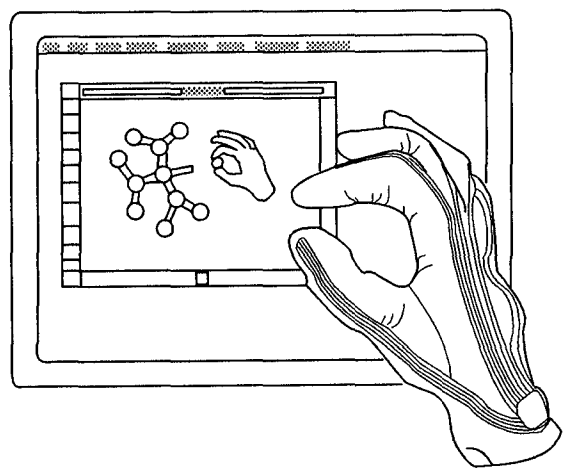


**Figure 45: Example data glove (after Helander, 1988)**

Recommendations and ergonomic guidelines are not available at present.

## *Additional comments:*

The use of Data Gloves is currently being explored in experiments with virtual reality.

As the only pointing device currently offering three dimensional control, it may be particularly interesting for Computer Assisted Design (CAD) applications, on multimedia terminals.

# Data Transmission

## *(Modems)*

Data transmission is the transfer of digital information across the network from terminal to terminal. It includes document file transfers (Modem, Fax, Telex, Teletex), interactive working (remote access to terminals or databases), data element of voice plus data (electronic shopping), and accessing bulletin boards.

## *Cross references:*

Communication and Transmission; Security; Voice Transmission

## *Recommendations:*

- call handling procedures for data transmission, e.g. electronic mail systems, should have message addressing which is flexible, and allows full user control; including allowing for single and multiple addressing, use of distribution lists, and reply to message received.
- within data transmission dialogues try to minimize user's memory load and shorten procedures. Providing standardized forms, pre-formatted letters, automatic address headers may be helpful.
- initiating transmissions - as far as possible the technical details of communication protocols, computer handshaking, data format conversion etc. should be handled automatically by the terminal.
- user's should have flexibility to select user initiated and computer initiated transmission, with queuing and queue priority.
- the terminal and network should provide feedback of success or failure of data transmission, and provide for record keeping of data transferred.
- during interactive live data transfers user's should receive immediate feedback of own control input or keystrokes, and feedback messages where unavoidable transmission delays occur.

## *Additional comments:*

CCITT identifies the following types of services that might be offered using broadband ISDN (CCITT Recommendation I.121):

- interactive high speed data transmission, during which two or more users can exchange information.
- messaging using a message service to store and forward data and images on demand.
- retrieval where users can demand information from an information centre or large data base.
- non-interactive distribution where information is distributed or broadcast from a central source for example, a broadband videotex.

Special consideration is needed of the user requirements for each of these services. In each case the needs and demands of the user will be largely specific to the application.

The more general requirements are:

- that the services should be easy to use with minimal training. This means that where possible the set up, control and terminate procedures should be compatible with other similar systems.
- that the system should be able to guide the user through the procedures keeping the number of keystrokes and memory load to a minimum. This means that additional signalling protocols may need to be defined between the terminal and the network to allow for additional user information.
- that the system should be tolerant of errors and aid error recovery.

# Dialling

The action of inputting the target address to the network of a known terminal to establish the wanted connection. It may be completed by keypad, using single digit-by-digit entry, or short code entry, from an auto-dialler, from an electronic directory.

### *Cross references:*

Addresses; Call Handling; Telephone Keypads

### *Recommendations:*

- ensure that all terminals intended for connection to the fixed telecommunications network fully support "overlap" dialling, i.e. where after going off-hook the user inputs the address digit by digit.
- in general, all terminals should also fully support the "en bloc" form of dialling, where the user inputs the address, and can edit it, before going off-hook. There is a minimum requirement for a small numeric display and a control to delete the last digit.

### *Additional comments:*

In general, people have a limited ability to remember long numeric strings. It is desirable to reduce memory load, for example, by offering abbreviated dialling, or directory facilities to store frequently used addresses.

Error rates when entering long strings of alphanumeric characters may be high, and it is helpful to provide visual feedback and to allow simple error correction.

# Dialogue Style

## *(User Interface Style)*

Dialogue style applies to the overall character of the interaction between the user and the system including who has the initiative and how much support the system gives to the user, and how much power the user has over the system.

## *Cross references:*

Auditory Menus; Command Language Style; Control Key Dialogues; Graphical User Interface; Menu Dialogues; Phone Based Interface; Usability; User Interface Design Principles

## *Recommendations:*

- use a computer initiated style, using prompts, and menus to guide unskilled users through simple tasks.

  *Examples:*
  - automated bank terminals guiding the user through the necessary procedures to achieve a limited range of tasks such as withdrawing money, checking a balance or requesting a bank statement.
  - re-routeing a call on a digital exchange with a synthetic speech output directing the user procedures.
- use hierarchical menu structure to guide users through more complex tasks.
- consider auditory dialogues to support users where input and output devices are limited.
- for skilled users of more complex tasks provide short cuts and more powerful command entries.
- consider mixed dialogues including form filling, graphic, object manipulation and animation to support users controlling more complex tasks with multi-function or multimedia terminals.

## *Additional comments:*

The dialogue style selected needs to take account of the user's level of skill, frequency of use and complexity of the tasks.

For many telephony tasks there is a demand to be able to utilize a standard telephone with a 12 key interface and no visual display. The use of coded numeric entries can result in a simple command language, but offers limited opportunity for user guidance, feedback and error handling. Auditory feedback (i.e. speech output, or acoustic tones) may help to compensate for some of these difficulties, but it is strongly recommended that a visual display is used to provide feedback for more complex tasks.

A summary of the advantages and disadvantages of different dialogue styles is shown in table 12.

**Table 12 - Dialogue style: summary of advantages and disadvantages**

| Dialogue Style | Advantages | Disadvantages |
|---|---|---|
| Phone based interface (12 key entry) | flexible, requires absolute minimum terminal<br>universal device | lacks user prompts<br>requires memorization or documentation<br>poor error handling<br>multiple key strokes<br>limited feedback available |
| Control key dialogue (function or soft-keys) | acts as prompt<br>reduces key strokes<br>easy to learn<br>direct control | increases number of keys<br>increased size of device<br>soft-keys require display |
| Menu Dialogues | improved learning<br>reduces key strokes<br>reduces memory load<br>structured decisions<br>error recovery | length of hierarchy<br>slow for frequent users<br>requires auditory or visual display<br>consumes display space or loads user memory<br>requires system responses in real-time |
| Graphical User Interface | visualization of task<br>easy to learn<br>easy to retain<br>low memory load<br>errors can be avoided<br>encourages exploration<br>user satisfaction | more difficult to program<br>requires graphical display<br>requires pointing device<br>requires real-time system responses |

See also: ISO DIS 9241 Parts 10, 14, 15, 16, 17 and 18, Shneiderman (1987) and Smith and Mosier (1986) for more general information relating to dialogue styles. See van Hardeveld and Mierop (1988), Noé (1988), Neumeier (1990), Marion (1985) and Deffner and Melder (1990) for more specific information on dialogue styles for ISDN terminals, principally multifunction telephones.

# Error Management

## *(Accidental operation, Mistakes, Undo)*

Making errors is a part of the natural learning process and also the result of breakdowns in skilled performance. Users will make mistakes. To be helpful, the user interface and system design needs to ensure the impact of user errors is minimized and where possible recoverable.

## *Cross references:*

Evaluation; Help; User Guidance; User Interface Design Principles; Security

## *Recommendations:*

- use error messages which do not blame the user, and which prompt the user on the correct action or choices.
- when exiting or recovering from an error, put the user back where the error was committed, particularly if they were part way through a procedure.
- the system should be designed to be error tolerant, protect from serious consequences and allow easy recovery.
- provide a simple error recovery, for example, delete last key stroke to correct minor keying errors.
- minimize the number of keystrokes in order to reduce keying errors.
- provide visual or auditory feedback to allow users the opportunity to review entries.
- users should be able to review and correct speech input entries.
- with complex systems allow for at least one level of undo last command
- with complex systems allow the user a quick escape route back to a recognizable point such as an opening menu, or current active work area.
- design the system to protect the user from the consequences of errors or forgetfulness.

  *Examples:*
  - make it difficult for a user to accidentally delete the contents of a personal telephone directory.
  - remind the user of a call left on hold.
- provide context sensitive error messages or help which will allow the user to recover from, or overcome, the source of the error.

  *Example:*
  - "the number you have dialled is temporarily unavailable, please try again later".

### *Additional comments:*

The normal breakdown of human behaviour is sometimes quoted as one in one hundred, which is greatly in excess of the accepted engineering breakdown tolerances that may be as low as one in one million operations. Design ought to allow for, and minimize, the impact of human errors and encourage rapid recovery.

One of the main differences between skilled behaviour and novice behaviour is not so much in the number of mistakes made, but in the amount of time the novice spends trying to recover from mistakes. A novice may reject a system as too difficult if he or she is unable to recover from their first few minor errors.

# Evaluation

## *(Product Testing, Prototype Testing, Quality Testing, User Trials)*

Evaluation, in human factors terms, is a process for gathering information about how users will perceive and use a product or system.

## *Cross references:*

Usability; User Interface Design Principles

## *Recommendations:*

- during early design stages compare product concepts, user interface prototypes and draft user guidance materials against predetermined usability criteria to avoid costly mistakes. (See subclause 2.2 Why Human Factors?).
- include evaluation against usability criteria as part of the design decision making.
- ensure all trials are conducted with a representative sample of users, including people with special needs. Ensure that the representative sample does not include any persons with overt connections with the development under review.
- at the prototype stage compare preferred design and design alternatives, for rate of errors, speed of performance, time to learn and subjective preferences against the predetermined usability criteria.
- modify the design to optimize the performance of the target user group on the product or system.

## *Additional comments:*

Evaluation is an essential element of user-centred design. By involving potential users in the design process to test out parts of the system and prototypes it is possible to highlight areas of difficulties and to improve the design details. (Herring, 1993).

Usability can be evaluated by two different approaches:

1 The Analytical Checklist Approach.

A usability checklist is based on accepted design rules and standards, which represent a set of requirements for the usability components identified. Checklists may be assembled from the information contained in this ETR. An example checklist prepared for ordinary telephone terminals has been published by ETSI (ETSI ETR 051 "Usability Checklist for Telephones"). The Functionality Matrix described in subclause 3.4.5 "The Impact of Task Analysis" is another form of evaluation checklist.

2 The Usability Testing Approach.

Usability tests can measure both user performance (time, errors, learnability, etc.) and user preference (satisfaction, acceptability, aesthetic appeal, etc.). The evaluation can be related to absolute criteria (e.g. time to complete a task, percentage and type of errors per task, or specified ranking on a standard satisfaction inventory) or alternatively, it can be comparative (users perform better and prefer the new prototype to the old system, or people make less errors on product A than on product B). Usability tests require a sample of users to perform a sample of tasks on the product or system, and for a variety of measures to be taken and analysed. Obtaining reliable data from experiments involving people is not a simple task, without due care and attention to correct procedures the experimenter/data collector can significantly effect the results. ITU-T and ETSI have both published guidance for the usability evaluation of telecommunication systems and services (ITU-T Recommendation F.901 and ETSI ETR 095).

# Eye/Head Movement

An input method where the movements of the eyes and/or head are detected and digitized for relating the current cursor position relative to the corresponding eye/head movement.

### *Cross references:*

Pointing Devices

### *Recommendations:*

- Can be useful for item selection and tracking, particularly when the hands are fully occupied. Use only for selecting and tracking relatively large objects, as natural involuntary movements of the eyes will make fine control very difficult. (Helander, 1988).
- Lightweight head movement tracking devices are available which are usually combined with a blow switch, specifically for people with special needs. The control display ratio which controls the rate of cursor movement relative to any head movement can usually be configured for the user.

### *Additional comments:*

Eye movement monitoring usually requires special head mounted equipment to detect the small changes in position. Corneal reflection and electro-oculography are typical sensor techniques. Both require expert assistance for implementation.

# Facsimile Machine

## *(Fax Terminals)*

Transfer of digitized image between two machines to a standard format, e.g. CCITT Group 3 and Group 4. In the majority of cases this is done from paper to paper, however, systems and products are emerging that allow software file copies to be transferred in fax format, and for transmitted faxes to be received and stored as software image files.

## *Cross references:*

Call Handling; Casework; Cables; Connectors; Input Hardware; Output Hardware; Paper Handling

## *Recommendations:*

- make use of the available recommendations given in the guidelines subclauses cross referenced above, and consider the human factors issues raised in subclause 4.3.

## *Additional comments:*

There are no specific human factors recommendations in the available literature with respect to the design of facsimile equipment. It will, therefore, be appropriate for any new terminal design to be tested against expected usability criteria.

In general, as users are less familiar with Fax operation than they are with normal call handling it is helpful to conform, as far as possible, to basic call handling stereotypes. (See Call Handling). Novice and casual users may need guidance on the product to solve such simple problems as which way up to place the original copy. Use a display to confirm control actions, and to give prompts and guidance.

# Feedback

## *(Indications)*

A response from the system to the user acknowledging that an action, or activity is taking place, or has failed.

## *Cross references:*

Acoustic Signals; Optical Signals; Response Times; Speech Output; User Interface Design Principles

## *Recommendations:*

- feedback should always be given in response to all user actions. Feedback needs to be considered at two levels:
  1 on the controls correct or incorrect activation, e.g. tactile feedback to a key press, pointer movement to a mouse movement, etc.
  2 on the terminal's, network's or system's response to the control input, e.g. the display of a character, menu or dialogue box, the sounding of an acoustic signal, etc.
- feedback may be positive, e.g. progress statements or "action complete"; or negative, e.g. error messages. In general people are thought to learn better from positive feedback.
- feedback is important to let the user know the system/terminal status. It is essential as an aid to learning and should always be immediate, but especially so in the case of errors and faults.
- feedback should always be consistent and tested to ensure conformity to user stereotypes.
- in general, essential feedback should not be restricted to one medium (visual, auditory, tactile). Duplication across different media should be available to support people with special needs, e.g. network activity, such as call progress, has been signalled by audible tones, but they may also be augmented by lamps or display messages in text or pictogram form. Spoken messages may be used as an extension of audible tones.

## *Additional comments:*

Feedback is an essential element of good interface design practice. It raises confidence in using the equipment, helps users to overcome errors and reduces learning time.

# Flexibility

Flexibility within the dialogue design accommodates different methods for achieving the same objective, and allows the user to apply different methods as their skill and experience develops.

## *Cross references:*

National Variations; Usability; User Interface Design Principles

## *Recommendations:*

- flexibility should be permitted to accommodate differing user expectations and preferences at the simplest level.

  *Example:*
  the date could be accepted in any familiar form: 24.02.1992
  24/2/1992
  24 February 1992

- consider permitting alternative control or command sequences to protect users from unnecessary pseudo errors, or to improve compatibility with other similar systems.

  *Example:*
  with a credit card payphone, permit the sequence of inserting the card before or after lifting the handset.

- where a system may be used by skilled users, offer short cuts, more powerful command sequences, or codes that allow for quicker or more efficient operation.

  *Example:*
  allowing a user to enter a short command rather than wait for a menu to be displayed visually or presented as speech output.

## *Additional comments:*

Flexibility within the design helps to protect novice users from frustrating minor errors that can arise as a result of breaking minor design rules.

Novice users may, however, be confused if too many choices are offered too early when they have no knowledge of how to choose between a number of options. Early design testing can help to indicate the point of balance between too much and too little flexibility.

Establish acceptable default values that can be easily personalized or returned to the default value as preferred e.g. page sizes, colour codes, or address labels.

# Foot Mouse

An input device where the foot is used to control a cursor. Typically consists of a metal pedal with a circular rubberized surface which pivots. Pressing the pedal at the top, bottom, left or right edge moves the cursor in the corresponding direction.

## *Cross references:*

Pointing Devices

## *Recommendations:*

- Recommendations on the optimum dimensions, force travel characteristics etc. are not available from the literature.

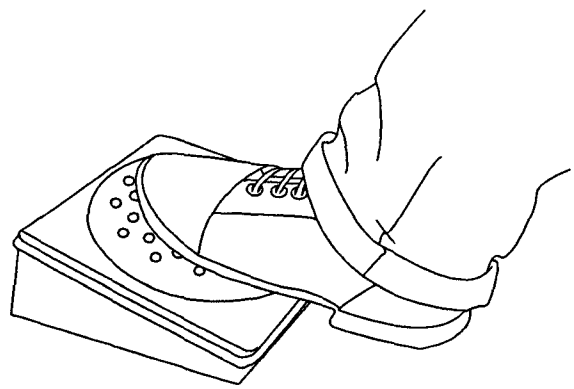


**Figure 46: Example foot mouse (after Helander, 1988)**

## *Additional comments:*

Available for rapid course control of the cursor by holding the pedal down. Some fine control, single point movements are also possible. May be useful in some applications for people with special needs.

# Function Keys

## *(Programmable Keys, Soft-keys)*

Keys dedicated to the direct select of commands and features. The named function or feature may be assigned by the hardware design. Where the function of the key is indicated by a visual display, according to the current dialogue state, these are termed soft-keys.

## *Cross references:*

Control Key Dialogues; Dialogue Style; Keys; Keyboards

## *Recommendations:*

- use named function keys to give rapid implementation of simple actions, and for frequently used features within more complex procedures.
- arrange function keys into groups that reflect the logic of the task such as sequential operation, importance, frequency of use, and function.

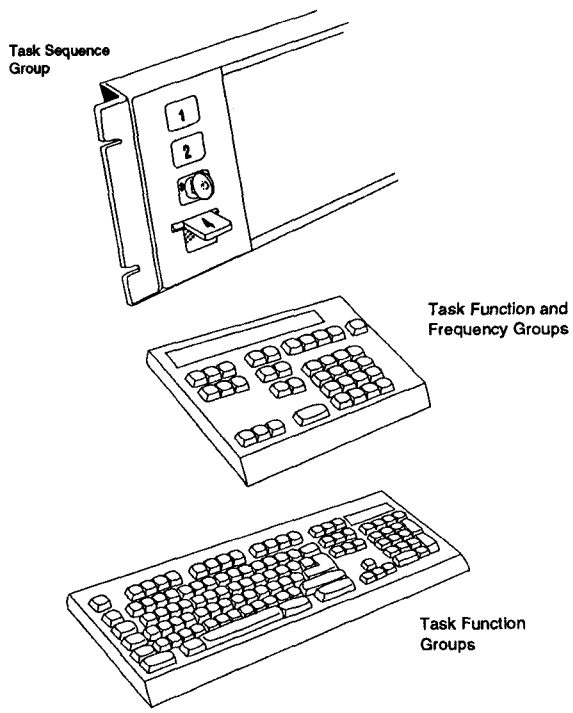



**Figure 47: Example function key layouts**

- separate or use colour coding to reduce risk of keying errors that might have irreversible effects such as terminating a call while still transmitting data.

- avoid multiple functions on a single key.
- where shifted functions are unavoidable, limit the number of shifted levels to two (preferred) or three (maximum).
- give feedback, which may be tactile, audible or visual to confirm has activated.
- use soft-key dialogue to give guidance and to minimize numbers of function keys.
- ensure alignment of soft-keys with display.

### *Additional comments:*

Dedicated function keys are usually quick and easy for novice users to operate since they provide a permanent reminder of the features available. (Frankhuizen (1985). See also Smith and Mosier (1986) for more detailed guidelines on specific function key usage.

# Graphical User Interface

## *(GUI, Object Manipulation Dialogues, Screen Graphics, WIMP, Window Systems)*

Graphical User Interface refers to a class of operating systems/software that provide visual images (icons etc.) instead of words for use in command dialogues. Object manipulation dialogues use visual images which can be selected and controlled by pointing devices. The functional elements of the dialogue are the windows, icons, menu and pointers (WIMP).

## *Cross references:*

Dialogue styles; Menu Dialogues; Standardization; User Interface Design Principles

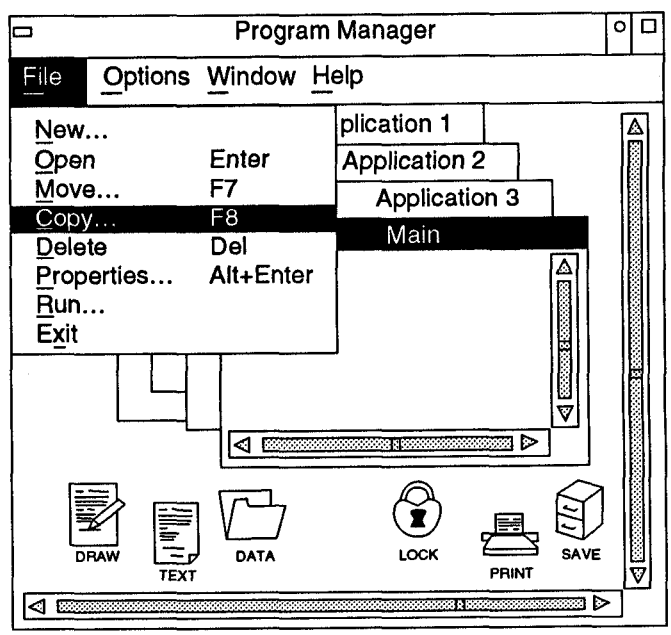



**Figure 48: Example graphical user interface (GUI)**

## *Recommendations:*

- develop a meaningful visualization or concrete metaphor of the user's tasks.
- use readily identifiable visual elements and icons in preference to abstract images.
- give immediate feedback of results of actions to ensure user perception of direct control of on screen objects.

  *Example:*
  when selecting and dragging an object it should appear to move and stop simultaneously with the movements of the mouse.

- any destructive actions should only result from an explicit action.
  *Example:*
  deleting the contents of a stored message should be the result of selecting the message, activating a delete command, possibly with confirmation.
- allow easy reversal of actions.
  *Example:*
  provide undo or cancel last action.
- use graphic device to clearly distinguish active window.
- use an object-action command style where the object is selected prior to being operated on.
- develop Help information.
- offer keyboard based shortcuts for frequently used menu items and to aid skilled usage.
- use proprietary style guides to ensure consistency and compatibility with other applications.

## *Additional comments:*

Research in this area is active and on-going. Benefits to the user are that the dialogue is easier to learn as options are either on-screen or easily identified from menus, and command string entry is minimized. The rule is point and select rather than remember and type. Subjective response to the visual imagery and animation is very positive, especially with people with either none or only limited computer experience.

See also: ISO DIS 9241 Part 16, Helander (1988), Shneiderman (1987) Verplank (1988) and Ziegler and Fähnrich (1988) for more general guidance on the design of graphical user interfaces. For detailed guidance on particular graphical interfaces, refer directly to the relevant style guide: Apple (1992), BT(1991), IBM (1991a & b), Microsoft® (1992), OSF/Motif™ (1990), Siemens/Nixdorf (1990a &b).

# Graphic Displays

## *(Display Colour, Full Dot Matrix Displays)*

The group of visual displays that provide a dot matrix or similar technology to display static or dynamic images, including text, graphics, symbols and pictures.

Typical displays may range from small LCDs (50mm diagonal) to large CRTs (525mm diagonal). The active display surface may be the classic 3:4 ratio (height:width) or maybe any other ratio suitable for the display technology and the user task. The display may be monochrome or colour.

## *Cross references:*

Character Displays; CRT Displays; Non-CRT Displays; Screen Formatting; Visual Displays

## *Recommendations:*

- use full matrix graphic displays where the visual information required by the user is complex, and requires visual separation and structure to assist in its comprehension.
- use full matrix graphic displays where the visual information requires by the user may extend across several screenfuls, when the users task requires browsing through large blocks of information.

## *Additional comments:*

The most flexible and economic display medium continues to be the CRT. Alternatives such as LCD and plasma panels have an advantage primarily when task requirements include a demand for low power consumption, and small size. Small LCD panels have become the prevalent technology for handheld games systems and may be useful for portable or handheld ISDN terminals to display still and moving pictures and text.

Consider task demands for provision of colour, resolution, and the quality of alphanumeric characters, graphics, and moving picture image, as well as portability and cost.

Review the individual guidelines for both CRT and Non-CRT displays for specific recommendations.

# Graphics Tablet

## *(Touch Tablets)*

An input device consisting of a sensitive flat panel which can detect finger or stylus positions and movements. Usually maintains a relative 1:1 relationship with an active area on the screen where cursor tracks current positions. Can be used for creating drawings and item selection.

## *Cross references:*

Pointing Devices

## *Recommendations:*

- use with a stylus in preference to finger, for higher resolutions and finer movement ability. Some evidence that a stylus is faster and less error prone than the finger. (Ellingstad et al, 1985).

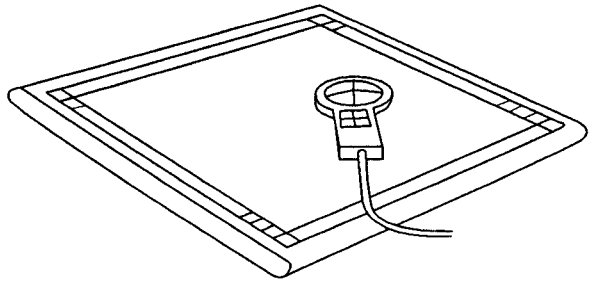


**Figure 49: Example of graphics tablet**

- provide visual and/or auditory feedback to confirm item selections.
- carefully control software for detecting item selection, to avoid "fall out", where the involuntary movements of the hand in releasing or lifting the stylus may relocate the cursor in a new active area. If small target areas have to be defined consider using a separate key press to confirm the selection.
- provide a display/control ratio for target acquisition tasks of between 0,8 and 1,0 for movement on the display relative to movement on the tablet (Arnaut and Greenstein, 1986).
- consider the task requirements to define when the tablet is in absolute mode (1:1 positional relationship between the tablet and display active area) or relative mode (direction of movement from current position of cursor is 1:1 with the display - like the mouse).

## *Additional comments:*

The choice of touch tablet technology can impact the user's tasks, e.g. the stylus of a voltage gradient tablet must touch the tablet surface, so it cannot be used with paper overlays; acoustic tablets may be affected by spurious inputs from a noisy environment; and touch sensitive tablets may be prone to accidental touches by the resting hand etc.

Graphic or touch tablets are the best input devices for freehand drawings.

# Handbooks

### *(Customer Documentation, Manuals, User Guides)*

Paper based documentation in the form of handbooks and user guides continue to be a valuable resource for providing user guidance that can be used at the same time as operating the equipment or taken away and read separately.

### *Cross references:*

User Guidance

### *Recommendations:*

- develop written instructions in parallel with the system development, taking account of the user requirements, the tasks to be done and the complexity of the tasks.
- instructions have to be complete, accurate and up to date.
- consider the need to include the following contents:
  - name of the product and manufacturer.
  - table of contents.
  - safety information.
  - installation or assembly.
  - diagram or picture of components, or parts.
  - operating instructions.
  - routine maintenance.
  - index.
- organize the instructions by user defined tasks, and build up confidence by starting with one that is simple, or frequently occurring, or likely to be done first.
- consider alternatives to narrative text:
  - illustrations.
  - flow-charts.
  - tables.
  - lists.
- write instruction procedures as lists of short sentences that can be followed as a sequence of steps.
- use short simple sentences, typically between 15 to 25 words long, with a maximum of 30 words.
- use familiar words, avoiding jargon and abbreviations.
- develop a consistent page layout to enhance readability and visual appeal within the following parameters:
  - choose a line length between 35 and 65 characters long.
  - on an A4 page allow top, bottom, left and right margins of 25mm, or more if necessary to allow for binding.
  - for continuous text use a typeface with a lower case 'x' height of at least 1,5mm, usually about 10 or 11 point depending on the typeface. When writing specifically for the elderly or children use 12 or 14 point.

- allow a space equivalent to one-quarter of the 'x' height between the lines.
- use left-justified text with a ragged right margin to avoid uneven gaps between words.
- choose a clear open typeface that offers a choice of size and weights to distinguish between text, headings, safety information etc.
- use a consistent logic for vertical spacing to distinguish paragraphs, clauses, sections, headings and sub-headings.
- set text in normal typeface using different sizes or weights for emphasis.
- avoid using all capitals, italic or underlining as these reduce ease of reading and legibility.

- test the instructions for technical accuracy by simulating tasks on the product, and test for understanding and usability with people using them to operate the system. Be prepared to edit or change the instructions to improve understanding.
- when instructions are translated it is advisable to use a translator whose first language is the one into which the translation is made, and to repeat the validation in the other language.

### *Additional comments:*

User guides and handbooks are going to be used most frequently in the early stages of operating the system or product. At this stage the user may initially want to know "what" the system can do to help them in their work.

All user guidance materials, handbooks, user guides and prompt cards should be tested to ensure they are usable by the target population; not just in terms of legibility, comprehension and presentation, but more importantly also on the content. The aim should be to answer questions like: "Can a sample of users take the product and the handbook, correctly install it and complete a simple task successfully, without reference to external help, within a reasonable time?".

See also: ISO DIS 9241 Part 13, BS 7649 and DTI (1988) for more specific information relating to handbooks.

# Handset

### *(Finger Clearance, Handset Design Template, Receiver, Telephone Receiver)*

The standard telephone component which combines the earpiece loudspeaker and microphone and is intended to be held close to the head to enable users to carry on a telephone conversation.

### *Cross references:*

Cables; Handset Cradle; Hookswitch; Voice Transmission

### *Recommendations:*

- the handset should have a profile which will fit comfortably to the user's ear and present the microphone close in front of the users lips. The handset profile should present sufficient clearance between the microphone and loudspeaker to enable fingers to wrap without touching the cheek or compromising the acoustic coupling with the pinna (CCITT Recommendation P.35, CCITT Com XII 49, 1974) (See figure 50).
- the weight of the handset should be approximately 150 to 180g and the balance should be evenly distributed between the ear and mouthpiece. If balance is not possible, then it is preferable that the mouthpiece is the heavier end. (Klemmer and Haig, 1988).
- provide an easy comfortable handhold area between the ear and mouthpiece, including provision for finger wrap and finger/cheek clearance. Ensure split lines (the join between two or more sections of the casework) within the handset moulding do not cause sharp edges or skin pinching.
- provide an easy comfortable handhold at the frequently used mouthpiece cupping position. Ensure flex and connector point to handset, if provided, do not interfere with hand and finger positions. (See Cables).
- consider providing a handset profile which enables the frequent ear-shoulder "cupping" position, without undue lifting (abduction) of the shoulder (Beese and Moggridge, 1982).

**Figure 50: Ear-shoulder "cupping" position**

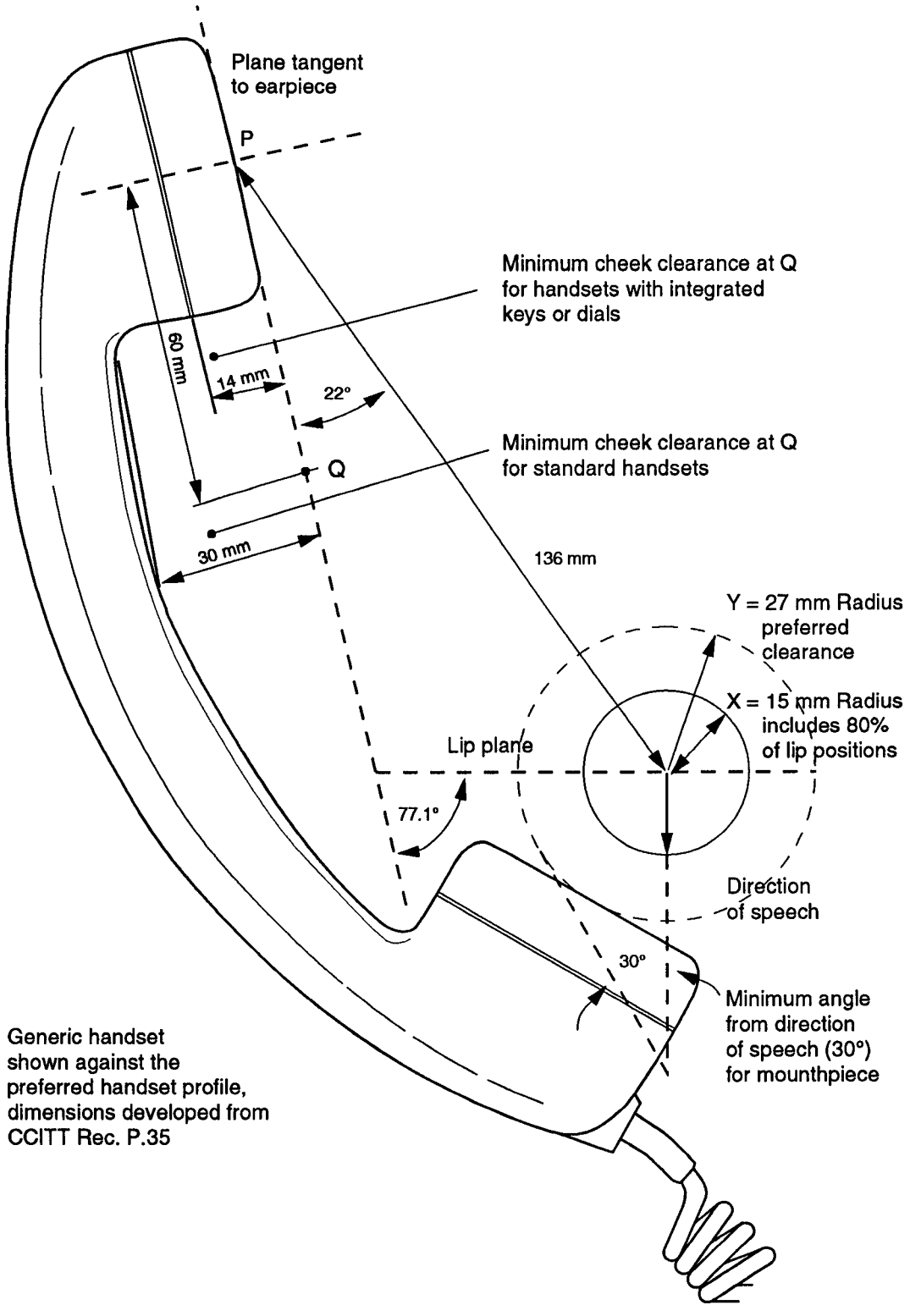



**Figure 51: CCITT preferred handset profile dimensions**

- ensure a sculptured earpiece is provided with suitable radiused curves to avoid sharp edges being presented to the pinna, and to avoid discomfort with the moving jaw bone when talking. Ensure the earpiece provides a good acoustic coupling with a broad range of ear sizes. Provide an acoustic cavity between the outer rim of the earpiece and the loudspeaker grill. (ETSI I-ETS 300 245-2).
- provide the mouthpiece with slots/holes or some other indication of where the microphone is located.
- ensure the mouthpiece is outside of the lip circle (minimum marked X, radius 15mm; preferred marked Y, radius 27mm).
- ensure the optical reflectance values of the handset meet the requirements of other office equipments (diffuse 15% - 75%, specular maximum 45%) (ECMA-110, ECMA-126).
- ensure any aerials provided within the handset are sited away from areas of the handset which are normally in contact with the human face or hands.
- ensure any controls provided on the handset, e.g. volume control for the loudspeaker, or microphone mute, are within finger or thumb reach from the accepted handling positions, irrespective of the hand being used (left or right), when the handset is operational.

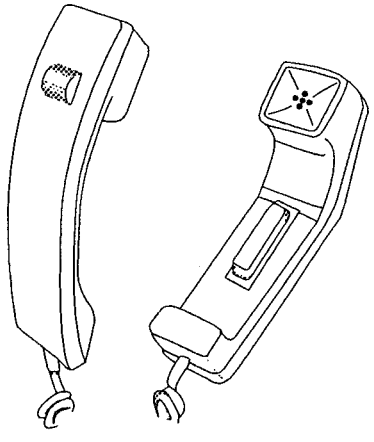


**Figure 52: Example handset controls**

## *Additional comments:*

Give the handset a feel of quality and ensure the casework is robust and rigid and not susceptible to flexing and creaking when handled.

# Handset Cradle

## *(Finger Clearance, Handset Rest, Subset Cradle)*

That part of the casework which is designed to accommodate the handset during idle. Usually incorporates the hookswitch.

## *Cross references:*

Handset; Hookswitch

## *Recommendations:*

- provide for easy pick up and replacement of the handset by either hand.
- ensure the pick up angle is at a comfortable angle for the wrist, maximum 5-10° abduction in any plane.
- ensure there is adequate room for 95th percentile fingers to wrap around to provide lift. Ensure there are no catch points (e.g. for fingernails) to prevent a clean, direct lift from the cradle to the ear single handed.

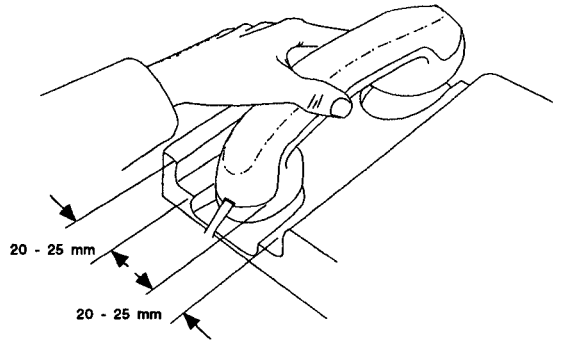



**Figure 53: Finger clearance around handset**

- provide for easy and rapid replacement of the handset to the cradle with either hand, with good positive tactile feedback when the handset locates correctly.
- ensure the handset relocates correctly within the cradle under its own weight, provide guiding slopes to help the handset home in.
- on portrait orientated handset cradles provide a good back stop at the rear of the cradle to prevent overshoot when the handset is thrown down hurriedly.
- avoid the use of locating pegs or similar devices which require precise detailed hand movements.
- provide an obvious "parking" position for the handset which will not cut off the call.

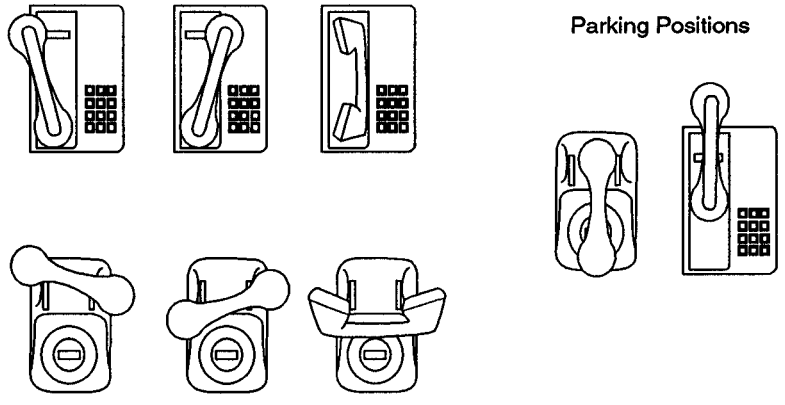



**Figure 54: Example handset parking positions**

### *Additional comments:*

None

# Hand Sizes

## *(Anthropometric Dimensions, Finger Clearance, Grip Size)*

Dimensions of the male and female hands and fingers are provided to enable designers to use suitable dimensions of space, reach, etc. for those areas of the terminal or product the user may be expected to handle.

## *Cross references:*

Handset; Handset Cradle; Keys; Maintenance; Portability

## *Recommendations:*

- use 95th or 99th percentile male dimensions, where finger, or hand clearance is relevant. For example, the space between adjacent connectors where finger/thumb grip is used to connect and disconnect the plug and socket.
- use 5th or 1st percentile female dimensions, where finger/hand reach or span is relevant. For example, the space between two keys that have to be pressed simultaneously.
- use average values where a compromise is essential, or use fitting trials to identify overlapping, and acceptable comfort zones for smallest and largest users.
- provide for flexibility so that different grips can be used and so that the grip can be varied. For example, finger tip grip on the side of a handset by a small female hand and a wrap around grip for a large male hand.

## *Additional comments:*

The dimensions are extrapolated from a British survey completed in 1981 of 300 male and 300 female hands (Kember et al, 1981). Designers may need to seek anthropometric data for their own country if they perceive that there may be significant ethnic variations from the British data. (See table 13 and figure 54).

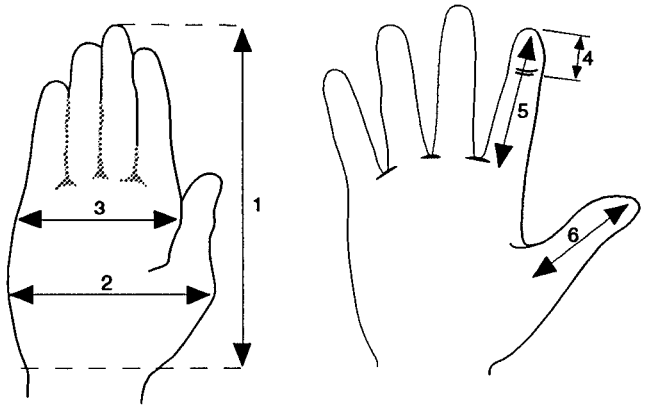



**Figure 55: Anthropometric dimensions**

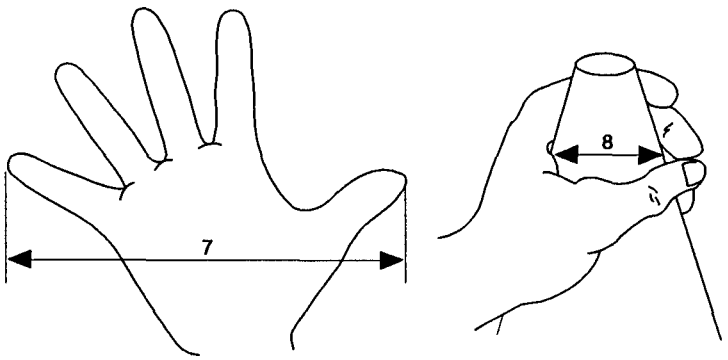



**Figure 55: Anthropometric dimensions...concluded**

**Table 13: Anthropometric data for hands and fingers, from dimensions shown in figure 55 (dimensions 1-6 after Kember et al, 1981, dimensions 7-8 after Pheasant, 1986)**

| **Dimension** (in millimetres) | | **Percentile** | | | | |
|---|---|---|---|---|---|---|
| | | 1st | 5th | 50th | 95th | 99th |
| 1 Hand length | Female | 157 | 162 | 174 | 186 | 191 |
| | Male | 171 | 177 | 190 | 204 | 209 |
| 2 Hand breadth | Female | 81 | 84 | 92 | 100 | 103 |
| | Male | 93 | 97 | 106 | 115 | 118 |
| 3 Hand breadth (excluding thumb) | Female | 69 | 72 | 78 | 84 | 86 |
| | Male | 78 | 81 | 88 | 94 | 98 |
| 4 Index finger tip length | Female | 2,1 | 2,2 | 2,2 | 2,3 | 2,4 |
| | Male | 2,3 | 2,4 | 2,5 | 2,6 | 2,6 |
| 5 Index finger length | Female | 57 | 60 | 67 | 74 | 77 |
| | Male | 61 | 64 | 72 | 79 | 82 |
| 6 Thumb length | Female | 38 | 41 | 47 | 54 | 57 |
| | Male | 41 | 44 | 52 | 59 | 63 |
| 7 Spread | Female | | 165 | 190 | 215 | |
| | Male | | 178 | 206 | 234 | |
| 8 Hand grip diameter | Female | | 43 | 48 | 53 | |
| | Male | | 45 | 52 | 59 | |

# Help

## *(Tutorials)*

Help systems are used to aid users to successfully perform tasks. Help can be offered so that the user is informed about the purpose of a function key, or command. Context sensitive help may be given to guide the user through an unfamiliar sequence, or recover from an error (Savage et al, 1991).

## *Cross references:*

Error Management; Evaluation; User Guidance; User Interface Design Principles

## *Recommendations:*

- for simple systems with limited display capabilities consider providing help using speech output.
- provide information about the ISDN and terminal services available.
- for more complex systems, provide help that is sensitive to the context and to the users' task requirements.
- write the help information in short simple sentences and include what to do next and how to return to the main task.
- use help information to identify features and controls.
- allow skilled users the option of switching off help prompts if they are not required.
- for complex help, for example, with a Graphic User Interface, provide cues to navigation within the help material with clear titles, e.g. page forward and back; and consider an audit trail so that the user can trace back to previous screens and see where they came from.
- use an evaluative design process to test out the level of support needed by first time and inexperienced users and examine how to improve the effectiveness of the help information being developed.

## *Additional comments:*

Help is essential unless it is immediately obvious how to operate a system. Sometimes the user may simply want to know the effect of a particular function key, or the range of features available. Most often users require help in order to complete a specific task, and in order to recover from errors.

Flexibility within the help information can allow users to gain information at different levels. As the users' skills for frequent operations increases, so they will become less reliant on the prompts and help information, however, the guidance may continue to be needed for more advanced features, and features used infrequently. Help is probably best developed as part of the dialogue design process.

# Hookswitch

### *(Dial-in-handset, Handset/Handsfree Operation)*

A switch to electronically connect and disconnect the terminal from the network, usually operated by lifting the handset or by replacement of the handset on the cradle. May be mechanical (operated by the weight of the handset), and/or sometimes non-mechanical, e.g. magnetic (operated by the proximity of the handset).

### *Cross references:*

Call Handling; Handset; Handset Cradle

### *Recommendations:*

- if a magnetic or electronic hookswitch is employed, some other means should be provided for terminating a call prior to re-dialling, to avoid replacing the handset each time.
- if the hookswitch is provided within the cradle, ensure that it operates when the handset correctly locates under its own weight.
- if the hookswitch is provided within the cradle and the handset fails to locate correctly and fails to operate the hookswitch successfully, ensure that it is visually obvious that it is still off-hook, e.g. it will fall off the cradle.
- if the hookswitch is provided within the cradle, ensure it is accessible during a call, that it is obvious and presents a good target, to enable rapid cancelling of the current call and return of dial tone.
- if there is no handset cradle, the hookswitch should be provided within the primary area (the area most easily reached) of the main keyboard or control block, and clearly labelled.
- if the terminal has a handset cradle hookswitch and an independent hookswitch (or control with a hookswitch function, e.g. Handsfree On/Off) then care should be taken to integrate the operation of the two hookswitches and to give clear indication to the user on the current state of the equipment. Ensure the control procedures for the terminals with two hookswitches (e.g. Handset and Handsfree) do not compromise user stereotypes. For example, users expect a single action to terminate a call, i.e. handset down or hookswitch on (Handsfree off). (Ferris, 1986)

### *Additional comments:*

Care should be taken in wall mounted and portable handset terminals on the siting of the hookswitch, to ensure calls are not ended accidentally, but at the same time enable easy access to recall dial tone quickly.

Dial-in-handset - Refers to single piece handset containing the keypad and hookswitch. Where the latter is the case, care needs to be taken that users are not able to terminate a call (go on-hook) accidentally.

# Input Hardware

## *(Controls)*

Relates to those parts of an ISDN terminal which allow the user to carry out the procedures or dialogue associated with a particular operation or function.

## *Cross references:*

Alphanumeric Keyboards; Analogue Controls; Bar-Code Readers; Cameras; Card Readers; Cursor Keys; Data Glove; Eye/Head Movement; Foot Mouse; Graphics Tablet; Joysticks; Keyboards; Key Operated Switches; Keys; Light Pens; Linear Sliders; Microphones; Mouse; Non-tactile Inputs; Pointing Devices; Pushbuttons; Rocker Switches; Roll Balls; Rotary Controls; Rotary Switches; Slider Switches; Speech Recognition; Stylus; Switches; Telephone Keypads; Thumb/Finger Wheels; Toggle Switches; Touch Screens

## *Recommendations:*

- when choosing a specific input technology designers should be aware of the typical failure rates for the technologies under consideration and, equally, the likely human error rates in using that technology within the range of tasks expected.

  *Example:*
  keys are the most reliable data input device for discrete data items for current technologies. The failure rates that can be assigned to the keys technology are typically 1 in 106 operations or greater. This far exceeds typical human error rates which are more normally between 1 in 10 and 1 in 102 for infrequent tasks, but can reach 1 in 103 or less for highly practised tasks.

- when choosing a particular input technology, designers should be aware of the limitations different technologies present to people with special needs. For example, keyboards may require dexterity in both hands, light pens and touch screens force the user to lift the whole arm, etc. In general, for people with special needs (Kanis, 1993, Nordiska Nämnden för Handikappfrågor, NNH 4/93, RACE Project 1066 IPSNI, 1991a, b & c):

  - minimize the force required to operate controls.
  - avoid simultaneous manipulations, e.g. pushing and rotating.
  - avoid making the user hold a control in a specific position for periods of time.
  - avoid controls which limit or restrict the handedness or grip of the user.

## *Additional comments:*

In the individual entries listed in the cross references, recommendations are included that:

- refer to agreed international standards, and to information given on draft international standards where these are relevant (e.g. ISO DIS 9241 Part 9).

- give guidance on Human Factors design for individual input technologies, based on good practice and recorded studies (e.g. Vees and Faber, 1985; Greenstein, 1988).
- highlight design requirements for People with Special Needs and to maximize safe operation (e.g. ETSI ETR 029).

# Joysticks, Finger/Hand

Hand joysticks are input devices consisting of small sticks that protrude from a fixed socket, they may be moved or pushed/pulled in any direction. Finger joysticks have been developed for hand held devices. The thumb or forefinger rests on a small concave pad which can move short distances in any direction.

## *Cross references:*

Pointing Devices; Roll Balls

## *Recommendations:*

- requires a separate control to select the object once the cursor is positioned, this may be integrated into the hand joystick, for finger or thumb operation.

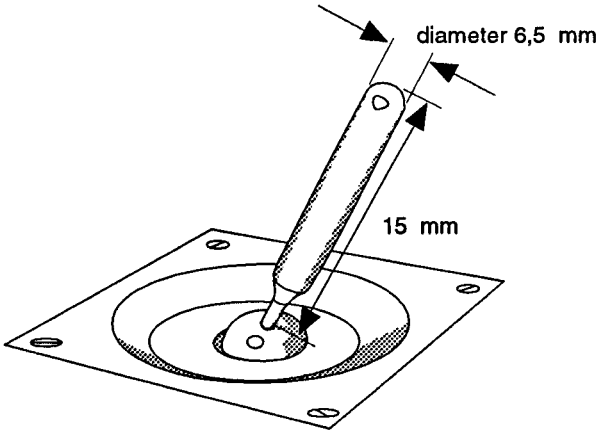



**Figure 56: Example hand joystick**

- best suited to continuous tracking tasks and to pointing tasks that do not require great precision.
- joysticks may be displacement (also called isotonic, the stick will physically move in the required direction), or force (also called isometric, the stick does not move but the force and its direction is detected and converted to a cursor movement). Either type may affect the distance the cursor moves directly or may affect the rate or speed of movement of the cursor.
- use displacement (isotonic) joysticks when positioning accuracy is more essential than positioning speed.
- ensure displacement joysticks which control the rate of the cursor movement return to the centre or null position when released. Ensure movement is smooth in all directions, without backlash (movement of the released joystick beyond the null position which causes a corresponding unintentional movement in the cursor). Enable the control

- use hand displacement joysticks with the following minimum dimensions (Mil-Std-1472C):
  - diameter 6,5mm
  - length 75mm,
  - resistance 3,3N. (Maximum displacement 45°).
- if the joystick can control the cursor beyond the current active screen area, provide indication on the edge of the area on the current direction of the cursor.

### *Additional comments:*

There are no recommendations available about finger controlled joysticks, except the basic ones of providing an adequate cup to accept the finger/thumb pad, and adequate friction to minimize the finger/thumb slipping in the control. If the thumb is the intended controlling limb, ensure the control is sufficiently close to the device edge to enable comfortable placement and an adequate range of movement.

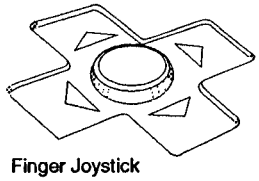



**Figure 57: Example finger joystick**

# Keyboards

## *(Keypads)*

An input control panel containing a number of keys or pushbuttons. The keys are usually arranged to conform to a standard layout, e.g. digits 0-9 and alphabet keys in ISO/IEC DIS 9995 "QWERTY/QWERTZ/AZERTY". Alternatively a number of function keys may be arranged singly, in groups or in column/row matrix.

## *Cross references:*

Alphanumeric Keyboards; Control Key Dialogues; Function Keys; Keys; Pushbuttons; Switches; Telephone Keypads

## *Recommendations:*

- recommendations are offered in detail in each of the cross referenced guidelines.

## *Additional comments:*

The optimum design of keys and keyboards is essential to minimize user errors (e.g. miskeying and double keying) and to speed data entry. Slow keying times and high error rates can increase network operation costs, without necessarily increasing revenue. At the same time, they reduce the users' acceptance of the system and their perception of quality.

Keyboards may comprise:

- the standard keypad, used for entering discrete data items, and operated by single fingers. The 10 or 12 numeric keys, principally used for entering telephony addresses, and for signalling to the connected network or terminal.
- the combined alphabetic and numeric keyboard with one key per character or digit, with or without shift keys to access alternative characters or symbols; and usually operated with both hands.

Alphanumeric keyboards, when used for a significant part of the working day, must meet the design requirements of the European Council Directive 90/270/EEC on the Minimum Health and Safety Requirements for work with display screen equipment.

For more general information, see Potosnak (1988).

# Key Operated Switches

## *(Call Barring, Locks)*

Control devices incorporating a lock with a removable key and used to prevent accidental or unauthorized change of the switch's state or setting.

## *Cross references:*

Input Hardware; Security

## *Recommendations:*

- use to lock a device in a particular state, setting or mode. Available with two or more switch positions, enabling the terminal to be locked in one of two or more settings.
- use the key position to indicate the current setting, ensure there is no ambiguity in the keys positioning, i.e. the key is not in the same orientation for two different settings.
- provide a label or legend for the controls function and for each of the control settings.
- use a key switch which provides a 45°-90° rotation between positions, which requires a torque of 0,1-0,2Nm and has a distinct tactile detent or indent at each position.

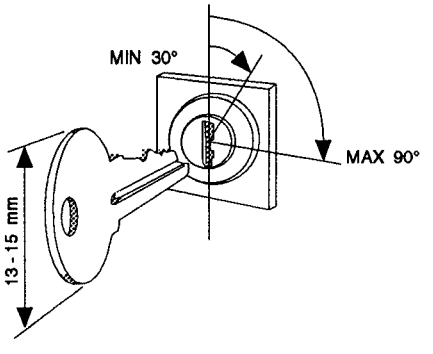



**Figure 58: Example key operated switch**

- provide a stop at either end of the range of positions.
- enable the removal of the key at the safe or lowest level position. This is usually in the vertical (or front to back) plane.
- keys which can be entered into the lock with either side up or forward are preferred. Tumbler action keys (Yale® or similar) which have a single orientation should have their teeth or similar, pointing up or forward to be inserted. (Mil-Std-1472C). Conventional lever action keys are normally inserted with the "teeth" pointing downwards or backwards.

## *Additional comments:*

None

# Keys

## *(Buttons)*

Discrete input selection devices used to enter single pulse inputs.

## *Cross references:*

Alphanumeric Keyboards; Keyboards; Pushbuttons; Telephone Keypads

## *Recommendations:*

- provide keys with flat or concave sculptured key caps, which accept a good proportion of the finger pad (minimum surface area 113mm² with minimum dimension 12mm, ECMA-110, ECMA-126).

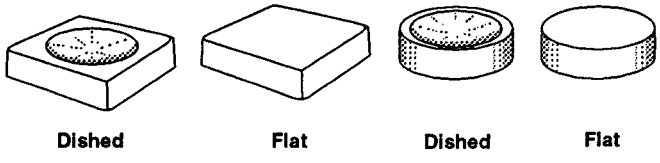



**Figure 59: Example flat/sculptured keycaps**

- in arrays of keys, consider the use of raised dots or lines on the touched surface to aid unsighted navigation about the array.
- concave sculptured key caps should accommodate 95th percentile finger tips (10mm minimum radius, Gepruefte Sicherheit (G.S.)-VBG).
- provide conventional ramp or snap-action force/travel keys (travel 1-8mm, force 0,25-1,5N ECMA-110/ECMA-126), in preference to membrane (zero travel) keys or touch panel (Pollard and Cooper, 1979).

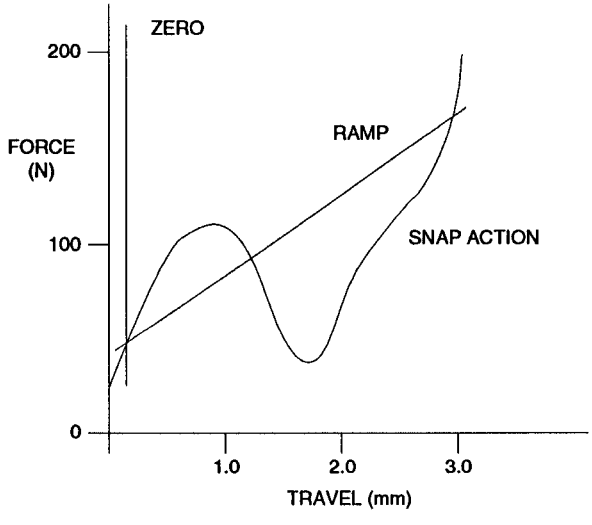



**Figure 60: Zero travel, ramp and snap action**

- if membrane keys are essential, there is evidence that bubble membranes with minimal travel, are more acceptable than flat ones (Kristensen, 1985).
- provide sufficient clearance around each key to accommodate 95th percentile fingertips (18mm minimum, 20mm preferred - Deutsche Bundespost Test finger - equivalent to 9-10mm radius circle from centre of key cap) irrespective of key cap size. This clearance recommendation also includes any raised edges or sides of other controls around the keys.

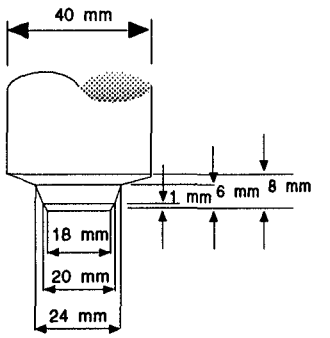



**Figure 61: Deutsche Bundespost test finger**

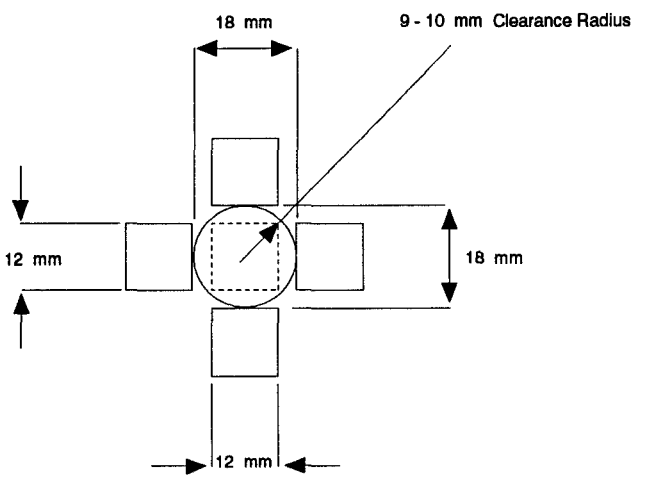



**Figure 62: Preferred minimum key clearances**

- if space is a premium for a data entry task and smaller key clearances are necessary, circular keys should minimize double keying errors (Yamagami and Matsuda, 1974) down to a clearance radius of 7,5mm (15mm side to side). Clearance radius below 7,5mm, limit the accessibility of significant proportions of the population, or may require the user to consider a stylus selector.
- ensure key cap diffuse reflectance is between 15% and 75% (20-50% preferred) and specular reflectance is a maximum semi-matt to silky matt (45%). (DIN 66 234 Part 6).

- key cap inscriptions should have a minimum contrast ratio of 1:3, and the character height for these inscriptions should be readable at the perceived viewing distance (2,6mm high for standard alphanumeric desk top keyboards). (DIN 30 640 Part 1).
- numeric and alphabetic keys that may be used for professional data entry should be protected by N-key rollover (where N=3 or more) and a burst rate minimum of 50 characters per second over 3 seconds. (ECMA-110, ECMA-126).
- numeric and alphabetic keys that auto repeat, shall provide a fixed rate (15 ± 5 characters per second) after at least 0,5 second. (ECMA-110, ECMA-126).
- ensure feedback is provided on each key's actuation and the resultant dialogue action. For key actuation provide tactile ("snap-action" force travel curve or distinct stop to key travel) or auditory (click) feedback. For resultant action provide auditory or visual feedback as appropriate (e.g. DTMF tones and/or display digit). (ECMA-110, ECMA-126).

### *Additional comments:*

LCD touch overlays can match conventional keys for data entry time and errors, if spacing is equivalent to conventional dimensions and feedback is given to signal the keys actuation (clicks and DTMF tone). (Bergman et al, 1985).

Snap-action keys give good tactile feedback when operating function and numeric keys. If the task requirements are for professional data entry, then "snap-action" feedback may prevent users from reaching maximum burst rates, and "ramp or continuous force" keys may be preferred. (Alexander, 1974).

Consider key cap shape; some evidence suggests that user preference is for square rather than circular keys on alphanumeric keyboards. (Goodman et al, 1983, Monty et al, 1983).

# Labels

## *(Legends)*

Single alpha or numeric characters, text string or symbol used to indicate the function or feature available from a control or display.

## *Cross references:*

Alphanumeric Keyboards; Casework; Character Displays; Control Key Dialogues; Handbooks; Keyboards; Keys; Symbols

## *Recommendations:*

- use alphanumeric labels or legends to identify controls, displays and other functional elements of the product or terminal.
- use full words that accurately describe the control or display's function. Avoid abbreviations, unless usability testing confirms they are acceptable.
- use symbols, icons and pictograms to overcome language difficulties when identifying controls or displays, connectors and sockets, or to give guidance. (See Symbols)
- ensure printed material is clear and legible and easily understood by the users. Keep printed text upright and on horizontal lines. Avoid vertical, curved or inverted text.
- for continuous text use lower case letters with 10 or 11 point typeface. Increase typeface to 12 to 14 point for information specifically aimed towards children and elderly.
- use a minimum character height of 3mm for labels to be read at arm's-length (700mm) (See Character Displays).
- dark text on a light background is preferred with a brightness contrast of 70 to 80%. Embossing the casework is not recommended as the lack of contrast makes it difficult to read the text.
- put the label or legend on the control or display, or in close proximity. Ensure there is no ambiguity about which label relates to which control/display.
- ensure safety labels are prominently displayed and durable for the expected life of the equipment.
- user-editable labels, provide paper inserts for users to designate their own descriptions.

## *Additional comments:*

Where a product is complex users may have difficulty remembering specific sequences of operations and a small reminder card on the product can be very helpful.

# Light Pens

An input device usually used with CRTs, the light pen is used to point and select items displayed, the pen detects the refreshing beam of the CRT and the timing of the signal gives the co-ordinates of the point touched. Resolution can be very high (at pixel level).

## *Cross references:*

Graphics Tablet; Pointing Devices

## *Recommendations:*

- consider the requirements of the task and the need to support the elbow and even the wrist if fine, accurate positioning is essential, may require the screen to be angled more to the horizontal than the vertical.
- has the disadvantage of obscuring the screen at and below the point of touch and this may limit the degree of fine control. Has the strong advantage of intuitive point and indicate or select with excellent hand eye co-ordination.

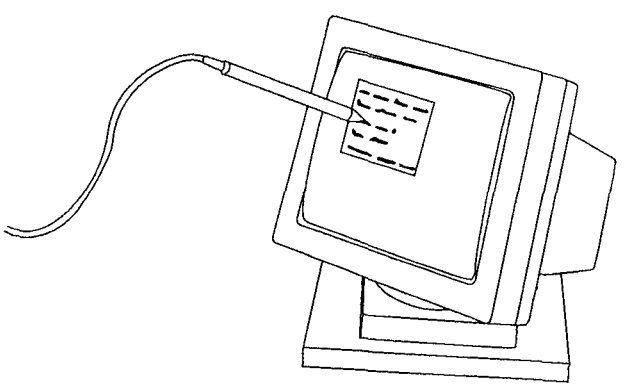


**Figure 63: Example light pen**

- can be available for people with special needs as a head mounted or mouth controlled selector.
- use a light pen within the following dimensions:
  - 120-180mm long.
  - 7-20mm diameter.
- ensure the cable attached to the non-pointing end is not restricting the user's hand movements. Consider providing a holder of some form for when the pen is not required, and to assist in pen pick up.
- provide feedback when the light pen is active on the screen and also when a selection is made.

## *Additional comments:*

None.

# Linear Sliders

## *(Sliders)*

A control input device for setting the chosen level of a continuous variable, where the operation is in a linear motion.

## *Cross references:*

Analogue Controls

## *Recommendations:*

- provide a label/legend parallel to the direction of movement, with a wedge element to demonstrate the variable increasing; provide indicator values if required.
- use finger tip sliders with force resistance of 1,5-2N or larger sliders with force resistance of 2-3N.
- sliders for finger/thumb grasping should be a minimum of 13mm high, 13mm wide and 6mm thick.

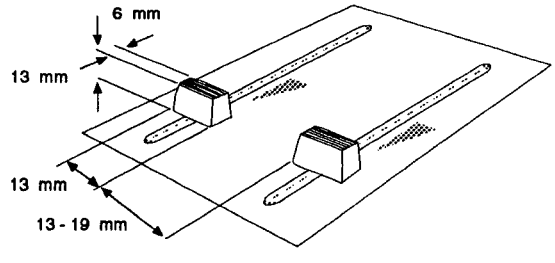



**Figure 64: Example linear sliders**

## *Additional comments:*

None

# Maintenance

## *(Batteries, Cleaning)*

The design requirements that will enable day to day and first line maintenance to be handled efficiently, e.g. replacement of consumables, clearance of paper jams and cleaning.

## *Cross references:*

Casework; Connectors; Safety; Tactile Displays

## *Recommendations:*

- avoid the need for special tools to be used, during day to day or first line maintenance. If special tools must be used for maintenance or operational adjustment they should be securely mounted within the equipment in an available location.
- as far as possible terminals should be designed for replacement of unit modules. If modules can be replaced as part of first line maintenance it should be impossible to replace or reconnect a module incorrectly and to connect the wrong module. (See Connectors).
- all surfaces should provide for basic cleansing and hygiene practice, with clean smooth contours and few recessed corners, particularly on the upper surface. Where possible loudspeaker grilles and ventilation slots could be sited off the upper horizontal surfaces. Cleaning should not require the use of special tools and materials.
- ensure battery compartments are obvious, and that the method of opening can be achieved by 95% of people. In preference, opening the compartment should not require tools and the lid should not become detached.
- provide clear indication of the orientation and, if necessary, the order of battery insertion. Where batteries are attached to terminal clips, ensure they cannot be attached incorrectly. In preference, the orientation indicator should be visible when the batteries are in situ, so that they can be visually checked. Consider a textured indication so that battery orientation may be checked by the visually impaired.
- consider the users expected method for removal of a battery. If there is insufficient clearance to allow the finger/thumb grip on one of the batteries, provide a battery removal aid and ensure it is difficult to get it mislaid, e.g. attach it to the battery compartment floor/wall.
- if possible, provide batteries (where required) which enable a simple single clean motion for insertion and removal. Avoid soldered connections.
- if security modules are required, e.g. smart cards for portable telephones, consider the method for insertion and removal. In preference enable the module to be inserted in any orientation. If only one or two orientations will work, provide visual and tactile guidance on the base unit and on the security module. For example, a notch on the card could be provided which matches a peg on the base unit. (See Tactile Displays).

- if specific test routines are a necessary part of the user's task, ensure clear guidance is given in the documentation on the procedures, and provide clear indications on the terminal on the results and possible follow up actions.
- if maintenance requires the removal of covers or the opening of equipment modules, ensure the holding mechanisms (catches, screws etc.) are retained with the cover or removal and do not become loose. Ensure the cover lifts off the sub-unit, avoid the sub-unit lifting out of the cover.
- if necessary, ensure individual sub-units that may require removal, are removable in a straight line and do not require complex movements for release.
- ensure there is sufficient finger/hand clearance around sub-units that have to be removed. Ensure the gripping points are accessible, robust and have friction surfaces.
- protect user safety; for example, from high voltages, and accidental misuse. (See Safety).

### *Additional comments:*

None

# Menu Dialogues

## *(Menus)*

A menu is carried out with the user being offered a list of choices from which a selection can be made. The result may be a second or third list of choices that builds up in a hierarchical structure. Each single list comprises a menu. Menus may take many forms: auditory menus, icon menus, pop-up/pull-down menus. Menu hierarchies may be sequential (single menus one after another), pull-down (vertical menus are opened from a horizontal menu bar), cascading (a second menu opens adjacent to a selected item in a primary menu), etc.

## *Cross references:*

Auditory Menus; Dialogue Style; Graphical User Interface; User Interface Design Principles

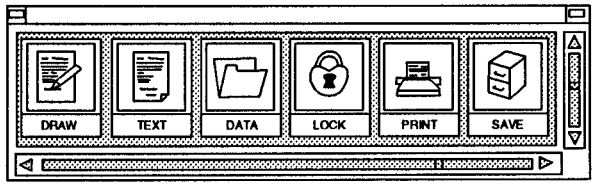
## *Recommendations:*

- use menus to aid novice, and casual users, e.g. to provide initial access to language variants at terminal installation, but allow shortcuts such as type ahead for skilled operators.
- give the menu a title that clearly indicates the contents and give the menu options informative names which relate to the users task.
- group the options meaningfully to the user or the task, or if this is not possible use, an alphabetic order.
- choose a menu item by point and select using cursor keys or mouse, by numeric entry, or initial letter.
- show all the options provided, use low-contrast or other techniques to indicate options currently not available.
- limit number of options to less than 12. If more options are required, arrange them into meaningful groups that can be accessed as a next evel menu.
- limit the hierarchy of menus to 3 levels. If more levels are required, provide navigational cues to the current level and navigational aids to assist backtracking, and/or returning to a main menu.
- minimize response times and provide feedback if delays are necessary.
- avoid automatic scrolling for menus; if they have to be used, test for comprehension to ensure the display rate is optimal.

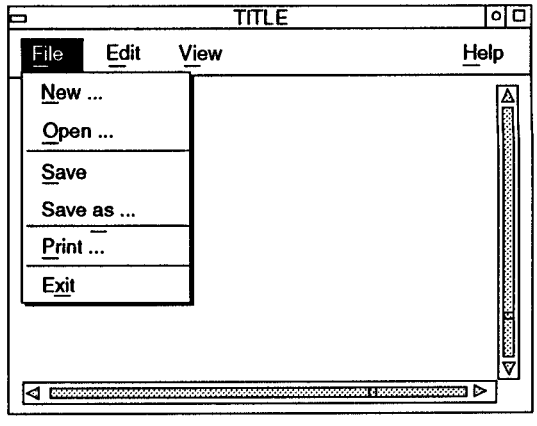
## *Additional comments:*

Menus are a valuable aid to novice and casual users since they reduce the need to know and remember. The titles and menu options should relate closely to the user's expectations and job requirements. The acceptability of these names should be assessed, with a representative sample of users.

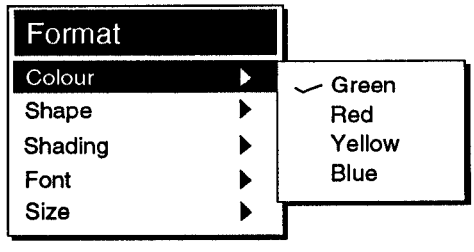
Highly skilled users may find menus slow and may benefit from having a short form access to the commands.




Icon Menu




Simple Pull Down Menu




Cascading Menus

**Figure 65: Example menus**

See also: ISO DIS 9241 Part 14, Allen (1983), Barnard et al, Papp and Roske-Hofstrand (1988), Smith and Mosier (1986) and Vees and Faber (1985) for more specific information on the design of menu dialogues. For more detailed guidelines on the format and structure of menu dialogues within graphical and other user interfaces, refer to the relevant style guide: Apple (1992), BT (1991), GO Corporation® (1992), IBM (1989, 1991a & b), Microsoft® (1992), OSF/Motif™ (1990), Siemens/Nixdorf (1990a & b).

# Microphone

An input device for capturing acoustic (usually voice) information and presenting it electronically into a transmission, recording or recognition system. Typically, microphones have a limited pick-up distance and radius.

### *Cross references:*

Non-tactile Inputs; Symbols

### *Recommendations:*

- ensure the mounting of a microphone within a terminal minimizes the effects of echo, sound reflection and reverberation from the expected terminal environment.
- ensure the response range of the microphone matches the expected output from the potential range of acoustic sources.
- ensure the mounting of the microphone enables the pick-up envelope (distance and radius) to include the likely physical location of the projected acoustic sources.
- ensure the acoustic properties of the microphone matches the potential range of acoustic outputs possible from the expected acoustic sources.
- ensure the quality of the signal is maintained in progressing form acoustic to electronic media.

### *Additional comments:*

Consider the presentation and mounting of microphones intended for voice capture. Ensure that users can easily keep their lips/mouth within the pick-up envelope without constraining their posture. For example, the standard handset or telephone headset allows the user to keep the microphone close to the mouth and at the same time be able to move, relative to the terminal.

Voice quality is a potentially very emotive aspect of telephony and voice transmission. People make psychological and emotional assessments of the people they are talking with, as part of the communication. It is essential, therefore, that the technology does nothing to interfere with this process.

There are a small but significant number of people who have vocal disabilities who could be helped with specialized microphone equipment, e.g. soft voices (with no carrier frequency). Where this type of facility is provided it should be very easy to switch between everyday and specialized use of the microphone circuits.

See Symbols for an example symbol for Microphone On/Off.

# Mouse

The mouse has become the most common point-and-select device. It consists of a small contoured "box" that fits under the palm or fingers. Movement of the mouse over a flat surface is reflected in co-ordinated movement of the cursor. It is usually provided with up to 3 buttons for selecting/de-selecting screen elements at the current cursor position.

## *Cross references:*

Pointing Devices

## *Recommendations:*

- enable the speed of movement and distance moved by the cursor to be adjusted by the user.
- provide sufficient space close to the display for hand arm movements to control the cursor, may require a special mouse pad (optical mouse) or suitable level of friction on the workstation surface (friction ball mouse).
- avoid using for free hand drawing tasks.
- use a single button to select one of a group of displayed alternatives or use different buttons to select different responses to a single attribute or function.
- use a mouse with a rounded peak close to the centre of the top surface to give palm support, with buttons on the front and top surface rather than just on top. Ensure the buttons are stiff enough to support resting fingers without activation and provide good tactile and auditory feedback when activated.
- provide a good textured surface for gripping particularly at the side. Ensure the mouse is stable (not rocking) and glides smoothly over the work surface, and provides a good platform for key operation (does not move on key presses).
- use a mouse within the following dimensions (Mil-Std-1472C):
  - width 40-70mm.
  - length 70-120mm.
  - height 25-40mm.

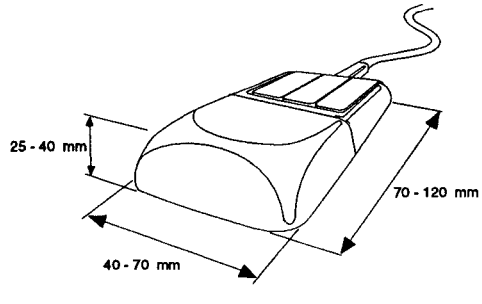



**Figure 66: Example mouse**

## *Additional Comments:*

For a more general discussion on the design requirements for a mouse, see Abernethy and Hodes (1987).

# Multimedia Terminals

Multimedia terminals have the ability to transmit and receive combinations of media having fundamentally different properties, e.g. text and video, or audio, graphics and video, simultaneously. This is in addition to the ability to communicate separately in each media. As a comparison, a telephone is an example of a monomedia terminal and a videotelephone is perhaps the first commercial example of a multimedia terminal, able to communicate in audio and visual media simultaneously.

## *Cross references:*

Addresses; Call Handling; Data Transmission; Videotelephones

## *Recommendations:*

- ensure call set-up, incoming call and call termination procedures meet user expectations, and are fully supported by prompting and feedback indications. Use the general rules and generic procedures shown in Call Handling, when new procedures have to be developed.
- keep addresses simple and consistent. Minimize the number of operations necessary to address any particular terminal or media. Consider a unique address for the user irrespective of the range of media involved in a call.
- consider facilities to enable a multimedia communication to degrade gracefully, i.e. service by service, when problems arise. Where audio is one of the media within a communication, it may be preferable to the users to lose the audio link last.
- keep call termination as simple as possible, preferably a single action/operation. At the same time, ensure any transmitted data is not inadvertently lost; enable the user to decide whether received data can be discarded or not.
- provide simple procedures to enable users to select different media both before and during a call. Ensure there is an opportunity for consistency between the default media selected for both outgoing and incoming calls. Inconsistency between default media for incoming and outgoing calls is not recommended, except for experienced users.
- ensure synchronization between different media objects within a communication meets user expectations. For example, maintain lip synchronization between audio and visual media within ±50ms, or between a pointer and an image showing the pointer in a shared viewing application, perhaps <100ms.
- ensure the user is kept informed of changes in call charges invoked because of changes to the media to be transmitted/received. In general, users should have an indication of the charges for different media both before and during a call.
- foster the user's perception of equally sharing the communication space within a multimedia call. Avoid dialogue structures that force an artificial hierarchy on the communicating parties, i.e. chairman vs. the rest.

### *Additional comments:*

Multimedia Terminals enabling the concurrent transmission and reception of audio, visual, text and other data, are still in the research and development stage. ETSI Technical Committee for Human Factors (TCHF) is currently working on the HF aspects of multimedia (ETSI DTR/HF-01016).

Significant work has also been done on a number of technical and human factors issues within the various research programmes under RACE (Research and Development in Advanced Communications Technologies in Europe) (RACE Projects: 1065 ISSUE, 1993b; 1066 IPSNI, 1991a, b & c; 1067 GUIDANCE, 1992; 1077 URM, 1990, 1992). See in particular "Human Factors Guidelines for Multimedia" RACE ISSUE - Usability Guidelines Volume III, (RACE ISSUE 1993b); and also Poulain and Guillot (1993), Benimoff and Whitten II (1993), Schweitzer et al (1993) and Faber et al (1993) for more background information on various human factors issues of multimedia.

# Music

## *(Earcons)*

Used in some applications, e.g. PABX, Key systems, etc. as an auditory indication of a current state, e.g. "Still connected, please hold", or to link Audiotex messages. May also be used in very short phrases as earcons (auditory icons), e.g. as an auditory logo, when connecting to an automatic service, or to gain attention to messages.

## *Cross references:*

Acoustic Signals; Auditory Displays

## *Recommendations:*

- ensure that any musical phrases used are reproducible within the limited bandwidth (3,1kHz) of the basic network (PSTN or ISDN).
- ensure the music is presented at a similar volume to acoustic signals, and that the dynamic range is limited to prevent apparent silences and sudden loud bursts.
- ensure the length of the repetition cycle of any musical phrase (excluding earcons) is greater than 150 seconds (2,5 minutes), or exceeds 95% of the expected waiting time on the system.
- ensure popular and recognizable music phrases are completed within their repetition cycle time.
- use a spoken message, e.g. "Please wait, we are trying to connect you" to introduce music on hold. Consider repeating a message, or use subsidiary messages, e.g. "Still trying to connect you" at between 30 and 60 seconds intervals. Consider offering the caller a method to get back to the operator and/or to leave a message.

## *Additional comments:*

Be sensitive to the potential user's listening habits, avoid musical extremes, acoustically harsh electronically reproduced sounds. Consider the fact that the musical quality should reflect the image of the company making use of it.

# National Variations

## *(Language Differences)*

Within the European Community there are differences of language, and social and cultural conventions which need to be accommodated.

## *Cross references:*

Acoustic Signals

## *Recommendations:*

- users should be able to select their preferred European language. During system development store system messages in separate text files so that they are easier to find and translate.
- allow flexible data formats for the following:
  - thousands separators : 1000, 1,000, 1.000, 1 000, 1'000.
  - decimal point : 1.5, 1,5.
  - currency symbols £5, 5DM.
  - date : 25,12,1992, 25/12/1992, 25-12-1992, 25:12:1992, 25th December 1992.
  - time 21:30, 21.30, 9:30 pm.
  - time zone: GMT, CEST.
  - telephone numbers: 12 3456, 12-3456, 12:3456, (12) 3456, [12] 3456, and for international numbers +44 12 3456.
- minimize national variations within icons and symbols; select icons and symbols from agreed international standards or "industry standards". If none are available, use text or evaluate the acceptability of new or local symbols to other nationalities and cultures.
- minimize national variations of labels and text. Use established words or phrases from "common jargon", "controlled language sets" or "industry standard practice". Avoid specialist national words and phrases.
- minimize national variations in acoustic tones and signals transmitted over ISDN, PSTN, or other networks. Use the ETSI agreed set of tones (See Acoustic Signals, ETSI ETS 300 295).

## *Additional comments:*

ISDN terminals may be used throughout Europe where language and cultural differences occur, and by visitors from other countries. The terminals should have the widest possible acceptance by the pan-European market and be readily available for export.

# Non-CRT Displays

## *(Display (Brightness, Colour, Contrast ), Electroluminescent Displays, Flat Panel Displays, Full Dot Matrix Displays, LCDs {Liquid Crystal Displays}, Plasma Displays, VDUs {Visual Display Units})*

Flat panel displays can be used to provide a similar display space to CRT displays. The available technologies include: plasma, electroluminescent, LCD.

### *Cross references:*

Character Displays; CRT Displays; Graphic Displays; Visual Displays

### *Recommendations:*

- use flat panel displays that conform to ISO DIS 9241 "Flat panel display addendum", and ECMA-136 "Ergonomics - requirements for non-CRT visual display units".

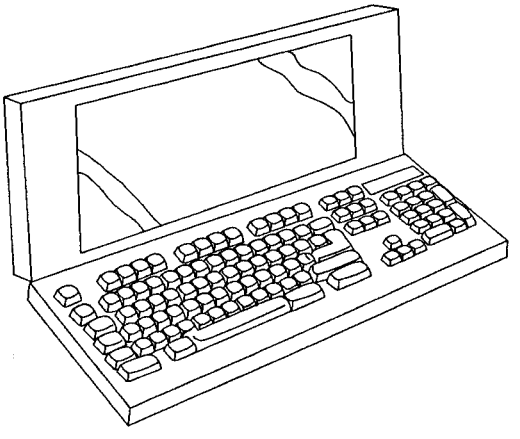


**Figure 67: Example flat screen display**

- flat panel display design should conform to the general requirements of legibility, stability and comfort.
- the display should offer a minimum contrast ratio of 3:1. Provide backlighting for LCD used in low ambient light.
- character height for a capital letter should subtend a minimum angle of 20 minutes at the eye, at the expected maximum viewing distance, typically 500mm. ECMA recommend a minimum character height of 2,9mm (ECMA-136). (See table 11, CRT Displays).
- character dot matrix cell of 9 x 7 dots is preferred with an additional four rows to allow for the ascenders and descenders of lower case letters, accents and interline space.

- use lower case letters for text, with uppercase at the beginning of the sentence and according to national language conventions.
- display should be positioned so that it is at right angles to the line of sight. Provide adjustment to the optimum angle for the user particularly for LCD which has a restricted field of view.

### *Additional comments:*

LCD and plasma displays are usually selected where the task requirements demand the smaller size and reduced power consumption of these technologies compared with CRT, e.g. portability.

When compared with CRT, LCD offers good spatial resolution, and is able to offer colour. The contrast ratio is low and in poor ambient light needs to be back-lighted. Rapid change may cause the image to smear as the old image fades slowly. Plasma displays have a high luminance contrast. Electroluminescent displays have a good luminance contrast that is not dependent on visual angle, and does not wash out in high ambient light. Neither plasma nor electroluminescent are currently able to offer an effective colour display. (Travis, 1991)

The overall requirements for legibility and screen format are the same as for CRT displays. See also ISO DIS 9241 Parts 7 & 8 for guidance with respect to reflections and displayed colours.

# Non-tactile Inputs

Input devices that are independent of touch from the user. Generally relate to electronic conversions of optical, acoustic or magnetic inputs, such as cameras, microphones and card readers.

### *Cross references:*

Bar-Code Readers; Camera; Card Readers; Microphone; Speech Recognition

### *Recommendations:*

- No generic recommendations are offered for this broad group of input devices.

### *Additional comments:*

Non-tactile devices can save the user time, for example, where data is digitized and transferred later. This further reduces task demands and stresses where the user's attention is directed to other activities. Additionally, there are benefits to people with special needs who are unable to operate a standard keyboard.

# Optical Signals

## *(Display {Brightness, Colour, Contrast}, Flashing, Flash Rates, Lamps, LEDs {Light Emitting Diodes}, Lights, Indicator Lights, Panel Lamps)*

Optical signals and lights are the simplest visual display devices. They are usually used to augment a control or label to indicate the current status. They include running (status) lights, panel lamps, warning signals and simple flashing light codes.

### *Cross references:*

Output Hardware

### *Recommendations:*

- status lights should be large enough and bright enough to be seen easily, across the range of expected environmental conditions, without being distracting.

  *Example; for LED displays (Siemens, 1987):*
  - recommended brightness level: 160 candelas/$m^2$ minimum
  - minimum contrast ratio on:off: 5:1
  - angle of view; 160° minimum

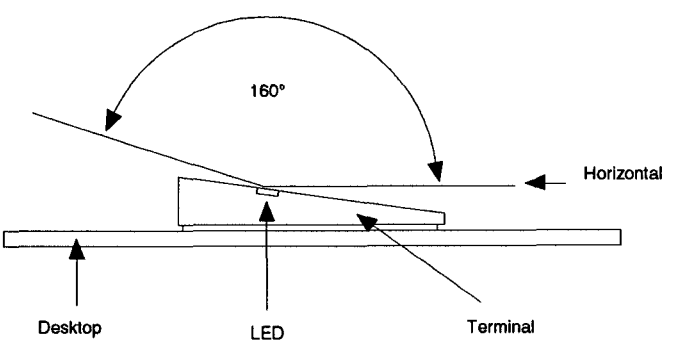



**Figure 68: LED preferred viewing angle**

- use accepted colour coding conventions

  *Example:*
  - red for stop, or danger
  - green for normal or go
  - amber/yellow for caution
  - white/blue for normal conditions
- to attract user attention use a change of colour or flashing light. Supplement with an auditory signal if the condition is urgent, or where user may not be facing the display.
- if flashing is used, limit the number of different flash rates to 2 (preferred) or 3 (maximum) across the complete terminal. (Siemens, 1987)

- preferred rate of flashing light is 3 to 10 flashes per second, with equal on-off intervals. Do not exceed 12 flashes per second. Avoid flash rates with long off periods and short on periods.
- limit the number of status indications on one optical indicator to three or a maximum of four. For example: OFF, ON (steady), ON (slow flash), ON (fast flash).
- position warning signals within 30° of the user's expected line of sight.

### *Additional comments:*

Optical light signals can be used as simple indicators of on-off status, and to attract attention with flashing codes.

The attention getting qualities of optical lights can be improved particularly for people with special needs, by providing a complementary audible signal.

For further information on the requirements for optical signals, in particular LEDs, see Cooper (1977a & b) and Richardson and Cooper (1977).

# Output Hardware

## *(Displays)*

The output hardware is an essential part of the user-system interface by which the user receives information from the system. The user needs to be able to sense the information, primarily using vision or hearing, to recognize it and to act upon it.

## *Cross references:*

Acoustic Signals; Auditory Menus; Character Displays; CRT Displays; Graphic Displays; Labels; Music; Non-CRT Displays; Optical Signals; Speech Output; Tactile Displays; Visual Displays

## *Recommendations:*

- select output hardware that is appropriate to the information requirements of the task. (See table 14).
- ensure display selected meets relevant standards.
- ensure that the user is given sufficient information in a form that is easily recognized and understood, and in an acceptable form.
- when choosing particular output technologies, designers should be aware of the limitations different technologies present to different people with special needs (ETSI ETR 029; RACE Project 1066 IPSNI 1991a, b & c; Nordiska Nämnden för Handikappfrågor, NNH 4/93). In general:
  - choose a modular solution so that alternative output devices can be used.
  - ensure critical warning signals are both audible and visible.

## *Additional comments:*

The choice of output medium should be based upon an assessment of user requirements and task complexity. Simple warnings, and indication of on-off status, can be indicated with simple light signals or warning tones. Status and instruction information can be presented using a small visual display or speech output. Displays of text documents and digitized pictures need to be displayed on high quality screens.

Environmental constraints such as darkness or noise, task dependency on one sensory channel either hearing or seeing, or disabilities in relation to sight or hearing may mean that it is beneficial to offer redundancy in the system by providing output information so that it can be perceived by sight, hearing and touch.

**Table 14 - Output information: summary of user information requirements**

| Type of Information | Output Requirements |
|---|---|
| Status | Display needs to show continuing state, use non-intrusive optical signal. |
| Warning | Demand user attention with auditory tone, flashing light, or provide centrally positioned text message. |
| Feedback | Provide rapid acknowledgement of action, such as audible tone, lamp flash, change of display, tactile feel such as click action of keys. |
| Numeric | Use numeric digital display, consider how to show rate of change, such as dials and clockface, and use of graphs or tables. |
| System Prompt | System needs input/response from user. Use audible signal to gain immediate user attention. Use specific speech or visual message to instruct user. Place visual message central to user's line of sight. Allow user to cancel message if no longer required.<br><br>Integrate display/controls to give soft-key interface or to prompt use of function keys. |
| Text | Use small panels or speech output for text messages.<br><br>For text documents use sufficiently large alphanumeric display, consider CRT of flat panel display. Needs to conform to accepted standards affecting legibility and safety. |
| Pictorial | Use high quality graphics display with rapid display rate to show digitised visual images. |

# Paper Handling

## *(Paper Path)*

This covers the requirements for manipulating paper based inputs and outputs for the terminal and the clearance of paper paths.

## *Cross references:*

Casework; Facsimile Terminals; Hand Sizes; Maintenance

## *Recommendations:*

- if the terminal provides for the feeding of paper master, i.e. for scanning in fax transmission, the orientation of the paper master required by the terminal should be clearly indicated and obvious. Orientation includes face up or down, short or long edge leading and left, right or centre registration.

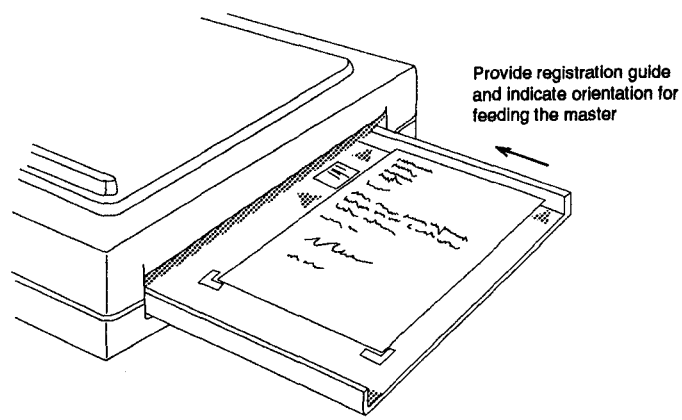



**Figure 69: Example paper registration/orientation guide**

- if the terminal provides an automatic or semi-automatic feed mechanism, there should be sufficient space to support the standard paper size used (normally A4) on the input side, a similar receiving area on the output side, and a clear indication which is which. (Williams, 1983). If the terminal provides only for manual or semi-automatic feed, clear indications should be given when to insert follow on pages.
- if the terminal provides for the output of printed paper sheets, i.e. for receiving transmitted faxes, it is good practice to provide sufficient clear space to collect and support the pages output.
- depending on the printing technology, it may be helpful to provide an earthing mechanism to minimize any static electricity build up on the printed pages.

- if continuous stationery is provided, either from fold or roll, it may be helpful for mechanisms to be provided to separate and if possible stack the pages sequentially. If such a facility is provided, it could be a user option to set the size of the cut sheet to enable larger than A4 pages to be received.
- whatever stationery is used, provide a clear visual (and perhaps auditory) indication, well in advance of the last sheet, that new paper will be needed.
- provide access to the paper supply area by a simple single action e.g. pull out paper tray, push button to realise lid, etc.
- if fan fold or paper roll stationery is used provide sufficient clearance within the paper store area for gripping, placing and adjusting the new paper supply. Ensure the direction of feed (under or over for paper rolls) and the paper path through the print mechanism is clearly indicated. Ensure the paper lead can be cleanly inserted and fed into the printer mechanism if this is a user task.
- provide suitable warning indicators if the new paper is loaded incorrectly. If possible, design the paper housing area to make incorrect loading difficult. If incorrect loading is possible, ensure that it is simple to remove the incorrectly loaded paper, without the need for tools, and with minimum damage to the paper stock.
- if cut sheet paper is used, ensure the paper tray gives clear indications of the required orientation(s) and maximum loads the tray can accommodate. If possible, consider avoiding the use of corner retaining lugs within paper trays, or direct paper loading to enable the new stock to be sited correctly under the lugs.
- consider the user's requirements for clearing paper jams within the scan and print paper path. Provide clear indication when a jam has occurred and consider offering the options to end any current transmissions relating to the paper jam.
- provide access to any paper path by a single simple control action. If possible enable the user to visually inspect the whole paper path when opened.
- avoid the need for tools to clear paper jams. If special tools are required ensure they are supplied with and stored securely within the terminals casework, and accessible when the paper path is opened. Provide sufficient clearance space for 95th percentile hands to clear the paths of paper. (See Hand Sizes)
- provide clear warning labels and guidance for any part of the path that may include hazardous elements e.g. heater, units.
- on the scanner or input side, make every effort to ensure paper jams can be cleared with minimal damage to the original master document.

### *Additional comments:*

The designer should be aware that the stereotype response for users who realise they have inserted the master incorrectly may be to attempt to grab back the master. Where possible, this stereotype should be supported, rather than forcing the user to complete the feed, at least for the majority of masters on the input stack.

When designing the paper path for a facsimile terminal, consider that the user may have to read, dial and check the fax address after the leading paper edge has been inserted.

# Phone-based Interfaces

## *(Analogue Display Services Interface (ADSI), Code Schemes, Stimulus Protocols)*

Many of the new services offered via ISDN and other networks can be initiated from a standard telephone, from which the only control entry keys are the 10 numeric keys, * (star) and # (square).

### *Cross references:*

Acoustic Signals; Auditory Displays; Auditory Menus; Speech Output; Supplementary Services; Telephone Keypads; User Dialogue Design Principles

### *Recommendations:*

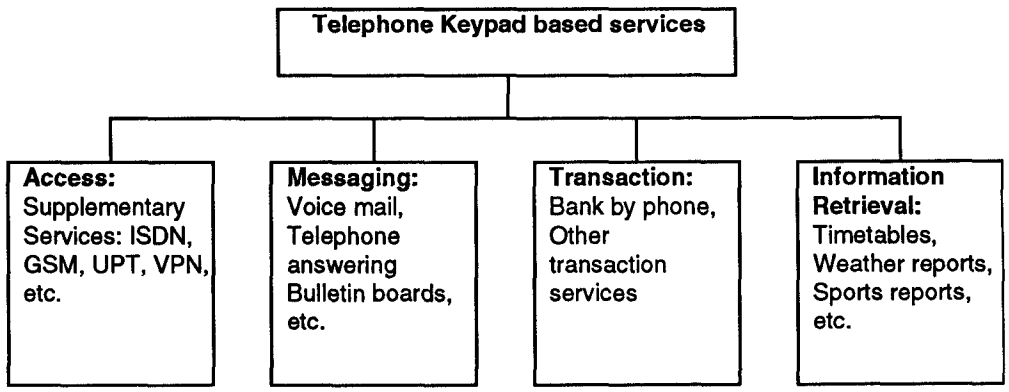
- as a minimum, provide tones as feedback to confirm entries and indicate error states. In preference, provide voice messages and speech output to identify services and to give prompts to help the user through the procedures and activities.
- numeric data entry is preferable to alphabetic data. If alphabetic data is necessary, avoid shift functions on the numeric keys, use the ITU-T preferred alpha key arrangement to code a data entry mnemonically. (ITU-T Recommendation E.161)
- minimize opportunities for user error by keeping data entry strings short and simple, and allowing for error correction.
- arrange menu items with most frequently used items first.
- allow "cut through", whereby users can enter required commands without having to wait for the full message. An exception to this is where a service is unavailable and the user needs to receive explicit information.
- clearly distinguish between menu options and commands. Offer commands to access help, language selection, back step and main menu, preferably available at all times in the dialogue.
- offer prompts if the user fails to respond.
- allow user to interrupt and cancel current activity and transaction.

### *Additional comments:*

At the time of going to press ITU-T were developing a new recommendation offering guidelines on the design of interactive services (ITU-T Draft Recommendation F.902). In addition, ETSI has produced a separate set of guidelines for the design of Minimum Phone-based User Interfaces (ETSI ETR 096). ETSI is also working on the definition of a minimum man machine interface for the access and control of public network services (ETSI DE/HF-01017); and ISO/IEC JTC1 are working on design guidelines for Voice Mail systems (ISO/IEC JTC1 CD 13714). See also France Telecom (1991) and Martin et al (1990).

There are a growing number of services being developed and intended to be accessed from the 12 key telephone pad. A simple taxonomy subdivides these services into Access, Messaging, Transaction and Information Retrieval.

**Table 15: Taxonomy of phone-based services**




Although the phone based interface will ensure widest possible availability of the services, its very simplicity creates usability difficulties. Every support needs to be offered within the dialogue design to minimize memory load and reduce impact of keying errors. The only available mode for doing this, is the auditory mode using tones and speech messages. The user's task would be made easier if, as a minimum, the telephone incorporated a small visual display.

Many U.S.A. based telephone service providers are now supporting the use of a new style of user interface for phone based services. The AT&T development, ADSI (Analogue Display Services Interface), uses a small character based display with soft-keys for accessing and controlling via interactive dialogues. (Schwartz, 1993).

# Pointing Devices

### *(Cursor Controls, Controls)*

Input devices which allow emulation of the pointing action of the user on a visual display. All these devices can drive a cursor either to position it over a screen element to enable the dialogue to proceed using that element, or to draw a figure/character on the screen.

### *Cross references:*

Cursor Keys; Data Glove; Eye/Head Movement; Foot Mouse; Graphics Tablet; Joysticks; Light Pens; Mouse; Roll balls; Stylus; Touch Screens

### *Recommendations:*

- when choosing a preferred pointer device for a particular terminal, consider the users' primary and secondary tasks, and refer to the table 16 below.
- consider the advantages of enabling a variety of pointing devices to be used, it may open the terminal to people with special needs, and provide other users with more flexibility. (RACE Project 1066 IPSNI 1991a, b & c, Nordiska Nämnden für Handikappfrågor, NNH 4/93).
- consider how the pointing device might be used and integrated with other input devices (built into a single unit) to support the user's tasks (Baraket et al, 1987).

### *Additional comments:*

Table 16 presents a comparison of different pointing devices in relation to two different sets of user tasks. See also ISO DIS 9241 Part 9 for requirements of non-keyboard input devices, and Janet (1982) for consideration of pointing devices for controlling a VDU cursor.

**Table 16: Comparison of pointing devices across two sets of user tasks**

| | Pointing/ Indicating | Selecting e.g. menu items | Selection No. of choices | Tracking | Tracing/ free-hand drawings | Dragging Objects | Speed of position-ing |
|---|---|---|---|---|---|---|---|
| **Cursor Keys** | Fair | Extra Key | 2 (Enter or Cancel) | Fair | No | Poor | Fair-Slow |
| **Data Glove** | Good | Good | ? | Fair | ? | Good | ? |
| **Eye/head movement** | Good | Fair | ? | Good | ? | Fair-poor | ? |
| **Foot Mouse** | Fair | Fair | ? | Fair | No | Fair | Fair |
| **Graphics Tablet** | Good | Extra Key-Good | Many | Fair | Good | Fair | Good |
| **Joystick** | Good | Extra Key | 1 or 2 | Good | Poor | Fair | Good |
| **Light Pen** | Good | Good | 1 at a time | Fair | Fair | Fair | Good |
| **Mouse** | Good | Extra Keys -Good | Up to 3 | Fair | Fair | Good | Good-Fair |
| **Roll Ball** | Good | Extra Keys | 1 or 2 | Good | Poor | Good | Good |
| **Stylus** | Good | ? | ? | ? | Good-Fair | Good-Fair | Good |
| **Touch Screens** | Good | Good | 1 at a time | Poor | Fair-Poor | Fair-Poor | Good |

| | Position-ing Accuracy | Space Require-ments | Eye/Hand Co-or-dination | Un-obstructed view of display | Parallax Problems | Low Cost | Free to position in work-place |
|---|---|---|---|---|---|---|---|
| **Cursor Keys** | Good | Small | No | Yes | No | Yes | No |
| **Data Glove** | ? | Special | Yes | Yes | No | No | Yes |
| **Eye/head movement** | ? | Special | N/A | Yes | No | No | No |
| **Foot Mouse** | Poor | Small | N/A | Yes | No | Yes | Yes |
| **Graphics Tablet** | Good | Large | No | Yes | No | Fair | No |
| **Joysticks** | Fair | Small | No | Yes | No | Fair | No |
| **Light Pens** | Good | Small | Yes | No | Maybe | Yes | Yes |
| **Mouse** | Good-Fair | Fair | No | Yes | No | Yes | Yes |
| **Roll Balls** | Good | Small | No | Yes | No | Fair | No |
| **Stylus** | Good | Small-None | Yes | No | Maybe | No | No |
| **Touch Screens** | Fair | None | Yes | No | Possible | Fair | No |

# Portability

## *(Carrying, European Directives, Manual Handling, Repetitive Strain Injury (RSI))*

This is the facility to pick up and carry, to relocate or to use the terminal or one of its modules.

## *Cross references:*

Hand Sizes

## *Recommendations:*

- where possible make the terminal or its modules compact and light enough for one person to lift and carry short distances, 16kg maximum (Mil-Std-1472C).
- consider the requirements for lifting and carrying terminals, for example, as part of normal installation, and provide carrying points or handles large enough to accommodate 95th percentile fingers or hands (Pheasant, 1986) with recesses, grooves or textured surface to aid gripping (Mil-Std-1472C).
- position carrying points or handles over, or symmetrically distributed to the sides of, the units centre of gravity, to ensure stable, clean lifting (Woodson, 1981).

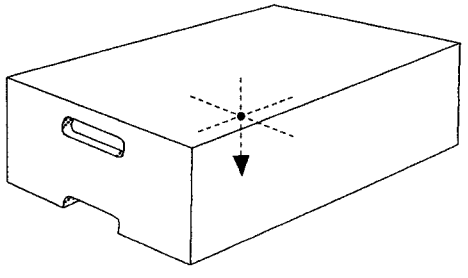


**Figure 70: Handholds in relation to centre of gravity**

- fully portable terminals shall be as light as possible. Controls should not intrude into the main handling area, which should be contoured to present a comfortable surface.
- if the terminal is designed to be pocketed or carried in a pouch, the terminal surface should not have any projections likely to snag on pocketing or removal.
- if the terminal is designed to be operated when hand held, provide the main controls above the centre of gravity and the main handling point below the centre of gravity. Also, ensure the terminal maintains a stable position when it is operated on a desk top or in a holder. Make sure it has four points of contact if the base is not flat.

**Figure 71: Smooth sided pocket terminal**

- provide a mechanism for relocating misplaced portable terminals, e.g. an acoustic signal triggered from a base unit.
- fully portable equipment should have the centre of gravity close to the approximate centre of the casework, to ensure it is well balanced when handled.

## *Additional comments:*

More than a quarter of all reported industrial accidents are associated with manual handling. There are also a very significant number of working days lost each year through back pain, frequently caused by the inappropriate lifting of manual loads. The European Directive (90/269/EEC) lays down some very basic guidance on how some of these problems can be avoided. The provision of proper handholds and the limiting of the overall weight of separate terminal modules could go some way to helping alleviate this situation.

# Printed Displays

The presentation of alpha-numeric characters, pictures or abstract symbols by printing, engraving or etching. This information may be on the product casework, controls, or attached labels.

### *Cross-reference:*

Handbooks; Labels; Symbols; User Guidance

### *Recommendations:*

- use printed, etched (and filled) or moulded displays to identify controls and displays on the equipment. Avoid the use of condensed, italic, light, or narrow fonts when labelling controls.
- ensure markings on casework and controls are sufficiently durable for the life of the equipment. Be especially concerned with markings that need to be placed in any user handling areas.
- provide printed labels and handbooks to offer user guidance, support user learning, and the safe and efficient use of the equipment.
- ensure printed material is clear, legible and easily understood by the user. Test prototype texts on representative users.

### *Additional comments:*

For further details see the entries listed in each of the cross-references.

# Pushbuttons

## *(Buttons)*

A control input device where a push action on the part of the user makes a contact to signal the input. Momentary pushbuttons maintain switch contact only as long as they are held down. (The control function may be maintained as long as the contact is held, e.g. doorbell, or may initiate a state change, e.g. Off to On). Latching pushbuttons maintain switch contact for as long as they remain latched. The latched pushbutton may be released by a second finger push on the same button, or by pushing an alternative button in a group of buttons (radio-button style).

## *Cross references:*

Alphanumeric Keyboards; Keyboards; Keys; Labels; Switches; Telephone Keypads

## *Recommendations:*

- pushbuttons for finger operation which are not pressed below the surface of the device's casework should have similar dimensions etc. to keys. (Mil-Std-1472C):

  - minimum surface 113mm$^2$, with minimum dimension 12mm.
  - travel 1-8mm and force 0,25-1,5N (snap action feedback).
  - clearance 9mm minimum radius from centre.

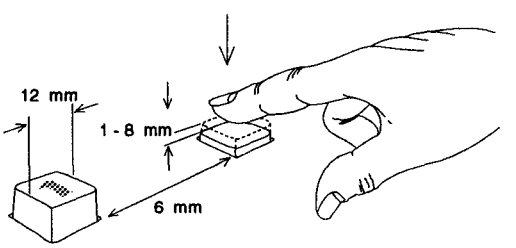



**Figure 72: Raised pushbuttons - recommended minimum dimensions**

- pushbuttons for finger operation which go below the surface of the casework have different requirements (Mil-Std-1472C):

  - minimum dimension 19mm in any direction.
  - minimum travel 3mm (5mm for latching switches).
  - minimum force 2,8N (5,6N if used in a moving vehicle).
  - minimum width 3mm between adjacent pushbuttons.

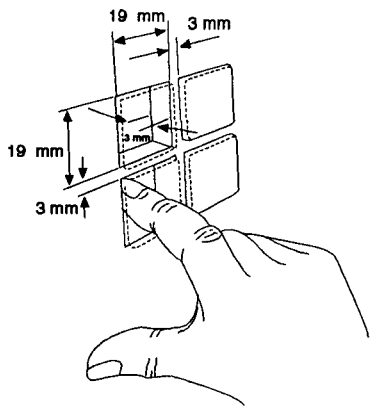



**Figure 73: Recessed pushbuttons - recommended minimum dimensions**

- pushbutton activation should be indicated by tactile feedback, e.g. snap-action, hard stop, or click.

## *Additional comments:*

Pushbuttons and keys are for most design engineers one and the same thing. The separation in this ETR is largely artificial, but does allow different features to be discussed.

# Response Times

## *(System Response, Timeouts)*

Response time is the time taken for the system to respond to the users inputs or commands.

## *Cross references:*

Call Handling; Feedback; User Interface Design Principles

## *Recommendations:*

- in principle, response times, from control activation to displayed result, should be as short as possible.
- immediate execution or acknowledgement should be offered as the result of single key strokes (maximum 0,03secs) or simple commands (maximum 2,0secs). Longer delays to more complex commands can be tolerated (maximum 15 seconds), (See table 17).
- unpredictable and variable response times are not acceptable (maximum variation ±10%). In practice, users will accept small delays to maximize response time consistency. For example, terminal generated responses times should try to be consistent with those of the network, for similar user features.
- where long delays are the result of task complexity or network constraints, immediate acknowledgement should be given together with an indication of how long the delay will last with an option to abort if the delay is unacceptable. In general, delays likely to be longer than 1 or 2 seconds should be supported by an acknowledgement, e.g. "Please wait"; and delays longer than, say 10 seconds, should give an indication of the possible delay length or percentage of task complete.
- consider whether tasks that necessarily take a long time, such as a file transfer or printing, may be carried out automatically as a background operation while the user performs other tasks.
- ensure timeouts at any part of the dialogue do not affect people who may be slower than normal in entering control responses to dialogue requirements, particularly if there are amounts of data to be assimilated/comprehended. Follow the principle of the user being in control at all times. Ensure that the dialogue is patient and forgiving to user delays, without being condescending.
- ensure timeouts do not inadvertently cause loss of data, particularly if the user has paid for it as part of a communication.
- in general, ask the user to confirm timeouts before disconnecting or losing a dialogue. Possible exceptions include situations where the current displayed information is security sensitive, or personal; even then consider the option of screen savers with passwords, etc.

## *Additional comments:*

As a general guide response times should match the speed and flow of human thought processes. Table 17 shows recommended response times. It is extracted from CCITT Com II-111 (1987). Similar tables are frequently quoted in human factors design guides, and seem to be based on two sources, Gallaway, 1981 and Miller, 1968.

It has been found that as systems improve and users gain more experience, lower response times may normally be expected. This should be balanced against the finding that some response times may be felt by the user as too fast, forcing the operational pace and causing stress. For more information see Chin (1993), Furner (1983), Kitawaki and Itoh (1990), and Lupker et al (1988).

**Table 17: Recommended response times**

| User activity/task | Time | Telecommunications examples |
|---|---|---|
| Reaction to key actuation | 0,1 sec | Audible or tactile confirmation of successful key actuation.<br>LED signal as a status check.<br>Displaying an entered character on a visual display.<br>Switching on a loudspeaker, microphone.<br>Switching through a connection. |
| Display of short and simple guidance information that can be taken at a glance | 0,5 sec | User prompts.<br>Error messages.<br>Reception of a system's ready status, e.g. dial tone on lifting handset.<br>Information on single or two line displays, e.g. display texts for telephone applications.<br>Paging through a list or menu on a line display.<br>Paging through a telephone directory or notepad.<br>Displaying document headings when paging through a document file.<br>Calling up a menu, displaying the following menu. |
| Display of large amount of complex information that needs to be read | 1,0 sec | Opening a document in an activated program.<br>Displaying the next page in the document.<br>Displaying a document section selected by means of scroll bars.<br>Calling up a complex operating field or dialogue box.<br>Terminating a program. |
| Simple inquiries | 2,0 sec | Activating a service or program with a function key, menu item or icon.<br>Ringing tone and busy tone after dialling.<br>Status interrogation, e.g. services on an ISDN feature telephone.<br>Reaction after insertion of a chip card.<br>Making up a page.<br>Manipulating graphics.<br>Calling up a specific page in a long document. |
| Complex inquiries | 5,0 sec | Identification at a terminal.<br>Opening a document, including activation of associated processing program.<br>Making up an entire document.<br>Interrogating a database. |
| Program loading and execution | up to 15,0 sec | Resuming a defined work status.<br>Loading long programs.<br>Executing complex programs.<br>Automatic layout processing performed on long documents (more than 10 pages), e.g. dictionary-based syntax checks, teletex to telex format conversion, word searches, search and replace operations. |

# Rocker Switches

An input device where the keytop is used with a rocking motion to select one of two or at most three states.

## *Cross references:*

Pushbuttons; Switches; Toggle Switches

## *Recommendations:*

- be aware that the current setting of a rocker switch can be ambiguous. Consider supporting with indicator light(s) or other display changes.
- use rocker switches when a protruding toggle switch may be accidentally switched on or is a safety hazard.
- be aware that rocker switches are acceptable for two position switches, they are not recommended for three or more positions. They can be used for momentary switches (if spring loaded), but keys or push buttons are more usual.
- use rocker switches with the following dimensions: (Pheasant, 1986, Mil-Std-1472C)

| | |
|---|---|
| - rocker length | 12-50mm |
| - rocker width | 6-25mm |
| - displacement | 30° |
| - force | 0,15 - 1,0N |
| - separation | 15-50mm |
| - height depressed | 3mm |

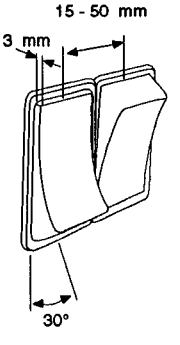



**Figure 74: Example rocker switches**

## *Additional comments:*

None

# Roll Balls

## *(Tracker Balls)*

An input device consisting of a small ball rotating freely in a fixed bed, with sensors to detect orthogonal movement which is digitized. It is usually fitted with 1 or 2 specific keys for co-ordinated control of point and select, etc. The control provides relative movement of a screen cursor in response to the direction the ball is rolled.

## *Cross references:*

Joysticks; Mouse; Pointing Devices; Touch Screens

## *Recommendations:*

- provide adjustment of the display control ratio i.e. the speed of movement and distance the cursor moves in response to the speed and distance the ball moves.
- suitable for mobile devices or for equipments that have to be used in moving environments (on ships, planes etc.). Provide space for forearm and wrist support, to enable the ball to be rolled with the fingers. A switch may be necessary to disengage the ball when it is not being used.
- avoid using for drawing tasks.
- if the roll ball can control the cursor beyond the current active screen area, provide indication on the edge of the area on the current direction of the cursor (Mil-Std-1472C).

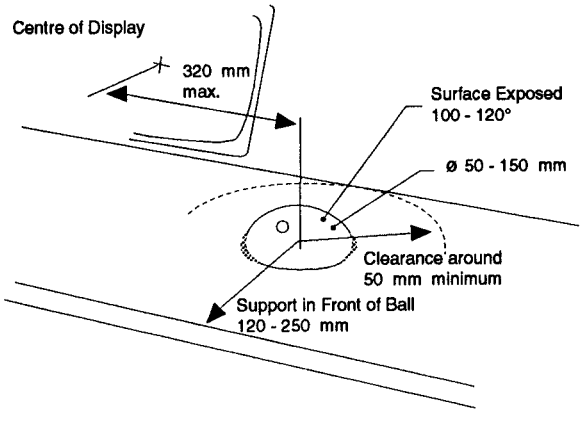



**Figure 75: Example roll ball**

- use a ball within the following dimensions:

  - diameter 50-150mm
  - surface exposed 100°-120°
  - resistance for precision 0,3N preferred (1,0N maximum)
  - resistance in moving environments 1,7N maximum
  - clearance around ball 50mm minimum
  - wrist arm support in front of ball 120-250mm
  - distance from centre line of relevant display 320mm maximum

- be aware that smaller roll balls may make precise control more difficult.

### *Additional comments:*

Roll balls require minimum space and enable rapid movement of a cursor across a large screen. They also require minimum effort and may be used by people who tire easily, e.g. muscular dystrophy and multiple sclerosis.

# Rotary Controls

## *(Knobs)*

A control input device for selection of desired value of a continuous variable by a rotary action.

## *Cross references:*

Analogue Controls; Linear Sliders; Thumb Wheels

## *Recommendations:*

- the direction in which the controlled variable increases is always to the right, i.e. clockwise, irrespective of where the control is situated. (Siemens, 1987).

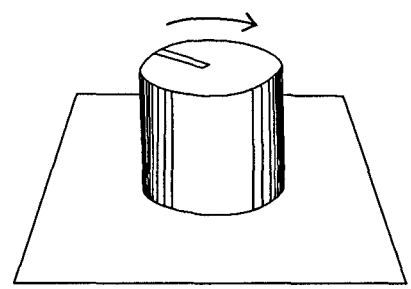


**Figure 76: Example rotary control**

- provide labels and legends which are parallel to the direction of motion, i.e. circular, as a wedge with the thickest part to the right. Give indicated values if required. (Siemens, 1987).
- provide a mark on the control to indicate the current set value if required. (Siemens, 1987)
- use rotary controls with the following minimum dimensions:
  - thumb/finger grip - 13mm diameter, 13mm high.
  - five finger grip - 25-75mm diameter, 13-25mm high.

  The finer the degree of control needed, the larger the control diameter that is necessary, up to the maximum for one hand (75mm). (Woodson, 1981).
- use knobs with straight sides and clear serrations with sharp peaks.
- use controls with the following maximum torque requirements:
  - thumb/finger grip up to 25mm diameter up to 0,032Nm.
  - five finger grip greater than 25mm diameter up to 0,042Nm.

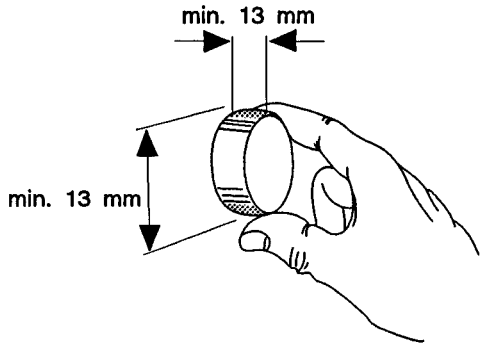



**Figure 77: Rotary knob - recommended minimum dimensions**

- if smaller knobs are essential, ensure that they are used only for occasional setting tasks and have minimum dimension of 6mm diameter, 13mm height from casework. (Woodson, 1981).

### *Additional comments:*

None

# Rotary Switches

## *(Knobs)*

A control input device where selection of discrete desired value is made in a rotary manner.

## *Cross references:*

Analogue Controls; Key Operated Switches; Switches; Toggle Switches

## *Recommendations:*

- provide a pointed knob with clear indication of which element is the pointer.
- use switches with the following dimensions:
  - length 25mm minimum
  - depth 16mm minimum
  - torque 0,1Nm minimum
  - rotation between switch positions, 15° minimum, 90° maximum (30° preferred minimum rotation, especially if the user is unsighted or visually impaired)

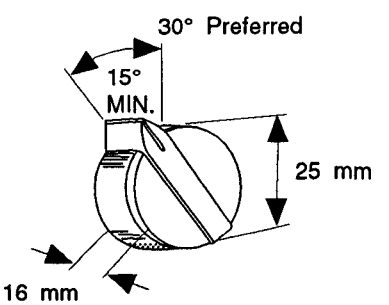



**Figure 78: Example rotary switch**

- provide a detent or indent to give tactile feedback when the control is in the next switch position, provide a stop at both ends of the range.
- use switch to move pointer to different functions or scale values. Do not use to move scale or functions past a fixed point.
- avoid having switch positions directly opposite each other (180° apart).
- if banks of rotary switches are used for different functions, allow for consistency of orientation when all are at normal operating position, to simplify check reading.
- make sure the knob pointer is close to the position markers to minimize parallax errors.

- available for three or more position selections, not usually preferred for two position selection. (Two position switches can be effectively used in mimic panels to indicate flow lines open or closed, they can usually be turned either way to open or close the line).
- provide a label or legend for the control and for each control position.

### *Additional comments:*

None

# Safety

## *(European Directives, Health and Safety, Repetitive Strain Injury)*

This covers all aspects of personal safety from physical, electrical, thermal, chemical or biological hazards.

## *Cross references:*

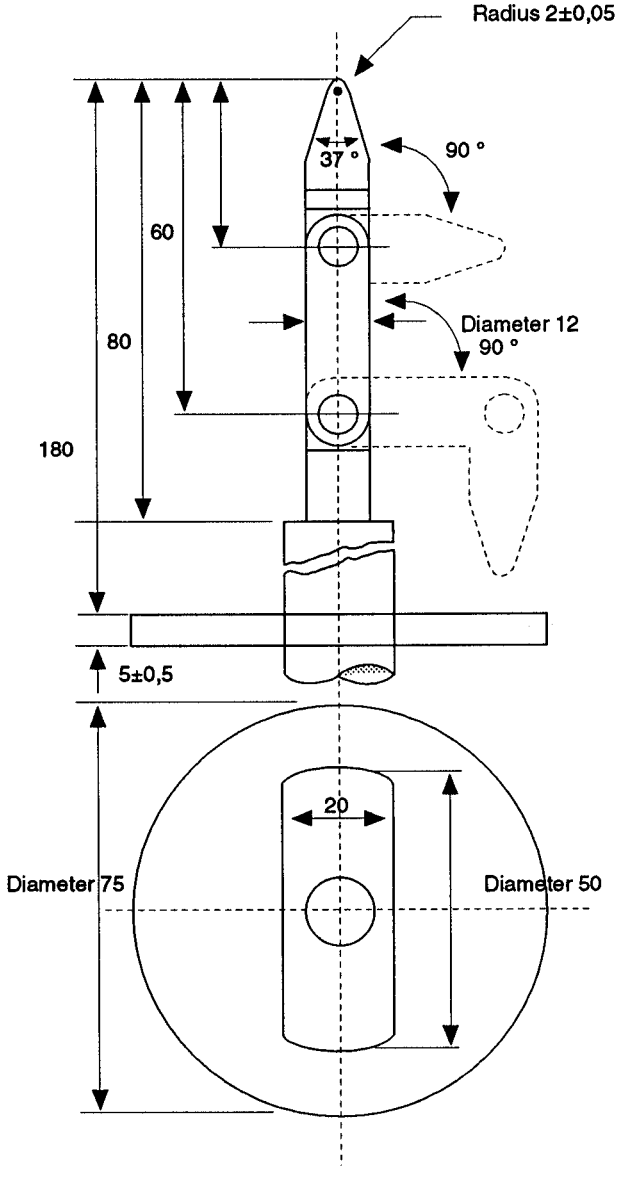
Alphanumeric keyboards; Casework; Connectors; Maintenance

## *Recommendations:*

- the casework should have no sharp edges or corners, particularly in areas or on modules that the user needs to handle or touch within any part of their normal or maintenance tasks.
- the casework should not present any split lines or pinching joints within handling and touching areas.
- if the terminal integrates a CRT display and keyboard there should be no sharp edges or corners. Edges should be radiused not less than 1,5mm and corners not less than 3mm (ISO DIS 9241).
- the material of the touchable surfaces during normal operation should be electrically and thermally non-conductive (CEN prEN 563, ISO DIS 9241 Part 4).
- the material of the touchable surfaces during normal operation should be chemically and biologically inert, particularly to household and office cleaning agents.
- the material of the touchable surfaces during routine maintenance operations, including clearing paper jams, replenishment of consumables, etc. should not present an electrical or thermal hazard. Where surfaces might provide such a hazard, adequate protection mechanisms and warning labels should be used. The recommended maximum temperature for touchable surfaces is dependent on the type of surface and the likely duration of the touch. For touches less than 4 secs the maximum for any surface is 60°C, for touches up to 10 mins, 48°C, and for touches over 10 mins, 43°C. (Siekmann, 1990)
- the equipment should be constructed to give adequate protection against user contact with Telecommunication Network Voltage (TNV) circuits that carry voltages which exceed 42,4V peak or 60V d.c. under normal operating conditions. (CENELEC EN 41003). Compliance involves the use of a test finger (CENELEC EN 60950 figure 10) which shall be applied with a force of 10N and shall not contact TNV circuits in operator access areas. The only exceptions are connectors which cannot be touched by a test probe (CENELEC EN 41003 figure 3, See Connectors) and equipment intended for installation in a restricted access location.
- all terminals should be supplied to the user with all necessary cabling, plugs and sockets complete. The user should not be expected to connect cables to sockets or to wire plugs.

### *Additional comments:*

Repetitive strain injuries is the common collective term for a number of musculo-skeletal conditions usually affecting the upper limbs (shoulders, arms, wrists, hands and fingers), which can severely affect users ability to use hardware input devices. As the name suggests these appear to be caused by repetitive actions. Poor and constrained working postures, for example, when working at a desk that is too high and the psychological stress of a heavy workload are also contributing factors. Where a screen based terminal is used for a substantial part of the working day, the design of the keyboard, screen, desk, chair, the software, the environment and the job design are all subject to the minimum requirements of the European Council Directive 90/270/EEC. It is, furthermore, good design practice to consider these elements in order to ensure the health and safety of users of any equipment.




All dimensions in millimetres

**Figure 79: CENELEC EN 60950 recommended test finger**

# Screen Formatting

### *(Display Layout, Legibility, Screen Size)*

Screen formatting applies to the layout of the information shown on the screen.

### *Cross references:*

Character Displays; CRT Displays; Graphic Displays; Non-CRT Displays; Screen Messages; User Interface Design Principles

### *Recommendations:*

- minimize the amount of information by presenting only what is necessary.
- decide on a format that is orderly, clutter free, and aesthetically pleasing.
- group related information according to user conceptual relationship, sequence, frequency of use, importance, chronological sequence or alphabetic order.
- develop a consistent layout that helps the user to find the required information:
  *Examples:*
  start from the top left of the screen.
  use a distinctive title for the screen or window.
  reserve specific areas for specific types of messages.
  group related information using blank space, lines, intensity or colour.
- when screen space is very limited (e.g. 2 line display) use a consistent strategy, e.g. line 1 for working information and line 2 for control information.
- when screen space is limited (e.g. less than 10 lines) display the information in the following order of priority:
  1 responses to keying by user.
  2 user guidance e.g. prompts.
  3 system event messages.
  4 display information e.g. menu items.
  5 permanent messages e.g. call forward on.
  6 idle state messages.
- locate information according to user expectations. In Western cultures people will usually start searching from the top left as they do when reading.
- distinguish titles and captions by coding with a larger font size, bold typeface, or upper case letters. Separate from the main text if space allows.
- avoid abbreviations except where space is limited in which case:
  - use internationally accepted abbreviations.
  - use a consistent scheme for creating abbreviations.
  - provide a dictionary of abbreviations.
- information should progress from generalities to specifics.

- for ease of reading limit line length to 40 to 60 characters per line and increase interline spacing.
- text for reading should be presented in lower case lettering, even letter spacing, line spacing in the ratio 1:2 and line length of no more than 60 characters.
- use cues to aid search and retrieval such as consistent location, colour, highlighting, flashing.
- parts of the screen may be coded by using up to two levels of brightness and using different colours of foreground, or background.
- flashing should be reserved for critical attention getting with a flash rate cycle of 2 to 5 Hz, and with a minimum on-period of 50%.
- use colour coding sparingly and use other coding devices where some users may have monochrome display units.
- when creating control key dialogues using soft-keys, position display elements close to control keys.

### *Additional comments:*

Users look to the screen to search for feedback, system prompts, status information and to read text. Search times of small and large displays can be greatly improved by using a logical format. Colour should be used conservatively in order to avoid creating colourful confusion. In preference, design the screen formats for monochrome presentation first, then add colour as an enhancing, attractive supplement, not as a necessity. (IBM, 1991a; Perris, 1993).

Consistency is a particularly important principle in screen layout design so that the user can quickly learn where to scan for the information required. At the same time it is important to provide variable features so that the user can recognize different types of information, or changes that have occurred.

See also: ISO DIS 9241 Part 12, Gallitz (1985), Herlong and Williges (1988), and Tullis (1988) for more information on screen formatting. For specific information on screen formatting for graphical and other user interfaces, refer to the relevant style guide: Apple (1992), BT (1991), GO Corporation® (1992), IBM (1989, 1991a & b), Microsoft® (1992) and Siemens/Nixdorf (1990a & b).

# Screen Messages

## *(Indications, Legibility)*

Within the user interface design, one of the main modes of communication from the system to the user is by displaying information on the screen as a message.

## *Cross references:*

Error Management; Feedback; Help; Labels; Screen Formatting; User Guidance

## *Recommendations:*

- use screen messages to give instructions, to offer available choices of actions, and to provide error messages and status information.
- messages should be short, factual and informative, avoid the extremes of being authoritarian or too familiar.
- use lower case lettering for the main part of the text with only the initial letter of the sentence in capitals.
- use short sentences and familiar words.
- avoid technical terms, jargon and abbreviations.
- use an active verb structure, and, when giving instructions, place verb first and object second e.g. "Press cancel key".
- use the positive "Do" construction in preference to negative "Don't"

## *Additional comments:*

The tone of the message should be factual and informative so that the user clearly understands what to do and what to do next. Humour may not translate well into other languages and over-familiarity may cause offence in different cultures.

Legibility and speed of reading is best served by using mainly lower case text, ensuring adequate interline spacing.

See also: ISO DIS 9241 Part 12, Gallitz (1985), Herlong and Williges (1988), Tullis (1988), and Perris (1993) for more information on screen messages.

# Security

## *(Locks, Passwords, Log-on)*

Material transmitted over the ISDN network should not be capable of interception or redirection by accidental or deliberate unauthorized methods or persons. Data security is possible at three levels. Firstly, to protect from the effects of accidental human error, for example, using an incorrect address, or an incorrect procedure. Secondly, to protect from unauthorized and possibly malicious attempts at access or interception. Thirdly, to protect calls and transmission quality from the results of computer or network failure.

## *Cross references:*

Error Management; Supplementary Services

## *Recommendations:*

- user authority to access secure systems or networks should be established during the initial log-on procedure.
- commensurate with security requirements, ensure that log-on can be accommodated within a single transaction.
- provide mechanisms to help rapid user recovery from simple syntax/data entry/keying errors.
- consider the use of double passwords for additional security in exceptional circumstances.
- consider setting a low maximum limit for unsuccessful attempts.
- prevent data loss at log-off, indicating if there are current transactions to be completed.
- minimize effects on voice, data, fax and picture transmissions due to loss of transmission quality, loss of service or disconnection.

## *Additional comments:*

From the user's viewpoint there is a need to minimize the effect of incorrect data and procedures and to prevent the loss of needed data. This can be achieved by including error checking routines that reject illogical and obviously incorrect entries. In addition, any commands or procedures that might lead to a catastrophic loss of data should be verified with a clear statement of the effect of the action.

As regards unauthorized and malicious entry into a system, it is important to balance the level of risk and possible damage, against the continuous inconvenience of a complex authorization sequence.

# Slider Switches

A control input device where discrete positions are selected with a sliding action.

### *Cross references:*

Rotary Switches; Switches; Toggle Switches

### *Recommendations:*

- available for multiple position switches (2 or more positions), not suitable for momentary switches.
- use switches for finger tip pushing with an activation force of 1,5-2N and which travel more than 3mm between switch positions. Larger sliders for finger/thumb gripping can have a higher activation force 2-3N and should travel further (5mm minimum) between switch positions. (Siemens, 1987)

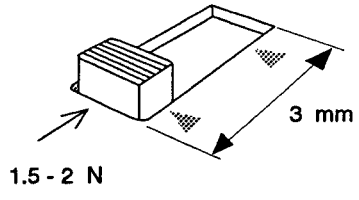



**Figure 80: Example slider switch**

- use separate switches for separate groups of functions e.g. ringer selection (Off, Ring A, Ring B, etc.), keyboard signalling (digital, DTMF).
- provide labels or legends for the switch and the switch positions. Ensure a good relationship between the switch position and its respective label.
- provide a detent or indent to give tactile feedback when the switch has reached its new position, and to prevent accidental movement.

### *Additional comments:*

None

# Speech Output

## *(Messages, Recorded Messages, Synthetic Speech, Voice Messages)*

Speech output includes the use of recorded natural and synthetic speech used to give information or feedback to the user.

### *Cross references:*

Auditory Displays; Auditory Menus; Phone-based Interface; Speech Recognition

### *Recommendations:*

- selection of speech output should be based on a full assessment of the task requirements (CCITT Recommendation E.183).
- for maximum intelligibility of speech output recorded natural speech is preferable to concatenated speech, with synthetic speech ranked third.
- speech output has an advantage where the user needs to be free to attend to other tasks such as watching a visual display or driving, or is unable to read because it is too dark, or the user is visually impaired.
- speech output may be considered in telecommunications to provide feedback, to give messages and provide instructions when there may be no visual display available.
- minimize the load on human memory by allowing users to hear the message repeated, and to enter commands or data immediately and not to have to remember and wait to the end of the message.
- consider whether the message should be available in more than one language for international visitors or international calls.
- evaluate and test speech messages for intelligibility, understanding and user acceptability during development with representative users. Aim for a high acceptance criteria, e.g. a minimum of 90% recognition accuracy on the first exposure, to maximize user acceptance in the field.

### *Additional comments:*

The user needs to find the message intelligible. Users generally prefer natural recorded speech to synthetic speech. Concatenated speech is natural speech stored as a carrier phrase, and variable data. An example is the British speaking clock where the phrase "At the third stroke, the time will be" is the carrier phrase, and the time data "ten" and "thirty" are selected from different files. With more complex phrases it is necessary to apply rules of syntax to alter the rise and fall of the voice, depending on the position of particular words in the sentence or to indicate questions.

A poor spoken interface may be perceived as more irritating than an equivalent poor visual interface. The elderly and partially deaf may have difficulty understanding poor quality speech output.

Where speech output is provided using a loudspeaker the speech needs to be loud enough not to be masked by other natural speech communication. Users may prefer some level of privacy of their message; for example, by hearing the message through the telephone receiver or a headset.

When using recorded natural speech it may be desirable to inform the user that it is a recording and/or to emphasize that it is a machine responding to avoid users trying to start up a conversation.

See also: Ayres (1987), Cox (1980), Dobroth et al (1990), Gellman and Whitten II (1988), Lauretta et al (1990), Neilsen (1990), Nusbaum and Pisoni (1985), Pisoni and Koen (1982), Slowiaczek and Nusbaum (1985) and Thomas et al (1989) for further information on the requirements for speech output in telecommunications services.

# Speech Recognition

## *(Voice Recognition)*

Sophisticated software technology for recognising human vocal sounds and converting these into dialogue commands, menu selections or data items. An alternative to the usual manually controlled input devices. Speech recognition systems can be speaker independent (available to different users) or speaker dependent (available to one or a restricted set of users).

## *Cross references:*

Input Hardware; Phone-based Interface; Speech Output

## *Recommendations:*

- use speech input where the demands of the primary task results in inability to use other input techniques, e.g. data capture, command entry whilst hands/eyes are fully occupied.
- position the input microphone to minimize external noise and to minimize breathing and other mouth noises which can affect the detection of word boundaries.
- allow more than one word to have the same response, i.e. redundancy in choice of command inputs (sometimes called "multiple mapping").
- use small vocabulary of familiar words, to minimize user memory load.
- use longer rather than short monosyllabic words to assist in recognition. Avoid single character/digit words.
- select speech input vocabulary words to minimize possible recognition confusions (speech recognition and auditory confusions are similar).
- allow for system recognition window, i.e. train users to pause after each input, single word or word string or sentence.
- provide recognition feedback after each input. Feedback method will depend upon the dialogue, e.g. commands may require repeating back to the user with a confirmation request or the response may be to integrate the keyword into the next display item.
- provide opportunity for user to undo incorrect inputs from whatever source (user giving wrong input, system making false recognition).
- if keyboard inputs, DTMF tones and voice are all used as inputs, provide clear prompts to state which is expected at any point in the dialogue.
- ensure "recognition windows" start early enough and are of sufficient duration; to minimize false errors by expert users who predict the dialogue and give "too early responses", and to ensure new users do not feel "rushed".

## *Additional comments:*

Speech recognition systems are usually reported to have recognition rates between 95 and 100% correct (or failure rates of between 5 in 100 to 5 in 1000). However, user performance levels are more usually reported around 70% (3 in 10 failures).

Do not expect speech input to compete directly with keyboard entry tasks, the error rates in speech are much higher and the data capture rates are much faster, except where keyboard entry is impossible, e.g. for some people with special needs.

Speech recognition systems require consistency of speech parameters to maximize the likelihood of correct recognition. Changes of speech, pitch, emphasis, rhythm, loudness, etc. may all increase recognition failure. Evidence suggests that perhaps 75% of people can be sufficiently consistent as long as task and environmental conditions remain the same.

At the current state of technology it is essential to make provision to compensate for errors by having redundancy within the dialogue, minimising the amount of human input and allowing the input to be corrected and confirmed before an action is initiated.

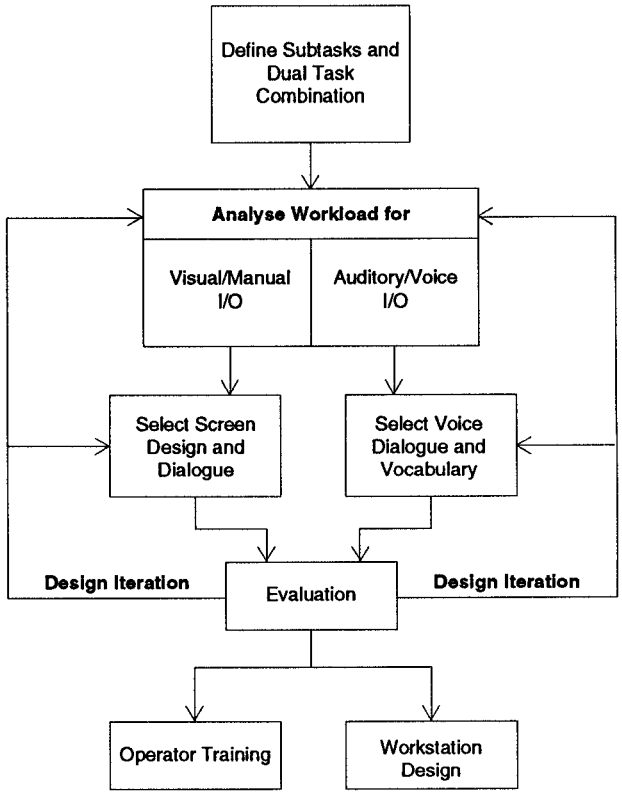



**Figure 81: Summary task analysis of dual task, manual and voice, interface (from Helander, 1988)**

**Table 18: Voice data entry modes for interactive systems (from Helander, 1988)**

| Speech Dialogue Type | Type of Prompt |
|---|---|
| Command words | No prompting - User takes initiative |
| Direct entry | e.g. "Input all information" |
| Query language | e.g. "What day are you travelling on" |
| Menu choice | e.g. "On a Weekday, a Saturday, or a Sunday" |
| Yes/No choice | e.g. "Travelling in the afternoon? Say Yes or No" |
| Grunt confirmation | e.g. "If you are travelling in the afternoon, make a noise now" |

See also: Waterworth (1984, 1988), van Noorden (1988), van Nes (1988), Puig et al (1993), Leopold and van Nes (1987), Lawrence and Stuart (1990), Klaus and Felbaum (1993), Jones et al (1989) and Fay (1993) for further information on the requirements for speech recognition in telecommunication services.

# Standardization

## *(Style Guides)*

Standardization provides for compatibility between systems which allow the user to transfer learning from the conventional telephone service, other ISDN terminal equipment and the proprietary software of other terminals. Standardization also provides manufacturers and service providers with a recognized benchmark for the appropriate technology to assist in both procurement and approvals.

## *Cross references:*

Call Handling; Consistency; Dialogue Style; Flexibility; National Variations

## *Recommendations:*

- user control procedures for basic voice call set-up, incoming call and call terminate should be available to users in a form which conforms with the basic telephone.
- user control procedures for non-voice, and voice plus, systems (e.g. videotelephones, voice/data, multimedia) should conform as far as possible to user's available experience with conventional telephone systems. (See Call Handling).
- whenever appropriate, reference should be made to internationally recognized standards and guidelines. (ETSI ETR 039, DTI 1991a)
- where an ISDN application is run from a multi-purpose terminal, reference should be made to appropriate proprietary software standards and style guides, to present a consistent look and feel to the interface.

## *Additional comments:*

Matching user experience and expectations can significantly improve learning times and reduce error rates. Where incompatibilities occur, these should be examined since they are likely to be a major cause of user error. Where possible, the system should be able to detect or compensate for these errors by offering some degree of flexibility. The marketing strategy of deliberate non-compatibility is not in the user's interest and could inhibit the overall take-up of the ISDN service if users find that they are unable to communicate with others.

Standardization of electrical interfaces between peripherals and user control procedures, is of particular value to people with special needs who need to be able to connect modified control or output devices.

The international organizations that produce standards, recommendations and guidelines include: ITU-T (formerly CCITT), ISO, IEC, ETSI, CEN, CENELEC, CEPT, ECMA. The organizations and companies that produce style guides for user interfaces include: Apple® - Macintosh® (Apple, 1992), British Telecom - Co-operative Network Architecture (CNA) (BT, 1991), IBM® - Common User Access (CUA) (IBM, 1989, 1991a & b), Microsoft® - Windows™ (Microsoft®, 1992), OSF/Motif™ (OSF/Motif™, 1990), Siemens/Nixdorf - System Interfaces for Applications (SIA) (Siemens/Nixdorf, 1990a & b).

# Stylus/Pen Computers

## *(Gesture Interfaces)*

An input device consisting of a transparent digitising tablet (Graphics tablet) on top of a flat screen, to provide a note pad style device which uses a stylus as the single control device. Advances in software have enabled hand printing and a number of pen marks or "gestures" (like carets, brackets, ticks, etc.) to be recognized successfully.

## *Cross references:*

Pointing Devices; Touch Screens

## *Recommendations:*

- No specific recommendations can be offered yet, except the basic dimensions of the stylus, i.e. 120-180mm long, 7-20mm diameter, and the need to provide a retaining clip or housing for the stylus (similar to the light pen).

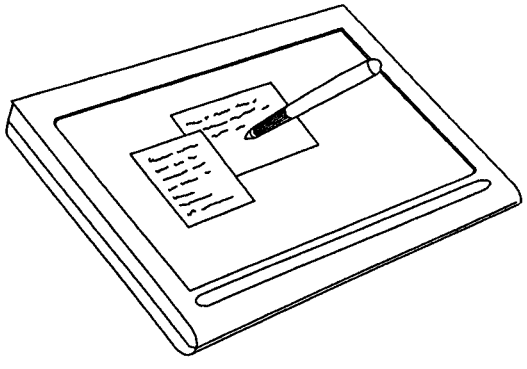


**Figure 82: Example stylus/pen computer**

## *Additional comments:*

The stylus/pen computer makes use of an available range of "gestures" to control the dialogue. For example, a double tap may select a software object, a stroke through text or brackets around some text or data may mark the items for subsequent action like deletion, copying or moving. The potential for portable devices is yet to be explored, but there are considerable advantages offered for editing or check style data entry tasks, particularly in environments which might preclude other solutions. Evidence suggests that for editing tasks, gesture interfaces may be faster and easier to use than keyboards or mice (Wolf, 1992).

Microsoft® have developed Pen Windows™ as an interface to take advantage of the availability of Windows™ applications. Pen Windows™ uses a small range of 12 special gestures to enable users to control a standard Window™ dialogue, principally these cover the editing commands, e.g. edit text, cut, copy, paste, etc. (Microsoft®, 1992).

GO Corporation® has developed PenPoint™ as an application program to create pen based interfaces (GO Corporation®, 1992).

# Supplementary Services

## *(Analogue Display Services Interface (ADSI), Code Schemes, Stimulus Protocols, User Procedures)*

CCITT and ETSI have defined a set of supplementary services to support ISDN communications. The European Memorandum of Understanding (MOU) on ISDN Supplementary Services sets a timetable for the introduction of a subset of these services within signatory networks.

### *Cross references:*

Call Handling; Symbols

### *Recommendations:*

- design the user interface for accessing and controlling supplementary services to minimize learning time, reduce memory load and reduce error rates.
- use single action feature keys to support selection of a small range of services but avoid creating a large control panel. Consider a soft-key interface, if access to a larger number of services is necessary.
- avoid creating a dialogue that requires the user to learn an extensive repertoire of numeric codes.
- provide a minimum interface to access all available services, ensure the procedures meet user expectations and are fully supported with prompting and feedback indications. As an absolute minimum (not preferred) provide access via an internationally recognized code scheme or stimulus protocol, e.g. CCITT, CEPT, Nordtel. (CCITT Recommendation E.131, CEPT Recommendations T/CAC 02 E and T/CAC S8 10 E, Nordtel NT/SIG-SPEC-2-1).
- where similar services are provided within the terminal, the customer premises equipment (PBXs, etc.) or the network (PSTN, ISDN, TACS, GSM, VPN, etc.), which the user may perceive as providing the same function, e.g. Call waiting at the terminal and Call waiting at the network level, the procedures, prompts, feedback, and error handling should be common throughout, i.e. they should have the same look, feel and effect at all levels.

### *Additional comments:*

Under the terms of the European Memorandum of Understanding on ISDN Services, the first services scheduled to be implemented internationally are:

Calling line identification presentation (CLIP)
Calling line identification restriction (CLIR)
Direct dialling in (DDI)
Multiple subscriber number (MSN)
Terminal portability (TP)
Advice of charges: at set-up, during, or end (AOC-S/D/E)
Completion of call to busy subscriber (CCBS)
Call deflection (CD)
Call forwarding: on busy, on no reply, unconditional (CF-B/NR/U)

Connected line identification presentation/restriction (COLP/COLR)
Conference call, add-on (CONF)
Call transfer: explicit (CT-E/S)
Closed user group (CUG)
Call waiting (CW)
Freephone (FPH)
Hold (HOLD)
Malicious call identification (MCID)
Meet me conference (MMC)
Sub-addressing (SUB)
Three party conference (3PTY)
User-user signalling (UUS)

These MOU services may apply to all types of communications (voice, data, fax, picture) or may be exclusive to one or more call types. For example, it is expected that users may be able to set Call forwarding for the different types of calls to different addresses and to set different levels of service for each, e.g. Fax - Call forward on busy to AAA, Voice - Call forward on busy to BBB, Call forward on no reply to CCC, etc. Refer to the relevant International and European Standards for the full requirements for network based supplementary services. (CCITT Recommendations I.250, I.251, I.252, I.253, I.254, I.255, I.256, I.257, Q.932; ETSI ETS 300 50, 300 53, 300 56, 300 59, 300 62, 300 89, 300 90, 300 94, 300 95, 300 128, 300 136, 300 139, 300 164, 300 178, 300 179, 300 180, 300 183, 300 186, 300 199, 300 200, 300 201, 300 202, 300 208, 300 263, 300 284, 300 357, 300 367).

Additional services and features, over and above the ETSI/CCITT defined set and the MOU set, that allow users to modify calls can be implemented in the network, customer premises equipments, or the terminals.

A standard ISDN terminal may have a large number (40 plus) services and features available at the terminal and network level, and potentially considerably more if customer premises equipment (PABX) is included. Considerable improvements in dialogue design are required to improve user confidence and take-up of available features. The user interface should be designed to support the user's level of skill and task complexity, without technical barriers preventing common procedures for common services and features. A number of studies, notably Frankhuizen (1983), Israelski (1988), Jones (1990) and Lindgaard (1993), have elaborated the problems users have in accessing and controlling supplementary services via a minimum command based interface.

AT&T®, in collaboration with other telecommunications companies in the U.S.A., has now developed a proprietary interactive user interface for accessing and controlling supplementary and other services available on the analogue network. The Analogue Display Services Interface (ADSI) provides a small display and a set of soft-keys for the user interface to a broad range of services. The services include: PSTN supplementary services (call forwarding, call waiting, etc.), multi-party call control (hold, broker call, conference, etc.) messaging services (voice mail) and information retrieval (directories, etc.). (Schwartz, 1993).

ETSI TCHF is currently developing a new standard for a harmonized minimum man-machine interface for the access and control of public network based telecommunication services, DE/HF-01017. The proposed standard attempts to raise the usability of the services by defining the required MMI as including the information, prompts and feedback that support the necessary user's control actions.

# Surface Finish

## *(Casework Finish, Texture)*

The physical appearance and feel of the exterior surfaces of the terminal or product which the user can see or touch during normal operations.

## *Cross references:*

Casework; Casework Colour

## *Recommendations:*

- Provide a finish which does not cause strong specular or diffuse reflections.
- If the casework includes a display, particularly for VDU based tasks, ensure the specular reflections of surfaces do not exceed 45 gloss units (silky matt) measured according to ISO 2813 (quoted in ISO DIS 9241-4) and the diffuse reflectance is between 15% and 50%.

## *Additional comments:*

None

# Switches

### *(Controls, User Stereotypes)*

A control input device for signalling one or more discrete functions to the system. Switches are usually operated with a linear (toggle, rocker, slider switches, push buttons) or circular motion (rotary, key operated switch). Keys, a special case of switches, are treated separately.

### *Cross references:*

Key Operated Switches; Keys; Pushbuttons; Rocker Switches; Rotary Switches; Slider Switches; Toggle Switches

### *Recommendations*

- Take advantage of people's stereotypes for the directions of motion used for switching on, increasing the value or functions, etc.:
  - for linear switches - to the right, upwards or backwards.
  - for circular switches - to the right, clockwise.
- Provide labels, legends and/or markings to:
  - identify the function of the switch,
  - identify the significance of switch settings, and
  - indicate the switch's current position (Siemens, 1987).

### *Additional comments:*

Table 19 provides a comparison of the different types of switches for different user task requirements.

**Table 19: Comparison of switches**

| | Toggle | Rocker | Slider | Push-button | Rotary | Key Operated |
|---|---|---|---|---|---|---|
| **Number of discrete elements** | 2 | 2 | 2+ | 2 | 3-24 | 2-12 |
| **Control setting speed** | quick | quick | quick-moderate | very quick | moderate | slow-moderate |
| **Visual check of setting** | easy | moderate | easy | impossible unless latching | easy-moderate | easy-moderate |
| **Non-visual check of setting** | easy | moderate | moderate | impossible unless latching | easy-moderate | easy-moderate |
| **Simultaneous operation of several controls** | easy | easy | easy-moderate | easy | moderate-poor | poor |
| **Space requirements** | smallish | smallish | small-medium | small | medium | medium |

# Symbols

## *(Pictograms, Icons)*

Symbols, pictograms and icons are all graphic devices used to label control keys, or to give information on screen, casework or in user guides. The word symbol is sometimes used specifically to refer to abstract representations. Pictograms may be used specifically for pictorial representations, and icons for screen based graphical user interfaces. In practice these distinctions are often unclear and so the term symbol is used here generically.

## *Cross references:*

Handbooks; Labels

## *Recommendations:*

- use internationally accepted and publicly recognized symbols, such as the CCITT telephone symbol (CCITT Recommendation E.121), the ISO safety symbols (ISO 3864).

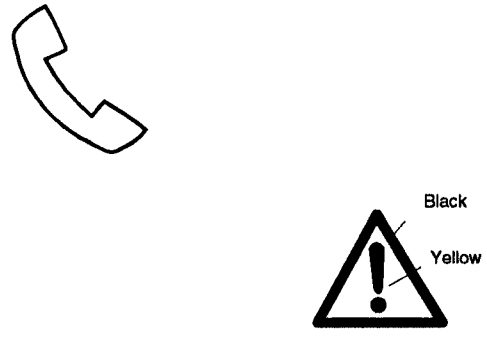



**Figure 83 CCITT telephone and ISO warning symbols**

- where they exist, use internationally agreed and proposed symbol sets, such as CCITT symbols for ISDN supplementary services (CCITT Recommendation E.121), IEC symbols for equipment and screens (IEC 417, ISO/IEC JTC1 CD 11581), and ETSI symbols for videotelephone functions. (ETSI ETS 300 375).
- where possible, use accepted or "industry standard" symbols or icons in screen based graphical user interfaces.
- ensure printed symbols are clear, legible and durable.
- ensure on-screen icons are sufficiently large to be clearly distinguishable, for the predicted viewing distance.
- ensure supporting documentation provides a glossary of symbols and icons to enable identification and learning.
- create new symbols only if essential, use a realistic representation and test for acceptability to the intended user group. Use an agreed test procedure as recommended by ETSI or CCITT (ETSI ETR 070; CCITT Recommendation E.121) (See also ETSI ETR 113 and Böcker, 1993).

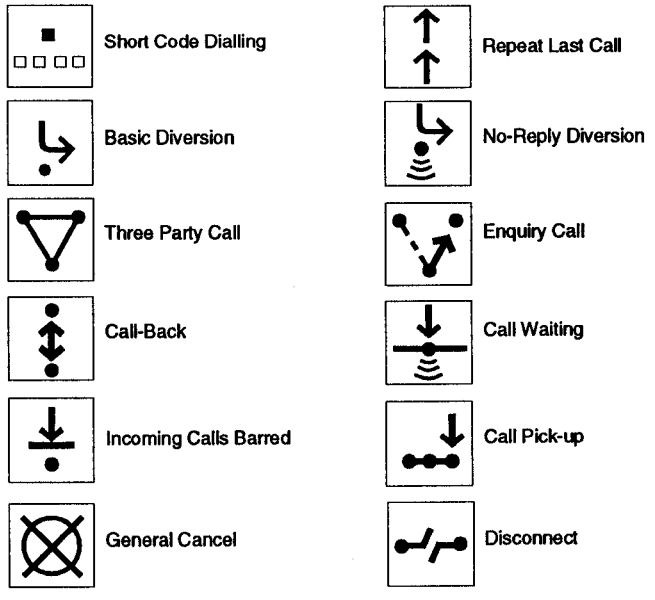



**Figure 84: CCITT supplementary service symbols (CCITT Recommendation E.121)**

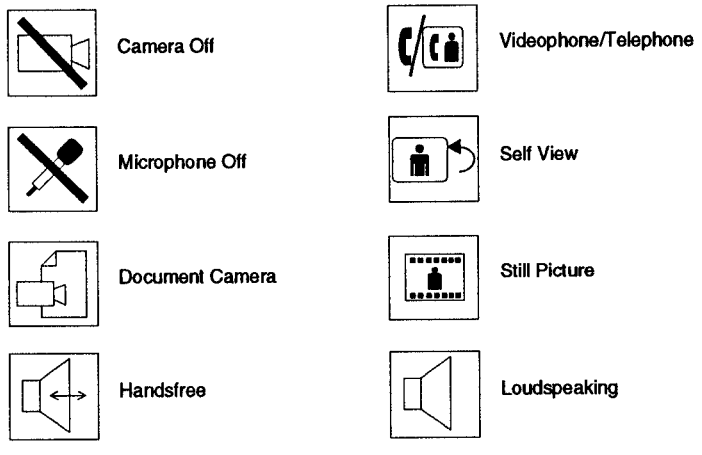



**Figure 85: ETSI videotelephone function symbols (ETSI ETS 300 375)**

### *Additional comments:*

The main advantage of symbols as compared with written text is that they are independent of language. Pictorial representations of concrete objects such as the telephone handset, are easily recognized as indicating a telephone service. Symbolic representations of abstract concepts as used to represent telephone supplementary services places demands on the user to learn a new language of symbols in combination with the new features offered. The benefit of language independence may be lost to new and casual users who will need a guide to recognising the symbols.

The advantage of the symbols then lies in their space saving compactness on keys, the casework or on the screen. Where the symbol is being used to label a control function, consideration should be given to providing feedback that allows the user to detect errors.

# Tactile Displays

## *(Displays, Tactile Markers)*

The type of display elements that rely on the user perceiving the intended information by touch.

## *Cross references:*

Auditory Displays; Card Readers; Keys; Visual Displays

## *Recommendations:*

- provide tactile on numeric keypads e.g. raised dot on number 5 and on typewriter style alpha keyboards e.g. raised bar on F and J.
- consider printing or engraving key labels to give texture.
- provide structure to the layout of keys to assist user orientation, e.g. familiar key groups include the 3 x 4 key-block for numbers, staggered QWERTY (AZERTY etc.) for alpha keys, short rows or blocks of function keys.
- smart cards and magnetic cards should have a notch or tactile marker to aid orientation. (ITU-T Draft Recommendation E.136, CEN TC244 N293).

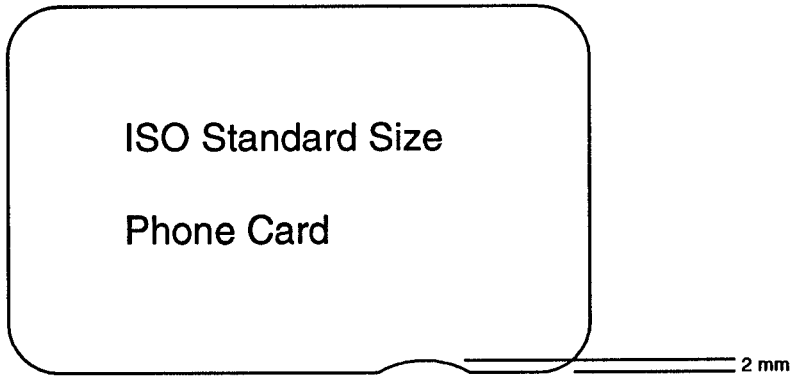



**Figure 86: Example tactile marker on telephone card**

## *Additional comments:*

Tactile displays can aid the development of skilled operation where for instance the user no longer needs to search the keyboard for the right key, and provides vital cues when there is a need to work in low ambient light levels, or the user has impaired vision.

Tactile markers for the ISO standard size magnetic or smart cards are in the process of being standardized, for telecommunication cards through ITU-T (ITU-T Draft Recommendation E.136), and generally through CEN (CEN TC244 N293). Experimental evidence collected by ETSI TCHF shows a user preference for a notch of 2mm depth and radius 12mm on the longer side of the card, centred 15mm from the end.

# Telephone Keypads

## *(Alphabetic Layouts, Keying Logics, Keypads, Mnemonic Dialling, Rotary Dial)*

The keypad on a telephone terminal used to enter the digits 0-9, plus * and #, for access to terminal or network functions.

## *Cross references:*

Alphanumeric Keyboards; Keyboards; Keys

## *Recommendations:*

- use keys in preference to rotary dials to input telephone addresses or other similar discrete data items (Leopold and Stremmelaar, 1967), even though there may be a slight increase in dialling error rates (Pollard et al, 1977).
- the recommended minimum keypad includes the 12 keys, 0-9, * and #. The preferred arrangement for telephone numeric keypads is 12 keys in a 3 column by 4 row layout. The digits 1, 2 and 3 should be assigned to the top row (CCITT Recommendation E.161; Conrad, 1967; Kramer, 1967; Magnusson, 1970; Wikell, 1981).

| | | |
|---|---|---|
| 1 | 2 | 3 |
| 4 | 5 | 6 |
| 7 | 8 | 9 |
| * | 0 | # |

**Figure 87: CCITT Recommended numeric layout**

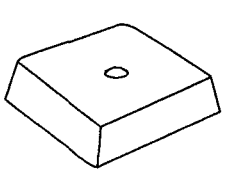


**Figure 88: Raised dot key identifier**

- consider providing a raised dot or line on the touching surface of the centre key "5", to help unsighted navigation of the keypad. (ETSI ETR 051).

- the preferred pitch (distance from key centre to key centre) on telephone keypads is 19mm ± 1mm, if tighter pitches are required, then be aware that pitches of less than 15mm (irrespective of key cap size) demonstrate significant increases in miskeyings. (Alexander, 1974).
- the preferred keypad angle for desktop telephone terminals is dependent upon the height of the keypad from the desk. For keypads with the Home row (4, 5 and 6) greater than 85mm above the desk, the recommended angle is 25° ± 10° from the horizontal (Cooper, 1976). For keypads with the Home row at 30mm or less, the recommended angle is between 5° and 18° (ECMA-110, ECMA-126).

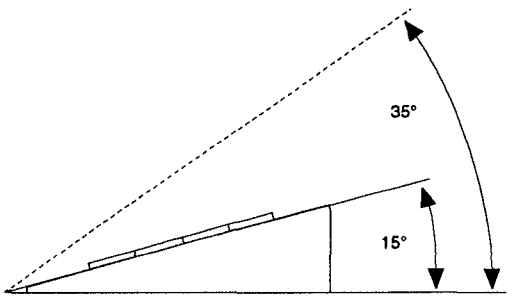



**Figure 89: Keypad angles - preferred range**

- if alphabetic letters associated with the numeric keys are required to enable simple mnemonics to replace numeric codes or addresses, e.g. I FLY PAS equals 4 359 727 (alpha-mnemonic dialling), the letters can be assigned to the numeric keys ABC=2, DEF=3 etc., Q and Z may be assigned 1 or 7 and 9 respectively. (ITU-T Recommendation E.161, Option A preferred). No provision is made for specific national characters.

Option A

| | | |
|---|---|---|
| 1 | ABC 2 | DEF 3 |
| GHI 4 | JKL 5 | MNO 6 |
| PQRS 7 | TUV 8 | WXYZ 9 |
| * | 0 | # |

Option B

| | | |
|---|---|---|
| QZ 1 | ABC 2 | DEF 3 |
| GHI 4 | JKL 5 | MNO 6 |
| PRS 7 | TUV 8 | WXY 9 |
| * | 0 | # |

**Figure 90: ITU-T accepted layouts for alpha characters on telephone keypads showing alternative positions for Q and Z**

- if alphabetic data entry is required a full alphabetic or alphanumeric keyboard should be provided.

## *Additional comments:*

In exceptional circumstances, where space precludes the use of an alphabetic keyboard and the alphabetic data entry requirements are limited it may be acceptable to use a multiple keying logic to enter alphabetic and numeric data via the standard 12 key keypad, e.g. press key "2" once for A, twice for B, three times for C (assuming the keypad is in alpha mode).

The designer should be aware that all multiple keying logics result in significant increases in keying time and greater incidence and variation in errors (Butterbaugh, 1982, Flohrer, 1972). If a multiple keying logic is unavoidable, the simplest logic, which uses repeat key pressings to select a character, shows the lowest error rates and marginally the best data entry times (Detweiler, 1990). The ITU-T mapping assigns up to four characters to the digits 1-9. This may be supported by rapid scrolling through the possible characters if the key is held down, like a "Spin button" (IBM, 1991a & b).

A number of portable telephones are currently using two scroll keys (up and down) to select all alpha characters one at a time when the dialogue is fixed in alpha mode. At present there is no evidence to compare between this and any multiple keying logic. However, although it is very simple to learn the philosophy, data entry by this method is necessarily slow. A possible alternative, for alphabetic data entry where space is limited and a trained user group is likely, is the Chord keyboard (Noyes, 1983). The Chord keyboard uses a small set of keys typically laid out to match the finger positions of the preferred hand. Alphanumeric data can then be entered by simultaneously pressing specific key combinations or chords.

Whatever keying logic is selected, single or multiple (shift function or chord), performance will improve if visual feedback is given of the character selected. The user should never be expected to key data "blind".

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Whatever keying logic is selected, single or multiple (shift function or chord), performance will improve if visual feedback is given of the character selected. The user should never be expected to key data "blind".

# Thumb/Finger Wheels

### *(Finger Wheels, Thumb Wheels, User Stereotypes)*

A control input device for selection of a continuous variable. These are usually mounted "invisibly" leaving just a small segment of the wheel for the user to push.

### *Cross references:*

Analogue Controls; Linear Sliders; Rotary Controls

### *Recommendations:*

- The preferred mounting position is vertical, parallel to the front edge and operated from above, the wheel and its label can be clearly seen. (Siemens, 1987). However, it is expected that other orientations will be used to meet printed circuit board (PCB) requirements and to avoid ingress of dust.
- The direction of motion stereotypes depend on the controls mounting position. The direction for increases in the value of the variable controlled, are shown below.

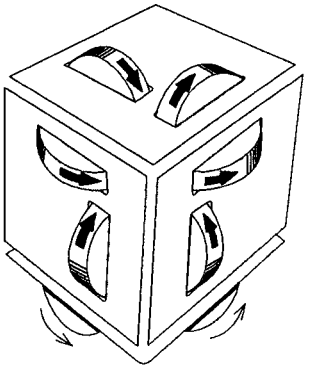

**Table 20 and Figure 91: Thumb/finger wheels, direction of control movement vs. control mounting orientation**

| Mounting Orientation | Movement Direction for Parameter Increase |
|---|---|
| Mounted horizontal, at front or back | to the right |
| Mounted horizontal, at side | to the back |
| Mounted vertically, operated from above or below, parallel to front edge | to the right |
| Mounted vertically, operated from above or below, parallel to side edge | to the back |
| Mounted vertically, operated from the side | to the top |

- Provide a label or legend to indicate the function of the wheel and to indicate the current value of the setting.
- Ensure the edge of the wheel has high friction surface (usually serrations) to enable easy setting.
- Use wheels with the following dimensions (Mil-Std-1472C):
  - minimum rim exposure 25mm.
  - minimum wheel width 3mm.
  - maximum resistance 3,3N.

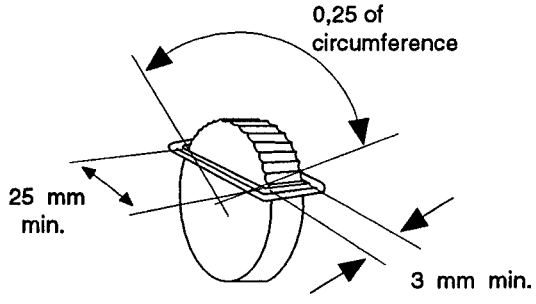


**Figure 92: Thumb/finger wheel, preferred minimum dimensions**

### *Additional comments:*

None

# Toggle Switches

An input device where a snap action changes position between two states (sometimes three). The control lever projects from the panel and is itself a feedback indicator.

## *Cross references:*

Analogue Controls; Linear Switches; Rotary Switches; Switches

## *Recommendations:*

- Available for two position switches not recommended for three or more positions. (Woodson, 1981).
- Use switches which require an activating force between 2-3N and travels through an arc 30° (minimum), or 10mm or more linear displacement with a 3mm diameter toggle (minimum). (Siemens, 1987, Woodson, 1981).

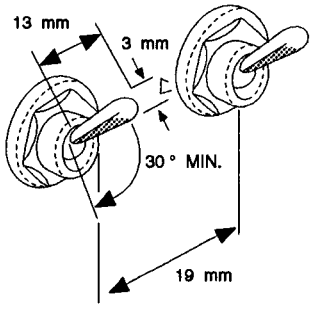


**Figure 93: Toggle switches, preferred minimum dimensions**

- If several switches are used on the same device, it is useful to have consistency in the significance of the switch settings (for normal operation), but do not compromise motion stereotypes. Allows system checking to be at a glance. (Siemens, 1987).
- In banks of switches, provide 19 ± 1mm centre to untie spacing horizontally, and 30-35mm centre to centre vertically (Woodson, 1981). Use horizontal rows if switches need to be operated together.
- If banks of switches are provided with increasing functions e.g. lines 1-10, then the progression of functions is expected left to right. However, if the switches represent a mathematical increase, e.g. 10's, 100's, 1000's etc., the progression may be from right to left.
- Do not intermix toggle and rocker switches on the same device. Consider protection from accidental operation if close to manual handling arcs in normal operation.
- Can be spring load and used for momentary switching, but keys or push buttons are more usual.

## *Additional comments:*

None

# Touch Screens

## *(Gesture Interfaces, Touch Panels)*

An input control device allowing the user to touch the screen at a position indicated by screen graphics to represent functions, actions or choices (as in a menu). The co-ordinates of the position are detected and stored as a digital input.

## *Cross references:*

Pointing Devices; Stylus/Pen computers

## *Recommendations:*

- Various technologies exist for detecting finger or stylus contact with the screen. Some require specific overlays, others use a matrix of emitters and detectors along the sides of the screen. The conductive overlays provide the greatest resolution and typically the LED arrays the lowest.

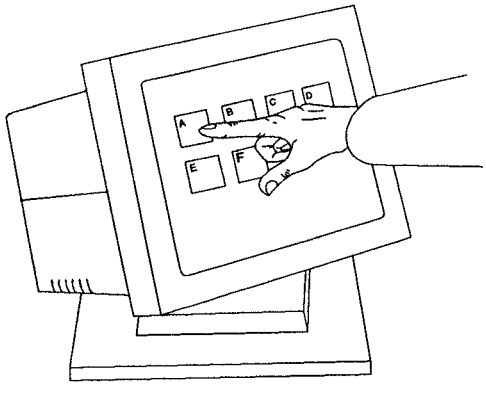


**Figure 94: Example touch screen**

- Capacitive screen overlays, use the bodies natural static to determine the position, so these are not suitable for clean room environments.
- The low resolution technologies can suffer from some parallax problems, where the centre of pointing is not coincident with the displayed centre of pointing (cursor position).
- The major advantage is the direct hand eye co-ordination with the selected object, and being intuitive to people with minimal training and experience.
- Provides for 1:1 absolute positioning, not good for tracking tasks.
- Requires simple software control to select from last touch position and to ignore finger "jitter" or "fall out" as the finger is removed.
- Use relative large finger sized targets for selectable items, or ensure there are no other selectable targets within a minimum 9mm radius.
- May require the display to be angled towards the horizontal to provide arm/wrist support for accurate selection of smaller targets.

### *Additional comments:*

The constant touching of the screen with fingers causes a build up of grease and dust, so the screen itself needs to be easy to clean with few corners to trap the dirt.The overlay screens can become scratched and affect the clarity of the screen.

Touch screens can be very tiring to use where the arms are reaching forwards without support, and it may be inadvisable to use this method of input for lengthy interaction. Mounting the screen more horizontally rather than vertically may reduce strain on arms and shoulders, but may create visual difficulties through increased reflections.

# Usability

## *(Effectiveness, Efficiency, Learn-ability, Satisfaction, Product Testing, Prototype Testing, Quality Testing, Usefulness, User Performance, User Preference, User Trials, Utility)*

Usability is: the effectiveness, efficiency and satisfaction with which specified users can achieve specified goals (tasks) in a particular environment. (ISO DIS 9241, Part 11).

Where effectiveness is, the accuracy and completeness with which specified users can achieve specified goals (tasks) in a particular environment; efficiency is, the accuracy and completeness of goals (tasks) achieved relative to the resources expended to achieve them; and satisfaction is, the comfort and acceptability of the work system to its users and other people affected by its use.

### *Cross references:*

Evaluation

### *Recommendations:*

- prepare a usability statement for each terminal, system or application developed in line with ISO DIS 9241 Part 11, to clarify who the users are, what the key user tasks are and when and where the users will do the tasks; also what steps have been taken throughout the design process to maximize usability.
- perform usability evaluations looking at objective and subjective measurements against absolute or comparative usability targets as an essential part of the design and quality assurance process.

### *Additional comments:*

ETSI ETR 095 "Guide to Usability Evaluation of Telecommunication Systems and Services" gives guidance on the evaluation methods available and the precautions to be observed.

ETR 095 enhances the ISO definition of Usability in the following ways:

1 Usability can be considered a pure ergonomics concept not depending on the costs of providing the system. Usability and financial costs together form the concept of UTILITY. This means that an ergonomically highly usable system may have low utility for a particular user who considers the cost to be too high in relation to his or her need for using the system.

2 The performance measures of effectiveness and efficiency, and the preference measure of satisfaction and appeal are independent from each other. Highly effective or efficient systems can be perceived as unsatisfying and unappealing, within the users experience over a single set of tasks.

3 The basic definition of usability should also include the concepts of learn-ability and flexibility.

Learn-ability is expressed in terms of performance measurements on successive trials on the same tasks by the same user group. Learn-ability adds a temporal dimension to usability. Systems which are easily learnt show greater improvements in performance on successive trials than systems which are less easily learnt.

Flexibility is expressed in terms of the breadth of tasks, users and task environments the system may accommodate. A highly flexible system will enable a broad range of naive and experienced users to perform equally well across a broad range of tasks conducted in a number of task environments. A less flexible system will be demonstrated when the broad range of naive and experienced users perform significantly worse across the range of tasks and task environments.

4 Usability in telecommunications is a very special case, as it typically involves more than one user impacting with the various levels of the system (local terminal, local exchange, central exchange, remote exchange, remote terminal) and with each other.

The performance and preference measures taken with the users and the range of tasks tested within the communications system should accommodate these differences. For example: Overall satisfaction should include components from User A with Terminal A, User B with Terminal B and Users A & B with the network.

For more general information on usability, see DTI (1990) and Gould (1988); also for a possible single metric, see Flohrer (1989).

# User Guidance

## *(Prompting, Training, Tutorials)*

User guidance is used as a global term to describe all forms of information offered to assist in the proper and efficient operation of the system. This may include information given as part of the dialogue or requested as help, on product graphics and labels, handbooks and user guides.

## *Cross references:*

Handbooks; Help; Screen Messages; Symbols

## *Recommendations:*

- provide user guidance appropriate to the user requirements and task complexity.
- provide clear and specific information to guide the user through the operational sequence, including how to recover from errors.
- support the user's memory by offering choices, for example, as menus, or prompts to show what telecommunication services are available, or what jobs can be done.
- include task sensitive messages that help the user proceed correctly, indicating the commands or syntax, or permitted range of values.
- develop task sensitive on-line help and paper based handbooks or guides.
- consider the need to for the user guidance to help develop or revise existing user models or expectations, especially in relation to ISDN features that substantially differ from conventional telephone operation.
- ensure that the guidance given is accurate and up to date.
- use familiar wording and short simple sentences.
- use an active verb structure and address the user:
  *Example:*
  "Connect the battery to the terminals", is better than "The battery is connected to the terminals".
- use positive statements:
  *Example:*
  "Begin speaking after the tone" is better than "Do not speak until after the tone".
- keep spoken messages simple.
- validate user guidance with sample users and be prepared to modify and improve the information given.

### *Additional comments:*

All users benefit from clear and easy to understand user guidance. Those most in need of support will be the least skilled of the intended user group, although even skilled users need support when using unfamiliar equipment or when attempting unfamiliar tasks.

In general, it is most effective to tell the user "what to do"; users are aware of what they are trying to achieve and only need to know how to follow the correct procedure. This applies particularly to the simpler systems and to novice users. The main content of the user guidance should be directed towards the questions that the user will ask and the tasks in hand.

Where a system is specifically designed to encourage the user to explore the system, as for instance in object-oriented dialogue styles, it may be necessary to give more general guidance on the capabilities of the system.

Similarly, with a complex system where the user may be expected to develop a level of familiarity and confidence in the system, it can be valuable to develop a concept of how the system works so that he or she is able to predict what to do and what the result will be.

No matter how complex the system is, the user guidance needs to build confidence in individual stages that are easy to understand, using everyday language.

See also ISO DIS 9241 Part 13, BS 7649 and DTI (1988) for more specific information on user guidance design.

# User Interface Design Principles

### *(Human-Computer Interface (HCI), Interface Design, Man-Machine Interface (MMI), Man-Machine Language (MML), User-System Interface (USI))*

Interface design principles are the generic rules and concepts that underlie the development of all applications.

### *Cross references:*

Auditory Menus; Command Language Style; Consistency; Control Key Dialogues; Dialogue Style; Evaluation; Feedback; Flexibility; Graphical User Interface; Menu Dialogues; Response Times; Screen Formatting

### *Recommendations:*

- the dialogue needs to be appropriate to the task complexity and the user's level of skill.
- self-descriptive procedures whereby the user can immediately perceive what to do should be made a priority for novice and casual users performing the basic task set.
- simplify interaction by reducing the number of commands to be remembered and the number of keystrokes to be entered.
- provide feedback immediately as confirmation of input.
- error handling needs to be provided so that users can correct data input errors and reverse actions requested in error. If appropriate, provide error detection and offer informative error messages indicating what to do next.
- provide flexibility to allow for differences in user expectations, short cuts for skilled users, to improve compatibility with other systems and to allow for national variants.
- apply design consistency so that, from the user's viewpoint, control actions have the same outcome throughout the system, control sequences have the same syntax, terms and labels remain the same and display items have a designated location.
- maintain compatibility with user's expectations and their experience with other systems (Fast. 1993).
- ensure control of the system always remains with the user, the system should not pace the user or pressure them to respond.
- redundancy in input and output should be offered where user's attention may be diverted to other tasks, and to accommodate people with special needs.
- prototype and evaluation of design decisions should be undertaken to optimize the dialogue design.

### *Additional comments:*

A good user interface design considers a user's needs as well as system requirements. Failing to take account of user needs can result in a high proportion of input errors, loss of confidence and motivation leading to high training costs, and possibly rejection of the system and service. A high quality user-interface needs to be based on an effective user model. (CCITT and ITU-T Recommendations Z.321 to Z.323 Extended MML for Visual Display Terminals).

At this stage in the development of ISDN products aimed for use by the general public, it is important to aim to support the least skilled and least technical members of the user community. The more complex dialogues and powerful commands should be reserved for the skilled operators of sophisticated tasks, that develop as a market matures.

RACE Project 1067 GUIDANCE attempted to define a generic set of usability principles for integrated broadband communications. The result included broad agreement on a set of User Interface Design Principles. (RACE Project 1067 GUIDANCE, 1992; Voigt et al, 1993). System designers should also see ISO DIS 9241 Part 10, IBM (1991a), BT (1991), Apple (1992), OSF/Motif™ (1990) and Siemens/Nixdorf (1990a) for specific principles and greater elaboration relating to graphical and other interfaces. For more general background material, see Helander (1988), Shneiderman (1987) and Smith and Mosier (1986).

# Videotelephones

## *(Codec)*

A videotelephone combines audio telephony with video capability. Present technology is concentrating on two 64Kbs channel working. Future systems may employ Broadband ISDN (B-ISDN).

## *Cross references:*

Call Handling; Cameras; Casework; CRT Displays; Non-CRT Displays

## *Recommendations:*

- design the ISDN videotelephone to accommodate the issues raised in subclause 4.4 Videotelephones, and to comply with the relevant European standards. (ETSI ETS 300 143, 300 144, 300 145, 300 264 and 300 267).
- if possible, design the casework and system to support parallax free videotelephony (where the axis of the camera's focal plane is coincidental to the eyes of the user and of the person in the video image).
- if a parallax difference is unavoidable, then position the camera's focal plane centrally above the display and minimize the angle between the camera and eye level focal planes, 8° maximum at the furthest point of the preferred viewing range (RACE 1065 ISSUE 1993a).
- provide a facility to enable users to check their appearance, the lighting levels, etc. in the transmitted image, i.e. Self-view. User requirements for the attributes of the self-view image depend on the type and number of cameras:
  *Example:*
  Single built in camera: mirror view only, coded and non-coded image.
  Document or object camera: non-mirror view, coded and non-coded image.
  Removable cameras: automatic or user control over mirror/non-mirror view, coded and non-coded image.
- access to the self-view image should be available at all times (minimum) or self-view should be continuously displayed.
- provide automatic iris control for all cameras.
- provide automatic focusing for each camera. If manual focusing is provided, enable the user to focus the self-view image using the uncoded image, i.e. without codec processing, to facilitate maximum perception of sharp edges. (RACE 1065 ISSUE 1993a)
- accommodate the range of different eye heights for the sitting/standing users by enabling adjustment of the camera and viewing screen.
- ensure synchronization between the displayed audio and visual signals (within ± 50ms). If a differential delay is unavoidable, the audio should be delayed with respect to the video, rather than vice versa. (Frowein et al, 1993; Kurita et al, 1993).

- the displayed image should have a minimum frame rate of 15 per second, to facilitate lip reading by the hard of hearing.
- provide a facility to enable users to make and receive telephone calls as well as videotelephone calls, i.e. Service Mode Change. Enable users to define a default Service mode (Videotelephony or Telephony) for all calls. Avoid mixing the default mode for incoming and outgoing calls. Provide a clear indication of the existing service mode, preferably at all times, but especially when receiving incoming calls, (consider a different ring signal for each type of incoming call).
- ensure the call set-up, incoming call and call termination procedures for both videotelephone and telephone calls, meet user expectations and are fully supported by prompting and feedback indications. (See Call Handling). (Deutsche Bundespost FTZ 121 TR10, Anderson et al 1993)

### *Additional comments:*

Videotelephony is in its infancy, for a broad acceptance the terminal design needs to be sensitive to the user's needs and perception of privacy. For example, consider providing a simple mechanical shutter in front of the camera. It may be an obvious way for the users to feel that they have control over whether they can be seen or not.

For more background information on Videotelephone design and the requirements for videotelephony, see in particular "Human Factors Guidelines for Videotelephony" (RACE 1065 ISSUE 1993a); and Flohrer and Weikinnis (1988), Frowein et al (1991), Gerrissen and Daamen (1990), Kellner et al (1988), Manzanaro et al (1990) and Mühlbach (1988). For videotelephone applications for people with special needs, see Pereira (1993), Konings et al (1993), van Hardeveld and Frowein (1993) and Wilson et al (1993).

ETSI is currently developing two human factors documents on ISDN Videotelephony. ETSI DTR/HF-01006 "Human Factors Aspects of Videotelephony" and DI/HF-01018 "End-User Control Procedures in basic call, point to point, connections for ISDN Videotelephones. These procedures are based on the general rules and generic procedures identified in Call Handling.

# Visual Displays

### *(Displays, Indications)*

The group of displays that rely on the user seeing the intended information.

### *Cross references:*

Character Displays; CRT Displays; Graphic Displays; Labels; Non-CRT Displays; Optical Symbols; Output Hardware; Printed Displays; Screen Formatting; Screen Messages; Symbols; User Guidance

### *Recommendations:*

- use visual displays to provide feedback to control input and data entry, to give prompts and system messages and to show text, graphics and pictures.
- use visual displays to complement auditory information; for example, because an audible signal may be missed due to excessive noise or may be unacceptably intrusive in a quiet environment. Visual displays also help people with special needs for hearing impairment.
- provide visual displays where the user needs the information for detailed study and to act as a reminder.

### *Additional comments:*

The visual display is an essential element in the design of the user interface and is the most flexible medium ranging from simple light signals used to give status and warning information, through simple alphanumeric character displays, to extensive text and live pictures shown on large CRT and LCD graphic displays.

See the cross reference entries for specific guideline entries, and also Biberman (1973), Snyder (1988) and Travis (1991) for more background information on visual displays and image quality.

# Voice Transmission

## *(Telephony, Voice)*

ISDN provides for voice transmission or telephony within the ISDN and PSTN networks. Currently there are two levels of service, the basic 3,1kHz and the high quality 7kHz. Communication across to the PSTN is only possible at the lower service level. Within voice communication there is the possibility for the full range of supplementary services including multi-party call handling with one or two B channels.

## *Cross references:*

Communication and Transmission; Multi-media Terminals; Supplementary Services; Telephones; Videotelephones

## *Recommendations:*

- to maintain and improve the quality of the audio service, it is essential that the user continues to perceive voice transmission as bi-directional, with both directions continuously and simultaneously active throughout the speech phase. The important element is for the users to feel confident that they continue to share the same auditory space, irrespective of the terminal, system or network technology.
- ensure the quality of the transmitted voice signal, 3,1 and 7kHz teleservices, (ETSI ETS 300 111, and ETSI T/NA1 (89)32) is equal to, or better than, that for analogue telephones across all parameters. Where appropriate use the international recommended procedures for assessment of transmission performance. (CCITT Recommendations G.111, G.121 and CCITT Series P Supplements Nos. 2 and 10).
- ensure the level of sidetone attenuation is adequate to prevent the user's speech from being transmitted from the microphone to the user's own earpiece (loudspeaker). (CCITT Recommendation P.11 and CCITT Series P Supplement No.11).

## *Additional comments:*

The prime requirement for voice transmission is to be heard and to hear the other person(s) clearly. The techniques used for voice switching and echo cancelling in handsfree operation have to be designed with care to ensure their is minimum impairment to the natural rhythm of voice communication, and to the user's perception of a shared auditory space. See also Larsson, 1974.

While users are unlikely to be familiar with the technical demands for frequency response, side tone or echo-suppression, they are very sensitive to subtle nuances of tone of voice, expression and hesitation. These can significantly affect the perceived quality of information exchange such as whether the other person is agreeing or disagreeing, understanding or confused. (Gleiss, 1968; Gleiss 1974, Kellner et al, 1988; Baden-Kristensen and Pedersen, 1990; Perosino and Usai, 1990).

# 6 The Last Guideline

One final word of caution. Maximising the usability of a product is not a simple task. It is possible to use only the latest technological developments in user interface design and still produce a thoroughly unusable product.

As John Whiteside (1985) discovered when he compared the usability of three different interfaces, a command based one, a menu based one and a new iconic user interface, across three levels of user experience. Unexpectedly, user performance and preference was not correlated with interface style, but careful design was. He concluded, **"New interface technology did not solve old human factors problems".**

Consequently, the last guideline that can be offered is:

> *There is no short cut. The design of the user interface, and the integration of Human Factors, needs the same dedication to analysis, specification, prototyping and testing as the design of any other part of the product or system.*

Therefore, it is strongly recommended that the advice of a professional ergonomist or human factors specialist is sought for further information on any of the guidelines given in this ETR or, perhaps more particularly, on how to apply them.

## 6.1 The Final Recommendation

Clause 5 of this ETR has attempted to bring together a broad range of guidelines for the design of telecommunications products. These have been extrapolated from the latest international standards; from papers presented at international and national conferences, or printed in international journals; from European research reports; and from the collective knowledge of the ETSI Technical Committee for Human Factors.

However, even with all this authority, we are aware that guidelines are still guidelines. They are not the panacea that will solve all design problems. Therefore, we offer one last word of design advice:

> *Throw away any, or indeed all, of the above design guidelines, in the interests of developing a user interface to your product or system, which has a PROVEN HIGHER LEVEL OF USABILITY for the full spectrum of people it is intended for, and across the essential range of the intended user tasks.*

# 7 References

The references are provided for all the documents used in compiling the recommendations embedded in this ETR. They are subdivided into: International Standards, Guidelines and Working Papers: European Standards, Guidelines and Working Papers; National Standards, Guidelines and Working Papers; and, Published Books and Papers. Every effort has been made to extrapolate the information correctly from these texts, but the reader is strongly recommended to go back to the original material to ensure the interpretation is appropriate for their own context. This is especially significant with the standards material.

The References Clause is completed by an alphabetical list of the abbreviations used in this ETR.

## 7.1 International Standards, Guidelines and Working Papers

**CCITT Blue Book 1988 Recommendations:**
E.121 "Pictograms and symbols to assist users of the telephone service"
E.123 "Notation for national and international telephone numbers"
E.131 "Subscriber control procedures for supplementary telephone services"
E.161 "Arrangement of figures, letters and symbols on telephones and other devices that can be used for gaining access to a telephone network"
E.180 "Technical Characteristics of Tones for the Telephone Service"
E.181 "Customer Recognition of Foreign Tones"
E.182 "Application of Tones and Recorded Announcements in Telephone Services"
E.183 "Guiding Principles for Telephone Announcements"
E.184 "Indications to Users of ISDN Terminals"

G.111 "Loudness ratings for international telephone connections".
G.121 "Loudness ratings for national telephone connections".

I.121 "Broadband aspects of ISDN"
I.250 "Definition of Supplementary Services"
I.251 "Number Identification Supplementary Services"
I.252 "Call Offering Supplementary Services"
I.253 "Call Completion Supplementary Services"
I.254 "Multiparty Supplementary Services"
I.255 "Community of Interest Supplementary Services"
I.256 "Charging Supplementary Services"
I.257 "Additional Information Transfer"

P.11 "Effect of transmission impairments"
P.35 "Handset Telephones."
Series P Supplements
No.2 "Methods used for assessing telephony transmission performance".
No.10 "Considerations relating to transmission characteristics for analogue handset telephones".
No.11 "Some effects of sidetone"

Q.931 "ISDN User-Network Interface Layer 3 Specification for Basic Call Control"
Q.932 "Generic Procedures for the Control of ISDN Supplementary Services"

Z.100 "Specification and description language (SDL)"
Z.321 "Introduction to the extended MML for Visual Display Terminals"
Z.322 "Capabilities of Visual Display Terminals"

Z.323 "Man-Machine Interaction"

**ITU-T Recommendations1993:**

E.134 "Human factors aspects of public terminals - Generic operating procedures".

E.161 "Arrangement of figures, letters and symbols on telephones and other devices that can be used for gaining access to a telephone network".

E.331 "Minimum user-terminal interface for a human user entering address information into an ISDN terminal".

F.901 "Usability evaluation of telecommunication services".

**ITU-T Draft Recommendations 1994:**

E.136 "Specification and use of a tactile identifier for use with telecommunication cards".

F.902 "Interactive services design guidelines".

CCITT Com II-111 May 1987
"System Response Times"

CCITT Com XII 49 July 1974
"Telephone handset design limits".

**IEC Standards**

IEC 417 (including supplement M) "Graphical symbols for use on equipment"

**ISO Standards**

ISO 2530 "Keyboard for international information processing interchange using the ISO 7-bit coded character set - Alphanumeric area".

ISO 2813 "Measurement of specular gloss levels of non-metallic paint finishes at 20°, 60° and 85°."

ISO 3243 "Keyboards for countries whose languages have alphabetic extenders -Guidelines for harmonisation".

ISO 3864 "Safety colours and safety signs"

ISO DIS 9241 "Ergonomic requirements for office work with Visual Display Terminals (VDTs)"

- Part 1 "General introduction"
- Part 2 "Guidance on task requirements"
- Part 3 "Display requirements", including addendum on Flat Panel Displays
- Part 4 "Keyboard requirements"
- Part 5 "Workplace requirements"
- Part 6 "Environmental requirements"

Additional parts currently in preparation

- Part 7 "Display requirements with reflections"
- Part 8 "Requirements for displayed colours"
- Part 9 "Requirements for non-keyboard input devices"
- Part 10 "Dialogue principles"
- Part 11 "Usability statements"
- Part 12 "Presentation of information"
- Part 13 "User guidance"
- Part 14 "Menu dialogues"
- Part 15 "Command dialogues"
- Part 16 "Direct manipulation dialogues"
- Part 17 "Form filling dialogues"
- Part 18 "Question and answer dialogues"

**ISO/IEC Joint Standards**

ISO/IEC DIS 9995 "Information Technology - Keyboard layouts for text and office systems"

- Part 1 General principles governing keyboard layouts
- Part 2 Alphanumeric section
- Part 3 Common secondary layout of the alphanumeric zone of the alphanumeric section
- Part 4 Numeric section
- Part 5 Editing section
- Part 6 Function section
- Part 7 Symbols used to represent functions

ISO/IEC JTC1 CD 11581
"Graphical symbols for use on screens: interactive icons"

ISO/IEC JTC1 CD 13714
"Information Technology - Document processing and related communication - User interface to telephone-based services: Voice messaging applications"

## 7.2 European Standards, Guidelines and Working Papers

**CEN**
CEN prEN 563 Oct 1991
"Safety of machinery - Temperatures of touchable surfaces - Ergonomics data to establish temperature limit values for hot surfaces"

CEN TC122 Work Item 3.1
"Safety of Machinery: Human Physical Performance, Part 3 - Recommended force limits for machinery operation"

CEN TC224 N293
"Machine readable cards - Man-machine interface - Part 2, Dimensions and locations of tactile identifier for ID-1 cards".

**CENELEC**
CENELEC EN41003 "Particular safety requirements for equipment to be connected to telecommunication networks"

CENELEC EN60950 "Safety of information technology equipment including electrical business equipment"

**CEPT**
CEPT Recommendation T/CAC 02 E "Subscriber control procedures for supplementary services in modern telecommunications"

CEPT Recommendation T/CAC S 10 E "Service and facilities aspects of an integrated services digital network (ISDN)"

CEPT Recommendation T/CAC S 10.7 E Annex 0.2 "User operation of supplementary services"

**ECMA**
ECMA 110 Dec 1985 "Requirements for Monochromatic Visual Display Devices"

ECMA 126 Dec 1987 "Requirements for Colour Visual Display Devices"

ECMA 136 Jun 1989 "Ergonomics - Requirements for Non-CRT Visual Display Units"

**ETSI**
ETSI ETS 300 050 "ISDN: Multiple Subscriber Number (MSN) supplementary service, Service description"

ETSI ETS 300 053 "ISDN: Terminal Portability (TP) supplementary service, Service description"

ETSI ETS 300 056 "ISDN: Call Waiting (CW) supplementary service, Service description"

ETSI ETS 300 059 "ISDN: Subaddressing (SUB) supplementary service, Service description"

ETSI ETS 300 062 "ISDN: Direct Dialling In (DDI) supplementary service, Service description"

ETSI ETS 300 089 "ISDN: Calling Line Identification Presentation (CLIP) supplementary service, Service description"

ETSI ETS 300 090 "ISDN: Calling Line Identification Restriction (CLIR) supplementary service, Service description"

ETSI ETS 300 094 "ISDN: Connected Line Identification Presentation (COLP) supplementary service, Service description"

ETSI ETS 300 095 "ISDN: Connected Line Identification Restriction (COLR) supplementary service, Service description"

ETSI ETS 300 111 "ISDN: Telephony 3,1kHz teleservice, Service description"

ETSI ETS 300 128 "ISDN: Malicious Call Identification (MCID) supplementary service, Service description"

ETSI ETS 300 136 "ISDN: Closed User Group (CUG) supplementary service, Service description"

ETSI ETS 300 139 "ISDN: Call Hold (HOLD) supplementary service, Service description"

ETSI ETS 300 143 "ISDN: Audiovisual services - Inband signalling procedures for audiovisual terminals using digital channels up to 2 048 kbit/s"

ETSI ETS 300 144 "ISDN: Audiovisual services - Frame structure for a 64 kbit/s to 1 920 kbit/s channel and associated syntax for inband signalling"

ETSI ETS 300 145 "ISDN: Audiovisual services - Videotelephone systems and terminal equipment operating on one or two 64 kbit/s channels"

ETSI ETS 300 164 "ISDN: Meet Me Conference (MMC) supplementary service, Service description"

ETSI ETS 300 178 "ISDN: Advice of Charge at Start of Call (AOC-S) supplementary service, Service description"

ETSI ETS 300 179 "ISDN: Advice of Charge During a Call (AOC-D) supplementary service, Service description"

ETSI ETS 300 180 "ISDN: Advice of Charge at End of Call (AOC-E) supplementary service, Service description"

ETSI ETS 300 183 "ISDN: Conference, Add On (CONF) supplementary service, Service description"

ETSI ETS 300 186 "ISDN: Three Party Conference (3PTY) supplementary service, Service description"

ETSI ETS 300 199 "ISDN: Call Forward on Busy (CFB) supplementary service, Service description"

ETSI ETS 300 200 "ISDN: Call Forward Unconditional (CFU) supplementary service, Service description"

ETSI ETS 300 201 "ISDN: Call Forward on No Reply (CFNR) supplementary service, Service description"

ETSI ETS 300 202 "ISDN: Call Deflection (CD) supplementary service, Service description"

ETSI ETS 300 208 "ISDN: Freephone (FPH) supplementary service, Service description"

ETSI I-ETS 300 245 "ISDN: Technical Characteristics of Telephony Terminals"
Part 1 "General"
Part 2 "PCM A-law: Handset Telephony"
Part 3 "PCM A-law: Loudspeaking and Handsfree Functions"
Part 7 "Locally generated information tones"

ETSI ETS 300 263 "ISDN: Telephony 7kHz Teleservice"

ETSI ETS 300 264 "ISDN Videotelephony teleservice - Service Description"

ETSI ETS 300 267 "ISDN Telephony 7kHz and Videotelephony teleservices - Digital subscriber signalling system No 1 (DSS1) protocol."

ETSI ETS 300 284 "ISDN : User-User Signalling (UUS) supplementary service, Service description"

ETSI ETS 300 295 "Specification of characteristics of telephone service tones when locally generated in terminals"

ETSI ETS 300 357 "ISDN: Call Completion on Busy (CCBS) supplementary service, Service description"

ETSI ETS 300 367 "ISDN: Explicit Call Transfer (ECT) supplementary service, Service description"

ETSI ETS 300 375 "Pictograms for point-to-point videotelephony"

ETSI ETR 029:1991 "Human Factors (HF); Access to telecommunications for people with special needs. Recommendations for improving and adapting telecommunication terminals and services for people with impairments"

ETSI ETR 039:1992 "Human Factors standards for telecommunications applications"

ETSI ETR 051:1992 "Usability checklist for telephones, basic requirements"

ETSI ETR 070:1993 " The multiple index approach (MIA) for the evaluation of pictograms"

ETSI ETR 095: 1993 "Guide for usability evaluation of telecommunications systems and services"

ETSI ETR 096:1993 "Human factors guidelines for design of minimum phone-based user interface to computer services"

ETSI ETR 113:1993 "Results of an evaluation study of pictograms for point-to-point videotelephony"

ETSI DTR/HF-01006 "Human factors aspects of videotelephony"

ETSI DTR/HF-01016 "Human factors aspects of multimedia telecommunications"

ETSI DTR/HF-01017 "Minimum man-machine interface (MMI) for the access and control of public network based telecommunication services".

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## 7.5 Abbreviations

An alphabetical list is provided of all abbreviations used throughout this ETR.

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|---|---|
| A4 | (ISO Standard paper size) |
| ADSI | Analogue Display Services Interface |
| AOC-D | Advice of Charge - During call |
| AOC-E | Advice of Charge - at End of call |
| AOC-S | Advice of Charge - at Start of call |
| AZERTY | (Standard French language keyboard layout - top row of keys) |
| B-ISDN | Broadband ISDN |
| BS | British Standard |
| BSI | British Standards Institute |
| BT | British Telecom |
| CAD | Computer Assisted Design |
| CCBS | Call Completion on Busy Service |
| CCITT | International Telegraph and Telephone Consultative Committee |
| CD | Call Deflection |
| CEN | Comité Européen de Normalisation |
| CENELEC | Comité Européen de Normalisation Electrotechnique |
| CEPT | Conférence Européen des Administrations des Postes et des Télécommunications |
| CEST | Central European Standard Time |
| CF-B | Call Forwarding - on Busy |
| CF-NR | Call Forwarding - on No Reply |
| CF-U | Call Forwarding - Unconditional |
| CIF | Common Intermediate Format (sometimes Common Interchange Format - 352x288 pixels in Video transmissions) |
| CLIP | Calling Line Identification Presentation |
| CLIR | Calling Line Identification Restriction |
| CNA | Co-operative Networking Architecture (BT Style Guide) |
| Codec | Coder/Decoder (Videotelephone signal transcriber) |
| COLP | Connected Line Identification Presentation |
| COLR | Connected Line Identification Restriction |
| CONF | Conference Call |
| CRT | Cathode Ray Tube |
| CUA | Common User Access (IBM Style Guide) |
| CUG | Closed User Group |
| CW | Call Waiting |
| dBA | Decibels (Weighting scale A) |
| DDI | Direct Dialling In |
| DE | Draft ETS |
| DI | Draft Interim ETS |
| DIN | Deutsches Institut für Normen |
| DIS | Draft International Standard |
| DOI | Department of Industry (U.K.) |
| DTMF | Dual Tone Multi-Frequency |
| DTR | Draft ETR |
| Earcons | (Small meaningful musical phrases - an auditory icon) |
| EC | European Commission |
| ECMA | European Computer Manufacturers Association |
| Ed(s) | Editor(s) |
| EEC | European Economic Community |
| EN | Europäische Norm |
| ESPRIT | European Strategic Programme for Research and development in Information Technology |
| et al | (Latin - "and others") |
| ETR | ETSI Technical Report |

| | |
|---|---|
| ETS | European Telecommunication Standard |
| ETSI | European Telecommunications Standards Institute |
| FPH | FreePhone |
| g | grams |
| GMT | Greenwich Mean Time |
| GS | Gepruefte Sicherheit (German Seal of Approval) |
| GSM | Global System for Mobile communications |
| GUI | Graphical User Interface |
| GUIDANCE | RACE Project 1067 Usability Design Information Support for the Integration of IBC Services |
| HCI | Human-Computer Interface (synonymous with MMI & USI) |
| HF | Human Factors |
| HOLD | Hold |
| HUFIT | Human Factors in Information Technology (an Esprit project) |
| Hz | Hertz (cycles per second) |
| I/O | Input/Output |
| IBC | Integrated Broadband Communications |
| IBCN | Integrated Broadband Communications Network |
| IBM | IBM (International Business Machines) |
| IEC | International Electrotechnical Commission |
| I-ETS | Interim European Telecommunication Standard |
| IPSNI | RACE Project 1066 Integration of People with Special Needs by IBC |
| ISDN | Integrated Services Digital Network |
| ISO | International Standards Organisation |
| ISSUE | RACE Project 1065 IBCN Systems and Services Usability Engineering |
| ITU-T | International Telecommunication Union - Technical (previously CCITT) |
| kg | kilogram |
| LCD | Liquid Crystal Display |
| LED | Light Emitting Diode |
| m | metres |
| MCID | Malicious Call Identification |
| Mil-Std | Military Standard (U.S.A.) |
| mm | millimetres |
| MMC | Meet Me Conference |
| MMI | Man-Machine Interface |
| MML | Man-Machine Language |
| Motif | OSF Graphical User Interface |
| MOU | Memorandum of Understanding |
| ms | milliseconds |
| MSN | Multiple Subscriber Number |
| N | Newtons |
| NDUB | Network Determined User Busy |
| Nm | Newtons per metre |
| OK | Okay |
| OSF | Open Software Foundation |

| | |
|---|---|
| PABX | Private Automatic Branch Exchange |
| PBX | Private Branch Exchange |
| PCB | Printed Circuit Board |
| PIN | Personal Identity Number |
| prEN | Provisional Europäische Norm |
| PSN | People with Special Needs |
| PSTN | Public Switched Telephone Network |
| QCIF | Quarter CIF |
| QWERTY | (Standard English language keyboard layout - top row of keys) |
| QWERTZ | (Standard German language keyboard layout - top row of keys) |
| RACE | Research and development in Advanced Communications technologies in Europe |
| RLR | Received Loudness Rating |
| RSI | Repetitive Strain Injury |
| sec | seconds |
| SIA | System Interfaces for Applications (Siemens/Nixdorf - Style Guide) |
| SUB | Sub-addressing |
| TACS | Total Access Communications System (Analogue cellular system) |
| TCHF | Technical Committee for Human Factors (ETSI) |
| TNV | Telecommunication Network Voltage |
| TP | Terminal Portability |
| UDUB | User Determined User Busy |
| URM | RACE Project 1077 Usage Reference Model |
| UPT | Universal Personal Telephony |
| USI | User-System Interface (synonymous with HCI & MMI) |
| UUS | User User Signalling |
| VDT | Visual Display Terminal |
| VDU | Visual Display Unit |
| VFD | Vacuum Fluorescent Display |
| VPN | Virtual Private Network |
| WIMPs | Windows, Icons, Menus, Pointers |

# 8 International Index

## 8.1 English Index

## 8.2 Index Français

## 8.3 Deutscher Index

## 8.4 Indice Italiano

## 8.5 Indice Español

## History

| Document history | |
|---|---|
| June 1994 | First Edition |
| February 1996 | Converted into Adobe Acrobat Portable Document Format (PDF) |
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