

# 13 Appendices

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# Appendix

## 13.1

Published interface design  
guidelines



CHAPTER FOURTEEN

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# Towards consumer product interface design guidelines

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## 14.1 Are Guidelines Useful?

Product designers are continually confronted with constraints, standards and guidelines. Therefore one response to this chapter would be is there a need for another set of guidelines? Their effectiveness in supporting the design process can certainly be questioned. Research by Klein and Brezovic (1986) asked designers to rate various types of human factors information and found that technical literature was rated least effective, with personal experiences and experimentation supporting design decisions rated the most useful. Designers complained that the literature was often difficult to apply to their particular design problem.

Relevant guidelines are, by their nature, difficult to produce because they have to apply in many situations. Furthermore, guidelines can be axiomatic: statements such as 'present data, messages and prompts in a clear and directly usable form' are self-evident and lack any suggestion or metric by which this statement could be measured. The problem is further compounded by many guidelines assuming that designers only need to be made aware of a rule or principle in order to implement it; or that a few applied psychology principles will provide an adequate design framework.

Designers do not deliberately design bad products. It is more a question of designers not recognising a particular problem existing when provided with design advice. For example, working with the statement 'reduce the amount of memorisation required to complete a command', many designers may critically examine their design with impunity, not recognising that the command sequence may require amendment because they have a different mental model of the users'



capabilities. This may be owing to the designer's knowledge domain of product interaction being incomplete at different levels. At a low level, a designer may recognise that providing meaningful and appropriate prompt messages is important but, on the other hand, not recognise that feedback is important when mistakes are made, for example some VCRs do not even beep when a mistake is made (Thimbleby, 1991). At a high level, the designer's understanding of how the product may be used can often be different from the users' or, put another way, the designer's conceptual model of a product may be at variance with the users' as people form mental models of a device through experience, training and formal and informal instruction (Norman, 1988).

When designers are faced with a range of guidelines, they may refer only to topic areas considered applicable and not consider other relevant information. Indeed, it could be argued that the interaction process between a product and a user can be so 'complicated and variable that it is neither possible nor desirable to develop general interface design principles' (Diaper and Schithi, 1995).

However, to argue a complete abandonment of guidelines would be unwise. The implementation of guidelines does require care and consideration, but designers need some form of 'good practice' to assist decision making. Empirical evidence from the field of human factors can be important in guiding and supporting the product development process if designers can readily access this information. Historically, however, consumer products have traditionally been too diverse in application and lacking in complexity to require interface standardisation; but with the increasing use of the microchip, there is a lack of 'interface conventions' in consumer products (Angiolillo, 1995). Consumer products are undertaking a radical change in terms of their functionality, control and management, with increasing 'intelligence' being built into products. Therefore, control and display technologies should be under frequent and critical review (Muckler, 1984). For this reason, product designers need human factors data to design these increasingly more complex products so that they are acceptable and usable by the user.

In contrast, computer-based technologies have developed under common human factors standards (Stewart, 1995), although Pheasant (1987) provides many relevant British standards that designers may find useful. The product designer will find that ergonomics or human factors data and research findings in the area of product interface design are sporadic, and product designers cannot be criticised for not finding relevant information. One of the main objectives of this chapter is, therefore, to provide 'access' to human factors literature that may prove useful in the product development process.

## 14.2 Guideline Parameters

To overcome some of the problems associated with using guidelines, the following guidelines have been structured to address many of the issues raised.



They are written with a checklist format with references to other publications for further reading and information, allowing the designer to source additional material. The guidelines are written to raise awareness of human factors issues and explain where further information can be sought. The number of guidelines is deliberately small in order to address broad issues at a high level of abstraction from the interaction process. Also implicit in all the guidelines is a user centred approach where emphasis is placed on 'performance benchmarking' in user/product interaction.

Terms used in the guidelines are illustrated in Figure 14.1 and have distinct relationships. The product interface refers to all the control, display and feedback mechanisms that exist on a product but are not necessarily physically located together on the product. Interaction is defined as the dialogue between the user and product, and the system is defined as the product/user interaction in the context of a task being performed in certain environmental conditions. The following points should also be noted. The guidelines are:

- based on 'conventional' products and do not include advanced interfaces such as 'intelligent' products;
- general and broad in nature, the regurgitation of specific prescriptive or declarative information from other guideline sources has been avoided;

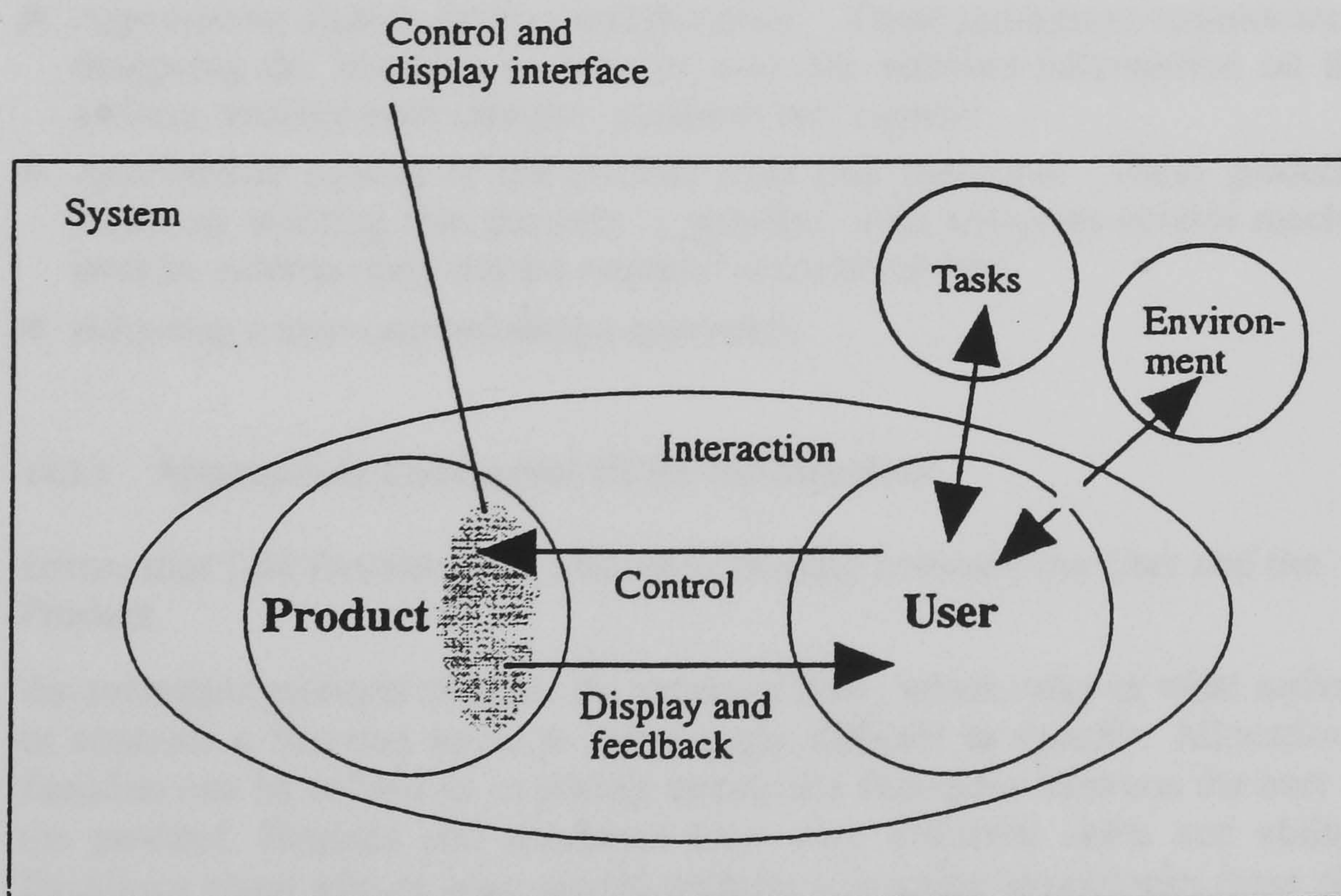


Figure 14.1 Interaction design in context.



- from the field of human/computer interaction (HCI) and have obviously been written with the computer user rather than a consumer user, and this should be borne in mind;
- written to be applicable to a wide range of consumer products and are application-independent.

### 14.3 Guidelines

These basic guidelines for good design practice for interface design are based upon a number of sources, predominantly from the fields of human/computer interaction (Asfour *et al.*, 1991; Brown, 1988; Galitz 1993; Helander, 1990; Nielsen and Molich, 1990; Ravden and Johnson, 1989; Shneiderman, 1992; Smith and Mosier, 1986) and ergonomics texts (Cushman and Rosenberg, 1991; Pheasant, 1987; Salvendy, 1987; Sanders and McCormick, 1993; Woodson *et al.*, 1992). They are grouped into four main sections:

- *Appropriate contextual fit for the interface* These guidelines discuss the importance of ensuring that the interface is suitable for the relevant user population and can accommodate their initial and dynamically changing requirements, the task or tasks that have to be performed, and the environment in which the interface will be used.
- *Appropriate display devices and feedback* These guidelines concentrate on designing the interface so that the user has relevant information on their actions, product state changes, guidance and support.
- *Appropriate control of the product state and functions* These guidelines focus on ensuring that the user is provided with adequate control mechanisms in order to carry out the required task effectively.
- *Adopting a user-centred design approach.*

#### 14.3.1 Appropriate Contextual Fit for the Interface

*Ensure that Task Functions Are Matched Correctly between the User and the Product*

As consumer products change, the issues of how, when, who or what activates or controls a function become increasingly difficult to specify. Allocation of function can be defined as explicitly stating the functions between the user and the product. Humans and machines have very different skills and abilities. Decisions about who or what should perform a function should take these skills into account. For example, humans are good at discriminating signals from high levels of visual or auditory noise and making complex decisions using past



experience, whereas machines are good at counting or measuring physical quantities and for literal reproduction (Brown, 1988).

However, these distinctions are very broad and do not help more subtle design decisions. As products become more complex in terms of functionality, this distinction becomes more blurred and the designer will have to resort to experiments to determine these factors more precisely. For example, advanced photocopiers take some of the copying decisions away from the user by preventing copying if the original overlaps the designated format size. In this example the system function has been increased by allowing the machine to make copying decisions. This function can be overridden by keeping the 'copy' button depressed. Many users, however, are unaware of this because the communication concerning the transfer of function between the machine and the user has been poorly considered by the designer. A good reference for this area is Kantowitz and Sorkin (1987).

#### *Ensure the Interface Communicates in a Consistent Manner with the User*

Much of the design literature states that interfaces should be consistent. It is relatively easy to evaluate the consistency of interface elements by listing all the interaction states and noting different descriptive attributes. Ravden and Johnson (1989) present a series of checklists on consistency and other usability issues which may be useful. In summary though, the consistency of the following interface elements should be addressed:

- Ensure all coloured elements have the same meaning throughout the user/product interaction.
- Text and numerical information should be written in the same style and using the same terms.
- Ensure that all graphical elements are understood by users in different contexts and by different user groups.
- Ensure that instructions do not contradict each other (see Cooper and Page, 1989).
- Control and display layouts should be closely mapped to the task requirements (some form of task analysis will have to be undertaken to achieve this).
- Data entry tasks should use the same protocols, although dangerous or permanent product state changes should require further confirmation or be difficult to process.
- Product interface display and feedback mechanisms should be consistent and appropriate for all stages of the interaction process.

Checking that the interface is consistent with user expectations is more difficult but nevertheless important. It is possible to design a product interface that fulfils all the above criteria which is still inconsistent.



The following considerations are related to other, more broad user expectations that have to be taken into account:

- Ensure compatibility with other products that users may have experience of or would expect to function in a similar way.
- Ensure that the product does not counteract other tasks that may be associated with the product.
- Consistency with the user's mental model of the product, task or relevant experiences.
- Consistency with user stereotypes (many of these are discussed in more detail later).

#### *Design the Product To Fit Normal Behavioural Patterns*

Products are not designed intentionally for the wrong user population. If a product fails to be usable and acceptable, this may be owing in part to an incompatibility between the designer's and user's mental models of the product. It is a common failing to assume that everyone's experiences are the same as one's own. Product designers should therefore develop a comprehensive picture of the different types of user/product interactions that may exist and ensure that the product design allows for this diversity, Loopik *et al.* (1994) provides an example of users' cognitive problems with vacuum cleaners. A useful background to human performance, limitations and differences in systems design can be found in Bailey (1982), whilst Gardner (1987) presents a series of psychological principles which can be applied to interface design.

During product design, the consideration of behavioural activities will inevitably have to be generalised and, to some extent, there are many product/user interactions which can be predicted. Humans are goal-oriented and use artefacts to achieve these goals. This means that users will be task-centred and will find any interface that prevents these objectives frustrating. To ameliorate this, an interface should have certain qualities. Galitz (1993) suggests that they should be:

- adaptive to different users, tasks and environments;
- transparent, allowing the user to be able to concentrate on the task not the product;
- comprehensible, with the user knowing what to do, when to do it and how to do it;
- natural and predictable according to users' expectations;
- responsive, by supplying feedback to user requests;
- self-explanatory, by providing interaction stages that are obvious or supported by appropriate instructions;



- forgiving, by allowing the user to explore and make mistakes;
- efficient, by only providing pertinent information;
- flexible for different user requirements.

To ensure that these qualities are considered, bear in mind the following guidelines in this section.

*Both the Physical Interface and the Interaction Processes Should Adopt or Reflect Familiar Conceptual Models Held by the User*

The designer communicates to the user through the 'system image' (Norman, 1988) which is based on how the designer thinks the system should work. This has also been defined as the 'metacommunication' (Van der Veer *et al.*, 1985) which refers to all activities which communicate the underlying conceptual model of the product. The user's mental model is developed from how the system suggests it works using prior knowledge and experience. For example, students are familiar with an educational model of assignments, lectures and assessments; these metaphors could be used for an educational product aimed at this user population.

*Reduce the Amount of Information the User must Remember in order to use the Interface*

This can be done by providing, for example, default settings, presenting sequences of actions in analogous form, providing clear signposting and navigation through menu structures and keeping categories or classification structures in single figures. Research by Sorce *et al.* (1990) on an information retrieval system for a video library found that subjects preferred to classify video tapes into nine categories as opposed to the 29 found in video shops. Cognitive loading can be reduced by providing the right type and level of functionality to suit the task in hand. Many products offer a wide range of functions which are perceived as being useful by buyers (Lee *et al.*, 1991). However, research suggests that very few of these functions are used because they are difficult to use or remember (Thimbleby, 1991).

*Allow the User To Make Mistakes*

A key rule in human/computer interaction is always to allow the user to undo a command. This cannot always be achieved in consumer products as they tend to have more actions that have a permanent and irretrievable effect, for example selecting record on a tape recorder. Therefore, associated cues or warnings should be provided to prevent accidental error but which allow the user to learn by experimentation and provide clearly marked exits.



### *Conform to Stereotypical Behaviour*

A stereotype belonging to a particular population can be defined as a commonly expected relationship between a control action or display and the resultant product action. For example, most people assume that green means start and expect that when a control knob is turned clockwise, it will move an object from left to right. However, although these stereotypical actions are widely adopted, some caution must be exercised. Stereotypical behaviour is dependent on experience, which is often culturally related. For example, Courtney (1992) found that Chinese subjects did not have the same colour associations as the western population: red for stop and green for go were not so strongly associated.

Generally, when control-display arrangements conform to population stereotypes there are distinct advantages. Asfour *et al.* (1991) found that reaction or decisions times are shorter, the first control movement made by the user is more likely to be correct and learning times are reduced.

### *Accommodate Different Types of Users*

User requirements will vary substantially depending on the user populations that they belong to, including:

- Children
- The elderly
- Users with special needs.

Some products such as washing machines require anti-tamper devices to prevent accidental or mischievous use by children. Whilst some products are designed specifically for their use, there is not a significant body of knowledge about characteristics and abilities of children which can be translated into design criteria (Wilson and Norris, 1993). Some development work on a communication tool, however, called PenPal (Piernot *et al.*, 1995) suggests that children prefer products with physically manipulable interfaces and a 'fuzzy boundary' between the physical and software elements of the product. Products should be fun to use and it should be possible to customise the interface.

Products have traditionally been designed for use by people during active adulthood, although there is increasing recognition of the elderly user (Benktzon, 1993; Sandhu, 1993; Vanderheiden 1991). Elderly users require a different type of interaction support. Research by Loring (1993) investigated an elderly user group and their opinions on consumer products and found that they liked to have instructions to learn how to use the product although they complained about the clarity of the instruction material. She also found that the size, number and spacing of the buttons greatly affected ease of use.



Ward (1989) found that for most disabled users, it is the variety of controls found on the product that cause concern. Furthermore, if one key control is inoperable by a user, the product may be unusable for that person. A preferred method for designing for the disabled is to use less variety in the selection of controls on each product. A considerable body of research has been conducted on telecommunication products (von Tetzchner, 1991) and some of these guidelines can be generalised to a wider range of products; Kanis (1993) provides some design recommendations on the controls of consumer products for physically impaired users, and Shein *et al.* (1995) offers advice for the design of computer interfaces for people with physical disabilities.

Other factors that determine differences in aptitude are: experience, both personal and culturally; 'technical aptitude', defined as spatial and reasoning aptitudes and task-specific knowledge. Egan (1988) has, however, argued that other personality-based characteristics are weak and inconsistent predictors of performance.

#### *The Product Interface Should Accommodate for the Changing Needs and Skill Development of the User*

Designing a product interface that is easy to learn can be counterproductive when users become more proficient with the product or related tasks. A step-by-step introductory procedure may become annoying and frustrating to a skilled user. The fundamental difference between a novice and expert user is in their level of knowledge and experience of the system. Therefore ensure that the interface permits different routes and paths to the same goal, including short-cuts. Skilled users prefer a higher level of control of the system.

Gaining knowledge about a system is an important factor in how the user will want to use a product. Shneiderman (1992) divides knowledge into two levels: syntactic and semantic. Syntactic knowledge includes device-dependent information such as which button will cancel a particular function. For users of consumer products, the retention of this type of knowledge is becoming increasingly more difficult as products provide more 'abstract' and similar or hidden functionality. Users may experience confusion when, for example, the remote control of a VCR is different in terms of key layout and symbols from a functionally similar product such as music centre remote control. Many products lack explicitness in conveying the purpose and consequence of control and display devices.

Semantic knowledge refers to concepts that allow the user to represent mentally what is going on inside the product. This is also referred to as the mental model that the user has of the system. Shneiderman (1992) differentiates between users who have a high knowledge of the task but not of the product and vice versa. It is important that the user develops a correct mental model of the product's operations to assist in the learning and retention of its functions.



This picture of changing or varying user needs is further complicated when intermittent or discretionary users, who tend to exhibit characteristics of both novice and expert users, are considered (Santhanam and Wiedenbeck, 1993).

### *Ensure that the Product Interface is Understood and Accepted by Different Cultural Groups*

As products reach wider global markets this aspect of product interface design becomes more important. Nielsen (1990) provides a useful information resource; although these issues are specifically related to computer-based interface design, they are relevant to product design. Russo and Boor (1993) provide a cross-cultural checklist to ensure that a product bridges cultural boundaries; it includes:

- Translators of text should be aware of the subtleties of product text and should have a full understanding of the product and its use to ensure that some meanings are not misinterpreted. Jargon should not be used. Designers should be aware of other character sets, e.g. Â, Ê, Å, å, ß and ensure these are feasible on electronic displays.
- Beware of the use of commas and full stops to separate large numbers, these vary particularly between Europe and the USA.
- Images and symbols can be misinterpreted across different international markets.
- The interpretation of colour varies widely across countries.
- The placement and arrangement of text and graphical images on the interface should consider other cultures, particularly Arabic and Chinese populations as they read and present information differently.

### *Design the Interface To Fit and Support the Intended Tasks*

To do this requires a full understanding of the task or tasks. This means that some form of task analysis should be undertaken. Task analysis, in this context, involves the study of user activity to achieve a particular goal. There are many task analyses and many of these are comprehensively described by Kirwan and Ainsworth (1992) and Stammers *et al.* (1990).

It must be acknowledged, however, that using or selecting a particular task analysis method can be difficult. Benyon (1992) cites various problems. For example, there is a complex array of terms that vary from one task analysis method to another, such as plans, goals, methods, operations, actions. Even the definition of task is questionable. Because there are many approaches to task analysis, a product designer may find it difficult to identify one that will map onto the product design process and provide pertinent results; although Baber and Stanton (1994) offer a synthesised approach using two techniques known



as hierarchical task analysis and state space diagrams which highlights where errors and confusion may occur in using an existing or proposed product.

The importance of a designer having a full understanding of the tasks involved in using a product cannot be overstressed, as such an understanding will inevitably facilitate in the reduction of usability problems. This requires some rigorous and methodical analysis of the tasks to be undertaken between the user and the product which cannot be explained in any depth here. Instead, some simple advice is presented which can be used in most design scenarios:

- Try to group functionally related devices together; this is typically done by placing controls or display information in close proximity. Other coding methods which have value include colour or shape coding.
- Group frequently used control devices together but also ensure that they are easy to execute and do not interfere with each other.
- Make important, initiation and shut down functions easy to learn.
- Anticipate human errors and design the interface to allow them to happen. For example, provide undo features or security devices to prevent errors. Predicting human error is very unreliable and it is wiser to make observations of typical user/product interactions. In doing this, important lessons can be learnt about the design of the interface. For example, Verhoef (1988) observed users of ticket vending machines and noted the following types of error: information presented by the system may not be noticed by the user; users may not have all the information to hand to complete a transaction; the system may not clearly explain the tasks; or the user may not perform the tasks in the correct order

#### *Accommodate Different Environments in which the Product Interface May Be Used*

Sanders and McCormick (1993) and Galer (1987) provide information on environmental issues as well as being good general texts on human factors. Environmental issues that may be relevant and affect the use, and therefore the design, of an interface can be divided into two broad areas: physiological and psychological.

The physiological factors that may affect the usability of an interface, and which, therefore, should be considered, are noise, illumination, climate and motion. Psychological factors include stress, social interaction and mental workload. If these factors are ignored and are not included in the interface design specification, there may be situations where the product may be dangerous or difficult to use.

Noise can be defined as unwanted sound, and it is important that any auditory displays are designed to be discernible not only from the environmental noise but also from each other. Ensure that display and control panels do not potentially present glare that may inhibit the use of the panel, and consider how



product interfaces can be used in extremely bright or light environments. Some products may be used in extreme climatic conditions. If this is so, ensure that controls can be operated whilst wearing gloves in cold conditions and that the panel does not become too hot to touch in hot conditions. Some products are used in unstable conditions, for example a car radio, where fine adjustments can be difficult – the environmental factor of instability would therefore need to be considered.

Psychological factors that may need to be considered in the design of the product interface include:

- Stress – products such as burglar alarm control panels are sometimes used in stressful conditions. People under stress are accident-prone and tend to revert to rehearsed and stereotypical behaviour.
- Consider that products may be used while the user is in a 'transitory state' such as tired, fatigued, under the influence of alcohol or drugs.
- Social and cultural factors may determine the usage of a product. Crozier (1994) discusses psychological responses to design by addressing issues such as the meaning and emotional response to products.

#### 14.3.2 Product Presentation

##### *The Product Interface Should Inform How and When It Should Be Used through Various Display Mechanisms*

A product display can be online, either dynamic (various forms of instruments that vary with time) or a static display information which does not change with time. Offline material includes manuals and operating instructions. The following types of display should be considered:

- *Alphanumeric displays* can be used for a variety of purposes such as instructions, prompts or labelling. There is plenty of literature on this subject, particularly on character recognition, height-to-width ratio, stroke width, letterspacing between and within words, spacing between lines and viewing distances. See, for example, Cushman and Rosenberg (1991) and Woodson *et al.* (1992) for detailed information. A good publication on writing instructions for consumer products is Cooper and Page (1989). There is very little literature on the effectiveness of instructions for specific product types.
- *Colour* can be used to highlight, group and code different interface objects (Van Laar and Flavell, 1990). These should, as far as possible, comply with standards or *de facto* standards. (See Diaper and Schithi, 1995, for some controversial views on this subject which relate to more general design issues on guidelines.)



- *Graphics* is defined here in its broadest terms, and can be used to display complex information, trends, predictive versus actual values and dynamic information. Graphic displays include symbols (where Easterby (1970) states that symbols should fulfil two major criteria of discriminability and meaning) and icons, which are small graphic images that represent familiar objects or abstract forms in order to convey their function. See Galitz (1993), Gittens (1986) and Lin *et al.* (1992) for specific guidelines and design issues.
- *Auditory displays* should be used when visual displays are not appropriate, (see Blattner *et al.*, 1989; Gaver, 1989) for example when driving a car and trying to tune in the radio or when there is a need to reduce the cognitive load on the visual channel. Sound has the advantage that it can be heard from all directions and the user does not need to be focusing on the output device. Auditory displays should be used to enhance visual displays and make their operation more memorable and when visually impaired users need to use a visual based interface. Reaction to auditory stimuli is faster than reaction to visual stimuli (Bly, 1982).
- Form or shape of controls can display how a control should be used, Norman (1988) refers to this as 'affordance'. For example, washing machine control knobs have been shaped in the form of an 'S' to suggest the direction the control should be turned.
- Dials and pointers are rarely used on products and therefore not discussed in detail here, though many general ergonomics books have detailed information if it is required.
- Grouping and clustering of displays can provide important cues on the functional process of the product. Spatial considerations should be closely linked with task requirements.
- Electronic displays are increasingly being used on consumer products. The field of human/computer interaction has much to offer in terms of guidelines that could be used in display design. Cushman and Rosenberg (1991) offer useful advice on selecting an appropriate display technology. Galitz (1993) is an extremely comprehensive book on screen design discussing user issues, the use of different dialogue styles, graphical screens and colour.
- Indicator lights are a useful display medium. Indicator lights can be used to indicate whether power is on or off, the status of a function, mode or hazard conditions or that a malfunction has taken place. See Woodson *et al.* (1992) and Pheasant (1987) for uses and effectiveness of indicator light displays. In contrast to industrial products, where coloured indicator lights have recognised meanings, consumer products do not comply so rigorously to standards.
- Conspicuity of target objects. Cole and Hughes (1984) define two types of conspicuity: attention conspicuity measures the propensity of a display object to attract attention when the observer's attention is elsewhere, whilst



search conspicuity measures the likelihood of a display object being located during a search for that object.

- Coding should be used with care, avoiding a myriad of display coding methods. Coding types include colour, text and letters, geometric shapes, size, brightness and flash rates.
- Semantic cues – the conscious use of product form and visual cues or metaphor to optimise the interaction between the product and user – can be provided. There are three important elements that should be considered when presenting a semantic cue: what the semantic cue(s) should be; how the representation should be conveyed (for example, visual or auditory); and how the semantic cues are interpreted by the user.

#### *Ensure that the Product Provides Effective Control Mechanisms which Are Understood*

Guidelines and information on control devices are numerous, although many of the control devices cited are not relevant to modern consumer products. Hard control devices (as opposed to soft control devices such as touchscreens) are liked by consumers and there is ample scope to develop these types of device further (Black and Buur, 1996). There have been few studies that determine consumer preferences for controlling consumer products. However, a study by Sorce *et al.* (1990) examined user preferences for a video service and found that subjects preferred a hand-held controller to a keyboard or joystick, a TV screen to a laptop computer screen for selecting a show, and a visual rather than an audible dialogue with the system. In a study of car radios (Johnson, 1991), subjects preferred rotary control knobs over other types (which were not specified in the paper) and preferred rotary knobs with resistance within the control.

The variation of control devices for consumer products is surprisingly narrow. A recent study by Bonner (1995), noted that 89 per cent of controls were pushbutton and that, generally, users found them too small. Similarly, Sandhu (1993) found that, for elderly users, control knobs rarely conform to ergonomics criteria. They are often too small, difficult to turn, provide little feedback and are too close to each other. In designing pushbuttons, the following criteria should be taken into account: dimensions, shape, grouping, guarding, forces and profile. For further information on control design, see Pheasant (1987).

### **14.3.3 Providing Appropriate Feedback**

#### *Make Sure the User Knows What Is Going On*

Appropriate feedback in the context of consumer product design can be defined as conveying to the user the right level of information before, during and after the execution of an action. Norman (1992) suggests that a person needs at least three



different kinds of confirming information: the act itself, intermediate results and a final outcome. Shneiderman (1992), describes this process as closure, where actions have a beginning, a middle and an end. That is to say that, at each stage of the interaction process, it should be apparent to the user where to begin, it should be apparent that the product has undertaken an instruction and is carrying out the task, and it should be apparent when this is complete.

The feedback process is complex in that it is dynamic and multimodal, making it difficult to measure the effectiveness by which users understand different feedback mechanisms. As product/user interactions become more abstract and removed from physical actions, feedback mechanisms need to be deliberately designed into the product. The only way to ensure that adequate feedback has been satisfactorily designed into the interaction process is to conduct user evaluations. The following types of issues should be addressed and considered in an evaluation programme:

- Assess whether the feedback is offering informative feedback: the product should only tell the user what he/she needs to know in order to continue work productively. It is important to find out if users obtain the right type of feedback.
- Check that the user has correctly understood the feedback provided.
- Make sure that the user is aware of state and mode changes and adequate support is provided when things go wrong. Conn (1995) provides a detailed study of response time particularly related to interactive systems and provides some useful principles.
- Navigation signposts should be given; for example, attempts should be made to present all relevant information to enable an action to be completed. Users should not have to remember data from one display page to another (Engel and Granda, 1975).
- Evaluate the help systems and ensure that they provide relevant and timely support.
- Warning displays can be either active, by presenting warning information when it is relevant, or passive such as labels and signs. See Silver and Braun (1993) for readability issues of warning labels, and Frantz (1993) for information on the location and presentation of warning instructions. Lehto (1991) states that it is important to match the warning design to the operator's level of performance. Some form of task analysis should take place to identify where errors may occur and, subsequently, a product evaluation conducted to establish whether the warnings are discernible, correctly perceived and interpreted.

#### 14.3.4 Work Directly with Users

Including end-users in the design process is not a trivial consideration. From an economic, organisational or practical point of view, it can be difficult to



implement. However, if this approach is considered then users can be involved in several ways:

- As part of the design team (participative design), for example in focus groups to develop solutions to product problems (Caplan, 1990).
- In user trials for existing or prototype products where testing user behaviour is measured rather than just opinions. McClelland (1990) gives a very good description of user trials. However, as products become more interactive it is the 'interactivity' that needs to be designed rather than the physical product (Webb, 1996).
- In formulating user requirements in terms of product needs.
- In developing a user profile which describes the cultural, physiological and psychological aspects of the user.

#### 14.4 Conclusions

The literature review that was carried out for this chapter has revealed many areas that need further investigation. Firstly, as consumer products begin to converge bringing together computer, telecoms and electronic consumer products, interaction issues will play a larger role in the design process to provide 'usable' products. The need for a greater understanding about user needs becomes more acute with an increased emphasis on participatory design required to accomplish product design objectives (Sanders, 1993). A greater understanding is required of consumers as a user population, particularly in fields where products begin to have more sophisticated interaction styles. Unlike the majority of computer users in an industrial context, consumers make their own purchasing decisions, at which point usability may not be a high priority, and can then subsequently be highly discretionary in using them. This may ultimately result in total abandonment of large parts of product functionality if the product lacks the transparency to allow the user to achieve a required task.

Secondly, in contrast to the commercial context where there is usually formal or informal product knowledge, the training and learning in the consumer market is usually totally dependent upon printed instructional advice, usually without any personal advice or experience to provide additional support. Thirdly, few human factors standards exist on how to design consumer products which may provide consistency in interaction dialogues and therefore reduce learning times and confusion. Finally, further investigation is required on emerging and conceptual interaction styles to assess the usability implications. It is important that products have an opportunity to be led by user needs and characteristics rather than be completely technology-led.

To summarise, the intention of this chapter has been to provide the product designer with some broad guidelines which can also act as a checklist to ensure



that ergonomic issues of consumer interfaces, particularly those containing electronic displays, are addressed. References to more detailed recommendations and guidelines have been provided and should be regarded as pointers to more specific and detailed research.

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# Appendix 13.2

Interaction designer's diary



## Diary on prototype development

Several prototype interfaces were built in order to achieve the following:

- To evaluate the complexity of constructing fully working prototypes.
- To test different methods of displaying information & to compare them.
- So as to work out some of the Lingo programming routines.
- In order to successfully come up with coherent models which covered all of the interaction styles we wished to test.
- To visualise the ideas we had in our head, before either developing them further or discarding them.
- To test the different interaction styles.

### Test Drag 'n Drop Interface

A simple test interface was constructed comprising of the following elements:

5 Boxes representing wash temperature (Cold, 30°, 40°, 60°, 90°).

5 Boxes representing spin speed (300, 700, 1000, 1200, 1400).

5 Boxes representing fabric type (Woollen, Delicate, Synthetic, Coloured Cotton, White Cotton).

A 'target' area box.

The idea was that one of each of the elements: wash temperature, spin speed, & fabric type should be 'dragged' into the target area to make up a wash programme.

This model was based on an idea of dragging 'icons' which could represent various programme elements, into a target area of some sort. The idea was to take the computer's interaction style, and by placing it on a washing machine, assess whether it improves the usability.

The drag 'n drop interaction style was simply based on a 'gut-feeling' that this method would produce an easier to use washing machine. None of the decisions made on this early interface were carefully considered, most of them were often 'first choice' solutions.

The three elements: fabric type, spin speed & wash temperature were by no means perceived as 'the correct' elements or the right number- they were based upon one of the AEG washing machines. Each of the three elements had five different settings - again this was based upon the AEG machine and not a conscious decision to create the 5 increments.

### Arrangement of Icons

The icons were arranged on the screen such that they were placed in a row sorted in single category groups - wash temperature, spin speed & so on. This



arrangement was based on my 'mental model' of what seemed a logical arrangement - left to right, greatest first in descending order (i.e. hot - cold, fast spin - slow spin). Guidelines would have been useful at this stage to give an indication of what should be the best arrangement of icons depending on their use - i.e. For dragging icons around a screen, the best placement is ... etc. Again, the spacing of such icons was not particularly well thought out - they were spaced out according to how much space was available on the screen, making sure that it was not too visually obtrusive, rather than being placed in the 'optimum' position (if such a thing exists!).

- Number of Icons
- Behaviour of Icons
- Dealing with Errors
- Target Position
- Target Size
- Target Shape
- Target Behaviour
- Method of Feedback used
- Starting programme

### **Test Fuzzy Logic Interface**

3 different ideas:

- Target Idea - 3 controls
- Fuzzy-Logic 'Map' - 3 controls
- Changeable Sprite - 3 variables + error variable

### **Other Interfaces**

A few simple lingo techniques were also tried out on other interfaces.

### **Main Interfaces**

Once the preliminary test interfaces were built, I was able to make a few decisions about which features could be kept or improved upon for the final interfaces.

### **Drag 'n' Drop Interface**

When designing the drag 'n drop interface, the first thing to be established was how to map the AEG's array of functions onto icons, and how to group them.

### **Grouping the Icons**

Firstly, it was decided that each separate programme, would map directly onto a single icon - this made things a lot simpler in terms of re-creating



exactly the same level of functionality as the AEG. Secondly, the icons had to be grouped. They did however naturally fall into the following categories:

- 6 Spin speeds: 1500, 1200, 1000, 900, 700 & Without Final Spin
- 7 Wash temperatures: 95°, Energy Saving (67°), 60°, 50°, 40°, 30° & Cold
- 4 Fabric Types: Cottons/Linen, Easy-Cares, Delicates & Woollens
- 10 'Other' Programmes: Gentle Rinse, Starching, Pump Out, Spin, Short Spin, Soaking, Pre-Wash, Quick Wash, Intensive & Conditioner

As a first thought, John Bonner thought it may be best to group the programmes in terms of a first stage, second stage & third stages in order of time, hence:

- Stage 1: Temperatures 95°, Energy Saving, 60°, 50°, 40°, 30° & Cold  
Fabric Types Cottons/Linen, Easy-Cares, Delicates & Woollens  
'Other Programmes' Soaking & Pre-Wash
- Stage 2: 'Other Programmes' Quick Wash, Intensive & Stains  
Spin Speeds 1500, 1200, 1000, 900, 700 & Without Final Spin
- Stage 3: 'Other Programme' Conditioner

This would be a logical conclusion, but meant that it confused the 'natural' groupings by 'type'. Hence, I concluded that it would be best to keep as close as possible to the natural groupings by type. I also thought it best to stick quite closely to the original groupings on the AEG machine. I therefore came up with the following groupings:

On the AEG machine, the rotary dial can only select *one* of the following, therefore, it made logical sense for these to become one grouping, hence:

- Group 1: Cottons/Linen, Easy-Cares, Delicates, Woollens, Gentle Rinse, Starching, Pump Out, Spin & Short Spin.

I then went on to follow the logical groupings of spin speed & temperature:

- Group 2: Temperatures 95°, Energy Saving (67°), 60°, 50°, 40°, 30° & Cold.
- Group 3: Spin Speeds 1500, 1200, 1000, 900, 700 & Without Final Spin.

This finally left a natural grouping of 'additional' programmes:

- Group 4: Soaking, Pre-Wash, Quick Wash, Intensive, Stains & Conditioner.



Once the four groupings had been established, I decided that some sub-grouping was necessary. For instance, by looking at the rotary selector on the AEG machine again, it became evident that when selecting a fabric type - cotton for example, one had automatically selected a temperature at the same time, from the range given on the dial. It was impossible to select a fabric type without choosing a temperature and therefore impossible to set any further parameters until the dial had been turned. This made me decided to sub-group groups 1 & 2 hence linking the association between fabric type & temperature.

I had now established 3 main groupings which seemed to be logical and well thought out, as well as being closely linked to the way AEG functioned. The next task was to choose a suitable 'metaphor' for the interface.

### **Choosing a suitable Metaphor**

The idea behind drag 'n' drop suggests that you 'drag' an object (in this case an icon representing a certain wash programme) and you 'drop' it onto or into something, for something else to happen. What should the user 'drop' the icon into?

By trying to link the act of 'doing the washing' with performing the task of 'dragging' and 'dropping' icons, I tried to think of something that was synonymous with the task in hand. Using graphical 'washing baskets' for the icons to be placed in for washing, seemed to be a suitable metaphor. After all, when doing the washing for example, you would perhaps place different sorts of washing in different washing baskets - for example sort whites in one basket, and dark colours in another basket.

This metaphor then, became the one which we used for the drag 'n drop interface. No other metaphors were in fact thought of or experimented with, so again, this was a first generation idea which was simply gone along with. I decided to use a separate basket for each major group to keep with the idea of separating different types of programme instead of mixing them all together in one basket. Hence, Basket 1 would contain fabric type & wash heat, Basket 2 would contain the spin speed & Basket 3 would contain any additional programmes.

Once many of the initial decisions had been made about how the interface was going to 'look', careful thought had to be given to how the interface was going to function. Many of the decisions that had to be made regarding the interfaces function did not emerge until the interface had been built to a certain level of functionality - it was only on trying to perform a certain task that it became evident that certain decisions needed to be made.

Once the icons had been arranged on the screen into their three major groups, I felt some visual way of grouping them was necessary. At first this was done



by surrounding the icon groups with boxes. Although once the icons were made able to be dragged around the screen, enclosed boxes seemed to be misleading. They gave the impression that the icons were 'fixed' inside a container, instead of making the icons look 'moveable'. By way of experiment, I amended the enclosed boxes by making them open-ended (3 sided containers). This seemed to improve the situation, there were now no visual 'obstacles' in the way of dragging out an icon. Although functionality, the interface behaved in exactly the same way, visually, it created a different impression. Certainly, at this stage, guidelines would have been very helpful, regarding the use of visual 'clues'.

Now the icons were draggable, there were all manner of decisions to be made to how they would behave. For example how far could they be dragged? What would happen if they were not dragged far enough? How would a user know that they have dragged an icon to the right place? How would the interface deal with errors? The list is endless!

The way I tackled this long list of decisions was to deal with them as each one came up. The first decision to make was:

### **Should all icons be made draggable?**

I had to decide whether the user could choose to drag any icon from the whole range of icons, or whether it should be limited in some way to avoid the user selecting a programme that was not possible. Looking again at the AEG machine, the user was forced to choose a wash programme (and a temperature if they were not choosing a short programme) *before* they could select anything else. I had to then re-create this on this interface. I had to also communicate this to the user somehow - distinguish between an icon that could be selected and an icon that was unavailable. The way a typical computer interface does this is to 'grey-out' icons, so I chose this method of communicating the information. This method of greying out icons immediately had knock-on effects. Once an icon had been greyed-out, should it remain in this state? The logical conclusion I came to is that it should remain greyed out until it is available for selection. This meant that the interface had to have some built-in prescribed order of performing tasks. It should have an 'emerging' functionality, i.e. one could not perform Task B until Task A had been completed. This meant that I had to have a very clear understanding of what combination of functions should be available at any one time. The interface had to therefore mimic this in which icons were greyed-out at any one time, automatically highlighting icons as they became available. I therefore made all greyed-out icons static, and any highlighted icons draggable.

### **How should draggable icons perform?**

Once an icon was able for selection and was able to be dragged across the screen, I was posed with the problem of determining its behaviour. When



dragging it to its target position (the basket), how would the user know that they had reached the correct position for it to be placed successfully? If the user had to drag an icon into the centre of the basket every time to place it correctly, this would become very tedious. I concluded that there should be a 'hot area' around the basket, so if the user dragged an icon 'near enough' the computer would 'assume' that you were dragging an icon to the basket and hence, drop it in. This decision created the need for two more immediate decisions - when would a user know they had reached the 'hot area' and how would the icon be placed in the basket? Firstly, I made an inherent decision to visually highlight the basket by way of a black border which appeared around it, every time the icon rolled-over the hot area. This gave visual feedback, indicating that the icon was close enough to be dropped into the basket. This seemed to be the most obvious thing to do, although guidelines would have helped in determining exactly how it should be done.

Secondly, I had to decide how the icon would be placed in the basket. I made several experiments. The first (and simplest) of these was to suddenly transform the icons position to the centre of the basket. This worked, although looked visually 'messy', and it did not provide the user with much feedback to where the icon was coming from, or going to. It may have left users confused if they dragged something by mistake and then suddenly saw icons 'appearing' and 'disappearing' before their eyes! John Bonner suggested that it may be best to make the icons move from position to position, so the user could see where they were coming from, and where they were going. I did this which improved it a great deal, but again, this led to all kinds of decisions having to be made. How fast should they move - or how slowly? Should they accelerate towards their target - or decelerate? What should happen if an icon was already in the basket, or an icon did not reach the basket?

For simplicity's sake I decided to make the icons move in a linear fashion at a constant velocity. If the icon reached the 'hot area' it would move towards the basket at a constant velocity until it came to rest in the basket, otherwise it would return to its original position, again at a constant velocity. I had to then decide where the icon would come to rest in the basket. In the case of the first basket, this was to contain 2 settings - a fabric type and a temperature setting. I decided that fabric types should rest at the left-hand side of the basket whereas the temperatures should rest at the right-hand side. The reason for this was that I was trying to give as many visual clues as possible in order to make it easier to use. By making default positions in the basket, if there were a big space in either the left-hand side or the right-hand side, it would indicate to the user that there was a parameter missing, and therefore they could not proceed to the next level until the basket had been filled.

**What should happen if there are more than two items in a basket?**

It seemed likely that although only two items would fit in the first basket at once, people would probably attempt to put more in at some stage. I had to



decided therefore what should happen in this case. There were two alternatives: Firstly, if the basket was full the icon being dragged could return back to its original position. This would seem logical, as in real life if a container is full, you have to remove some of the contents before putting something else in. However, although this was a logical solution, it may have not been the best, or easiest to use. A second conclusion therefore proved to be better. Rather than an item being discarded if the basket was too full, an item previously placed in the basket would move out to make room for the new item. This meant that if users changed their minds to which programme they should use, rather than having to remove items first, an item could simply be plonked in the basket and the older item would return to its original position.

### **Default settings**

Another decision I needed to make was how the drag 'n drop system would handle defaults. The AEG washing machine automatically gave a default spin speed for each fabric type. This meant that the drag 'n drop system had to follow suit also. I therefore made the default spin speed setting automatically jump into the correct basket once a wash programme had been selected. I decided that these should also be able to be overridden in the same fashion as replacing old icons etc.

Once many of the decisions had been made to how the first basket would operate, without realising it, I had created a set of 'rules' which would apply to all of the baskets. This meant that any of the similar decisions I had to make on the other baskets, had already been pre-determined.

### **Fuzzy Logic Interface**

The Fuzzy Logic Interface, was based upon a number of different experimental interfaces. All these test interfaces were simply ideas of how an interface *could* work and were not necessarily thought through at this stage in any great detail. The interfaces are described below:

#### *Test Interface 1 - Target Idea*

The target idea had 3 parameters: Wash Heat, Fabric Type & Spin Speed. This kept the model simple, although it was also due to the fact that these were the AEG machine's main functions on which the model was based. Each of these variables were mapped onto a different toggle switch, which could be used to adjust the parameters up & down. As each of the parameters were adjusted, this would control a cursor towards a target.

#### *Test Interface 2 - Graph Idea*



The graph idea also had three parameters to set, the same as above. Each parameter was represented by a bar graph, which could be adjusted manually in increments either up or down.

*Test Interface 3 - Rotating Shape Idea*

Finally, with the rotating shape idea, the same three parameters were chosen to be represented. Again, the parameters could be adjusted manually by the use of toggle switches. This time however, each parameter was represented in a different way. Heat was represented by a colour: blue for cold, and red for hot. Fabric type was represented by shape, and spin speed represented by the speed of rotation.

Each of these interfaces were similar in terms of which parameters could be set, and the way they could be set. They differed however, by the way in which the information was displayed. Each interface needed some way of representing the ‘fuzzy-logic’ data, and some important decisions had to be made in this regard.

**Target Interface**

The Target interface had to have some way of recognising how ‘viable’ a given programme was - i.e. the more ‘viable’ it was, the closer to the target the cursor would get, or conversely, the worse a given programme, the further away the cursor would get. This meant that I had to create a system of establishing how good a given combination was and calibrate it, so that certain combinations could have degrees of ‘good’ or ‘bad’.

I therefore decided to nominate each fabric programme with an ‘optimum’ setting, and anything that veered away from this combination would be viewed as ‘less-viable’. The temperature ratings shown below were based on my own idea of what a suitable temperature would be for the fabric type, whereas the spin speed ratings were based upon the default settings on the AEG machine. I made the following optimum programmes:

Fabric Type	Wash Temperature	Spin Speed
Cottons/Linen	95°	1500 rpm
Easy-Cares	60°	1000 rpm
Delicates	40°	1000 rpm
Woollens	Cold	900 rpm



Once the 'optimum' programmes had been established, I was able to assign various 'error' ratings to certain settings. I decided to give an error rating on a scale from 1 - 6. For example, if Cottons/Linen was set at temperature 'Energy Saving', and 1500 spin speed, this would be an error rating of 1 (as 'Energy Saving' is one temperature setting below the 'optimum' setting of 95°). In simple terms, if either the temperature setting *or* the spin speed was 1 setting off the optimum, the error rating would be 1. If *both* parameters were one out, the error rating would be 2. I worked out that the most inaccurate setting could be a total of 6 errors out, hence the scale from 1 - 6 was introduced.

## Rotating Shape Idea

This idea seemed to provide the most scope for development and would be perhaps the most visually interesting. The 'error' ratings I had previously assigned to an earlier example also proved useful for this idea.

This idea basically required a number of shapes to represent a different fabric type. As there were four different fabric types, four unique shapes were needed. I quite liked the idea of having a continuous scale from one fabric to another, with lots of in-betweens. I figured that cotton was quite a tough, resilient fabric, whereas wool would be a more delicate fabric. I wanted to choose shapes that would represent these. I also wanted to keep it fairly simple, so I chose the basic shapes: a cube, and a sphere. A cube, with its hard lines, and corners seemed to well represent cotton (in an abstract way) by expressing its hard wearing, tough nature. A sphere, on the other hand with its smoothness seemed to better represent a smooth, soft fabric. I then decided to visually 'morph' from the cube to the sphere to indicate the continuum from one to the other.

I had to decide also what would represent the other two parameters, wash heat, and spin speed. The spin speed was straight forward as this could map onto a direct representation - i.e. the shape could rotate at a certain speed. The representation of temperature was also quite straight forward, as typically blue represents cold, and red represents hot - I therefore used the same method of representing heat with colours.

Once I had decided how everything was going to be represented, it was simply a matter of determining a few further details.

Using the error rating method (as described earlier) I had to determine how this should be interpreted. I came up with the analogy of a washing machine shaking vigorously if loaded incorrectly. So if the parameters set had a high error rating, this should be shown in the way the object spun, the more the programme was badly set, the more the object should spin off centre.

One feature which was quite hard to determine was how to establish how large the increments between different settings needed to be. The speed



difference between the different spins, or whether to 'morph' between each different shape, or make a static transition. Most of these details still need experimentation, and the fuzzy logic interface would benefit from, further experimentation in this area.

### **Auditory Icon Interface**

The auditory icon interface had a relatively few number of decisions to be made compared to the other two interfaces. This was partly due to it being based closely to the original control interface. Another reason is that the guidelines that already exist for auditory icons were used, so this limited the number of 'unknown' parameters. However, the following had to be decided:

The interface was going to be changed slightly from the control interface, this was to strip it from some of the visual clues such as lights and displays, and replace them by auditory displays. I made a decision in selecting sounds to represent certain parameters, which really involved not much more than guess work. Again, simple things like leaving gaps between multiple sound bytes was simply a question of personal judgement of what a 'reasonable' length should be.

Ben Norris



# Appendix

## 13.3

Investigative questions and  
evaluation methods for  
Study 3



# Auditory Display condition (AD)

Questions posed (at each level of Interaction)	Data capture method	Data analysis
<i>Task</i>		
How usable do users think auditory displays are?	Questionnaire using subjective rating scales, comparative analysis between auditory displays	Wilcoxon test or t test: compare rating with neutral answer
How well are different washing programmes remembered compared to the control condition?	Video record verbal recall of tasks using teach back	Analyse for completeness, correctness and style of representation
Can programmes be learnt quickly and what is the learning behaviour?	Measure times to complete using data logging from Director	ANOVA and paired comparisons on time completion to establish learning effect and or plateau
What mental model of programming do user have with auditory displays?	Video record verbal recall of tasks using teach back	Analyse for completeness, correctness and style of representation
What type of errors are made?	Observations during trials and post analysis of video tapes	Frequency count of categorised error types (probably semantic and syntactic types)
<i>Semantic</i>		
Do users understand the meaning of the composition and differences between auditory displays?	Observations during trials and recognition of auditory displays after trial	Frequency count of accurate recognition
Is there any confusion between the auditory displays?	Observations during trials and post analysis of video tapes	Pattern of confusion table
Is the correct level of feedback given with auditory displays?	Questionnaire using subjective rating scales	Comparisons against a neutral response
<i>Syntax</i>		
Understand what is possible and not possible at each stage?	Observation of responses during trials and post analysis of video tapes	Frequency count of responses indicating (lack of) understanding of what is possible at each stage
Understand that the auditory displays are presented in a set order?	Observation of responses during trials, post analysis of video tapes, questionnaire responses to sounds	Frequency count of responses during trials, comparisons against a neutral response



<i>Device</i>			
Are all or any of the auditory displays irritating?		Observation of responses during trials, post analysis of video tapes, questionnaire responses to sounds	Qualitative analysis of responses during trials, comparisons against a neutral response
Do the auditory displays behave in a manner expected by the user?		Observation of responses during trials, post analysis of video tapes, questionnaire responses to sounds	Qualitative analysis of responses during trials, comparisons against a neutral response



# Drag and Drop condition (DD)

Questions posed (at each level of interaction)	Data capture method	Data analysis
<i>Task</i>		
What are the usability issues related to directly manipulating the 'design' of a washing programme using a touch screen interface?	Questionnaire using subjective rating scales, comparative analysis between control and drag and drop interface	Wilcoxon test or t test: compare rating with neutral answer
How well are different washing programmes remembered compared to the control condition?	Video record verbal recall of tasks using teach back	Analyse for completeness, correctness and style of representation
Can programmes be learnt quickly and what is the learning behaviour?	Measure times to complete using data logging from Director, Questionnaire using subjective rating scales	ANOVA and paired comparisons on time completion to establish learning effect and or plateau
What mental model of programming do user have?	Video record verbal recall of tasks using teach back	Analyse for completeness, correctness and style of representation
What type of errors are made?	Observations during trials and post analysis of video tapes	Frequency count of categorised error types (probably semantic and syntactic types)
<i>Semantic</i>		
Do users understand the meaning of the icons?	Recognition of icons after trial	Frequency count of correct and incorrect responses to each icon
Is the correct level of feedback given?	Questionnaire using subjective rating scales	Comparisons against a neutral response
<i>Syntax</i>		
Understand what is possible and not possible at each stage?	Observation of responses during trials and post analysis of video tapes	Frequency count of errors



<i>Device</i>			
Do the icons move and behave in a manner expected by the user		Observation of responses during trials and post analysis of video tapes	Qualitative analysis of responses during trials, comparisons against a neutral response



# Animated Object condition (AO)

Questions posed (at each level of interaction)	Data capture method		Data analysis
Questions at each level of interaction	Data capture method		Data analysis
<i>Task</i>			
What are the usability factors for setting 'vague' washing programmes?	Questionnaire using subjective rating scales, comparative analysis between control and fuzzy logic interface		Wilcoxon test or t test: compare rating with neutral answer
Can users remember washing programme settings using visual cues?	Video record verbal recall of tasks using teach back		Analyse for completeness, correctness and style of representation
Can programmes be learnt quickly and what is the learning behaviour?	Measure times to complete using data logging from Director, Questionnaire using subjective rating scales		ANOVA and paired comparisons on time completion to establish learning effect and or plateau
What mental model of programming do user have?	Video record verbal recall of tasks using teach back		Analyse for completeness, correctness and style of representation
What type of errors are made?	Observations during trials and post analysis of video tapes		Frequency count of categorised error types (probably semantic and syntactic types)
<i>Semantic</i>			
Do users understand the meaning of the different graphic representations for programme selections?	Recognition of graphics after trial		Frequency count of correct and incorrect responses to each image
Is the correct level of feedback given?	Questionnaire using subjective rating scales		Comparisons against a neutral response
<i>Syntax</i>			
Understand what is possible and not possible at each stage	Observation of responses during trials and post analysis of video tapes		Frequency count of errors
Is the logic of graphic display evident	Questionnaire, Observations during trials and post analysis of video tapes		Comparisons against a neutral response



<i>Device</i>		
Do the controls behave in a manner expected by the user	Questionnaire, Observation of responses during trials and post analysis of video tapes	Comparisons against a neutral response



## **Teachback instructions, coding scheme and notes concerning effectiveness of methodology**

### ***Teachback instructions (Experimental condition)***

We are interested to know in what way you have remembered how to use this type of panel. For that reason we are asking you the following question.

Imagine someone who uses an automatic washing machine regularly but has never used the drag and drop control panel. Using diagrams and/or words show how you would explain to him/her how to perform the following tasks using the drag and drop panel:

*The jeans that you want to wear tonight have a grass stain on them. They are the only item of clothing which you need to be washed at the time. What washing programme will you use?*

*Describe how you would set the washing machine to gentle rinse at 900 rpm using the conditioner option and then how you would change this to 30 degrees at 900 rpm with conditioner*

### ***Teachback instructions (Control condition)***

Imagine someone who has never used an automatic washing machine. Using diagrams and/or words show how you would explain to him/her how to perform the following tasks using the push button control panel:

*You are baby sitting a toddler. Whilst out playing she manages to fall into a small puddle and her new white cotton tee-shirt is covered in mud. Her parents are coming home to collect her soon and you would like to send her home clean. What washing programme will you use?*

*Describe how you would set the washing machine to easy care at 700 rpm with a quick wash and then how you would change this a cotton wash with economy wash at 700 rpm*

Coding details and comments for teachback analysis



### ***Misconceptions coding***

- 1 Non existent spin speed (CC)
- 2 Poor description of temperature (AO)
- 3 Incorrect selection of shape (AO)
- 4 Temp not mentioned
- 5 Wrong spin speed (CC)
- 6 Spin sound misunderstood (AD)
- 7 Wrong positioning of control setting (CC)
- 8 Misunderstanding of 'energy saving' (CC)
- 9 Incomplete instructions for spin speed selection
- 10 Confirming button with dial (Stains) (CC)
- 11 Confusing fabric type 'easy care'
- 12 Icons in wrong basket
- 13 Incomplete drawing of icon
- 14 No mention of fabric type

### ***Overall problem codes***

- 1 Not understanding icon meaning (DD)
- 2 Don't understand basket function
- 3 Not used
- 4 Task descriptions such as 'Place 'T' shirt in the machine' not really a problem or possible to code but suggests task level thinking
- 5 Wide range of interaction levels used but no level dominates
- 6 Confusion between syntax errors of selecting icons and placement of icons in baskets
- 7 Syntax problems with standard control panel (CC)

### ***Coding problems noted***

- how do you code graphical descriptions?
- coding often based on the use of one word
- exercise instructions can influence the words used in the subject's teach back
- teach back omissions in latter exercises - do we penalise? i.e. subjects give detailed explanations to start with and then use brief descriptions
- evaluators had subtly different interpretations of error types and coding level
- errors can demonstrate a higher or wider understanding of the task even though it is incorrect
- problems of defining 'spatial' syntax rather than 'temporal' syntax - placing objects in the right place rather than in the right temporal order



## General comments about teachback process and some observations about the analysis

- despite being confronted with an audio based interface, few described the teach back in these terms
- subjects don't describe each task to the same level of detail - omit repetitious parts of the task
- some tasks are too short to make any real analysis e.g. 'start button', subjects could be using convention rather than knowledge to describe tasks
- subjects may be using 'teaching' or 'how to' language rather than knowledge language, in other words subjects may be trying to describe the tasks in a way that someone else would understand rather than attempt to divulge all their knowledge
- Method assumes that subjects can change their descriptive or narrative style between conditions - this may not be so
- some concepts were difficult to describe (AO vs DD for example)



**Icons used on this interface**

**Fabric types**



cotton



delicates



easy cares



woollens

**Short programmes**



gentle rinse



starching



pump out



full spin



short spin

**Temperature of wash**

The temperature of the wash is shown as a number within the icon.

For example:



95 degrees



energy saving



60 degrees



cold wash

**Spin speed**

The spin speed is shown as a number below the spin icon.

For example:



1200 rpm



1000 rpm



no spin

**Additional functions**



soaking



prewash



quick wash



intensive




conditioner





stains





## Icon recognition answer sheet


 wash temp 30 degrees

 no spin

 cold wash


 delicates

 short spin

 stains

 wash temp energy saving

 cotton

 soaking

 spin at 1000 rpm

2. Selectable icons are: 1 3 4

3.

1. Pre wash l

2. Intensive h

3. Gentle rinse c

4. Easy care fabrics f

5. Woollens k

6. Quick wash a

7. Pump out b

8. Conditioner e

9. Delicates n

10. Cotton d



Interview 3 July.

## Post trial questionnaire - Control

Subject U23.

- 1) I know what all the different controls can do

Agree

1 2 3 4 5 6 7 8

Disagree

9 + 1 2

- 2) I know what washing programme options are available

Disagree

1 2 3 4 5 6 7 8

Agree

9 - 1 - 1

- 3) I don't have a clear idea of the different ways I can programme the washing machine

Disagree

1 2 3 4 5 6 7 8

Agree

9 1 2

- 4) I think the control panel is complicated

Agree

1 2 3 4 5 6 7 8

Disagree

9 1 2

- 5) The control panel made it easy to know what to do next

Disagree

1 2 3 4 5 6 7 8

Agree

9 0 0

- 6) It was not clear what to do when I made a mistake

Agree

1 2 3 4 5 6 7 8

Disagree

9 2 4

- 7) Information on the control panel is logically organised

Disagree

1 2 3 4 5 6 7 8

Agree

9 1 2

- 8) The control panel did not contain all the information I needed

Disagree

1 2 3 4 5 6 7 8

Agree

9 2 3

- 9) The controls are not cluttered on the panel

Agree

1 2 3 4 5 6 7 8

Disagree

9 2 4

- 10) It was very quick to learn

Disagree

1 2 3 4 5 6 7 8

Agree

9 2 3



What were your overall reactions to the control panel

11)

Terrible

12

3

4

5

6

7

8

9

Wonderful

-1

-1

12)

Frustrating

12

3

4

5

6

7

8

9

Fun

2

3

13)

Dull

12

3

4

5

6

7

8

9

Stimulating

-1

-1

14)

Difficult

12

3

4

5

6

7

8

9

Easy

2

3

15)

Rigid

12

3

4

5

6

7

8

9

Flexible

1

1

16)

Rewarding

12

3

4

5

6

7

8

9

Unrewarding

+1

2

17)

Pleasant

12

3

4

5

6

7

8

9

Unpleasant

2

3

18)

Enjoyable

12

3

4

5

6

7

8

9

Unenjoyable

1

1

19)

In general I am able to make use of all the capabilities of the control panel that are relevant to selection of washing programmes

Agree

12

3

4

5

6

7

8

9

Disagree

1

2

20)

I don't know enough about the control panel to select washing programmes

Disagree

12

3

4

5

6

7

8

9

Agree

-1

-1

21)

I fully understand how the control panel works

Agree

12

3

4

5

6

7

8

9

Disagree

-1

-1



Entered 3 July

Post trial questionnaire - Condition

Subject UB

1) I know what all the different controls can do

Agree

1 2 3 4 5 6 7 8

Disagree

9 -2 -3

2) I know what washing programme options are available

Disagree

1 2 3 4 5 6 7 8

Agree

9 -2 -3

3) I don't have a clear idea of the different ways I can programme the washing machine

Disagree

1 2 3 4 5 6 7 8

Agree

9 2 4

4) I think the control panel is complicated

Agree

1 2 3 4 5 6 7 8

Disagree

9 2 3

5) The control panel made it easy to know what to do next

Disagree

1 2 3 4 5 6 7 8

Agree

9 +1 2

6) It was not clear what to do when I made a mistake

Agree

1 2 3 4 5 6 7 8

Disagree

9 2 4

7) Information on the control panel is logically organised

Disagree

1 2 3 4 5 6 7 8

Agree

9 1 2

8) The control panel did not contain all the information I needed

Disagree

1 2 3 4 5 6 7 8

Agree

9 2 3

9) The controls are not cluttered on the panel

Agree

1 2 3 4 5 6 7 8

Disagree

9 -1 -2

10) It was very quick to learn

Disagree

1 2 3 4 5 6 7 8

Agree

9 0 0



What were your overall reactions to the control panel

11)	Terrible								Wonderful	
	1	2	3	4	5	6	7	8	9	-1-1
12)	Frustrating								Fun	
	1	2	3	4	5	6	7	8	9	-1-1
13)	Dull								Stimulating	
	1	2	3	4	5	6	7	8	9	-1-1
14)	Difficult								Easy	
	1	2	3	4	5	6	7	8	9	-1-1
15)	Rigid								Flexible	
	1	2	3	4	5	6	7	8	9	00
16)	Rewarding								Unrewarding	
	1	2	3	4	5	6	7	8	9	12
17)	Pleasant								Unpleasant	
	1	2	3	4	5	6	7	8	9	121
18)	Enjoyable								Unenjoyable	
	1	2	3	4	5	6	7	8	9	12
19)	In general I am able to make use of all the capabilities of the control panel that are relevant to selection of washing programmes									
	Agree								Disagree	
	1	2	3	4	5	6	7	8	9	-1-1
20)	I don't know enough about the control panel to select washing programmes									
	Disagree								Agree	
	1	2	3	4	5	6	7	8	9	-1-1
21)	I fully understand how the control panel works									
	Agree								Disagree	
	1	2	3	4	5	6	7	8	9	-1-2



Interview  
2 July

Subject no: U23.

### Final Questionnaire

1. Compared to the standard washing machine panel, I found the new style panel easier to use when performing the tasks.

Agree

1

2

3

4

5

6

7

8

Disagree

9

-2 -3

2. I felt more confident about washing programmes using the new style panel as compared to using the standard panel.

Agree

1

2

3

4

5

6

7

8

Disagree

9

1

3. I was more certain that washing programmes were correct using the new style control panel as compared to using the standard panel.

Agree

1

2

3

4

5

6

7

8

Disagree

9

1

4. What were the best and worst features of the standard washing machine panel?

EASY to operate no symbols to remember.

I found no real fault.

5. What were the best and worst features of the new washing machine panel?

Symbols were harder to remember and not as clearly set out. 20 cluttered together on the top the bottom was fine.

6. What common mistake would you say you made on the standard washing machine panel?

wrong setting on dial lost part of dial  
Seemed never to be used.

7. What common mistake would you say you made on the new washing machine panel?

wrong setting on Quick Wash.



8. What were your initial impressions of the standard washing machine panel?  
wonderful a vast improvement on standard washing machines
9. What were your initial impressions of the new washing machine panel? horror. touch panels would worry re thinking its too easy to glide your finger on the wrong control.
10. What changes would you make to the standard washing machine panel? none.
11. What changes would you make to the new washing machine panel?  
Spread top line controlling out.
12. Over all which was your favourite washing machine panel and why? Standard. the program was so clearly marked. wash spin etc.



# Appendix

## 13.4

Draft CPT guidelines for  
evaluation



**Draft**

# **Consumer Product Interface Design Guidelines**

John Bonner

Institute of Design

Teesside University

Oct 1997



# Part 1



## Introduction

### What are these guidelines about?

As part of a research project, a set of guidelines related to the ergonomics or human factors issues of user interface for complex consumer products is being produced. We need to test these guidelines with designers and other experts to ensure that they, in themselves, can be used. In effect, these guidelines are being designed with a user centred approach just in the same way as any user interface should be.

These guidelines are being produced to help designers consider in more detail the 'interaction' issues during the design of a user interface for consumer products. They are being written with a heavy emphasis on emerging and advanced interfaces which are becoming increasingly common on a wide range of products.

However, the following points must be considered when reading or using these draft guidelines.

- They are not complete, at this stage only the structure and framework has been provided with only a little content
- Only the more traditional user interface design guidelines have been included at this stage. This is so the more tried and tested type of guidelines can be assessed in terms of the way they are delivered. More state-of-the-art material will be added once we are confident that the format of the guidelines fits with user needs
- As far as possible the guidelines have been written with advice on how to implement each them
- They have been written so that it is possible to access the guidelines in different ways

### How do I use them?

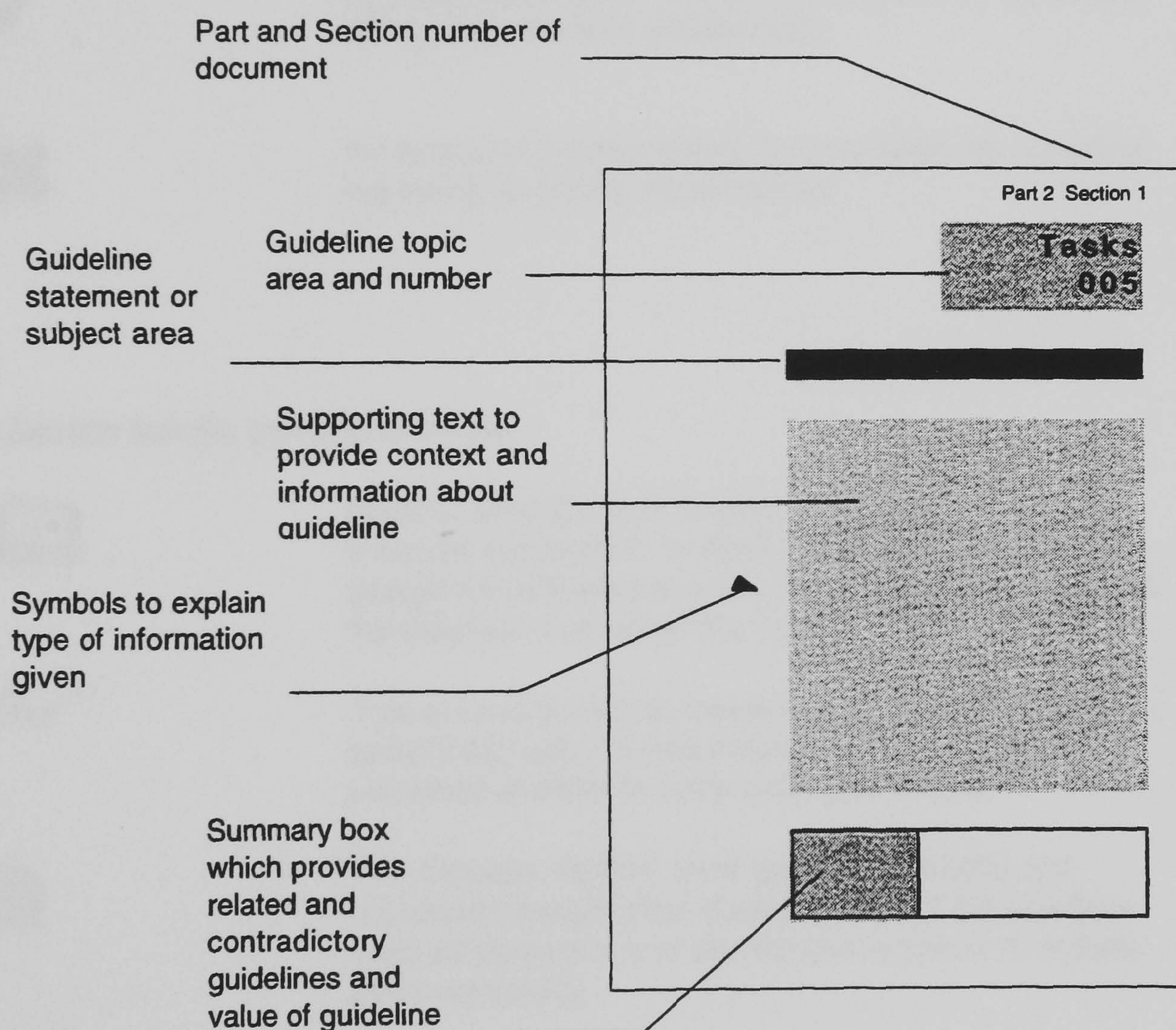
The guidelines are divided into two parts. The first part, this one, explains how to use them; while the second part contains the guidelines. This second part is again divided into two sections.

- Section 1 presents process guidelines. That is, guidelines that do not provide definitive answers but describe how to obtain answers and use high level principles and guidelines. These guidelines have the following sections to support the guideline statement or topic area
  - A method which usually provides a step by step approach to implement the guideline
  - Examples which demonstrate successful or unsuccessful use of the guideline
  - A 'things to think about' section which brings in related or conflicting information



- Section 2 deals with specific control and display devices that make up an interface and provides more prescriptive guidelines. Each guideline is divided into three levels of consideration.
  - The tasks that may affect or determine the type of control or display that should be used or conversely how each type of control or display may affect the task
  - How the user may or should interact with specific control and display devices
  - At the device level the physical and perceptual characteristics of each device are considered

The diagram below describes how each guideline is presented. A series of symbols are also provided in the margins to summarise the type of information presented in that particular section.



All guidelines have reference lists (only a few contain the actual references in this draft set) where information has been drawn from. There is also a summary box which lists related guidelines and also importantly other guidelines they may



conflict with the referenced guideline. Also a rating is given to each guideline to state the level of importance that should be placed on each guideline.

There are a series of symbols in the margin to explain roughly what the associated text will cover. The symbols used in section 1 are:



This explains that there is a step by step approach that can be adopted in order to comply to the guideline



Indicates each step within the method



This symbol defines the type of example being presented. In this case, the example will help to set the guideline in context or provide suggestions about how to implement the guideline



An example is given which demonstrates the guideline being implemented successfully



An example is given which demonstrates the guideline not being or poorly implemented

In Section two the symbols used are:



Used to describe task related design issues and presents information on how tasks can affect interface design considerations or conversely how the design of the interface may affect the task



This is used to denote interaction issues which deal specifically with how the interface may be used or perceived in order to carry out a goal or task



This denotes 'device' level guideline material and addresses the physical characteristics of the interface such as dimensions or correct use of colour to ensure good readability



### Selection methods

In order to help you get access the guidelines, a series of selection methods are offered below, these are:

- index list of topics covered in the guidelines with page numbers
- a checklist to ensure that all relevant guidelines have been considered at different stages of the design process
- a guideline contents list



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Checklist for Guidelines within the design process

This check list will help you to ensure that you have considered all the guidelines that are covered in this document at all stages of the design process. These are divided into four stages.

- Problem definition
- Interface specification
- Interface design
- Evaluation

At each stage of design activity you should go through the checklist to identify any human factors design issues that you may need to consider in more depth.

Problem Definition

Have you considered:	Yes	n/a	No	Guideline references
The type and range of tasks that the interface will have to support	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	005, 006
The environments in which the product interface will have to perform	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	007
The types of users who may use the interface				
Children	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	003
Elderly	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	003
Special needs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	003
Expert/Novice	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	003, 004
The different ways in which the interface may be used and how these should be accommodated				
Used over a long period	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	004
User perceptions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	002, 004



Specification

Have you considered:	Yes	n/a	No	Guideline references
General human factors rules for controls	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	014
The types of controls that would be most appropriate				
Rotary controls	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	016
Touch Screens	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	017
Touch pads	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Switches	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Scrolls/Sliders	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Push buttons	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	015
Direct manipulation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Field sensing controls	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Gesture controls	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3D manipulative control	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Function keys	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Soft function keys	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Voice	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
The types of displays that might be most appropriate such as:				
Print				
Alphanumeric	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	018
Graphics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	018
Colour	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	018
Symbols/icons	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	018
Electronic displays				
Alphanumeric	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	018
Graphics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	018
Colour	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	018
Symbols/icons	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	018
Animation of				
Characters	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	



Objects	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Indicator lights	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Menus	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Multi-mode displays	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2D/3D representation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Auditory			
Earcons	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Voice	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sounds	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Music	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Form and shape			
Grouping	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sequencing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Semantic form	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Dials and Pointers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
How you might specify the interaction style(s)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
How you might specify the interaction dialogue(s)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
How you might document or record the user/product process	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Setting usability criteria	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Design

Have you considered:	Yes	n/a	No	Guideline references
What type of interface prototypes should be developed				
Paper based	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Software based prototype				
high/low fidelity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
local/complete	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Optimal dimensional criteria for controls <i>(control types would be listed here)</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Optimal ergonomic criteria for displays <i>(display types would be listed here)</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	



Evaluation

Have you considered:	Yes	n/a	No	Guideline references
How well the intended interface will fit and support different users	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	003
How well the intended interface will fit and support the users' tasks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	006, 008, 011, 012, 013
The type of errors that could be made	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	012
Whether the interface is consistent throughout	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	010
Provides the right type and level of feedback	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	013
Provides the correct level of flexibility and control for users	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	004
Provides the correct level of support to use the interface effectively	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	004, 001, 012



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**Part 2**

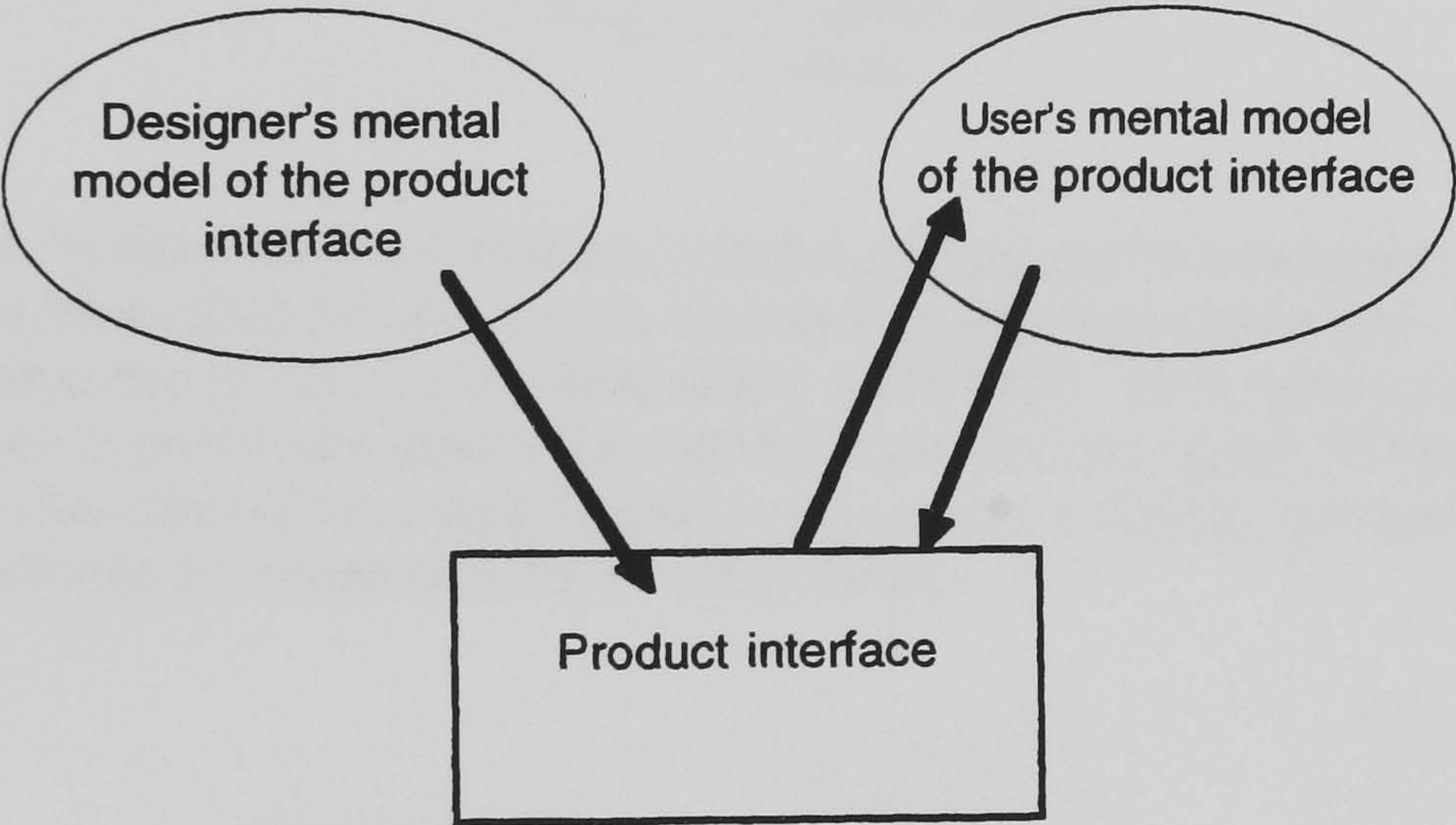
**Section 1**





**Both the physical interface and the interaction processes should adopt or reflect familiar conceptual models held by the user**

The designer communicates to the user through the 'system image' which is based on how the designer thinks the system should work. This has also been defined as the 'meta-communication' which refers to all activities which communicate the underlying conceptual model of the product. The user's mental model is developed from how the system suggests it works using prior knowledge and experience.



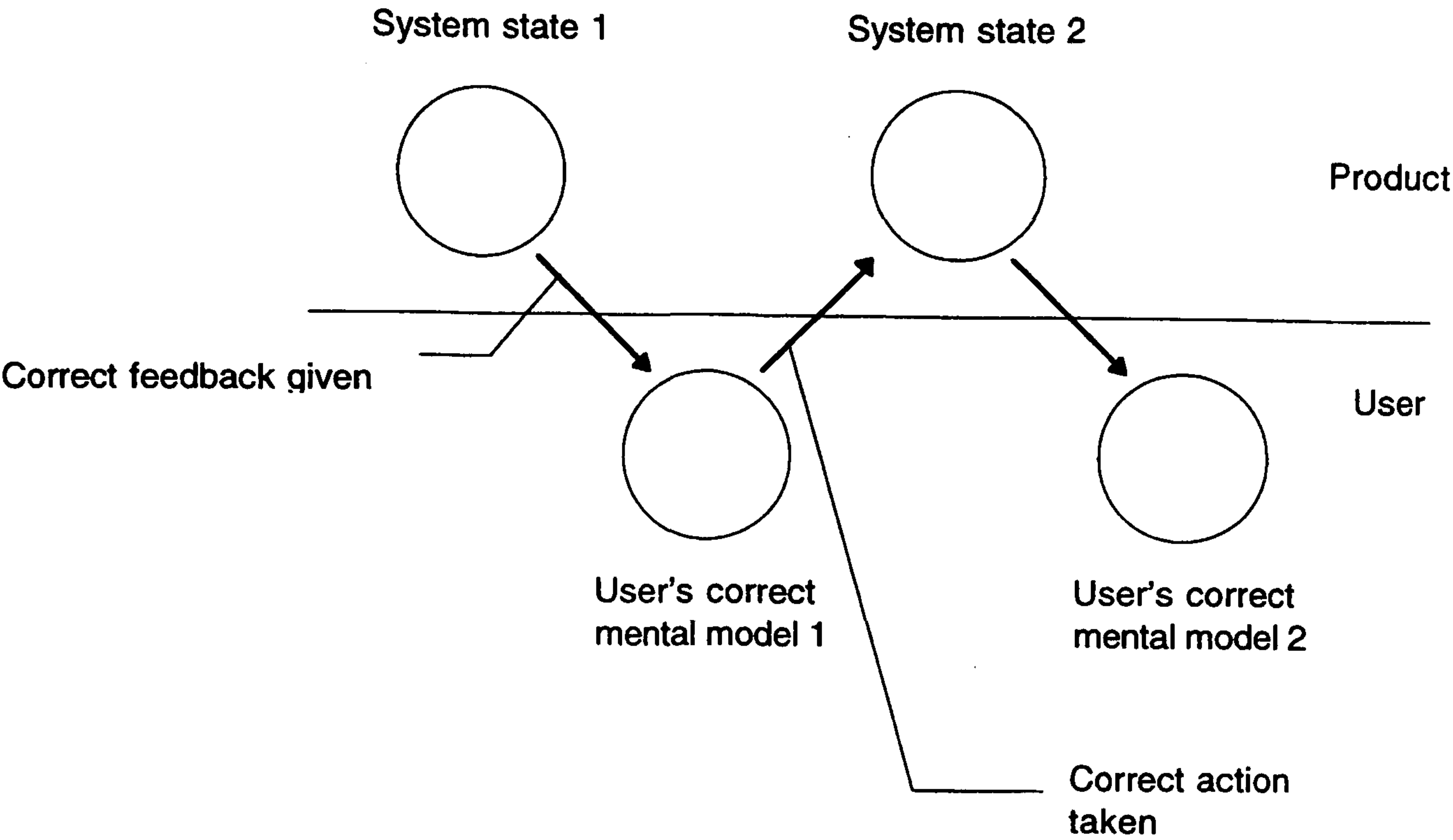
**Method**

To design an effective interface you should either know the type of model being used or design with a particular type of model in mind. There are four types of mental models which have been broadly defined as being used with interactive systems, these are:

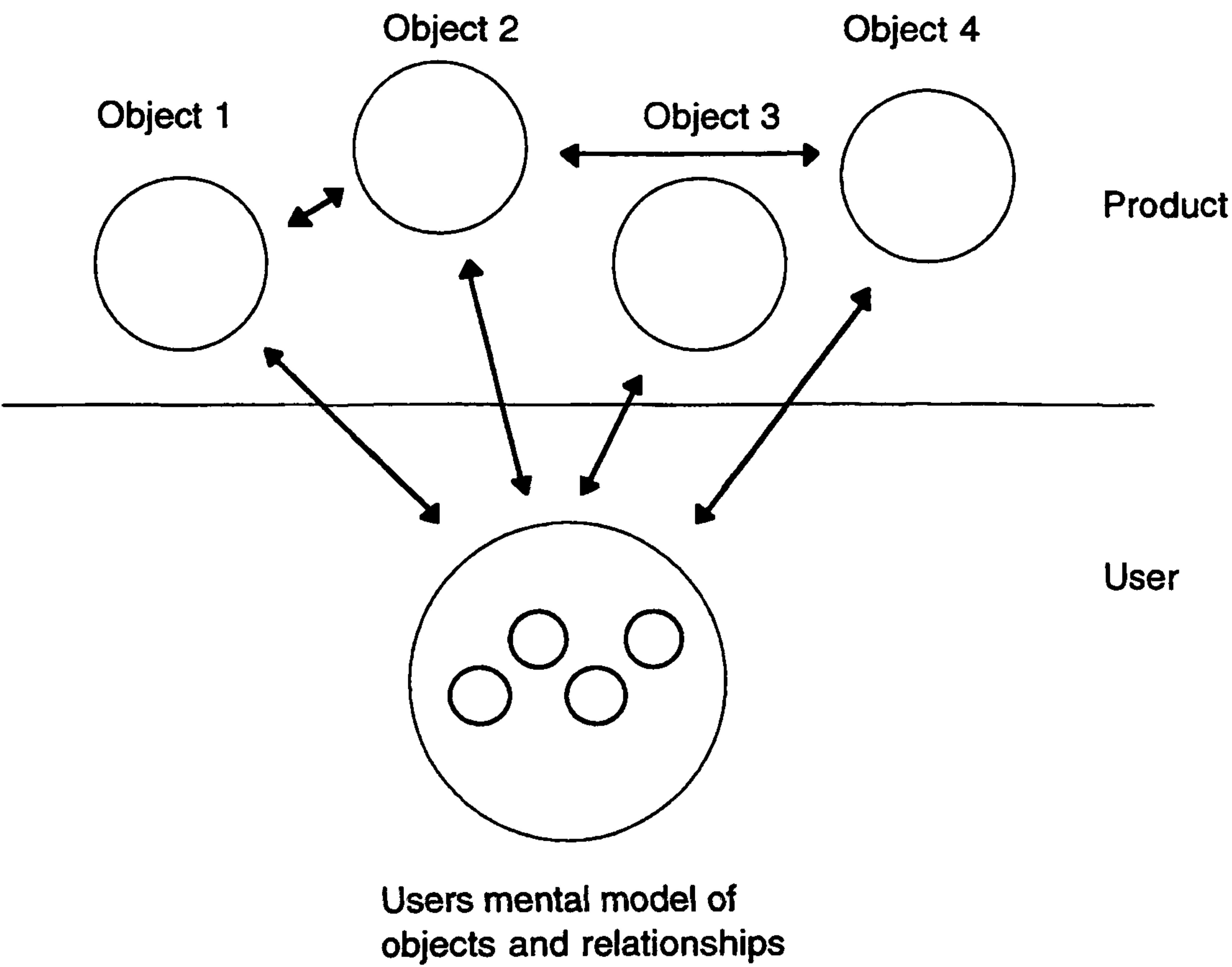
- State transition models
- Object-action models
- Mapping models
- Metaphor models

These are described in more detail below.





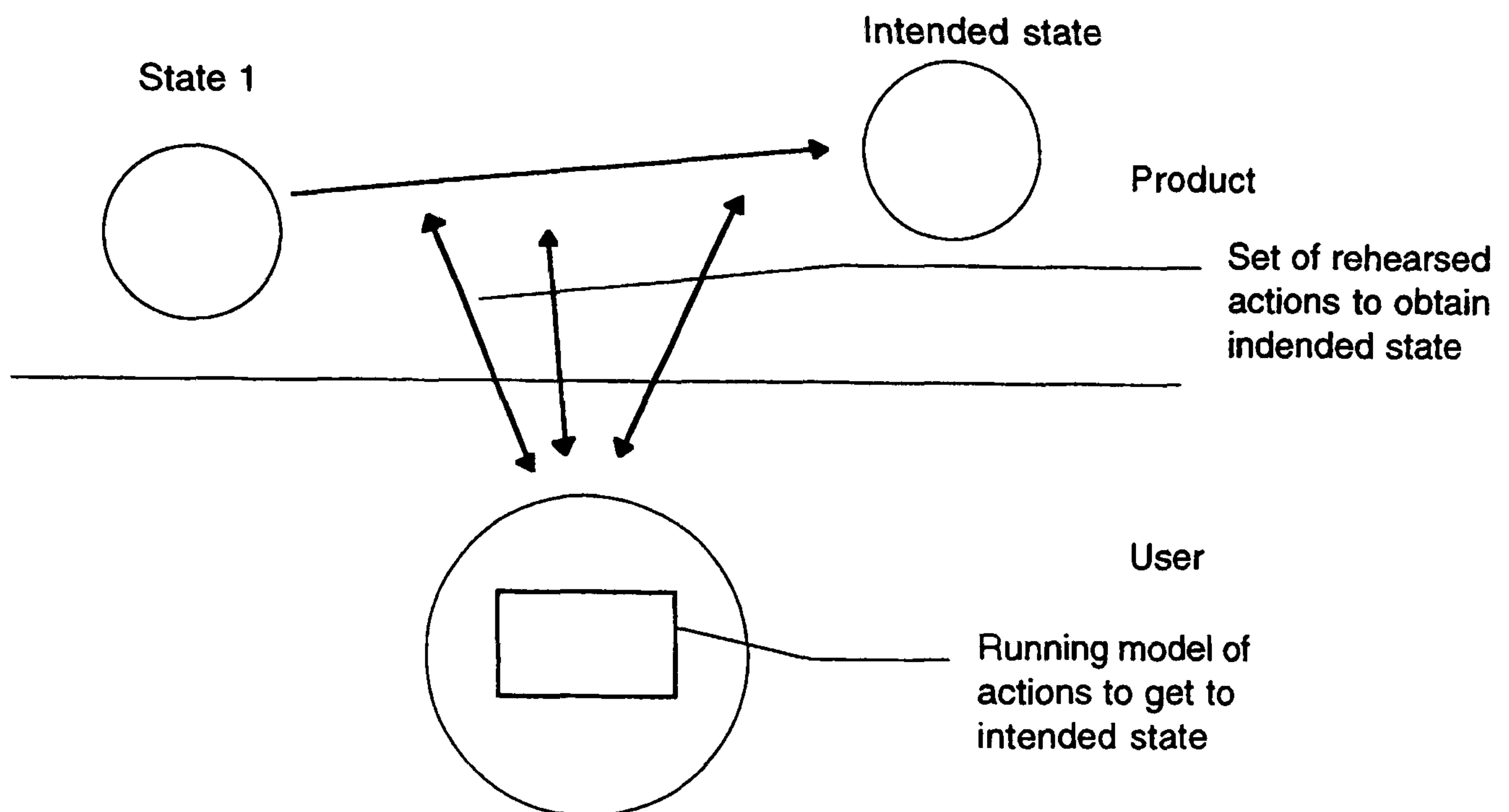
State transition models rely on a stimulus-response approach to interaction. The user learns the interaction process by the changes in interface states and understands what can or can not be done within each state. Many products rely on auditory cues to inform the user of the system state, for example a VCR will not only inform the user when a tape is being rewound by a display symbol but the system state can be heard with the whirring motor.



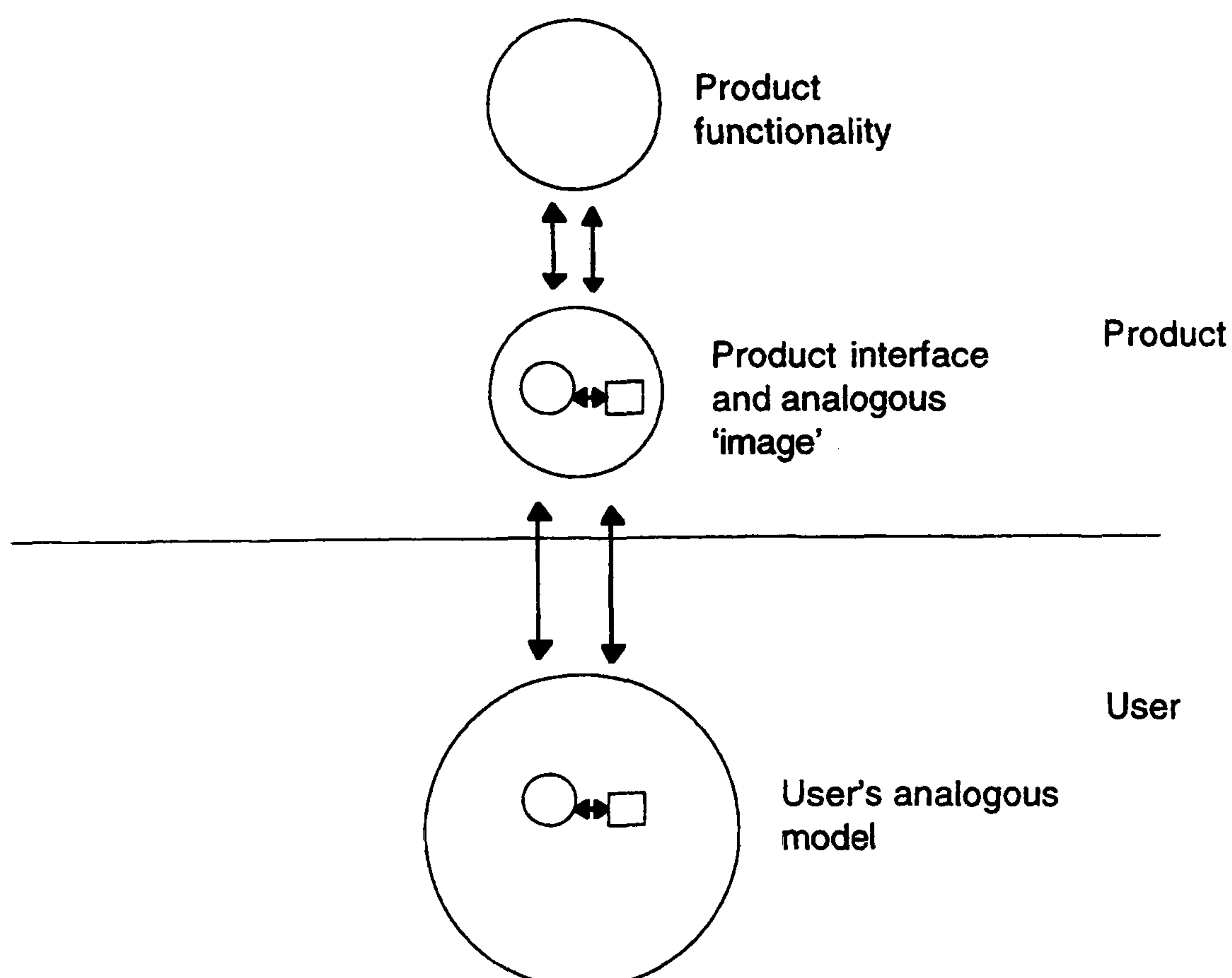
Object-action models rely on the user understanding the 'object' elements of the interface and building up a model of the functional attributes and relationships



between objects. Users are also aware of the actions they can perform on objects. In product interfaces objects could be either hardware based such as a rotary programme selector or software based such as a touch screen button.



Mapping models can be viewed as executive running models where the goal of a task is converted quickly into a sequential series of actions that the user simply runs without constant review from the interface. A mapping model could be based on either a state transition or object-action models but the mapping model overrides the interaction dialogue cues and simply invokes a series of actions to achieve the required task. A simple example of this would be conducting a calculation on a calculator where the user plans the syntax of the calculation and then types the data in quickly without referring to interim results from the calculator.





Metaphorical models are used where the interface presents an interaction style that is similar to another type of mental model that the user will very likely be familiar with. A good example of this is the VCR where many of the controls are analogous to an audio tape recorder.

The checklist questions below should be used using a method known as Cognitive walkthrough ⇒ 000. The primary purpose of the technique is to analyse product interfaces in terms of problems users may encounter due to a lack of understanding of the interface. It is often used to analyse walk-up-and-use interfaces.

So to ensure ‘cognitive compatibility’ between the user and the product interface walk through the stages and steps of the interface asking the following questions.

- ☐ Will the correct action be sufficiently evident to the user while using their existing mental model of the interface or via the system image?
- ☐ Will the user connect the correct action with what he or she is trying to do either by using their mental mode or the display description?
- ☐ Will the user interpret the product’s response to the chosen action correctly from their mental model?
- ☐ Will the user’s mental model be affected by new concepts being added or existing concepts being lost?



**Example**

Here are some metaphors to describe collections or categories of component objects, some of which also provide natural relationships between components.

Metaphor	Components of metaphor model
Desk	Drawers, files, folders, papers, note cards
Publication	Books, newspapers, newsletters, articles, figures, forms
Television	Programs, channels, networks, commercials
Music	Tracks, CD, Tapes, Music charts,
Games	Boards, cards, game pieces
Film	Rolls of film, slide holders, still and moving images
Storage	Shelves, boxes, filing cabinets, folders, paper clips
Trees	Branches, trunk, leaves, roots



Here are some examples of action metaphors, these are often more difficult to select and describe.

Action	Types of mental model
Browsing	Window shopping, thumbing through books
Selecting	Touch items, place boundaries around items
Deleting	Putting items in a waste bin, rub-out
Assign values	rotate knobs, move sliders, select items over time

Things to think about

The use of metaphor does have to be used with some degree of care. The only way to find out if they are successful is through some form of user trial ⇨008.

Advantages	Disadvantages
Can convey functionality and relationships quickly to the user	Interpretation of metaphor may be taken too literally
Easy to learn and remember	A mixture of metaphors may build in contradictory cues
Can simplify the interface	Limits of metaphor may be difficult to discern
Invites exploratory learning	Mapping between the product functionality and the metaphor may be too weak to understand
Reduces anxiety	Difficult to describe abstract concepts such as pre wash or reheat



**References**

Norman, D A ., The psychology of everyday things, Basic Books, 1988

Van der Veer, G C, Tauber, M, Waern, Y and van Muylwijk, B., 'On the interaction between system and user characteristics', Behaviour and Information Technology, vol 4 no 4 pp 1985

Marcus, A., Future user interface metaphors., Proceedings of the Human Factors and Ergonomics Society 37th Annual Meeting, Seattle, California, pp 258-262, 1993.

Related Guidelines Contradictory Guidelines Rating	002 005	
	003 004	
	* * * *	*
	Novel interfaces	Simple or commonly used interfaces



Conform to stereotypical behaviour

A stereotype belonging to a particular population can be defined as a commonly expected relationship between a control action or display and the resultant product action. For example, most people assume that green means ‘start’ and expect that when a control knob is turned clockwise, it will move an object from left to right.

Example

However, although these stereotypical actions are widely adopted, some caution must be exercised. Stereotypical behaviour is dependent on experience which is often culturally related. For example, in one study, it was found that Chinese subjects did not have the same colour associations as the Western population. Red for ‘stop’ and green for ‘go’ was not so strongly associated.

Culture	Red	Blue	Green	Yellow	White
USA	Danger	Masculinity	Safety	Criminality	Purity
France	Aristocracy	Freedom Peace	Criminality	Temporary	Neutrality
Egypt	Death	Virtue Faith	Fertility Strength	Happiness Prosperity	Joy
India	Life Creativity		Prosperity Fertility	Success	Death Purity
Japan	Anger Danger	Villainy	Future Youth Energy	Grace Nobility	Death
China	Happiness	Heavens Clouds	Ming Dynasty Heavens Clouds	Birth Wealth Power	Death Purity



**Things to think about**

Generally, when control-display arrangements conform to population stereotypes there are distinct advantages. It has been found that reaction or decisions times are shorter, the first control movement made by the user is more likely to be correct and learning times are reduced.

**References**

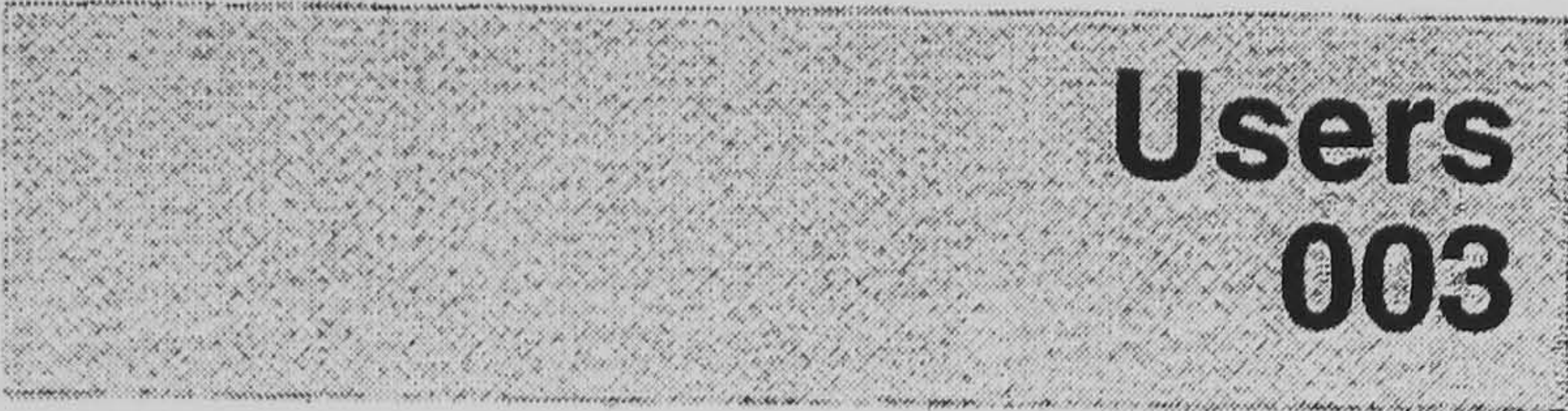
Courtney, A J., Control - display stereotypes for multicultural user systems., IEEE Transactions on Systems, Man, and Cybernetics, vol 22 no 4 pp 681-687, 1992.

Asfour, S S, Omachonu, V K, Diaz, E L and Abdel-Moty E., Displays and Controls., In: "Workspace, Equipment and Tool design" Mital, A. & Karowski, W. (eds) Elsevier, Amsterdam pp 257-276. 1991

Russo, P and Boor, S., How fluent is your interface? designing for international users., Proceedings of INTERCHI 93 Conference on Human Factors in Computing, pp 342-347., 1993

Related Guidelines Contradictory Guidelines Rating	001 010	
	* * * *	*
	Interfaces that will be used internationally	Specific national users





**Accommodate for different types of users**

User requirements will vary substantially depending on user populations they belong to. Users can also be distinguished by psychological attributes as well as physical attributes. Below are some design consideration that consider different types of users.

User type	Suitable design considerations
Children	Some interfaces may require tamper proof features
Elderly	
People with special needs	
Visually impaired	Don't rely solely on colour cues but if unavoidable avoid shades of blue
Hearing impaired	Auditory tones should be less than 900 hz in frequency
Wheel chair bound	Commonly used controls should be accessible from a seated position

Psychological distinctions

User type	Suitable design considerations
Expert or frequent user	Provide short cuts for frequent tasks
Novice	Provide a step by step interaction dialogue and consider the type of mental model that users might adopt
Intermittent	Provide easy access to reminders or aide memories





## Method

In general terms user characteristics are usually grouped and described under the following headings

- ☐ Age, gender and other demographic data
- ☐ Physical characteristics such as visual and auditory characteristics, body dimensions such as height and weight and reaction time
- ☐ Cognitive characteristics such as problem solving and decision making
- ☐ Attitude such as motivation, personality and initiative
- ☐ Skills and training such as educational background
- ☐ Experience with product or range of products



## Example

Microwave ovens are often made with smooth control panels. That is, there are no tactile discernible buttons. This can present a problem for visually impaired people. Ideally, the control panel should be designed with ridges around each button and some type of tactile identification of button function. If this is not desirable, it could be possible to make available raised letters or a Braille overlay. (245)

## Things to think about

Some products such as washing machines require anti-tamper devices to prevent accidental or mischievous use by children. Whilst some products are designed specifically for their use, there is not a significant body of knowledge about characteristics and abilities of children which can be translated into design criteria. Some development work on a communication tool, however, called PenPal suggests that children prefer products with physically manipulable interfaces and a 'fuzzy boundary' between the physical and software elements of the product. Products should be fun to use and it should be possible to customise the interface.

Products have traditionally been designed for use by people during 'active adulthood' although there is increasing recognition of the elderly user. Elderly users require a different type of interaction support. Some research investigating an elderly user group and their opinions on consumer products and found that they liked using instructions to learn how to use the product although they complained about the clarity of the instruction material. It was also found that the size, number and spacing of the buttons greatly affected ease of use.

For most disabled users, it is the variety of controls found on the product that cause concern. Furthermore, if one key control is inoperable by a user, the product may be unusable for that person. A preferred method for designing for the disabled is to use less variety in the selection of controls on each product.



Other factors that determine differences in aptitude are: experience both personal and culturally; 'technical aptitude' defined as spatial and reasoning aptitudes and task specific knowledge. However, it has been argued that other personality based characteristics are weak and inconsistent predictors of performance.

**References**

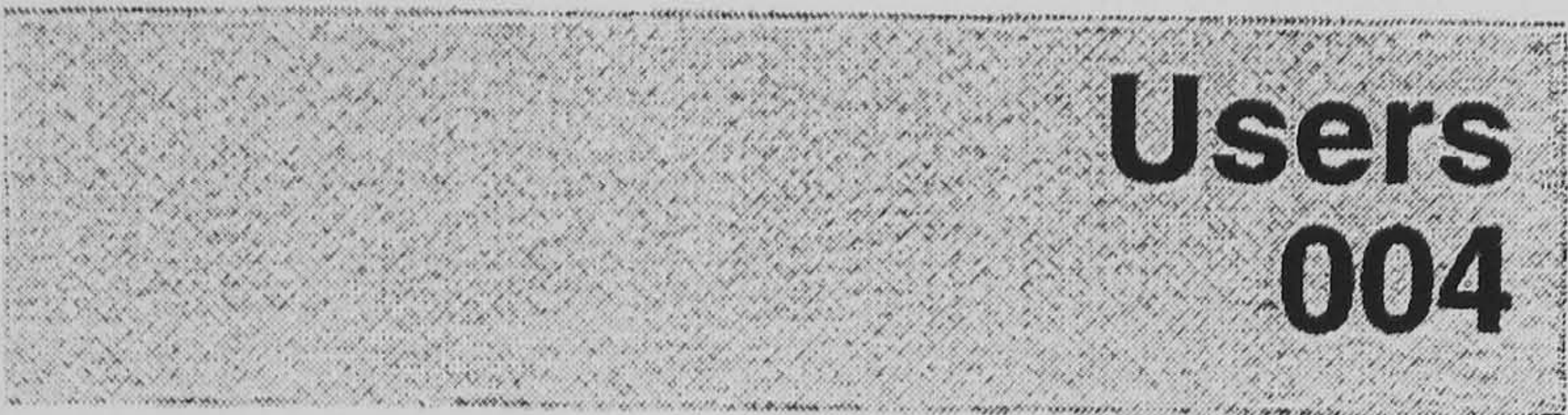
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Wilson, J R and Norris, B J., Knowledge transfer: scattered sources to sceptical clients., Ergonomics, vol 36 no 6 pp 677-686 .,1993

Piernot, P P, Felciano, R M, Stancel, R, Marsh, J and Yvon, M., Designing the PenPal: Blending hardware and software in a user-interface for children'. CHI '95 - Mosaic of Creativity, Procedures of Conference on Human Factors in Computer Systems, Denver, Colorado, Ed. I.R. Katz, et al. pp 511-518 1995

Related Guidelines Contradictory Guidelines Rating	* * * *	*
	Wide population usage	Specific population usage





**The product interface should accommodate for the changing needs and skill development of the user**

Designing a product interface that is easy to learn can be counterproductive when users become more proficient with the product or related tasks. A simple step-by-step introductory procedure may become annoying and frustrating later to a skilled user. The fundamental difference between a novice and expert user is in their level of knowledge and experience of the system. Therefore ensure that the interface permits different routes and paths to the same goal, including short cuts. Skilled users prefer a higher level of control of the system.

Expert user needs	Coded commands Access to settings
Novice user needs	Context setting Clear navigation



**Method**

Understanding changing needs requires a slightly different approach to the conventional user trial which places a heavy emphasis on the immediate impact of the interface. To find out how a user's needs may change as they learn the interface requires a study that allows formative learning to take place. There are two methods that can be adopted: longitudinal study or repeated tasks.

- ☐ Longitudinal studies usually take the form of providing the user with access to the product over a extended period of time which can be days weeks or even years. Users are observed or interviewed to build up knowledge of how the user's needs and behaviour have changed.
- ☐ Most consumer products tend not to have interfaces that require lengthy and intensive usage. If this is the case, then a more intensive longitudinal study can be conducted over several hours or perhaps days. This repeated tasks method requires that similar types of tasks are repeated over an intense period of time. This approach can often reveal changes in behaviour or needs. Rest periods should be designed into the study to monitor memory recall.





**Example**

Very occasional users of mobile phones tend to dial the whole number when making a call. However, if the user changes their frequency of usage, recall and looking-up telephone numbers can hinder speed of use. In this situation the user is likely to invest time in learning how to use memory functions that dial frequently used numbers automatically.

**Things to think about**

When trying to understand and monitor changing needs, many users of unfamiliar products tend to be very bad at predicting future behaviour. However, the reverse tends to be true with users of familiar products. In this situation, interviews and focus groups can be a very useful method to anticipate future usage.

Related Guidelines Contradictory Guidelines Rating	004 001	
	010	
	* * * *	*
	When there are many levels, paths to gain access to information or functions with frequent or occasional use	Quick and small number of operations



Tasks  
005

Ensure that task functions are matched correctly between the user and the product

As consumer products become more complex, issues of how, when, who or what activates or controls a function becomes increasingly difficult to specify. Allocation of function can be defined as explicitly stating the functions between the user and the product. Humans and machines have very different skills and abilities. Decisions about who or what should perform a function should take these skills into account. For example humans are good at discriminating signals from high levels of visual or auditory noise and making complex decisions using past experience, whereas machines are good at counting or measuring physical quantities and for literal reproduction. However, these distinctions are very broad and do not help more subtle design decisions.

People are good at	Machines are good at
Tasks that require constant adjustment, reappraisal and creativity	Routine and repetitive tasks
Gaining access to information from a range of sources	Remembering literal data and information
Error correction	Entering data with little or no errors
Working with one channel of information input	Working with many channels of input



Example

Advanced photocopiers take some of the copying decisions away from the user by preventing copying if the original overlaps the designated format size. The system function has been increased by allowing the machine to make copying decisions. This function can be overridden by keeping the 'copy' button depressed. Many users, however, are unaware of this because the communication concerning the transfer of function between the machine and the user has been poorly considered by the designer.



Example

Telephone directory services in the UK have been re-designed with improved allocation of function between the operator and the telephone computer system. Operators initially answer the call and deal with the caller's request for a



telephone number. Once a number has been identified the caller is handed over to an automated voice message system which provides the caller with their telephone number. This increases the number of calls the operator can deal with and reduces the repetitive elements of the task.



**Method**

In order to carry out function allocation, carry out the following activities:

- ☐ Functional analysis ⇒000
- ☐ Allocate functions
- ☐ Evaluate iteratively ⇒000

**Things to think about**

While the use of intelligence is still not used comprehensively in products, its use of intelligence raises some important issues regarding the allocation of function between the user and the product as this could in theory shift over the use of the product. There remains considerable research to be undertaken to investigate the consumers' perceptions and understanding of intelligent products. For example, consumers can exercise a high level of discretion in both purchasing and using consumer based products and may be highly wary of devolved responsibility. A recent study illustrates this point very well. In the introduction of an adaptive interface for an auto-teller machine, they found it was important that users where made explicitly aware that they were using an adaptive interface for the interaction with the product to be successful. This suggests that the introduction of intelligence into products will probably be evolutionary and incremental to accommodate user acceptance.

**References**

Related Guidelines Contradictory Guidelines Rating	001 006	
	004	
	* * * * *	* *
	For tasks that are: highly repetitive safety critical high frequency	For tasks that are: discretionary occasional uncritical



**Tasks  
006**

**Design the product to fit normal task patterns**

Products are not designed intentionally for the wrong user population. If a product fails to be usable and acceptable, this may be due in part to an incompatibility between the designer's and user's understanding of how to use the product. It is a common failing to assume that everyone's experiences are the same as ones own. Product designers should therefore develop a comprehensive picture of the different types of user/product interactions that may exist and ensure that the product design allows for this diversity.



**Method**

During product design, the consideration of behavioural activities will inevitably have to be generalised and, to some extent, there are many product-user interactions which can be predicted. Humans are goal oriented and use artefacts to achieve these goals. This means that users will be task centred and will find any interface that prevents these objectives frustrating.

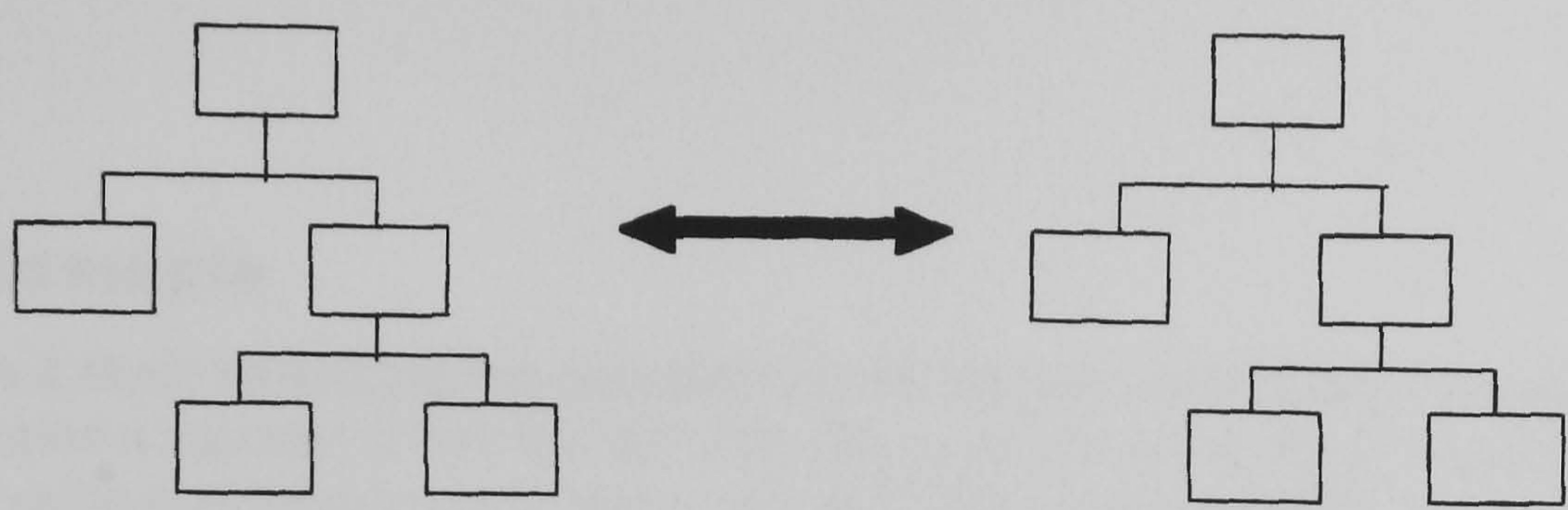
If it is not possible to observe interaction behaviour that would allow you to design the interface with more insight try to:

- ☐ Predict behaviour attitude using likely interaction scenarios
- ☐ Design and evaluate against these predictions

There are some general guidelines that can be adopted in most situations, these are:

- ☐ Try to group functionally related devices together, typically this is done by placing controls or display information in close proximity. Other coding methods which also have value include, colour or shape coding
- ☐ Group frequently used control devices together but also ensure that they are easy to execute and do not interfere with each other
- ☐ Make important, initiation and shut down functions easy to learn
- ☐ Anticipate human errors and design the interface to allow them to happen
- ☐ Try to make the interface reflect and map the task process see diagram below





Plan showing hierarchy of sub tasks

Layout of interface 'events' that map the sub task hierarchy

However the best approach is to understand, as fully as possible, the tasks that will be undertaken. To do this, follow these steps.

- ☐ Do a task analysis, in this context, this involves the study of user activity achieving a particular goal ⇒009.
- ☐ Identify critical steps and procedures
- ☐ Design to accommodate critical task elements
- ☐ A user trial should usually be conducted in order to find out the answers to the following checklist ⇒ 008. This checklist will help check if normal tasks patterns have been considered.

	✓	✗	N/A
Has a user profile been drawn up that considers the range of users that might use the product? ⇒ 003			
Has all the possible types of tasks and environments (untypical as well as typical) been listed and considered? ⇒ 007			
Is the interface 'transparent' ? - allowing the user to focus on the task and not be hindered by the interface ⇒ 001			
Do users always know what to do and how to accomplish their task?			
Does the interface fit with user expectations? ⇒002 ⇒010			
Does the interface allow the user to explore and make mistakes? ⇒ 012			





**Example**

In a study examining the operation of new vacuum cleaners the researchers found a number of operational difficulties such as being able to operate the mechanical (where some users had difficulties in placing their hands in their preferred position) or electronic suction power regulators (where users did not understand the purpose of the feature and also how to operate it once they were familiar with the feature). The researchers state, “regularly subjects could be seen to apply ways of operation they were used to, thus bypassing poor design qualities such as in the operation of the nozzles”.

This example demonstrates how important it is to consider how users traditionally use existing products as these methods will be enforced by the user on the new product.

**Things to think about**

Applying this type of guideline is particularly difficult with novel products or interfaces. Subjects used in user trials normally find it difficult to appraise novel solutions objectively and are usually anxious to appear supportive and positive about the design. One way of getting round this is to place the trial in context and present the user trial in some form of scenario. For example, suggest to the subject that they have to explain how to use the design to a friend. This often exposes gaps in their understanding of the interface.

**References**

Related Guidelines Contradictory Guidelines Rating	002 012	
	004	
	* * * *	*
	Important with novel interfaces where little is known about the interaction process	Less important with common or very simple interfaces



# Environments

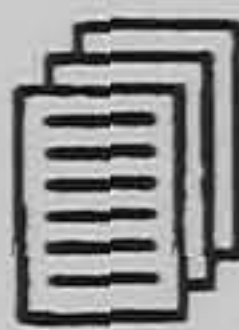
## 007

### Accommodate for different environments in which the product interface may be used

Environmental issues that may be relevant and affect the use and therefore the design of an interface can be divided into two broad areas:

- Physiological
- Psychological

The physiological factors that may affect the usability of an interface and therefore should be considered are noise, illumination, climate, and motion. Psychological factors include stress, social interaction and mental workload. If these factors are ignored and are not included in the interface design specification, there may be situations where the product may be dangerous or difficult to use.



#### Method

Psychological factors that may need to be considered in the design of the product interface include:

- ☐ Stress, products such as burglar alarm control panels, are sometimes used in stressful conditions. People under stress are more accident prone and tend to revert to rehearsed and stereotypical behaviour.
- ☐ Consider that products may used while the user is in a 'transitory state' such as tiredness, fatigue, drink and drugs
- ☐ Social and cultural factors may determine the usage of a product such as the meaning and emotional response to products.

Physiological factors that may need to be considered in the design of the product interface include:

- ☐ The level of ambient noise that the interface may have to compete with. Noise can be defined as unwanted sound and it is important that any auditory displays are designed to be discriminable from the environmental noise but also that auditory displays are discriminable form each other.



- ☐ Display and control panels do not potentially present glare that may inhibit the use of the panel and consider how product interfaces can be used in extremely bright or light environments.
- ☐ Extreme climatic conditions. If this is so, ensure that controls can be operated whilst wearing gloves in cold conditions and that the panel does not become too hot to touch in hot conditions.
- ☐ Unstable conditions, for example a car radio where fine adjustments can be difficult, the environmental factor of instability would therefore need to be considered.

References

Related Guidelines Contradictory Guidelines Rating	* *  Domestic environments
--	----------------------------------



**Methods & Tecs**  
**008**

**User Trials**

In order to achieve this guideline, some form of user trial will inevitably have to take place to understand the usability of the interface product. They can be used at different stages of the design process to answer a wide variety of questions, such as:

- preferences to different interaction styles or dialogues
- the level of fit between the interface design and the task and user requirements
- usability problems
- results to new or novel methods of interaction

Benefits ✓	Problems ✕
Gain a considerable amount of information about the users' view of the product interface	Can be difficult to be sure that you have a 'representative' sample of opinion or usage behaviour
Can be used as part of the design process	Design direction can be lost if results of user trials reveal contradictory findings
Very effective in persuading decision makers that changes have to be made to the interface design	Can be time consuming and difficult to administer



**Method**

Of the many ways in which users can be used in the product development process, user trials are described in detail here. User trials are used to evaluate and appraise design solutions and this can be done at different stages of the design process and also at different levels of design detail.

The steps to undertake a user trial are as follows:

- ☐ Decide specifically on the elements of the products which will be evaluated
- ☐ Decide on a set of tasks that will allow a broad range of interaction activity to be assessed
- ☐ Select a representative sample of the intended user population





Decide what aspects of the users or their behaviour are going to be assessed in the user trial(s)



Decide what type of measurement techniques you are going to use  
⇒ 000



Decide on how you will analyse the data



## Example

This example provides a case study of using user trials for a novel application which integrates handwriting and recorded audio in a semi-portable device. (840)

Given the designers lack of knowledge about this class of audio application, they began with two interview studies. In the first series of interviews they talked to people who had used audio equipment in offices and asked them what the benefits and disadvantages were. The second series of interviews they investigated people who were used to conventional notetaking in meetings.

In the first study they found

- one of the major benefits of new technology would be access specific portions of recorded information from long recordings
- recording own voice was not seen as a desirable feature

In the second study they found

- note taking was accepted as being error prone e.g. not taking down vital information
- reduced involvement in meetings

From this a prototype product was produced called 'Filochat' which was based on a PC with an LCD tablet which allowed the manipulation of written text and audio recordings. Laboratory based usability tests were carried out where people undertook simple note taking, recording and searching operations and the use of different audio recording. Minor modifications were made to screen layout, menu options and paging.

More natural trials were then conducted with seven groups using Filochat in nine different meetings. One participant in each group agreed to take their notes and received a 5 minute tutorial. The type of meetings were very different and lasted between 1 to 3 hours and where in different settings. The meetings were observed and a short questionnaire was given to all the members of the group to identify intrusiveness etc.

The observations showed how users improved their minutes and also highlighted unanticipated usage such as the Filochat being used as a audio editor.

One of the problems with the field trials was the difficulty to evaluate objectively the benefits of the verbatim speech recording over hand-written notes alone. To test this a controlled experiment was set up in the laboratory where subjects had to remember a small speech under three conditions: using pen and paper, listening and using the Filochat to recall the passage. This helped to compare the different conditions and make direct comparisons.



**Things to think about**

Users of products can include other types of users other than end users, for example Sales teams. As far as possible all the identified user groups or stakeholders should be represented on the design team.

Using end users in the design process is not a trivial consideration. From an economic, organisational or practical point of view it can be difficult to implement. However, if this approach is considered then users can be involved in other ways:

- As part of the design team (participative design), for example in focus groups to develop solutions to product problems
- In user trials for existing or prototype products where testing user behaviour is measured rather than just opinions. However, as products become more interactive it is the ‘interactivity’ that needs to be designed rather than the physical product.
- In formulating user requirements in terms of product needs
- Developing a user profile which describes the cultural, physiological and psychological aspects of the user

**References**

Related Guidelines Contradictory Guidelines Rating	* * * * *	
	With team commitment	Without team commitment



# Methods & Tecs

## 009

### Task Analysis

There are a very wide range of task analysis methods and techniques that can be used to understand, document and appraise task activity in order to improve interface design and interaction. The task analysis method described here is simple and provides a simple description of task activity. It is called activity frequency analysis and is based on a very similar technique known as activity sampling.

#### Method

Activity frequency analysis requires the designer to observe task activity. This could be either existing tasks to understand how to implement or improve a product user interface. Or it could be to evaluate a prototype interface. There are four key steps to take.

- ☐ Categorisation of activities. This is an important part of the method as the success and reliability of the analysis rests on understanding what type and levels of categories should be devised. It is important that each activity can be clearly differentiated from each other. It is also important that the evaluator is very familiar with each activity and understands the limits of each activity (the beginning and end).
- ☐ Developing a sampling schedule. Product interaction tends to be sporadic and intermittent and may not require sampling. However, if task activities could be conducted over a long period of time, sampling may be required to optimise activity analysis.
- ☐ Information collection and recording. This can be done by video but this method can be more time consuming than recording the activities manually. As the analysis of video tapes can be very accurate (they can be played over and over again) but also time consuming. A good data collection sheet can often glean all the relevant information during the actual trial itself. The simplest recording method is to simply tally up each activity (see example).
- ☐ Analysis of activity frequencies. The analysis is very simple by reviewing the relative frequencies of each activity and judging these against a set of design criteria. For example is a high frequency count for one type of activity acceptable to users? Are certain high frequency activities prone to error? Why are certain activities not used so frequently?

Remember that this method only works with clearly defined observable activity.

#### Things to think about

It must be acknowledged, however, that using or selecting a particular task analysis method can be difficult. There are various problems, for example, there are a complex array of terms that vary from one task analysis method to another



such as plans, goals, methods, operations, actions and so on. Even the definition of task is questionable. Because there are many approaches to task analysis, a product designer may find it difficult to identify one successfully that will map onto the product design process and provide pertinent results.

The importance of a designer having a full understanding of the tasks involved in using a product cannot be over stressed, as such an understanding will inevitably facilitate in the reduction of usability problems. This requires some rigorous and methodical analysis of the tasks to be undertaken between the user and the product which cannot be explained in any depth here. Instead, some simple advice is presented which can be used in most design scenarios.

**References**

There are many task analyses and many of these are comprehensively described by Kirwan and Ainsworth in A guide to task analysis published by Taylor and Francis (1992).

Related Guidelines Contradictory Guidelines Rating	* * * * *	*
	Vital to undertake, even informally, to understand the interaction process	Can be time consuming and difficult to select an appropriate analysis method



User/Product  
Interaction  
010

Ensure the interface communicates in a consistent manner

One of the key rules of interface design is that the interface should present information and act consistently. This is to ensure that the user always receives information in a way that can be learnt quickly and will be predictable.



Method

It is relatively easy to evaluate the consistency of interface elements in terms of the physical attributes by listing all the interaction states and noting the different descriptive attributes. Use this checklist to quickly check interface consistency. It is more difficult to evaluate the consistency of the interface in terms of the expected user/product behaviour. Some of these issues are considered in the ‘things that think’ section.

	✓	✗	N/A
Do all coloured elements have the same meaning throughout the interaction?			
Is all the text written in the same style and does it use the same terms?			
Are all graphical elements or descriptions mean the same to a wide range of intended users?			
Are the feedback mechanisms always understood in the same way by the intended users?			
Is data always entered in the same way?			
Do any instructions contradict each other?			
Does the layout of the interface fit with task and user requirements			



Things to think about

The following considerations are related to other, more broader, user expectations that have to be taken account of:

	✓	✗	N/A
Ensure compatibility with other products that users may have experience of or would expect to function in a similar way			
Consistency with user stereotypes, many of these are discussed in more detail later			
Consistency with the user's mental model of the product, task or relevant experiences			
Ensuring that the product does not counteract other related tasks that may be associated with the product			

References

Related Guidelines Contradictory Guidelines Rating	002 001	
	004	
	* * * * *	* * *
	Actions that are irreversible, irredeemable or where low errors are required	Other situations



User/Product  
Interaction  
011

The amount of information the user must remember in order to use the interface should be low

This can be done by providing, for example, default settings, presenting sequences of actions in analogous form, providing clear signposting and navigation through menu structures and keeping categories or classification structures in single figures.



Method

Below are some interaction dialogues that reduce memory load

Dialogue guideline	Example
Provide default settings	Establish which settings are most commonly used and provide these as default settings
Present sequences of actions in analogous form	Provide time settings that adopt the analogue clock format
Provide clear signposting and navigation through menu structures	Use coding mechanisms such as colour, visual maps or use designated parts of the interface for particular functions
Keep categories or classification structures to single figures	See the ✓ example below



Example

Research on an information retrieval system for a video library found that subjects preferred to classify video tapes into nine categories as opposed to the 29 found in video shops. Cognitive loading can be reduced by providing the right type and level of functionality to suit the task in hand. Many products offer a wide range of functions which are perceived as being useful by buyers. However research suggests that very few of these functions are used because they are difficult to use or remember.



Example

Many faxes have an array of set-up and configuration options. Navigating through the menu option is difficult because of these small alpha-numeric



displays. The memory 'load' on remembering selection options could be reduced by taking a non-numeric approach. For instance, instead of nominally numbering menu options to set up and configure a fax machine say from 1-6, these could be related to the alphabetic labelling associated with each key. For example, instead of assigning the '1' key to return a 'no' statement and use the '2' key to return a 'yes' statement which both have no meaning to the user; a better and less cognitively demanding solution would to use the '9' key for 'Yes' which is labelled with the letters 'WXYZ' and the '6' key for no (MNO). This principle could be used for more complex applications.

space	ABC	DEF
1	2	3
GHI	JKL	MNO
4	5	6
PQRS	TUV	WXYZ
7	8	9

Things to think about

Providing easy to remember interfaces is useful for occasional or intermittent use. However, remember that if an interface is going to be used frequently, users may find a step by step interaction dialogue frustrating. If this type of use is envisaged then provide other quick interaction dialogues that allow functions to be performed quickly.

References

Related Guidelines Contradictory Guidelines Rating	001	
	003	
	* * * *	* *
	High memory load	Low memory load



# User/Product interaction 012

## Allow the user to make mistakes

A key rule in human-computer interaction is to always allow the user the ability to 'undo' a command. This cannot always be achieved in consumer products as they tend to have more actions that have a permanent and irretrievable effect, for example selecting record on a tape recorder. Therefore, associated cues or warnings should be provided to prevent accidental error but also allows the user to learn by experimentation.

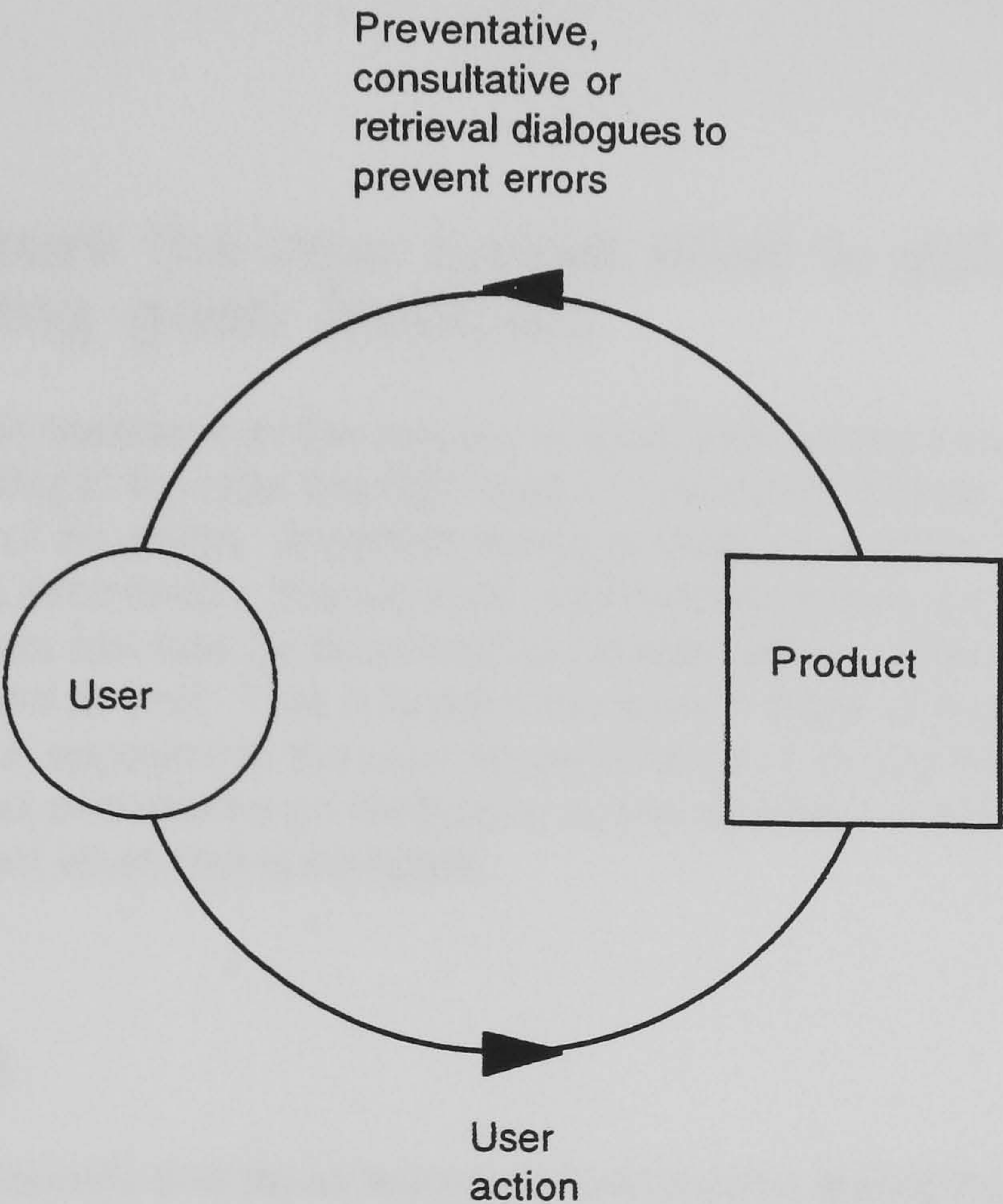


### Method

In order to allow for mistakes, common errors that may occur need to be known. This method should identify errors and provide some ideas about how to accommodate them.

- ☐ Conduct a task analysis ⇒009
- ☐ Identify errors and classify them as either semantic or syntactic. Semantic errors are those where the error is based on a misunderstanding such as the task process, interface functions, representation of interface functions or control feedback. Syntax errors are based on a misunderstanding of the order in which actions have to be performed
- ☐ Design error handling dialogues that handle both syntax and semantic errors
- ☐ There are three types of dialogue design that can help prevent errors. Preventative errors simple do not allow actions to be carried out in certain system states, for example the use of locking devices, 'greyed-out' menu selections and controls under concealed covers. Consultative dialogues provide some form of warning or advice before the product will carry the action such as help systems or warning sounds or text displays. Retrieval dialogues allow the user to 'un-do' their error in some way.





**Example**

Predicting human error is very unreliable and it is wiser to make observations of typical user-product interactions. In doing this important lessons can be learnt about the design of the interface. In a study observing users of ticket vending machines, the following type of errors were noted: information presented by the system may not be noticed by the user; users may not have all the information to hand to complete a transaction; the system may not clearly explain the tasks; or the user may not perform the tasks in the correct order

**Things to think about**

Simple intelligence can be incorporated into the interaction dialogue by logging and therefore learning where errors are constantly made. The interface could perhaps suggest ways in which the user could reduce these errors.

Related Guidelines	006
Contradictory Guidelines	010
Rating	* * * * *
	At points in the interaction dialogue where irretrievable actions are to be performed



User/Product  
Interaction  
013

Make sure the user knows what is going on by  
providing good feedback

Appropriate feedback in the context of consumer product design can be defined as conveying to the user the right level of information before, during and after the execution of an action. A person needs at least three different kinds of confirming information: the act itself, intermediate results and a final outcome. This process can also be described as ‘closure’ where actions have a beginning, a middle and an end. That is to say that, at each stage of the interaction process, it should be apparent to the user where to begin, it should be apparent that the product has undertaken an instruction and is carrying out the task and it should be apparent when this is complete.



Method

- ☐ Identify and list all feedback mechanisms during the interaction process
- ☐ With each of the identified feedback mechanisms, ask the following questions

	✓	✗	N/A
Does the feedback offer informative feedback; the product should only tell the user what he/she needs to know in order to continue work productively?			
Does the user correctly understand the feedback provided?			
Is the user aware of state and mode changes?			
Is adequate support provided when things go wrong?			
Do users have to remember data from one display page to another?			
Do help systems and ensure they provide relevant and timely support?			
Is all relevant information presented to enable an action to be completed?			

Things to think about

The feedback process is complex in that it is dynamic and multi-modal making it difficult to measure the effectiveness by which users understand different feedback mechanisms. As product functionality becomes more abstract and removed from physical actions, feedback mechanisms need to be deliberately



designed into the product. Many studies suggest that tactile feedback is a highly rated feedback mechanism. Be also aware that too many feedback mechanisms can be annoying and even over bearing.

References

Related Guidelines	010 006	
Contradictory Guidelines	003	
Rating	★ ★ ★ ★	★
	Complex or critical stages of the interaction, particularly where the user actions are not physically evident	High physical evidence of user actions



**Part 2**

**Section 2**





**General use of  
controls  
014**



**Task**

Controls should be:

functionally grouped where possible

in sequence of use

most critical and most frequently used controls  
should be most accessible

provide feedback as to the status of a device at  
the result of operating a control

keep number of controls to a minimum and  
conceal infrequently used controls





Interaction

- should be positioned and labelled in such a way that the relationship with the associated display is obvious
- each control should be identified unless its function is obvious
- design control surfaces to prevent slippage
- directional movement of a feedback display should be in the same direction as the movement of the control
- labels on controls should not be obscured by the user when operating them.



Device

Device	Uses	Disad- vantages	Recommended for	Not recommended	Comments
Touch Sensitive panel (touch screen)	Select	Accidental activation; tired arms	Infrequent use; Course pointing	Continuous use; Precise pointing	Mount to provide arm rest
Mouse	Point; Selects; Draw; Drag; Move cursor	Requires desk space; has trailing cord	Tasks requiring little keyboard use	Frequent mouse to keyboard changes	Can integrate function buttons with cursor
Fixed function keys	Frequent or critical functions	Keyboards space permits limited number of keys	Continuously available, important functions	Seldom used, non-critical functions	Label keys with function names
Program function keys	Application-specific functions	Meanings change; no direct labelling	Frequently used of critical functions	Seldom used, non-critical functions	Define keys on display screen
Light pen	Move cursor; Select; Draw	Parallax; Tires arms	Infrequent use; Tasks with little keyboard use	Frequent pen-keyboard changes; Continuous use	Mount display to provide arm rest



Device	Uses	Disad- vantages	Recommended for	Not recommended	Comments
Voice entry	Enter numbers; Initiate predefined actions	Requires step-by-step confirmation of entries	When hands or eyes are not free	Noisy or stressful environments	Recognition of fluent speech not practical
Joy stick	Track; Select; Move cursor	Mouse may be faster for selecting text	Tasks with intensive cursor positioning	Frequent changes to and from keyboard	Provide for left handed users
Tracker ball	Track; Select; Move cursor	Mouse may be faster for selecting text	Integrating graphics with keyboard entries	Frequent changes to and from keyboard	Provide for left handed users
Alpha numeric keyboard	Select; Enter text; Enter numbers	Suboptimal for graphics and direct manipulation	General purpose entry device	Selection by typing slower than by pointing	Use standard layout type writer keys
Cursor control	Discrete cursor movements	Slow for moving cursor long distances	Tasks requiring short cursor movements	Extensive or fine cursor movements	Provide "double speed" mode
Numeric Keypad	Enter numbers (keypunch)	Limited value for other tasks	Fast entry of massed numbers; calculations	Provide for left handed users	

Related Guidelines Contradictory Guidelines Rating	****	*
	High number or complex controls being used	Uncomplicated, non critical and rarely used controls



# Push Buttons

## 015

### When to use

The major types of push buttons, which can be operated by either hand or foot (972) are:

- latching (push-on, lock-on) - Activation should be indicated by a sudden drop in resistance and if possible an audible click. Best used for critical functions or buttons located in dimly lit areas
- momentary (push-on, release off)
- alternate action (push-on, push off) - Activation indicated by feel, auditory click and by associated display action
- matrix system - button acts as a scroll command through a list of options. This can cause problems with short term memory load.



### Task

Problems with push buttons

- buttons can become indistinguishable if there are too many
- hidden buttons and hidden functions can cause problems for novice users



### Interaction

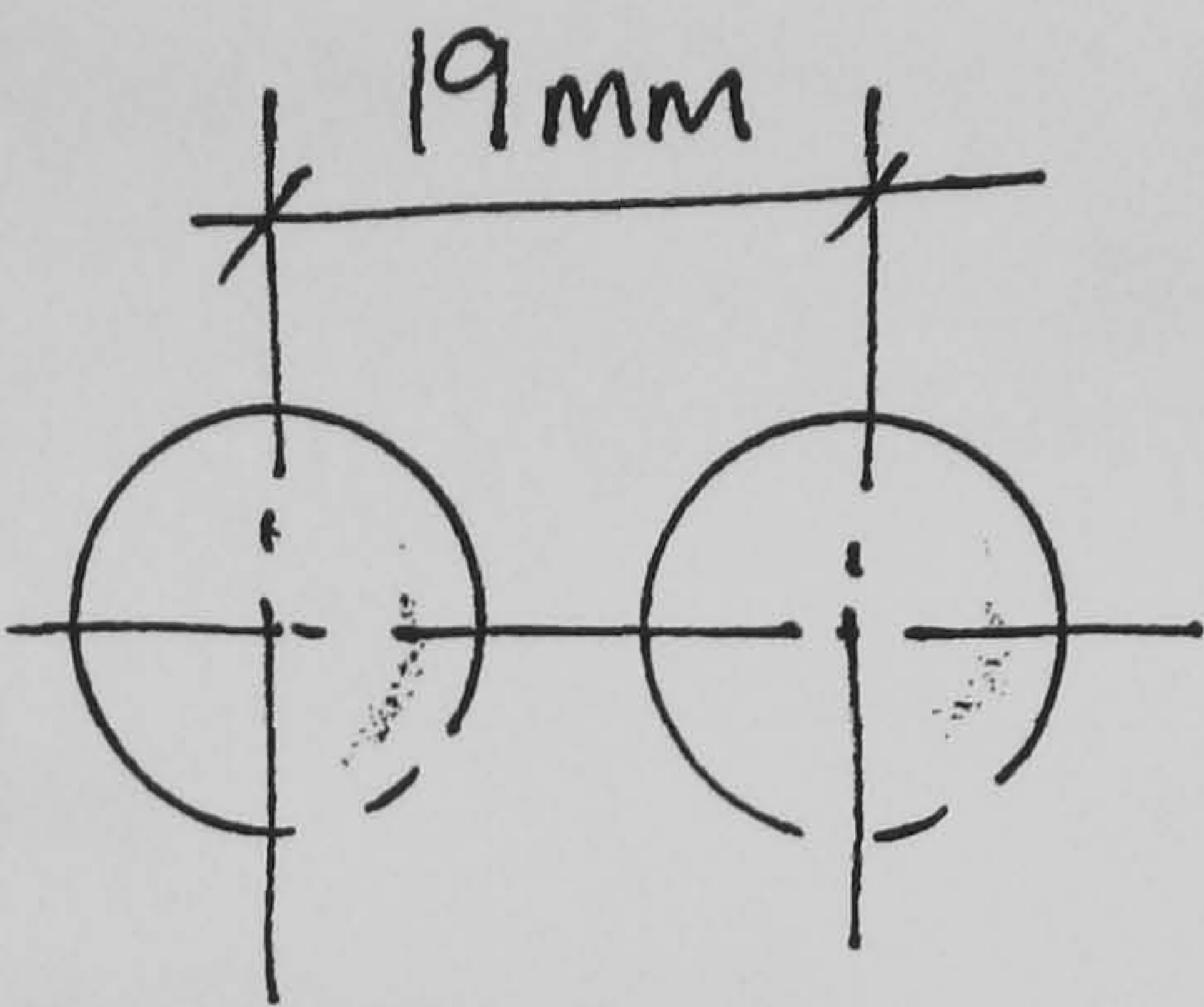
- The curvature of the button/keycap should also be taken into account. Should be designed so that the fingers will not slide off them. The surface can be made concave or with some form of increased friction
- Try and use elastic resistance
- The button should present a certain resistance to the movement of the finger, the resistance should be reduced somewhat when the operating point is reached. An alternative to this is to add a sound signal.
- Activation forces of controls should be low enough that the least capable user (person with 5th percentile strength) can manipulate them without difficulty



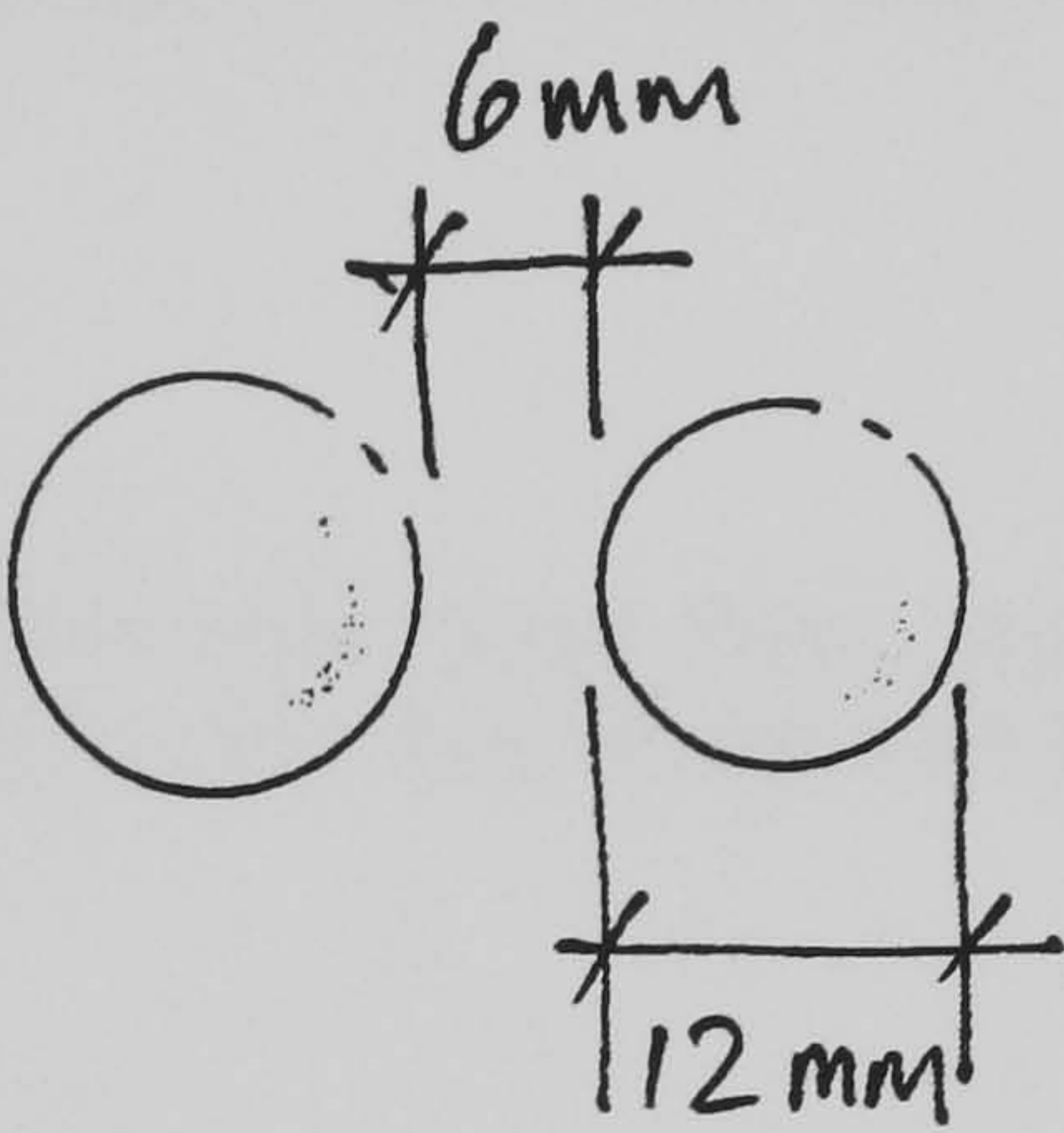


Device

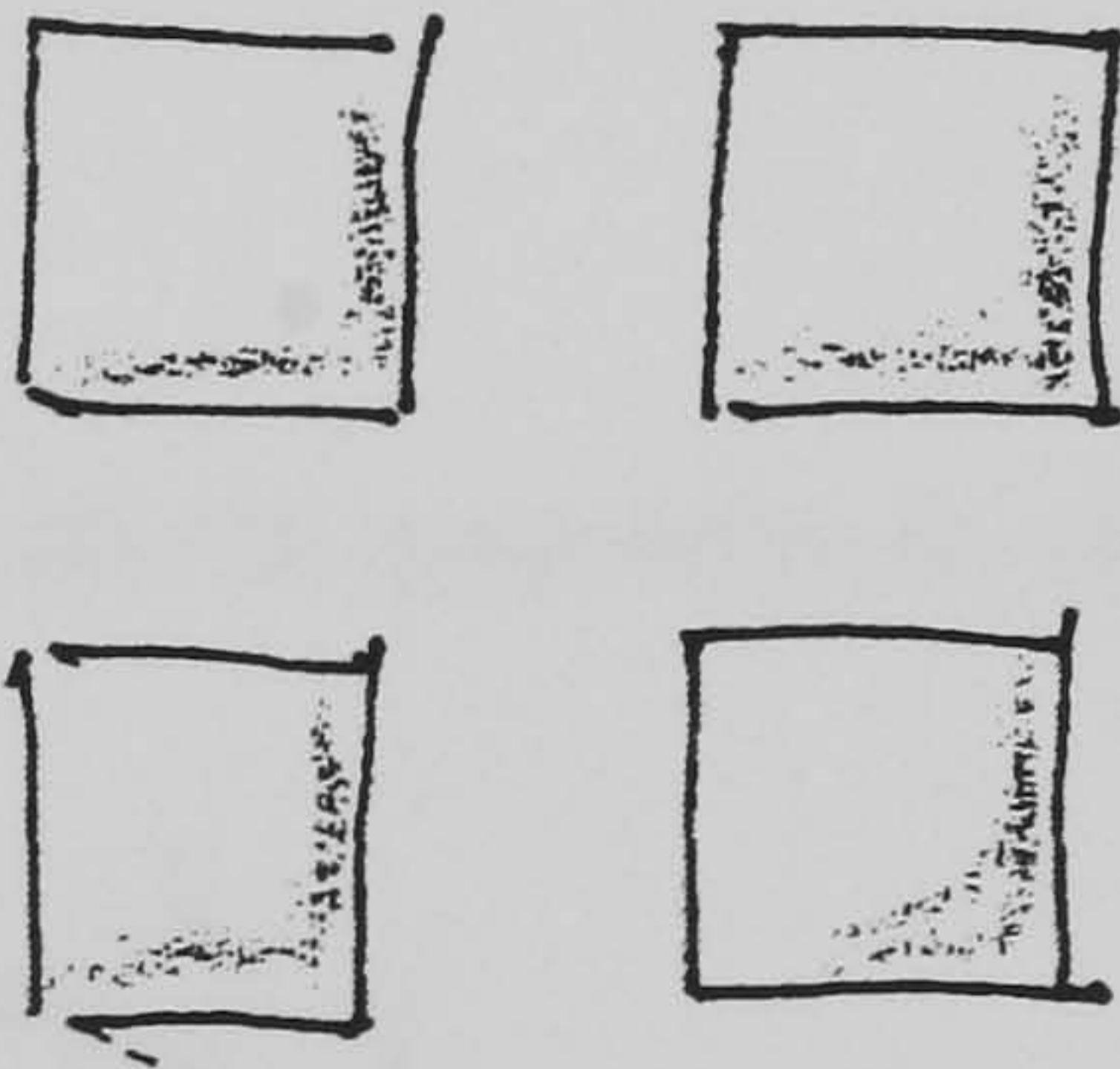
Buttons should have a minimum size of 12.7mm<sup>2</sup> and have a centre to centre key spacing of around 19 mm.



Round buttons should be at least 12 mm in diameter with 6 mm spacing between them



Square keys/buttons are the best shape for inputting data as they provide more surface area within the same amount of space between keycaps.



Related Guidelines Contradictory Guidelines Rating	<p>***</p> <p>Many products have controls that do not conform to the above criteria. Non conformance tends to prohibit usage by the elderly and people with special needs.</p>
--	--



# Rotary Controls

## 016

### When to use

Rotary controls can be used for two type of control:

- discrete control where there are set, pre-defined settings
- continuous where the control has variable control such as a volume control



### Task

Studies have shown that when visibility limited, rotary controls are more popular than other controls. It was also found that users favoured rotary knobs with feel (i.e. resistance within the control).



### Interaction

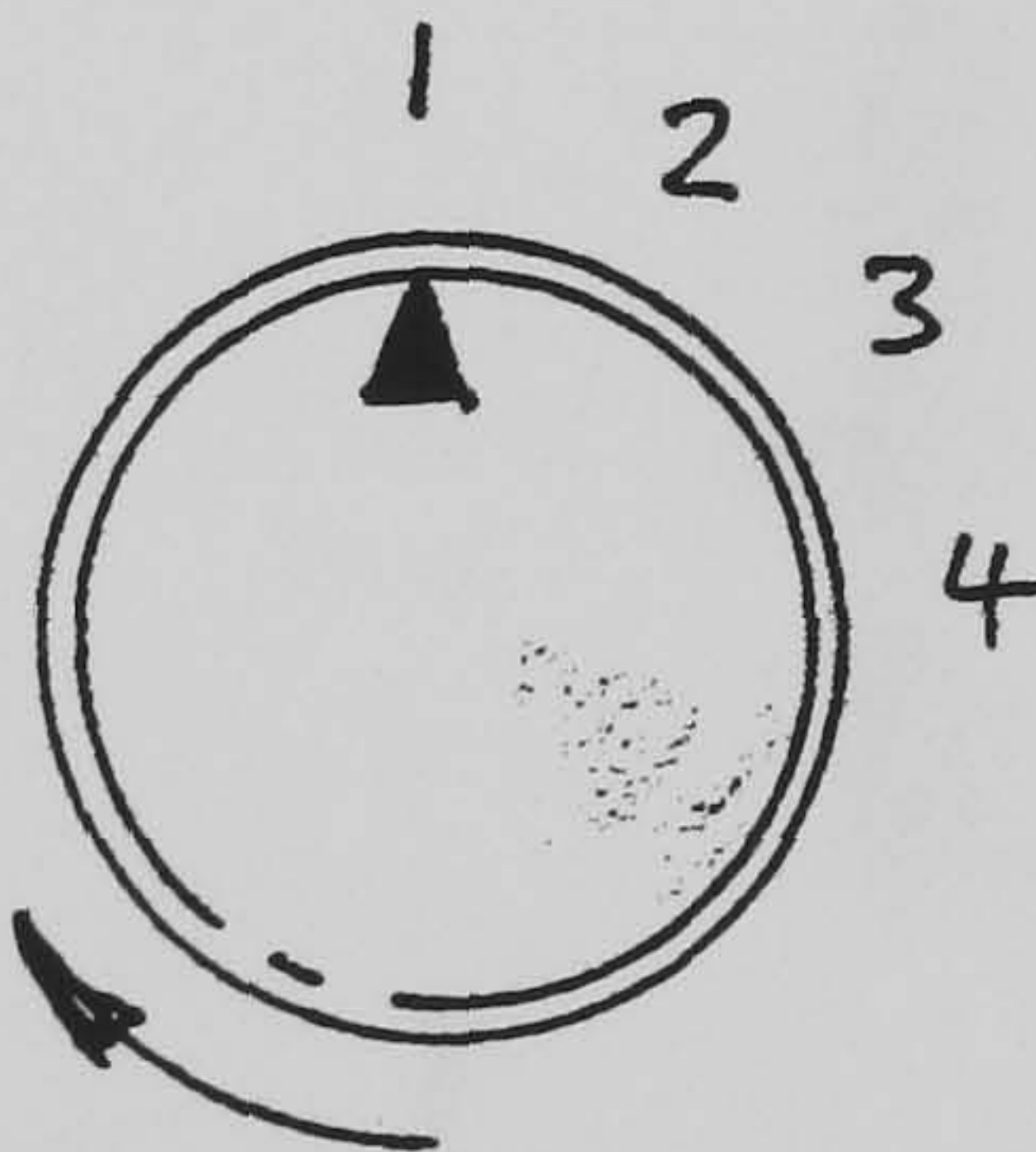
Each discreet position must be labelled to indicate the position of the control, if numbered then these markings should increase in a clockwise direction.



### Device

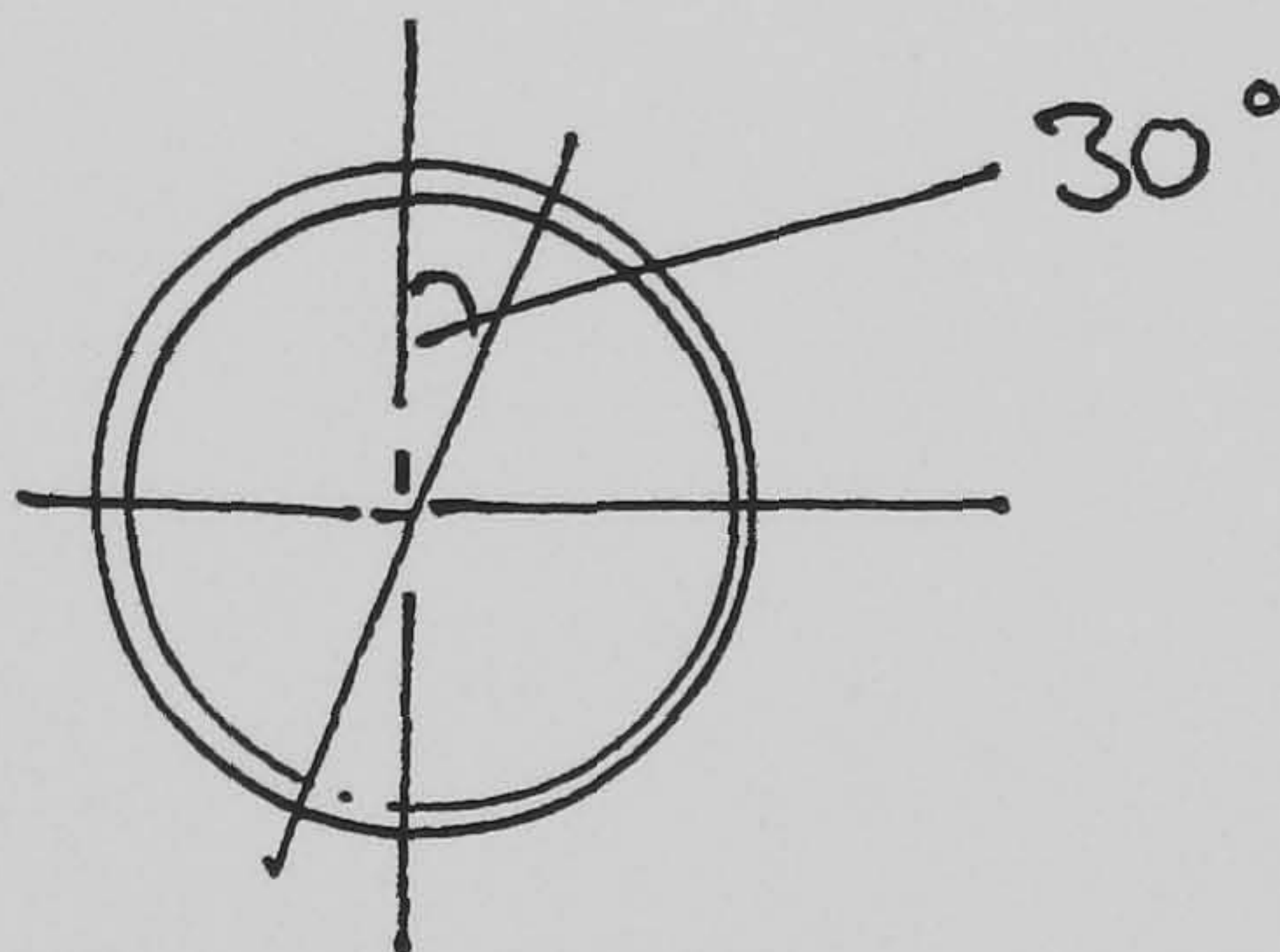
Simplest style is a circular knob with a notch or dot on the outer edge to indicate the position of the control.

Selector switches should have fixed scales and moving pointers

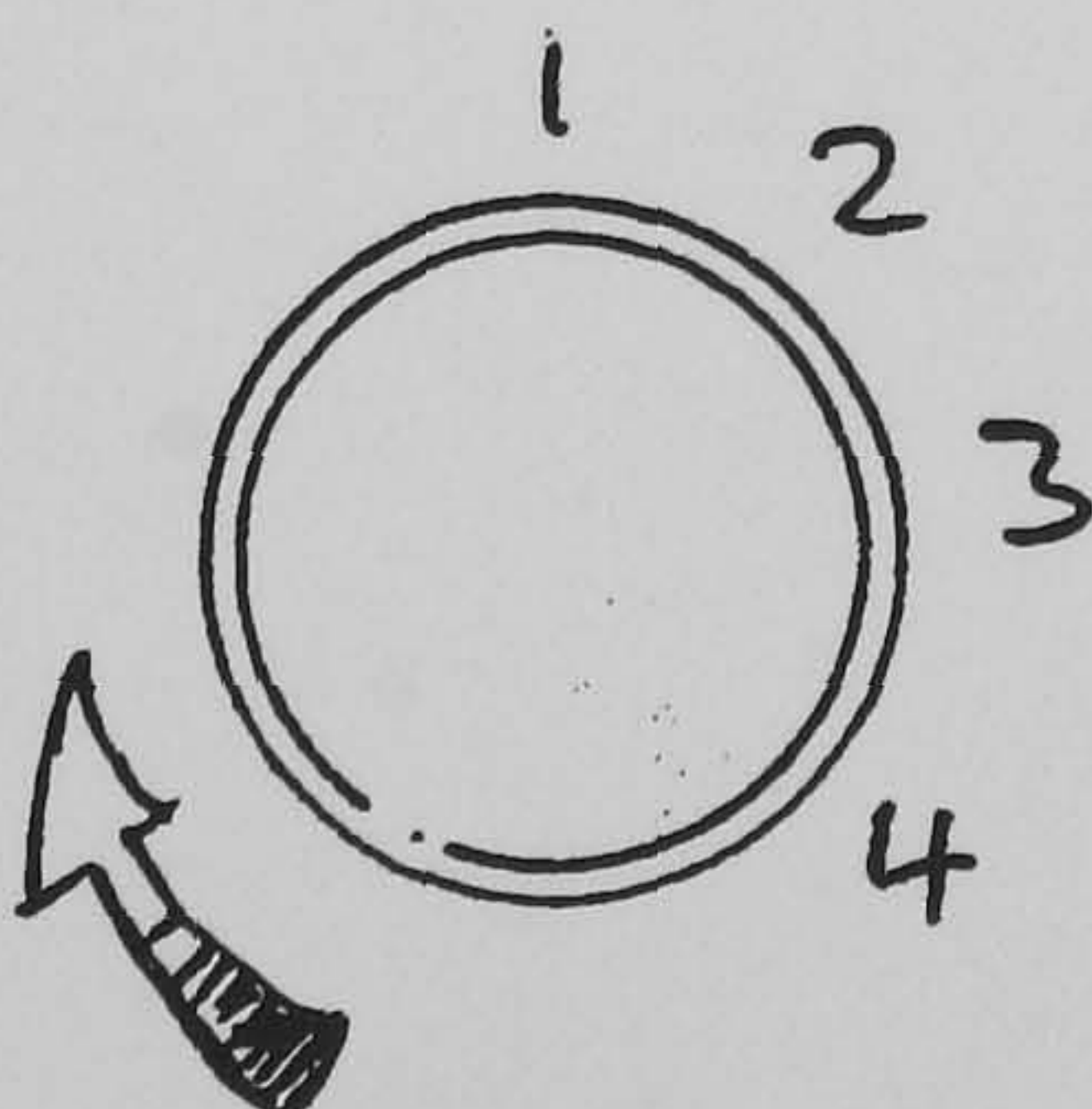


Detents should be provided at each control position (setting)

When few settings are required the settings should be separated by about 30 degrees

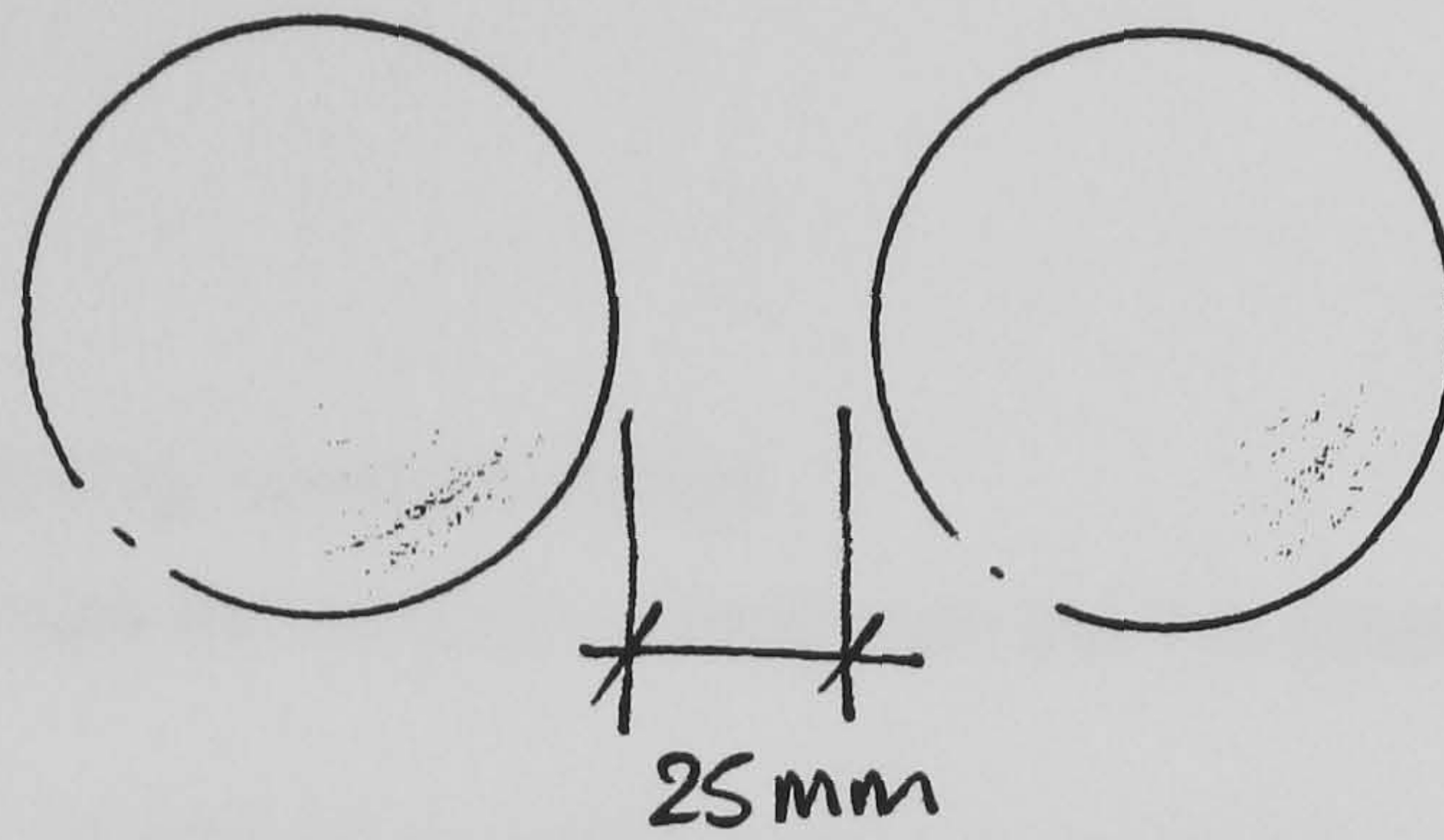


Settings should increase with a clockwise rotation

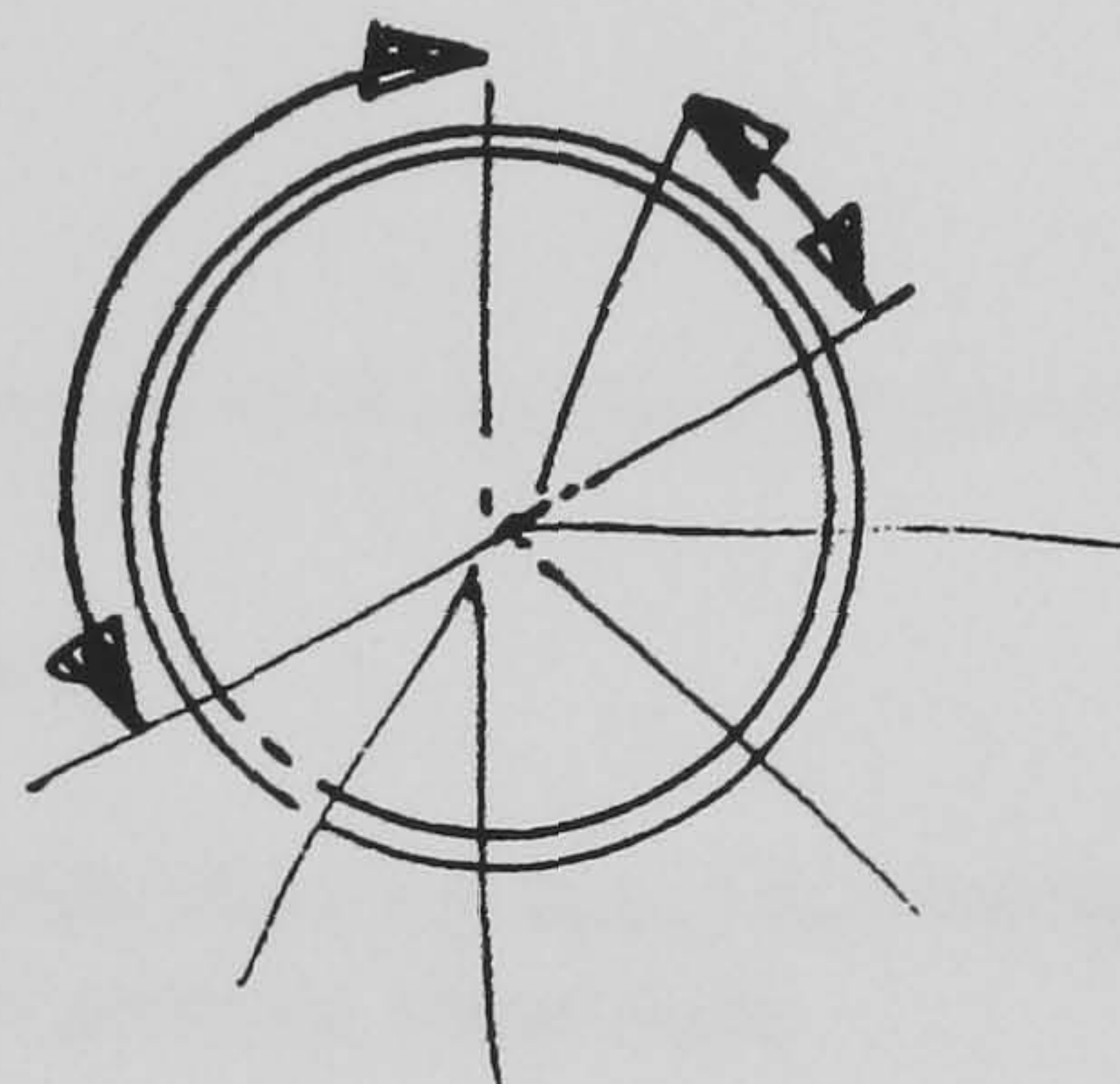




Minimum recommended spacing between rotary selector controls is 25mm



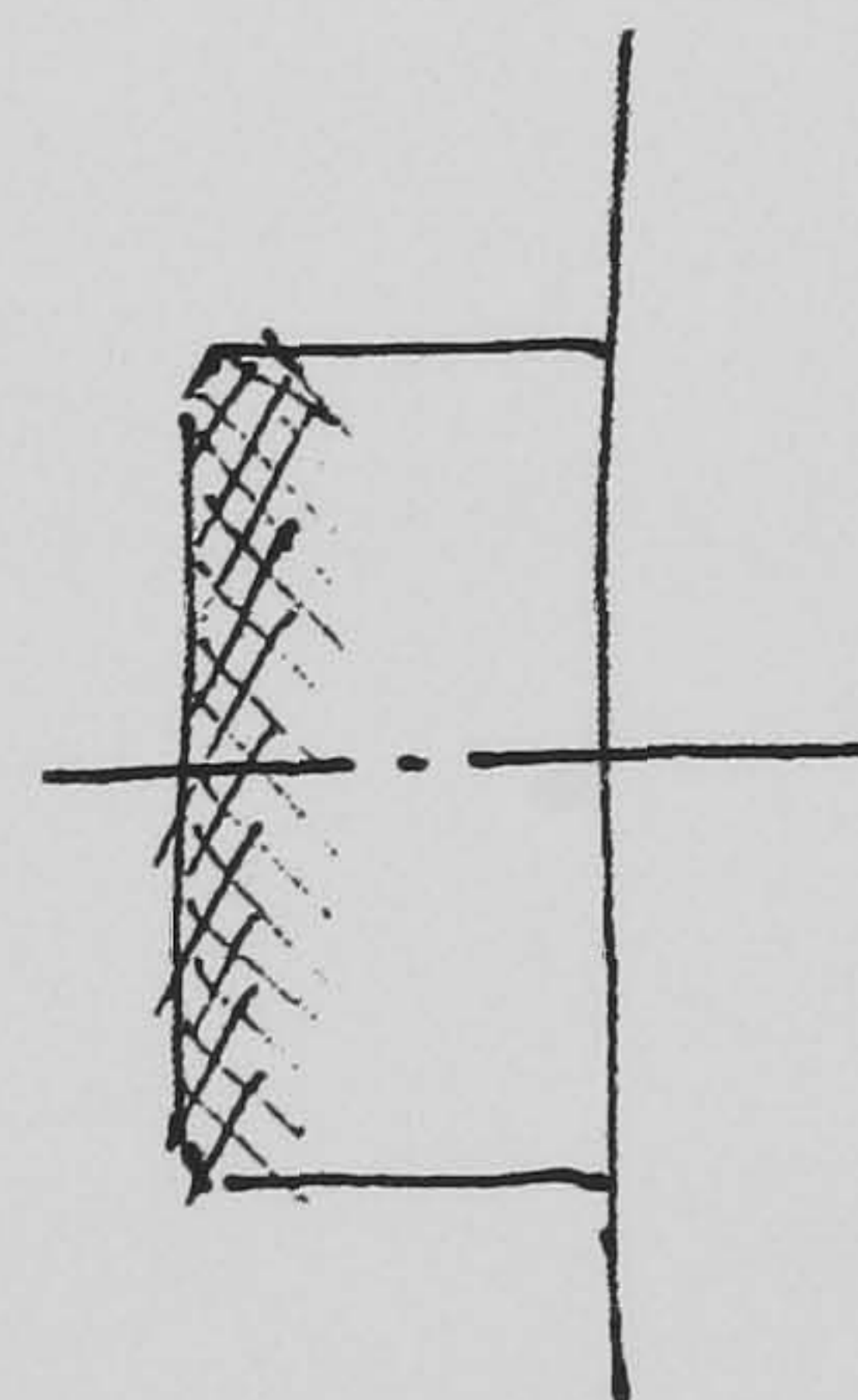
For speed and ease of operation there should be no less than 15 degrees between settings



When less than 24 settings are required then the beginning and end of the scale should be separated by a gap larger than the displacement between the adjacent positions

Audible clicks should be provided to give users feedback

Grasp area should have some method of increasing friction to prevent fingers from slipping.



Minimise parallax by designing the end of the pointer to come close to the scale index



Index numbers should not be obscured when the hand is on the control



Types of resistance

- Elastic resistance - as in spring loaded controls
- Static friction - friction to initial movement is maximum but this drops off sharply
- Coulomb (sliding) friction - continuous resistance to movement. Prevents accidental activation and helps to hold control in place
- Visco dumping - resists quick movement, helps smooth control especially useful if maintaining a prescribed rate of movement
- Inertia - difficult to get to move initially but once started difficult to stop.

Related Guidelines Contradictory Guidelines Rating	<p>*****</p> <p>Generally liked by users but being used less and less in product interfaces</p>
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# Touch Screens

## 017

### When to use

Touch panels are a “natural” input mechanism. Users prefer and respond faster with a touch screen as an input device than with any other type of input device.



### Task

The benefits of using touch screens are as follows

- uses a natural interaction style
- little or no training required for a user to operate a touch screen
- are easy to operate for both experienced and inexperienced users
- have a familiar action for users
- however, when using touch screens there is an increased level of hand eye co-ordination.

Users who are standing to operate touch screens prefer them to be at an angle of 45 degrees provided that the glare onto the screen is controlled.

More errors are made at the top of a vertical computer screen at eye level than at the bottom. This is caused by the relative positioning (extension distance) of the hand/arm and parallax.

Objects in the lower section of the screen are more likely to be obscured by hand when selecting objects from upper region of screen.

Users are more likely to hit just below a target on a screen at an angle of 45 degrees.

For user control think of the following issues

- allow the user control the rate of information which is displayed
- users should be given feedback as to where they are within the program
- provide constant means from moving from one screen to the next
- provide facility for moving back to the main menu screen
- provide a map on how to get through the program
- user should be able to correct any mistakes made

Smearing can be a problem but this can be overcome if the screen used is lightly ground

Arm fatigue is a problem if the device incorporating the touch screen will be used for long periods of time.

Parallax between the touch screen surface and the display surface can cause users to misinterpret where their fingers are actually touching by a significant amount. A small cursor (<+>) can be employed which appears just above the



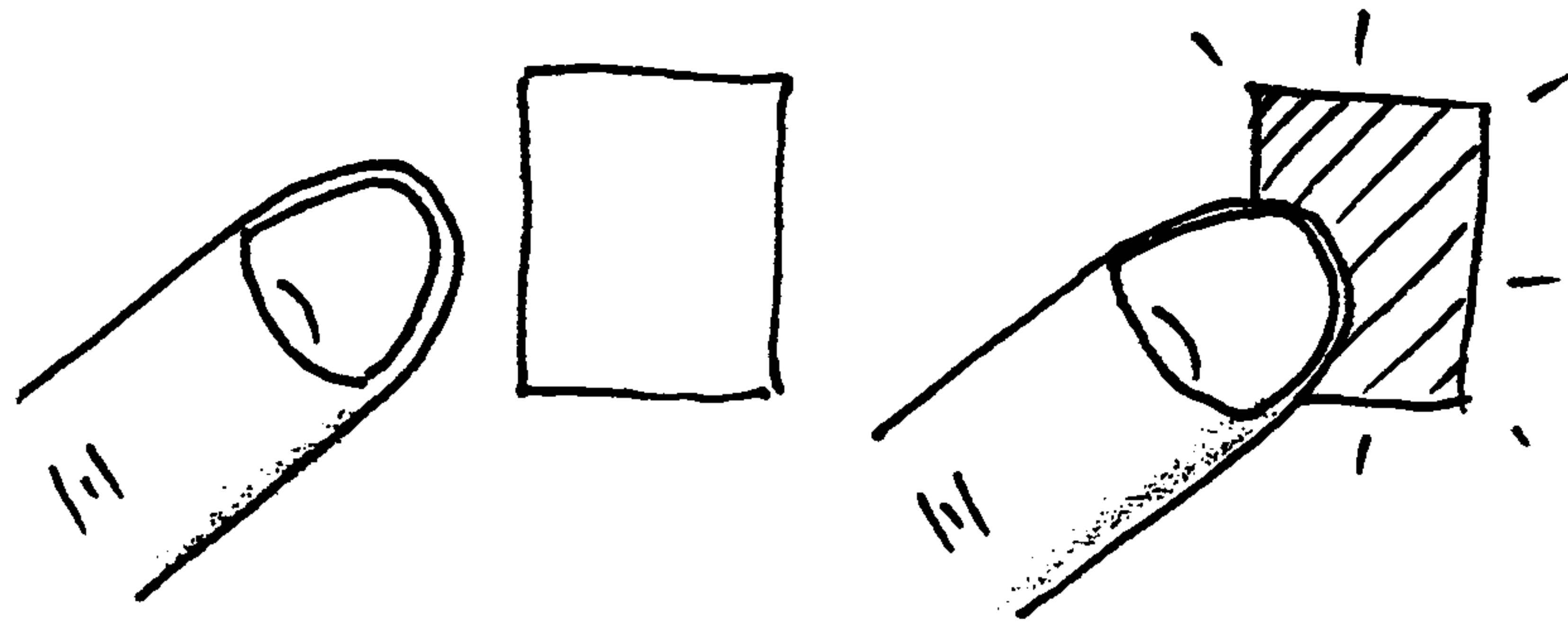
users fingers. This device provides continuous feedback of the position which the user is pointing to. This method tends to be needed more in 'finger off' selection strategies.



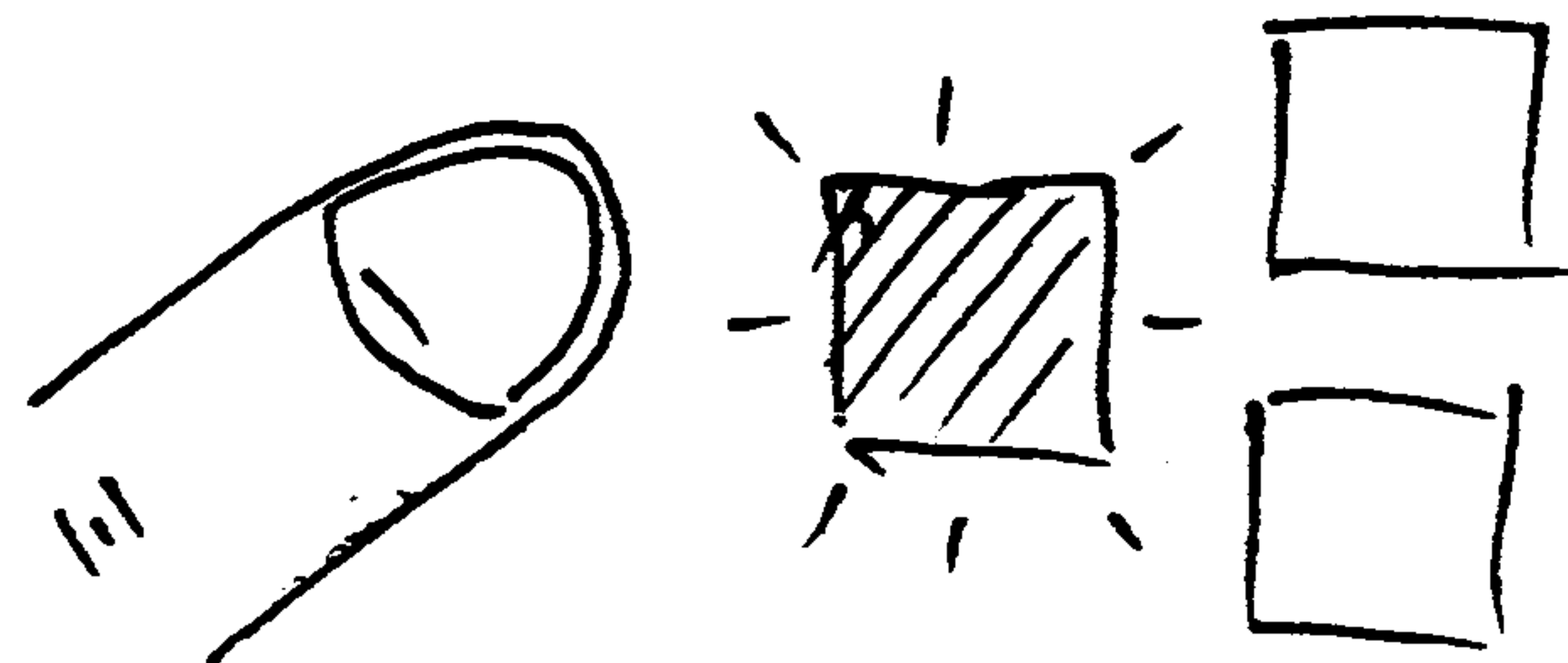
## Interaction

### Types of activation

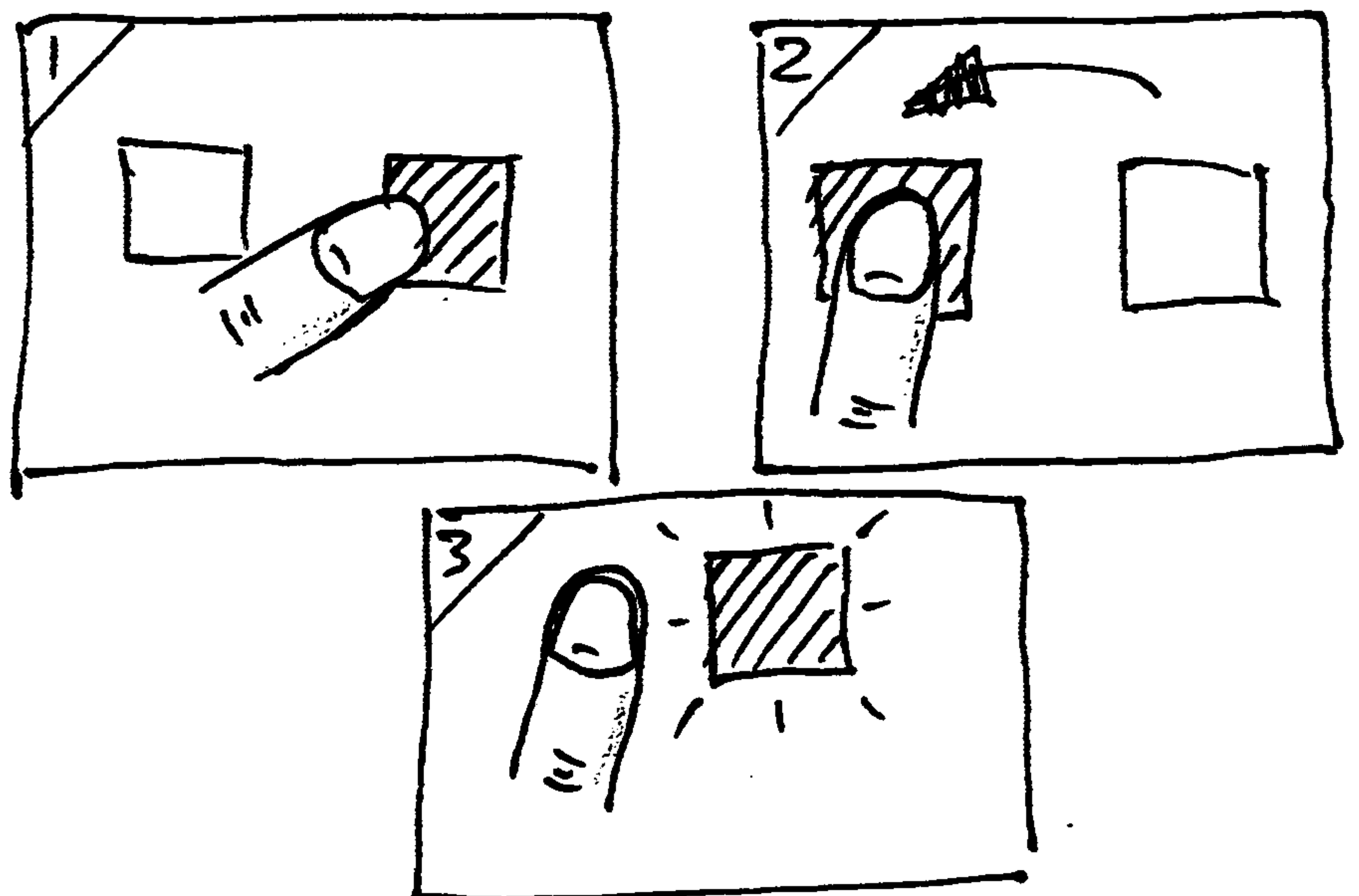
**Land on**  
finger must land directly on specified target.



**First contact**  
first active area of screen touched is selected.



**Take off**  
last active area of screen touched before removing finger is selected. Users may move fingers round the screen. Needs to have a small cursor placed slightly above the finger



For a most touch screen devices first contact activation is probably the most appropriate selection strategy as it has a lower error rate than land on selection and faster to use than both land on and take off selection strategies.

Take off selection strategy produces fewer errors in items selected than first contact selection and can be used for considerably smaller targets, but screens using take off as the selection strategy must also have jitter control so as to prevent the "finger mouse" jumping about. Take off strategy is also considerably slower to use than the other methods.

A major problem with touch screens is the lack of tactile feedback to the user. This lack of feedback can lead to errors. Good feedback increases user accuracy.

Auditory feedback can be used and shown to make reactions of user faster and more accurate. Some research suggests that touch screen buttons should beep and change in appearance from hollow to solid when active.



Consider visual cues, for example buttons changing colour, shape, position, etc.

- indicate the state of the device unambiguously
- suggest that the user can change the state of the device and how this can be done
- must acknowledge the actions of the user
- Coding and labelling: label size, colour, brightness and back lighting effects and be used to indicate states.



**Device**

**Button styles for touch screens**

Interaction device	Ease of use	User preference
1 button *	very easy	high
2 button (e.g. On/Off)	moderate	high
rocker switch	moderate	high
words only (ON/OFF)	difficult	moderate
slider	difficult	low
lever	difficult	low

\* The major problem with using a one button device is that it is sometimes difficult to determine whether the device is on or off.

**Size of target areas**

For take off strategy this can be accurate to a level of 4 pixels by 4 pixels provided that the screen is stabilised. A first contact touch screen works best for 16x16 pixels

For first contact and land on strategies, the touch area must be larger than 20-30 mm<sup>2</sup>) and that the touch area works most efficiently when it comprises of the whole button and not just a small part of it.

Users will operate the device more efficiently if buttons to be activated look familiar (e.g. light switch, rectangular buttons with icons within them. Ideally the touch area should encompass the entire target choice or object plus one character surrounding it



**Colour of interface**

Choose colours which contrast the text colour well - for example

Text	Background
white	magenta red green blue
yellow	blue
cyan	blue
green	yellow white
magenta	blue white
red	white yellow cyan green
blue	white

Try to avoid bright back grounds with dark text as bright colours appear more dominant.

Related Guidelines Contradictory Guidelines Rating	<p>*****</p> <p>Increasingly popular interaction dialogue but does often suffer from poor feedback</p>
--	--



Types of Display Media 018

When to use

A product display can be on-line, either dynamic (various forms of instruments that vary with time) or a static display information which does not change with time. Off-line material includes manuals and operating instructions.

Display media	Variants	Example
Print	Alphanumeric, graphics, colour, symbols, icons	Can be used for a variety of purposes such as instructions, prompts or labelling
Electronic displays	Alphanumeric, graphics, colour, symbols, icons, colour, animation, refresh or flashing rates, indicator lights	Dynamically changing information such as status indicator lights changing from green (OK) to amber (hold)
Auditory	Earcons, voice, sounds	Warning signals such as 'beeps'
Form and shape	Grouping, clustering, semantic shaping	'S' shaped rotary controls on washing machines
Dials and pointers		

Below are comments on the table above

- Colour can be used to highlight, group and code different interface objects these should, as far as possible, comply to standards or de-facto standards.
- Graphics is defined here in its broadest terms, and can be used to display complex information, trends, predictive versus actual values and dynamic information. Graphic displays include: symbols, images and icons (which are small graphic images that represent familiar objects or abstract forms in order to convey their function).



- Auditory displays should be used when visual displays are not appropriate. For example, when driving a car and trying to tune in the radio or when there is a need to reduce the cognitive load on the visual channel. Sound has the advantage that it can be heard from all directions and the user does not need to be focusing on the output device. Auditory displays should be used to enhance visual displays and make their operation more memorable and when visually impaired users need to use a visual based interface. Reaction to auditory stimuli is faster than reaction to visual stimuli.
- Form or shape of controls can display how a control should be used, for example, washing machine control knobs have been shaped in the form of an 'S' to suggest the direction the control should be turned.
- Dials and pointers are rarely used on products and therefore not discussed in detail here, though many general ergonomics books have detailed information if it is required.
- Grouping and clustering of displays can provide important cues on the functional process of the product. Spatial considerations should be closely linked with task requirements.
- Indicator lights are a useful display medium. Indicator lights can be used to display whether power is on or off, the status of a function, mode or hazard conditions or that a malfunction has taken place. In contrast to industrial products, where coloured indicator lights have recognised meanings, consumer products do not comply so rigorously to standards.
- Conspicuity of target objects. There are two types of conspicuity; attention conspicuity measures the propensity of a display object to attract attention when the observer's attention is elsewhere, whilst search conspicuity measures the likelihood of a display object being located during a search for that object.
- Coding should be used with care, avoiding a myriad of display coding methods. Coding types include colour, text and letters, geometric shapes, size, brightness, and flash rates.
- Semantics - can be defined as the conscious use of product form and visual cues or metaphor to optimise the interaction between the product and user. Visual metaphors that assist in the use of the product can be provided. There are three important elements that should be considered in presenting a semantic cue: what the semantic cue(s) should be; how the representation should be conveyed for example, visual or auditory; and how the semantic cues are interpreted by the user.

## Design Issues

See relevant guidelines

## References

There is plenty of literature on this subject particularly on character recognition, height to width ratio, stroke width, letter spacing between and within words, spacing between lines, and viewing distances. See for example Cushman and Rosenberg (1991) and Woodson (1992) for detailed information. There is a very good publication on writing instructions for consumer products by Cooper and



Page (1989). There is very little literature on the effectiveness of instructions for specific products types.

Electronic displays are increasingly being used on consumer products. The field of human-computer interaction has much to offer in terms of guidelines that could be used in display design. Cushman and Rosenberg, (1991) offer useful advice on selecting an appropriate display technology. Galitz (1993) is an extremely comprehensive book on screen design discussing user issues, the use of different dialogue styles, graphical screens and colour.

<div>Related Guidelines Contradictory Guidelines Rating</div>	<div>* * * *</div> <div>Where a wide range of displayed information is required</div>
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# Appendix 13.5

Draft design tools handbook  
'Interaction design tools for  
product user interfaces'





Interaction

# **Design Tools**

for product user interfaces

v2.2



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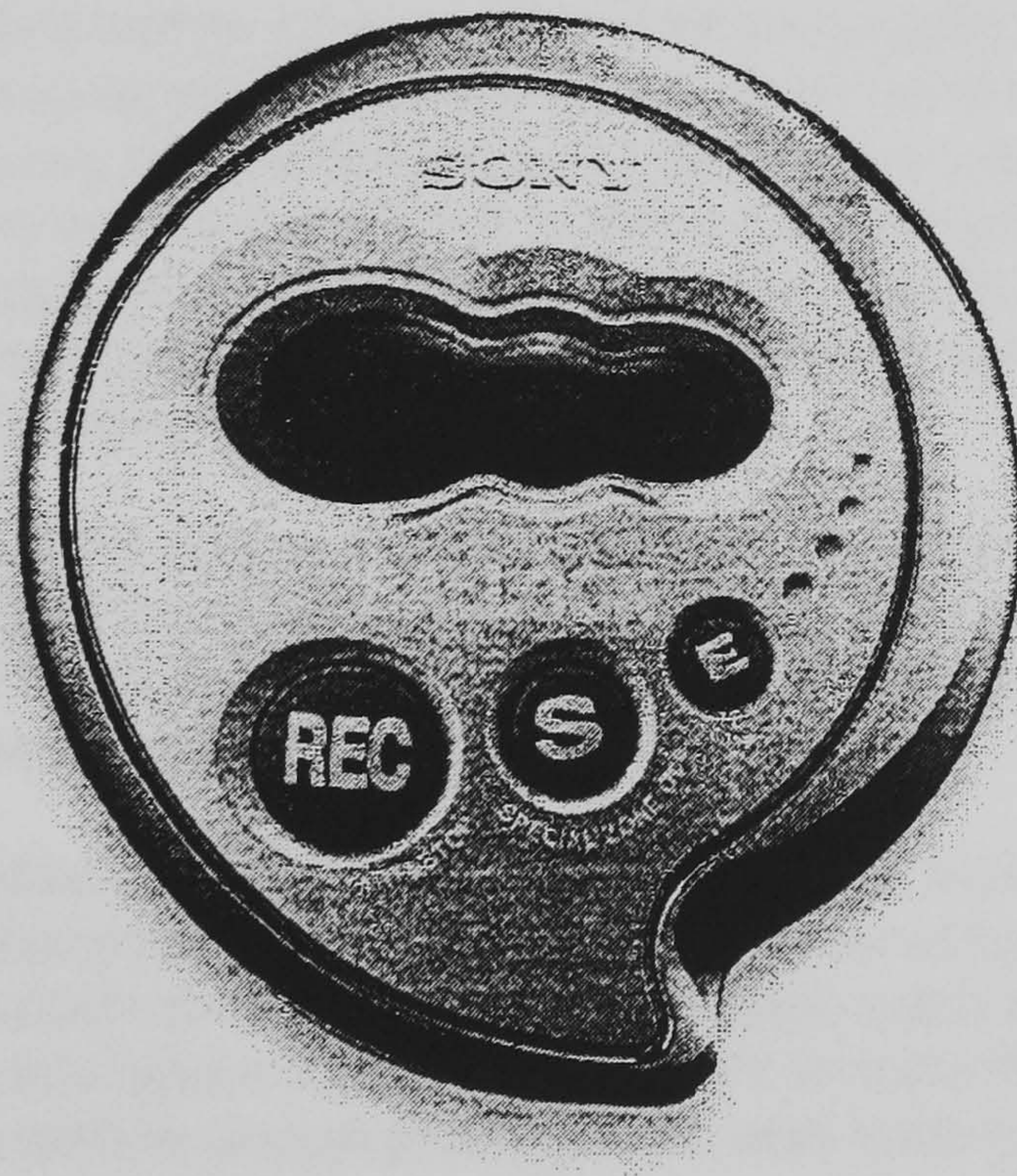
# Introduction



# Introduction

## Interaction design tools for novel product user interfaces

With developments in control and display technology, coupled with the increasing use of embedded computer systems in consumer and industrial products, product design issues related to the user interface are beginning to broaden. Product interfaces now include more complex displays, often with touch screen capability allowing designers a wider degree of creativity in terms of interface design. These interface design issues have gathered enough pace to create the need for a new multi-disciplinary subject known as 'interaction design'



Interaction design has human factors or ergonomics principles at its core, but also includes the social sciences and pure creative design skills. Many manufacturing organisations now employ interaction designers coming from a mixture of backgrounds including graphic design, industrial design, ergonomics, and psychology.

Because it is now possible to develop software rather than purely hardware based control and display devices, interface design is less dependent on traditional control and display components and more dependent on the software design capability within the design



organisation. This permits the possible introduction of more 'novel' control and display devices or interaction styles

These design tools and guidelines were developed to fill a gap in current industrial or interaction design methods and were developed to:

- provide design and evaluation tools specifically tailored to designers
- fit working methods used by designers rather than human factors experts using scientific methods
- address interface design issues which are predominately novel and unproved
- handle usability issues at early and highly conceptual stages of development
- use participative design methods

Much of the material gathered together to form these design tools has originated from a discipline known as Human Computer Interaction (HCI) where many similar design issues have been developed over a period of about 30 years. Human computer interaction as oppose to user product interaction, embedded with a computer, differ in many ways. Most computers, for example, rely on a narrow range of input devices (usually the keyboard and mouse) whereas product user interfaces are more diverse both in terms of input devices and how they are used. This offers a tremendous challenge to interaction designers as product applications and usage can be very specific while also having to meet the demands of a potentially wide user population, often including children and the elderly.

For these reasons it is extremely important that the usability of any novel interface is influenced heavily by this diverse user population. Therefore, much of the emphasis of these design tools hinges on participative design.

Most designers do have any training in research methods so these design tools have developed using working methods familiar or approximate to conventional design methods. Many of the design tools have a 'hands-on' approach to make them relevant to each interface design problem while also making them interesting to use.

## **Scope of design tools and guidelines**

These design tools were developed to support early and conceptual consideration of a product interface, particularly novel interfaces where little is known about the usability of a proposed interface design; where even the detailed functionality of the product may not be determined. The design tools are not prescriptive but provide a framework or process by which user requirements and 'scenario' usage can help define and determine the interface design specification.



The design tools briefly are:

**Card sorting (Section 2)**

A user requirements capturing tool which allows potential users to articulate their needs for product interfaces that they have not yet encountered. The tool uses card sorting exercises to prompt more creative and speculative discussions about future product interfaces.

**Scenario Design (Section 3)**

High level interface design proposals can be evaluated and designed further using 'scenario' based methods. By allowing users to explore different interaction styles within a pre-defined context or scenario, a richer opportunity for both designers and users exists to evaluate different design concepts

**An Inspection Tool (Section 4)**

Designer led evaluation design tool based on outputs from each iteration of the previous design tools. Concepts are evaluated and refined using inspection based methods. This inspection based method is divided into three:

The first part, Interface Design Criteria, provides a set of 8 quick reference criteria which should cover most aspects of good usability design

If problems are identified with any of the criterion, the second part can be used by going through the checklists

If problems can still not be resolved then a walkthrough procedure is provided in the third section.

The final two sections are bound in a separate document and include:

**Prototyping guidelines (Section 5)**

Design and evaluation guidelines on the combined and effective use of high and low level prototyping

**Interface Design Guidelines (Section 6)**

The interface design guidelines are prescriptive and based on conventional rules and principles on interface design. The guidelines only deal with control and display devices typically found on most products and also consider more novel devices which are emerging in product interfaces.

Further reading and references are provided in Section 7.

The diagram on page 1 - 5 illustrates the relationship between the design tools and guidelines and how they feed into each other.



## **Validity and reliability of tools and guidelines**

The design tools themselves have been developed in a user centred and iterative manner. Some of the design tools have already been used by designers and also by student designers.

Feedback has been sought by the users of the design tools to establish how they could be improved through interviews and questionnaires. At this stage the design tools have been assessed individually. The next stage is to evaluate them as a 'tool-set' and so they are still in development.

## **Presentation of tools and guidelines**

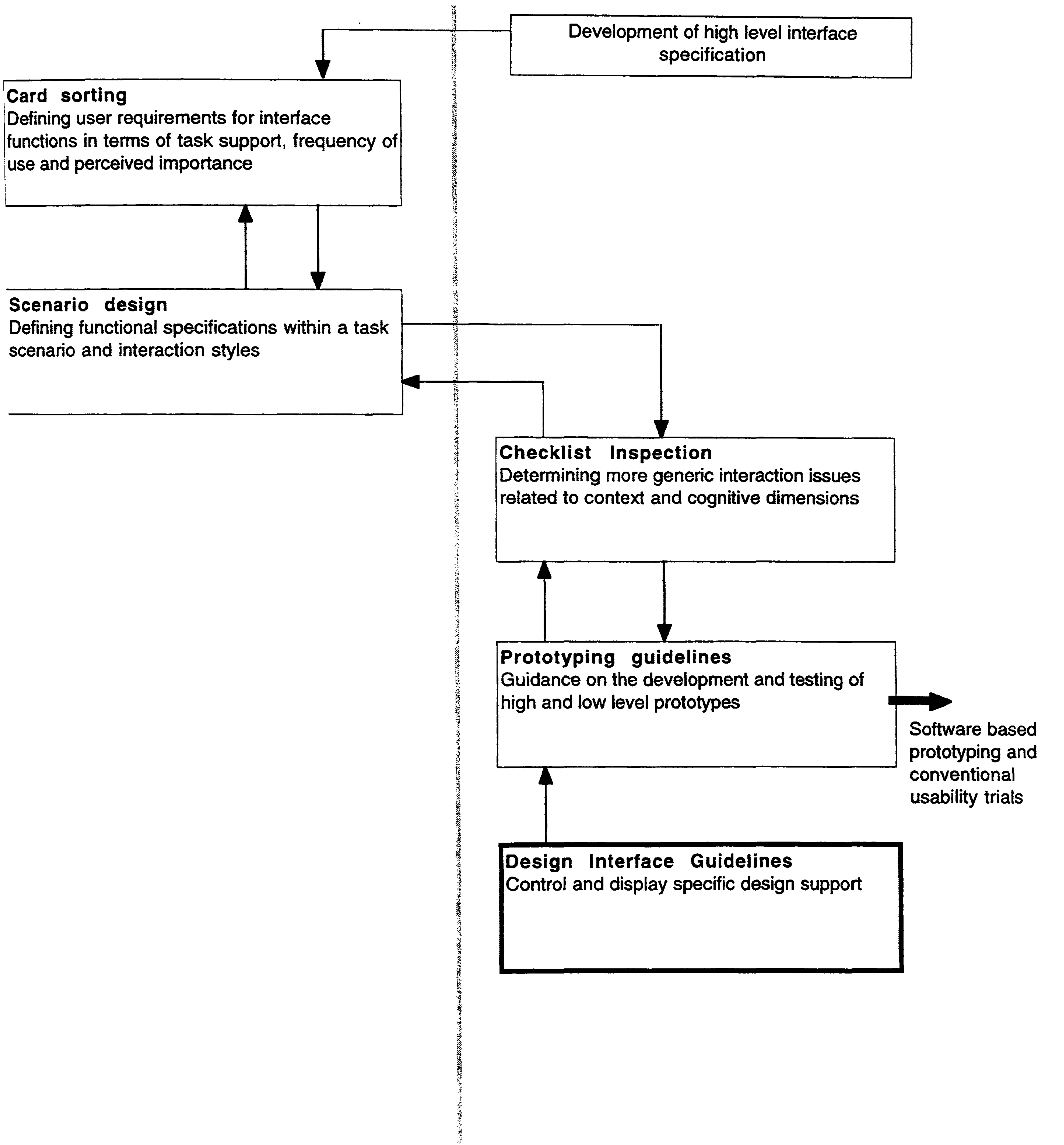
The design tools are presented in chronological order to the design process, although at some stages there should be iteration between design tools. Plenty of examples have been provided to demonstrate how they should be used. Also, there are 'Things to think about' sections which provide concepts and ideas that may prompt deeper consideration.



Design tools and guidelines

Participative design activities

Design team activities





# Card Sorting



# Overview

Brief description:	A user requirements capturing tool which allows potential users to articulate their needs for product interfaces that they have not yet encountered. The tool uses card sorting exercises to prompt more creative and speculative discussions about future product interfaces.
Purpose of the tool:	To identify and prioritise existing, amended or new functional needs for an interface. To establish, at a very high level, how users would like to use the interface.
Resources:	Quiet room with a large flat table, cards, video equipment, post-it notes, sticky tape, flip charts and pens, cards (with graphics), blank cards, 4-5 participants for each group.
Inputs:	A high level functional description including an array of functional options. A workshop activity plan Instructions for participants in the workshop Appropriate descriptors for the cards.
Outputs:	Card plan (which can used as a task analysis) Recorded observations for design discussions User requirements and needs (after analysis) for interface functions and potential interaction styles which can be used in the scenario design tool.



# Card Sorting

## What is card sorting?

This design tool is a collaborative activity between anticipated users of a proposed interface, who sort and place cards on a table, with interface designers. The main purpose of the tool is to find out what needs and requirements potential users of a conceptually or loosely defined interface maybe. Users are given various card sorting exercises to answer the following questions.

- what importance do users place on a range of proposed functions?
- what type of functions are needed?
- when and how may these functions be used within a 'typical' task that users perform?

The design tools also provides a form of task analysis that can be used in subsequent interface design discussions.

Depending on the objectives of the exercises, participants arrange the cards, adding new ones if necessary, which best fit their jointly agreed representation of the exercise objectives. The arranging of cards prompts discussion between the participants both about the card content and also where they should be placed on the table. The descriptors on the cards need to be carefully composed by the design team to ensure appropriate discussions take place. The cards allow users to think differently about the role and significance of each card descriptor permitting a less constrained, more creative approach to their needs for a proposed product interface.

## What are the benefits of using this design tool?

One of the main problems in consulting potential users about future or prospective interface proposals is that users find it difficult to communicate ideas or concepts beyond their own experiences. The use of focus groups, questionnaires and product clinics often depend upon users being able to anticipate scenarios of product usage that they are not familiar with or to be able to reliably describe



or interpret their own usage behaviour with existing products. While these methods can reveal very useful information, if performed correctly, frequently designers can be left with data lacking insightful information which can activity assist in the specification and design of a product interface. In addition, these data gathering methods often require considerable analysis before any meaningful results can be revealed.

Furthermore, criticisms are often levelled at user participation in the design process because users don't know what they need; can't articulate their needs, or if they can, they don't know what is possible or impossible. Also, they find it difficult to be critical about what and how a product might be used and therefore tend to specify an interface which can do everything. Also users often disagree with each other or perhaps respond superficially.

Card sorting offers a mechanism to overcome many of these problems, but nevertheless still requires careful planning to obtain meaningful and insightful results.

Card sorting provides four main advantages over more traditional methods.

- the cards provide a discussion mechanism or act as 'transitional objects' allowing more critical contextual thinking to occur about product interaction
- providing a broad range of card descriptors allows novel concepts to be introduced without having to design the interface to support such a concept, allowing the participant to interpret or define the descriptor in their own terms
- descriptors can be divorced from defined or existing technology therefore product functionality which is currently not possible can be discussed
- the card sorting exercises can provide a physical schema or representation of tasks which may assist in interface design

The card sorting tool proposed here has been specifically designed or limited to obtaining an understanding of the type of functional requirements a product interface should have. The tool may also provide some indication of interaction styles that may support these functional needs. These are dealt with in more detail when using the next design tool - scenario design.



## Planning for card sorting exercises

For the card sorting tool to work effectively some degree of planning is required. This should not take longer than a half to one day. The key steps in planning the exercise are provided in the table below.

Stage	Activity
1	Produce a high level functional specification
2	Design cards
3	Design card sorting tasks
4	Plan the workshop
5	Select users

### Produce a high level functional specification

The functionality of the proposed interface needs to be defined in broad, high level terms. This will probably have been defined already at the project management level. Even if this is not the case, it is important that the participants have an understanding of the general capabilities of the interface.

The high level specification should define the boundaries of the interface functionality without defining the functions within the boundaries. For example, if an interface was being designed for a cooker, the specification may be defined as follows.

It should be possible to:

- Control* four hob temperatures
- Control* temperature of two ovens
- Use a *delay switch* feature for the oven
- Select and de-select* the oven fan
- Use a *cooking guide* to *assist* in cooking new meals

This specification determines the functions of the cooker while allowing the participants, through the card sorting exercises, to define at a high level what these functions could be; more importantly how much importance they would place on using these functions during a cooking task.



The phrasing of these functions is important. The italicised words carry a great deal of contextual meaning about how these functions maybe interpreted by the participants so they need to be selected with care. The specifications should identify what the functions will be with little suggestion about how the control and display of these functions could be manifested on the interface.

Card Design

Cards depict entities which can belong to one of the following categories:

*Interface control and display functions* - The description of these cards is critical and involves creative talent. What and how function are described will have an important bearing on the future of the interface design process. The design team need to decide the level of 'departure' from existing interfaces. In other words how radical they would like the functional concepts to be. One of the advantages of this approach is that a radical concept can be simply changing a few words on a card.

To aid this process, the following card design method is suggested.

	Existing	Incremental solution	Radical solution
Function			
Washing program selector	<i>Select washing program with rotary dial</i>	<i>Select washing program with dial and display</i>	<i>'Build' washing program by selecting program element from a menu</i>
Pre wash	<i>Push 'Pre wash' button with red light indicator</i>	<i>Touch 'Pre wash' symbol on display panel</i>	<i>Automatically selected 'pre- wash' using washing programme builder</i>

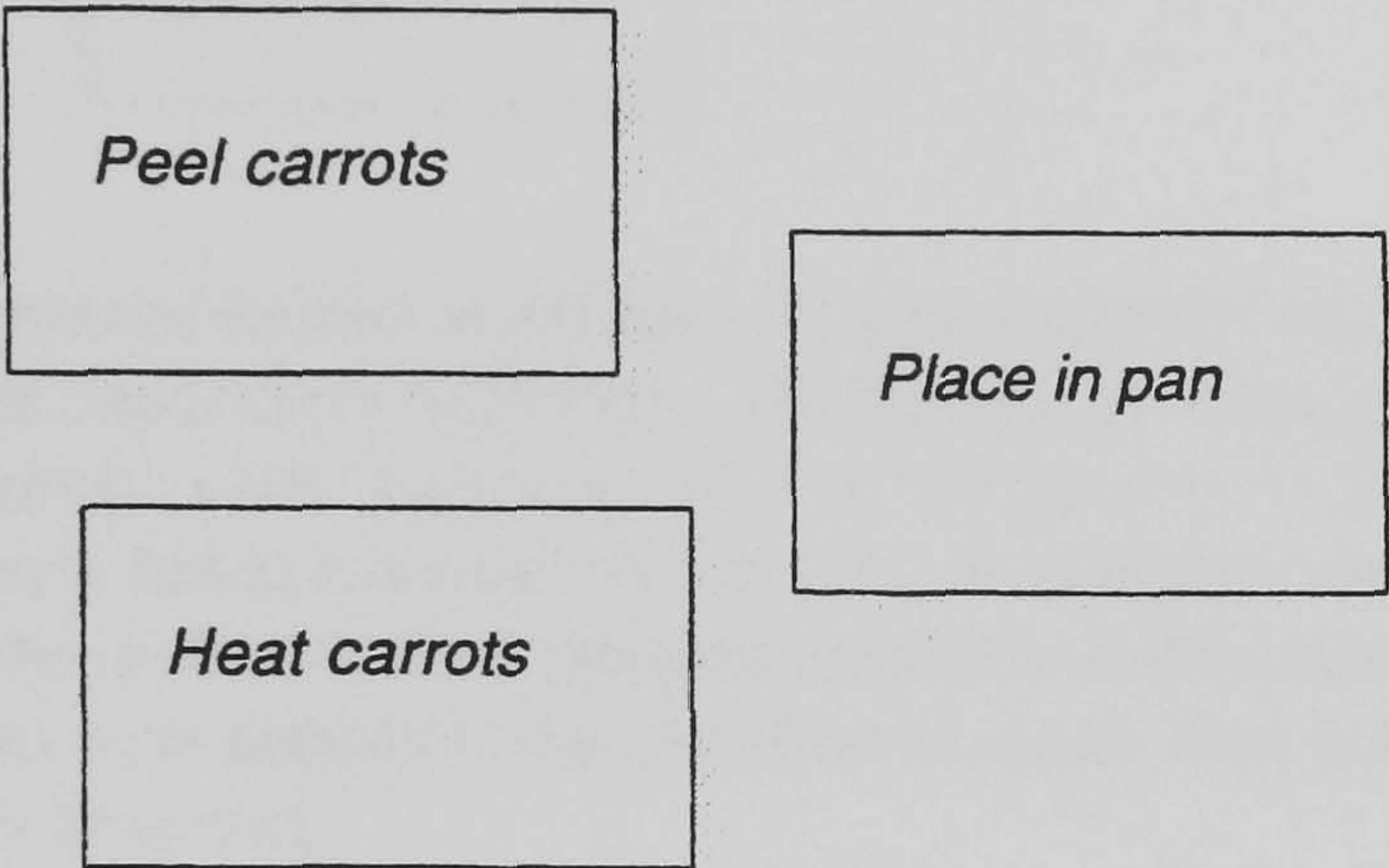
The first step is to list all the possible functions that the proposed interface could contain including speculative functions which may be considered in the design of the interface. List different functions vertically, some functions such as 'auto' features maybe clustered together. This list should form the basis of the function cards. Secondly, each function should be described using the descriptor headings on the horizontal axis. It is suggested that no more than three different descriptors are used. Descriptors could be, for example, interactions styles, levels of automatic and manual control and traditional and non-traditional control and display technology (used in the example above), or using different verbs. In each cell,



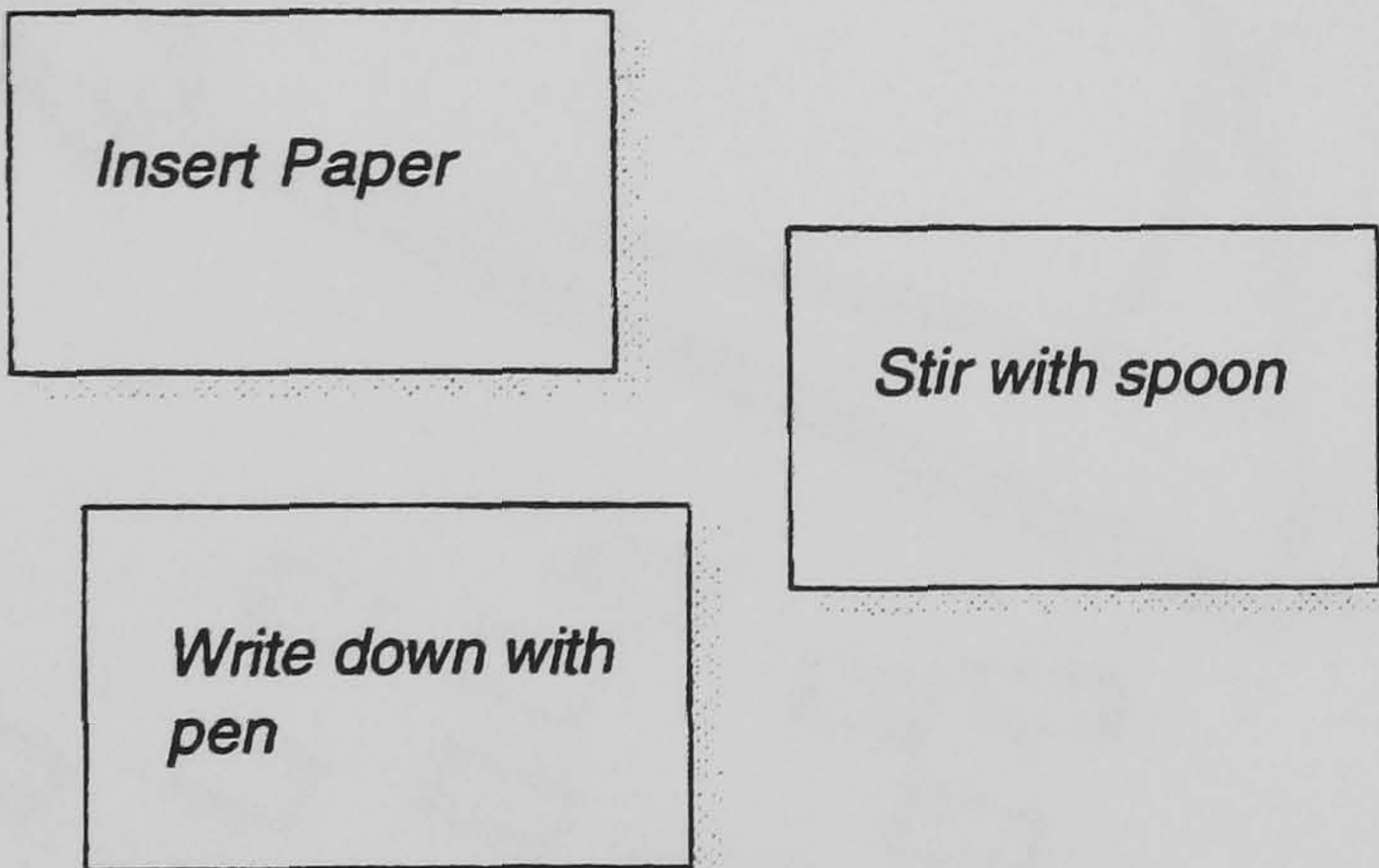
provide a card description that satisfies the functional and descriptor requirements.

Hint  
Graphic illustrations can be used to speed up the recognition of task elements. Colour coding can also assist participants in finding and ordering cards and is also useful in analysis.

*Tasks or task elements descriptions* - these should be short and precise task or task element statements. Tasks should be described at the same level as the proposed interface function level. This is important so that the functional descriptors can be inserted along the task plan. Task descriptions at too high a level would force too many functional descriptor cards to be clustered together.

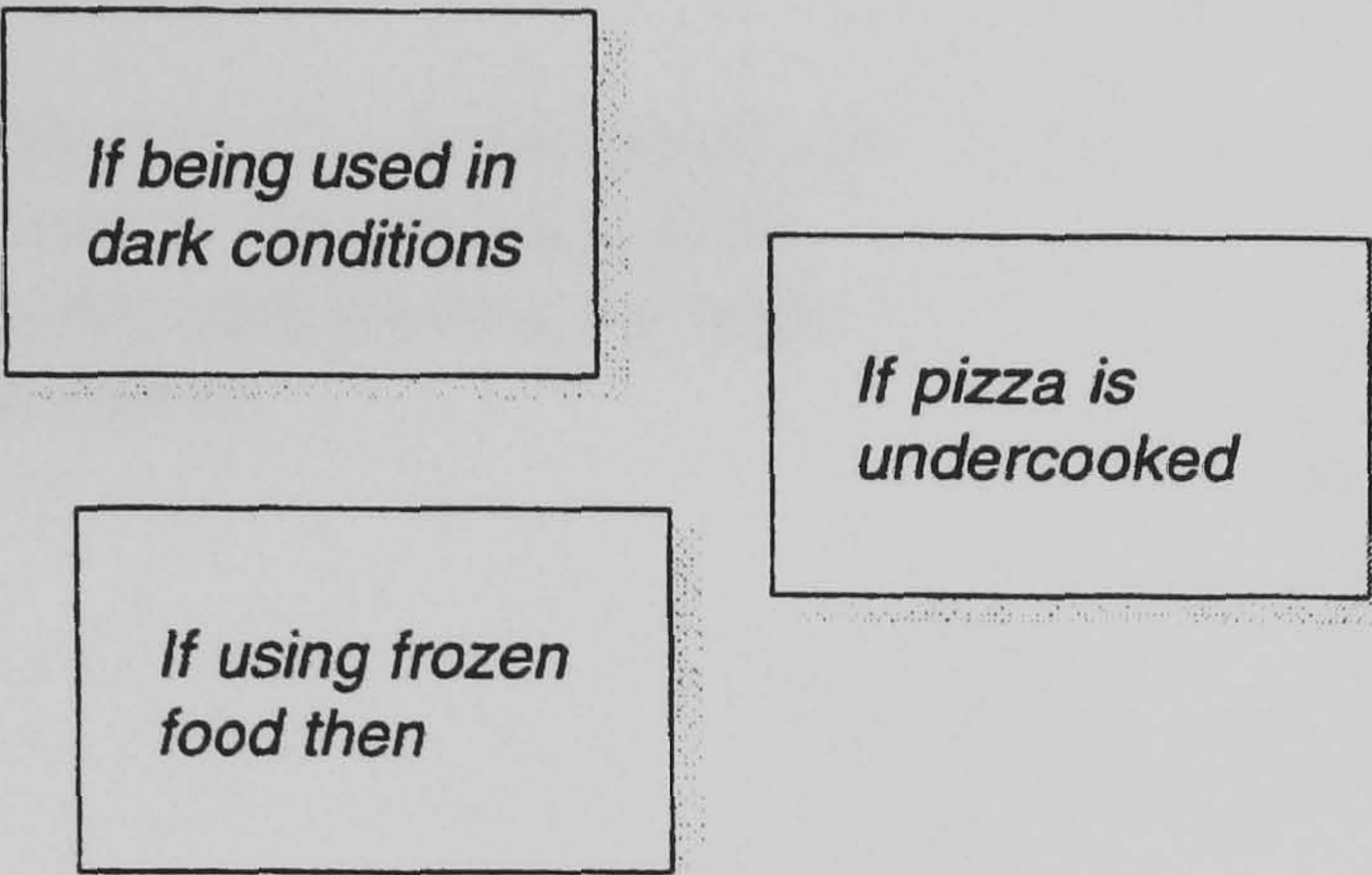


*Objects* - includes any artefact that is required in order to complete a task or task element such as pens, paper, spoon, etc. Object descriptors should be accompanied by a verb in order to make its insertion into the task plan more meaningful such as 'write down with pen'

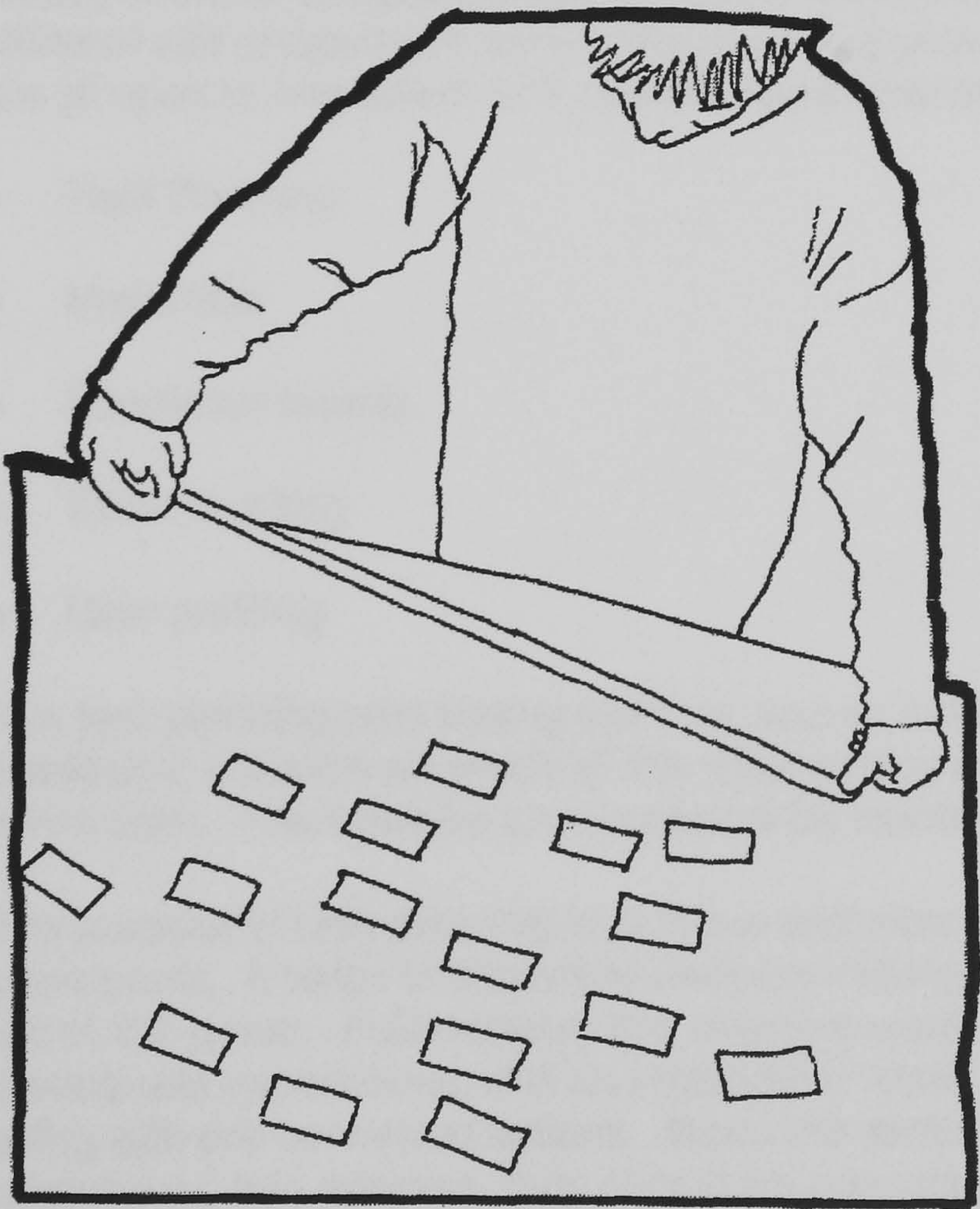




*Events* - are conditions that either effect the nature of the task. Event cards control the variability of outcomes with tasks and force participants to consider a range of situations. Event descriptors begin with 'if' and end with 'then'.



*Temporal based activities* - These suggest the passing of time or time dependent activities. Cards can be used to indicate this, for example 'Now wait one hour' or '10.30 am, 11.30 am etc.'. If the task plan is being inserted into a fixed time span a length of masking tape works well with time periods marked on the tape. Ensure that time slots over estimate the number of cards that could be inserted in any one time slot.



*Stakeholders* - in some task descriptions, it is important that roles or specific individuals are identified during the task. If this is so, try to select an existing rather than fictional or stereotypical person. This



helps the participants to think in more concrete terms. Cartoon characterisation also helps the process.

*This is Sid*

*He's 54 and not very keen on cooking. He only uses the cooker and microwave when he has to.*



## Design card sorting tasks

There are many different ways in which card sorting tasks can be used. However, it's important to select the correct type of card sorting exercise to elicit appropriate and relevant information. Five different and progressive sorting tasks are suggested here but they are all open to adaptation to fit specific requirements.

- Task Planning
- Matrix filter
- Functional inserts
- Event building
- User profiling

The *task planning* card sorting exercise acts as a reference or 'backbone' exercise on which all the other sorting exercises can follow from. This exercise should always be introduced first.

The purpose of task planning is to focus and orientates the participants. It helps to determine decision making rules and roles within the group. Furthermore, this exercise exposes the participants' experiences, skill and motivation levels for the task along with pre-conceived notions. While the participants are undertaking this exercise, they should be encouraged to discuss all these issues. This exercise should also be regarded as providing the participants an opportunity to settle into the workshop.

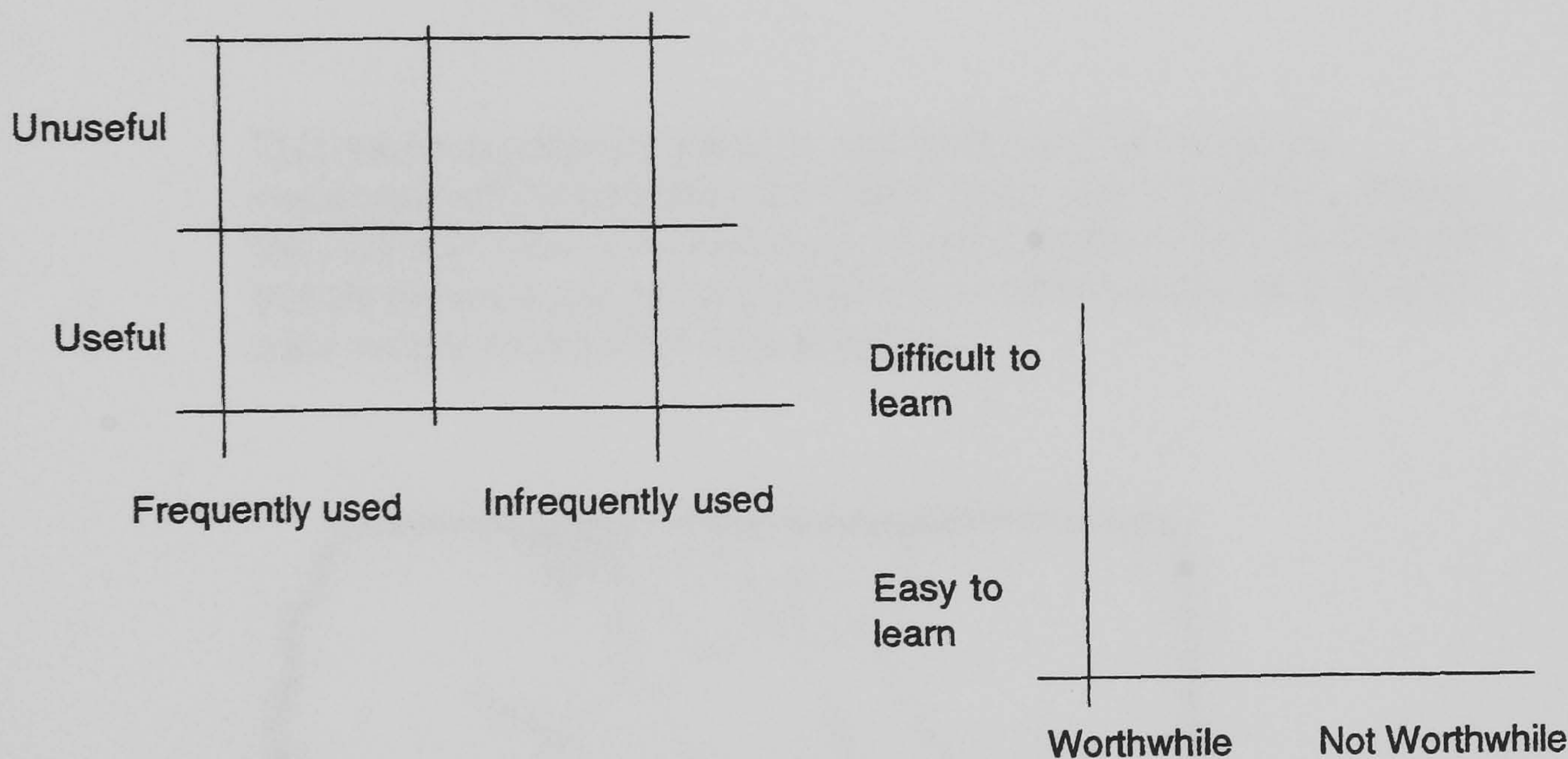
Select a task that all participants are familiar with which is reasonably self-contained and having a clear start and finish point. It is wise to select a task that covers more than the proposed or existing product



interface would support. This helps to broaden the discussion beyond the boundaries between the task/user/product interaction and can add important contextual relevance to the user needs of the product interface.

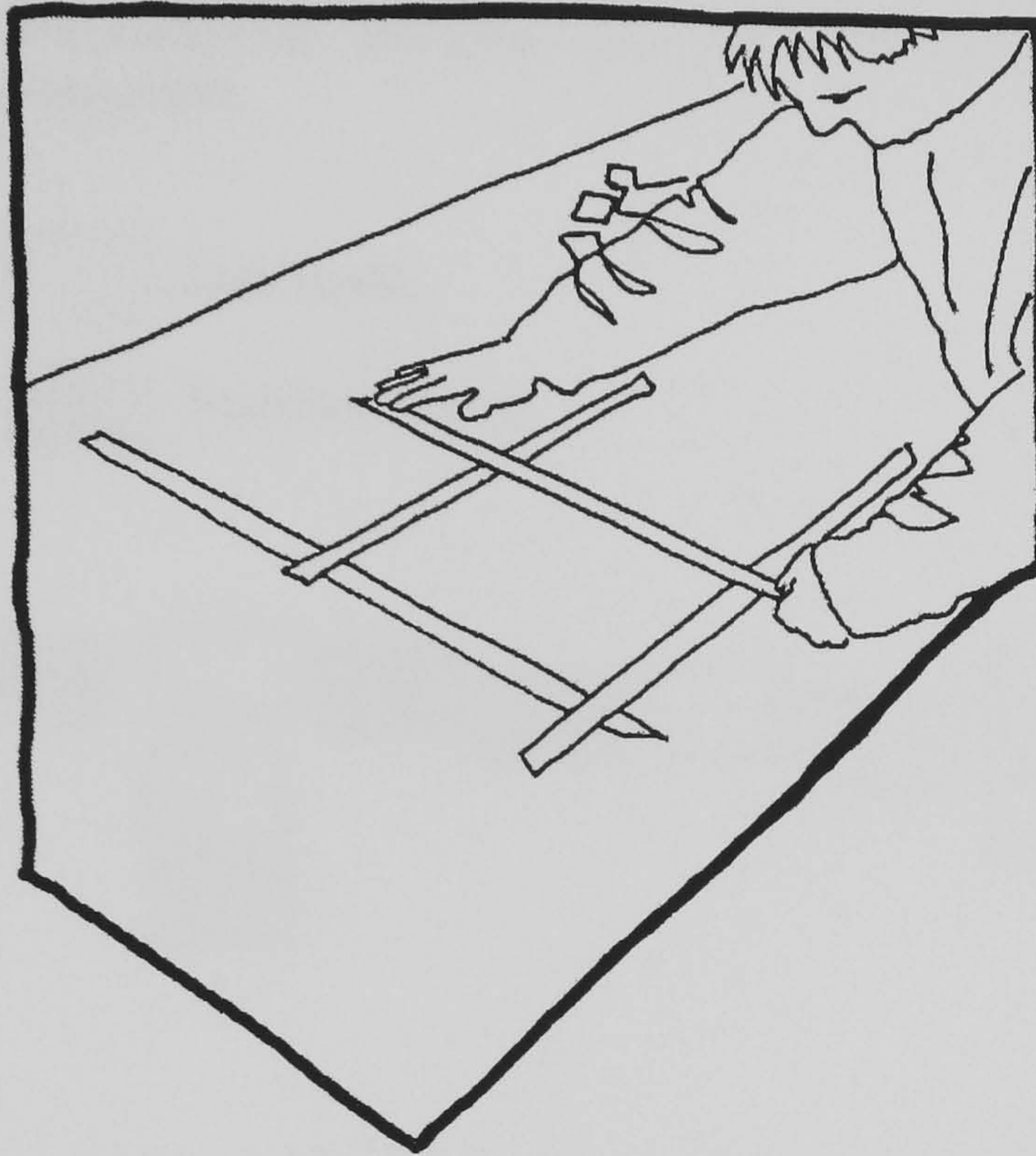
Produce cards that describe task elements at an appropriate level of granularity. The wording of the task elements is very important and should, as far as possible, use phrases and terminology that the participants are familiar with. It may be important to provide temporal based cards, that is, cards that suggest, for example, an hour should pass before the next task element is undertaken. Don't forget to consider the use of graphics and colour coding to improve card selection and also analysis.

The *matrix filter* exercise allows participants to place value judgements on control and display function cards. Each function card is considered by the group and judged against two rating scales placed on a 'x' and 'y' axes. The rating scales are arbitrary and can be defined by the design team. Some suggestions are presented here.

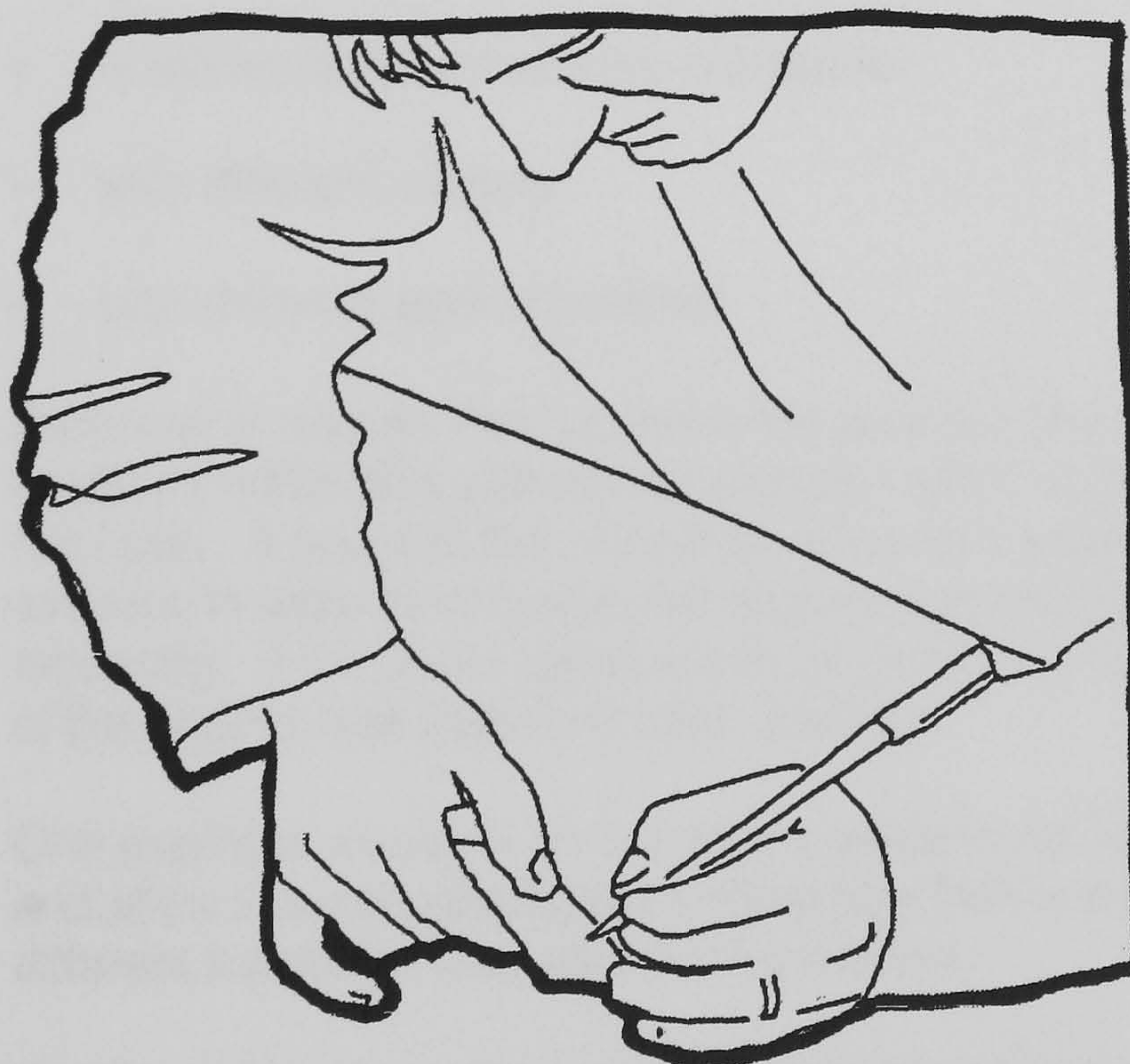




Place masking tape on the table to represent the two axes and label the axes using cards. These axes labels can be changed for other labels if further matrix filtering exercises are necessary. The axes can be divided into quadrants or used as a variable scale.



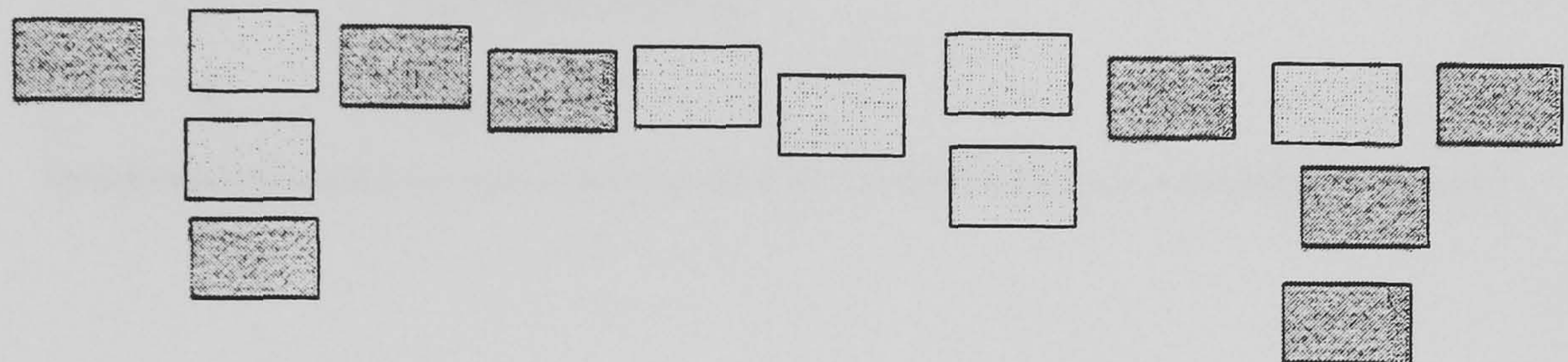
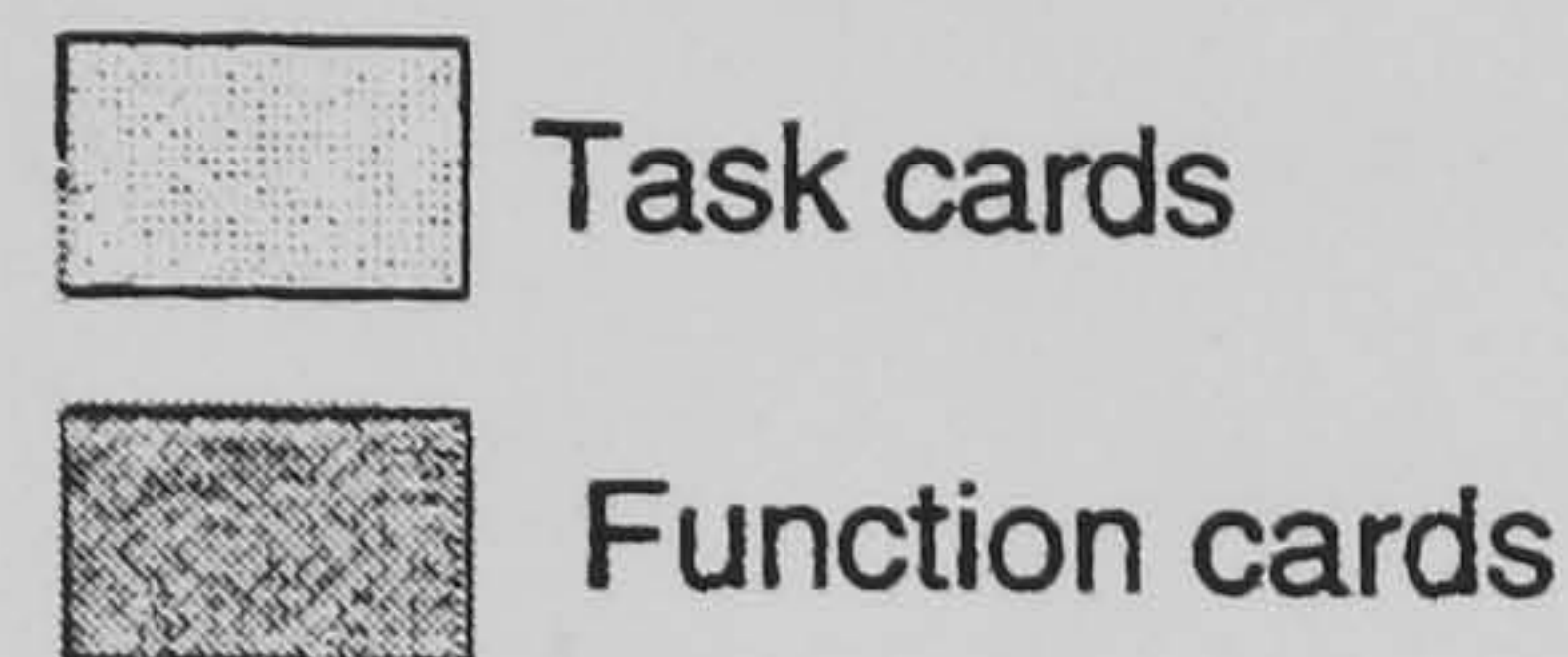
This exercise places a value on each card and provides the designers with qualitative information about each function. Before the next exercise, the designers should consider if the card clusters should be coded by placing a number or letter on the back of each card before starting the next exercise.



During the next exercise, *functional insert*, participants should place the filtered cards onto the task plan at appropriate points. Give the cards to them in piles as they sorted them in the matrix filter.



Obviously by starting with those that have they have assigned the most value to. Inserting a card must be agreed by most of the participants as being important or a typical feature to use at this stage of the task. This may require duplicate copies of frequently used functions. If a particular function is not considered to be appropriate this should be placed in a 'bin' pile for examination after the workshop. Bin piles could be labelled to qualify reasons for exclusion.



The illustration above shows a task map with the function cards inserted.

If appropriate, the next stage of card sorting can be introduced. This forces the participants to consider the task and associated functional support by building these into events (*event building*). Examples of these could be the product being used :

- at different times of the day or week
- in different environmental conditions
- with different objects
- with different task objectives

Participants should then consider the task and the associated functions within this altered context and reflect on how the card map may alter. If possible this should be done as a separate card sorting exercise in order to preserve the original card map for analysis or recording. If the same cards are to be used then take photographs of the original task map for further analysis.

One example would be to consider a week in the life of the product and allow the participants to examine how task and the use of different functions, may alter during a week.

Finally, using *character profiles* helps participants to explore how different users may perform tasks and use interface functions in different ways. Characters should be chosen that are familiar to the group. If this is not done, participants tend to resort to stereotypical notions of the character profiles.



# Card sorting workshop

Stage	Activity
1	Planning
2	Introductions and making people feel at ease
3	Controlling discussion and time keeping
4	Recording events
5	Guidelines

## Planning

In planning the workshop, you will need to decide:

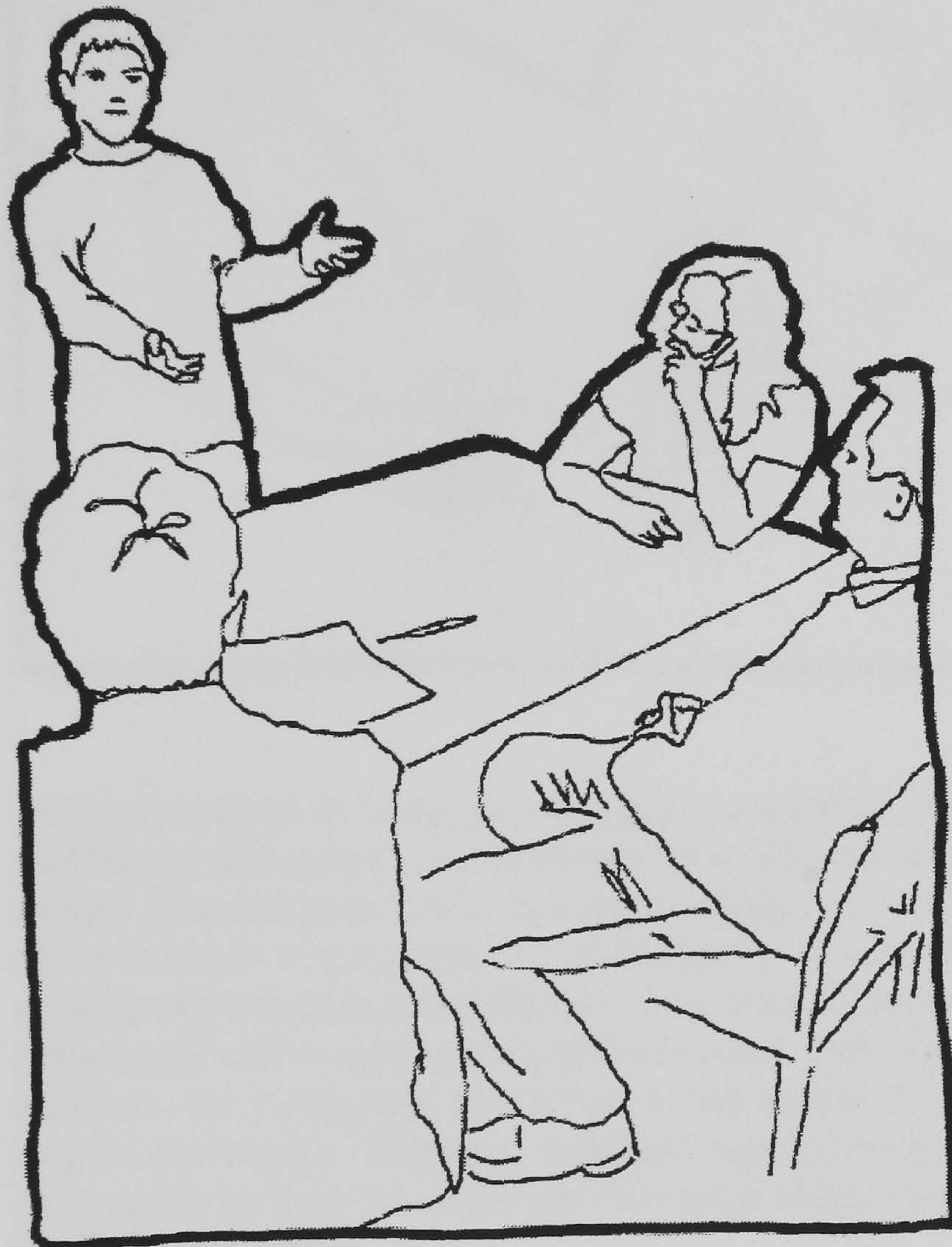
- ☐ what exercises will be undertaken
- ☐ how to control and record the exercises
- ☐ who the participants will be and how the groups will be composed
- ☐ whether or not to video record the exercises
- ☐ time required for analysis

Participants should be representative, but also reflect different types of users. It is advisable to have no more than four participants in a group. At least two different groups should be involved for comparison.



## **Introductions and making people feel at ease**

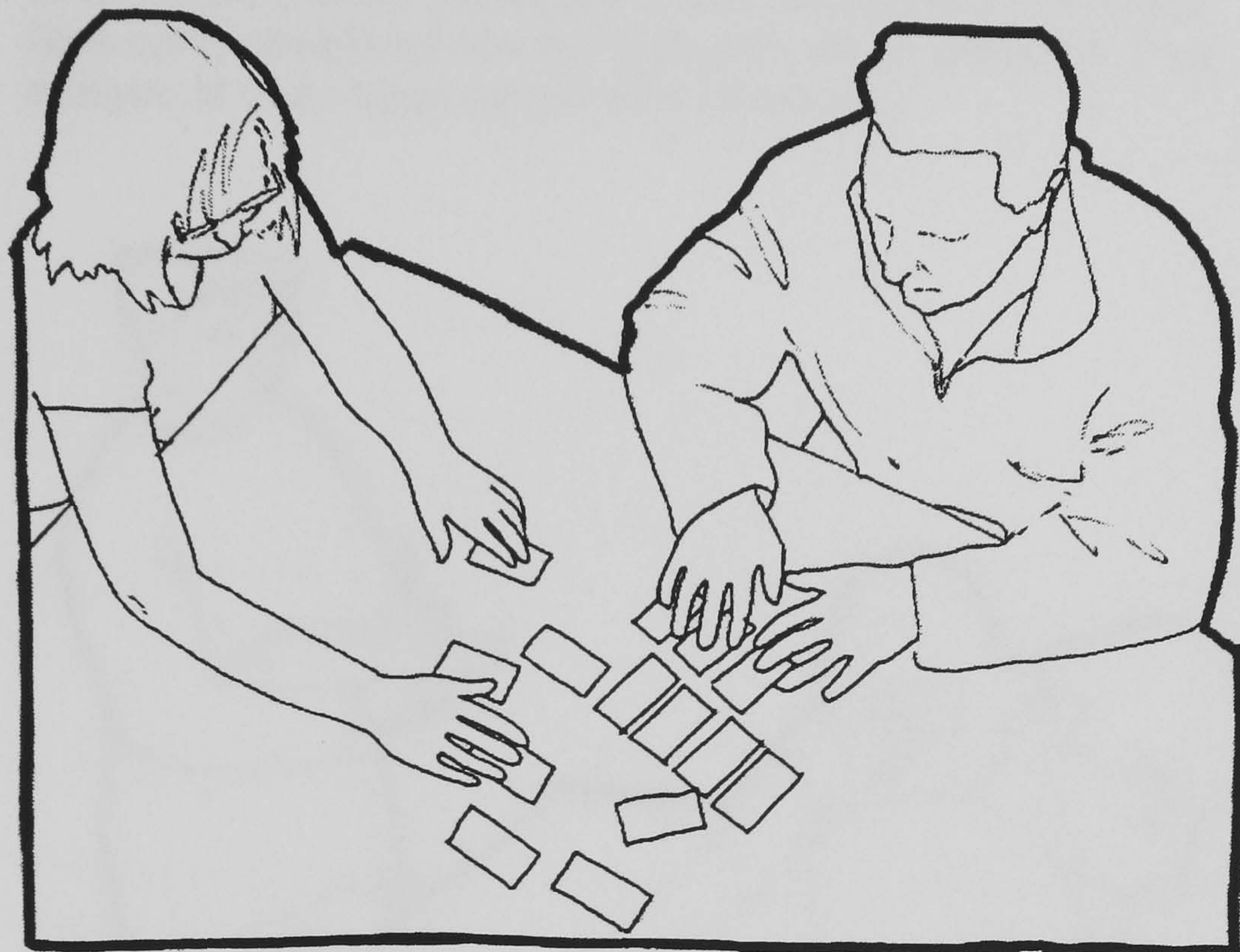
It is important that people feel at ease and are happy to engage in debate and supposition. This is easier with people who know each other. If the participants do not know each other it is probably a good idea to let them go round the table and explain a little about themselves.



If the workshop is being videoed, then permission from the participants must be sought. Explain the purpose of the workshop and emphasise that their own performance or intellect is not under scrutiny.



## Controlling discussion and time keeping



There should be at least two designers managing the card sorting workshop: one acts as a moderator while the other takes notes and makes observations. The moderator should ensure that exercises move towards a productive outcome but at the same time not entirely dictate discussion topics. This type of moderation is concerned with the process activities within the exercises. In addition, the moderator should draw out design discussion and ensure that topics related to interface design issues are discussed thoroughly so that the observer can draw meaningful conclusions from the exercises.

## Recording events

The observer should record information that will contribute towards deriving interface design solutions. To do this, a recording sheet should be prepared which identifies key discussion and action points. Some examples for an event logging sheet are:

- ☐ differences in attitude towards task design, when and how product functions are used
- ☐ strategies adopted in introducing function cards
- ☐ strong points of agreement
- ☐ type of process activities discussed, e.g. planning, teaching others, decision making



☐ type of 'objects' discussed and frequency

Photograph the card sorting exercises for future reference. Video is a good idea but be aware of the problems of analysis. Ideal for showing good typical examples of user perceptions and needs. Give some thought for how the workshop will be analysed. Post analysis of video tapes can be time consuming.





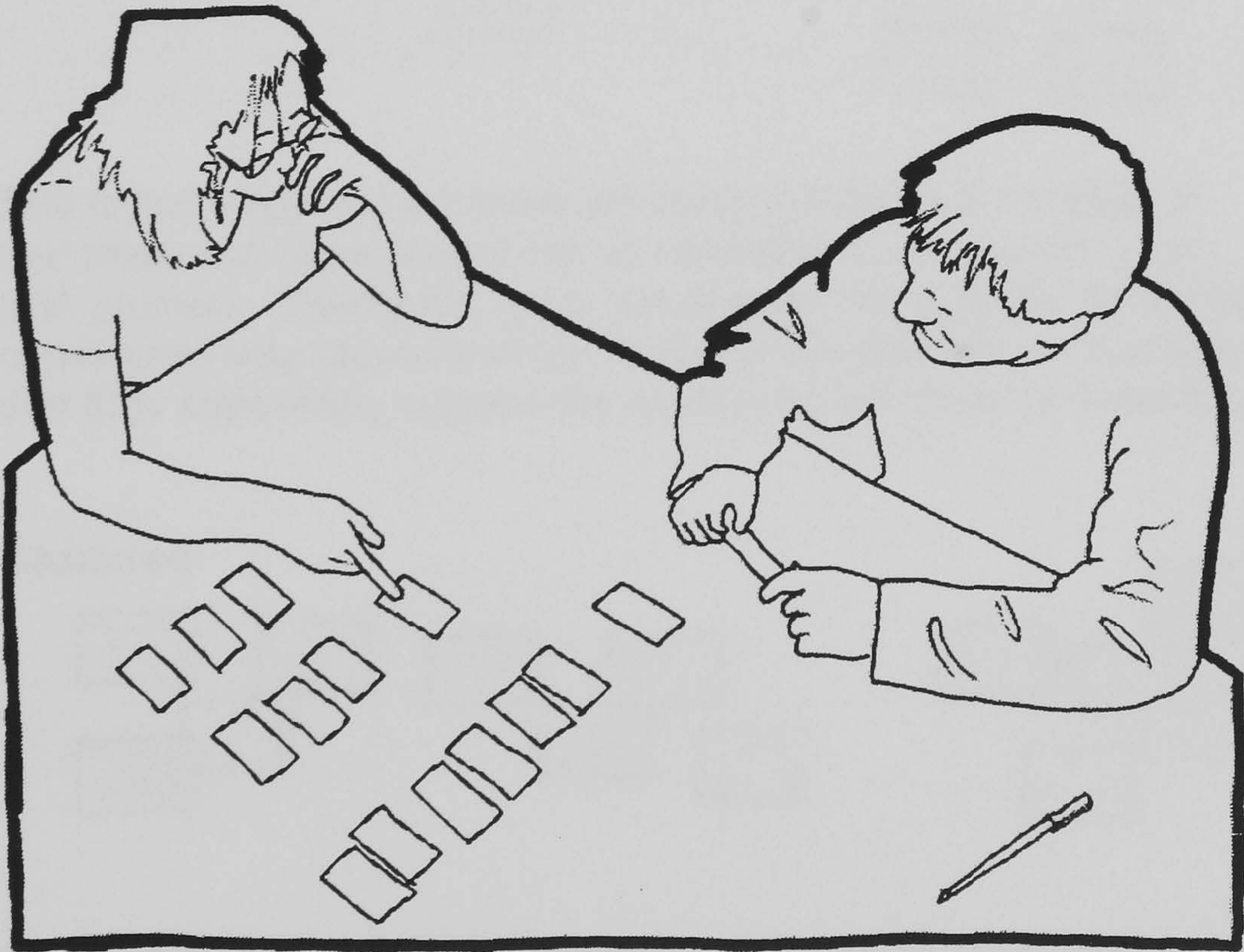
# Analysis

Some suggestions on how to analyse the card sorting exercises are presented here.

Stage	Activity
1	Layout of cards
2	Event logging form
3	Card laying and selection strategies
4	Video tape analysis

## Layout of cards

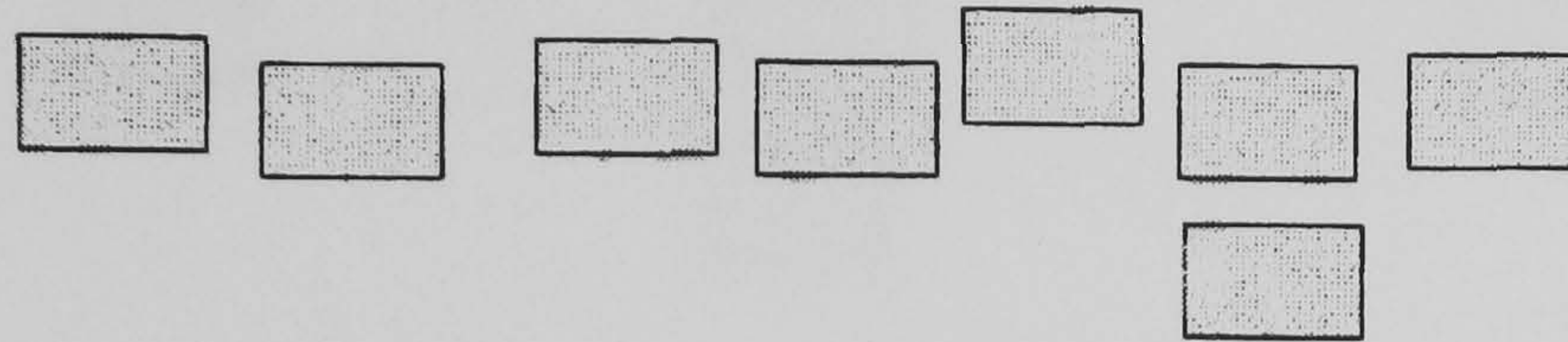
Arrangement of cards can often suggest how an interface could be designed. Some examples are given below and suggestions of how this could influence the design of the interface.





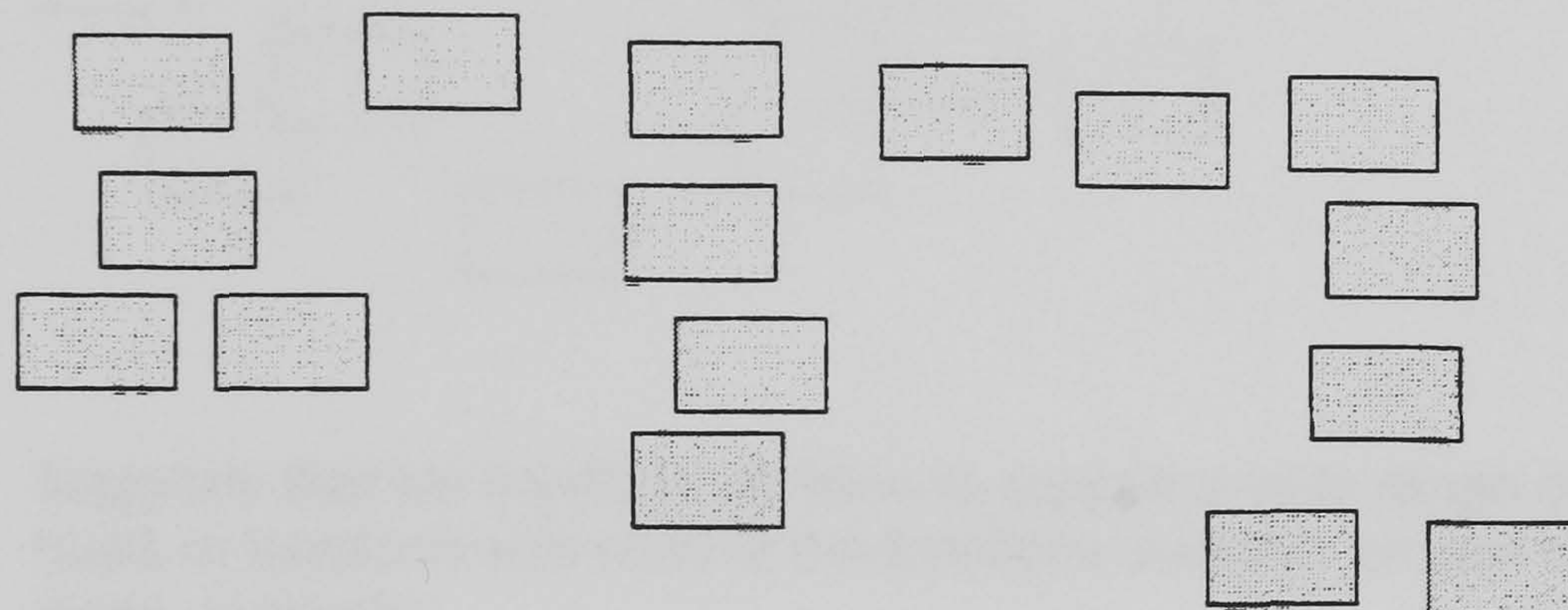
Below are examples of different card layouts which should provide some clues about how the interface could be designed.

### Serial



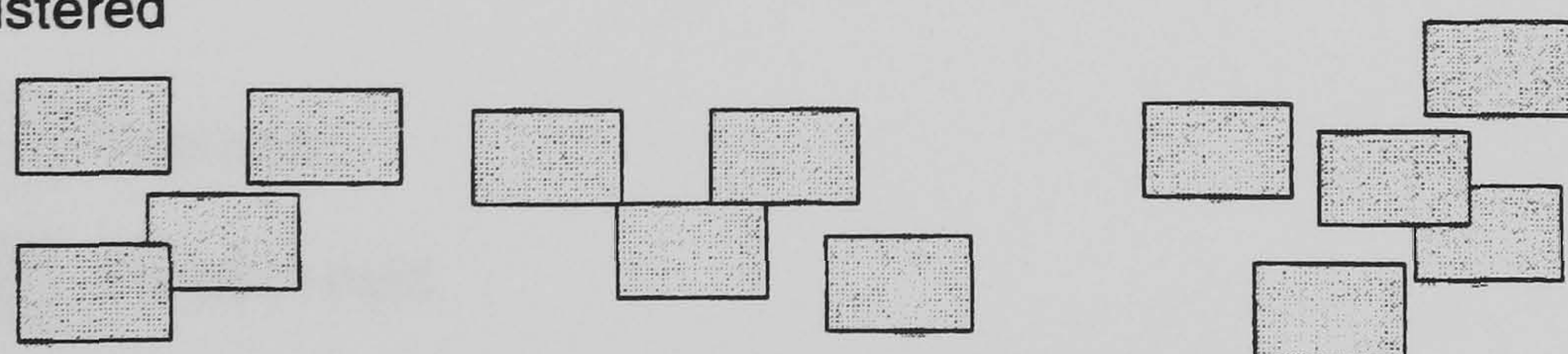
Cards are laid from left to right and follow a procedural or step by step procedure. This type of task/function map suggests that the interface should be designed to strongly map the task steps and provide clear guidance through these steps.

### Hierarchical



This layout suggests that there are many sub tasks or routines or that many sub tasks have to be conducted at critical points in the task process. Clearly the cards that indicate these points should be considered very carefully in the design of the interface and ensure that they adequately support the associated sub tasks or functions.

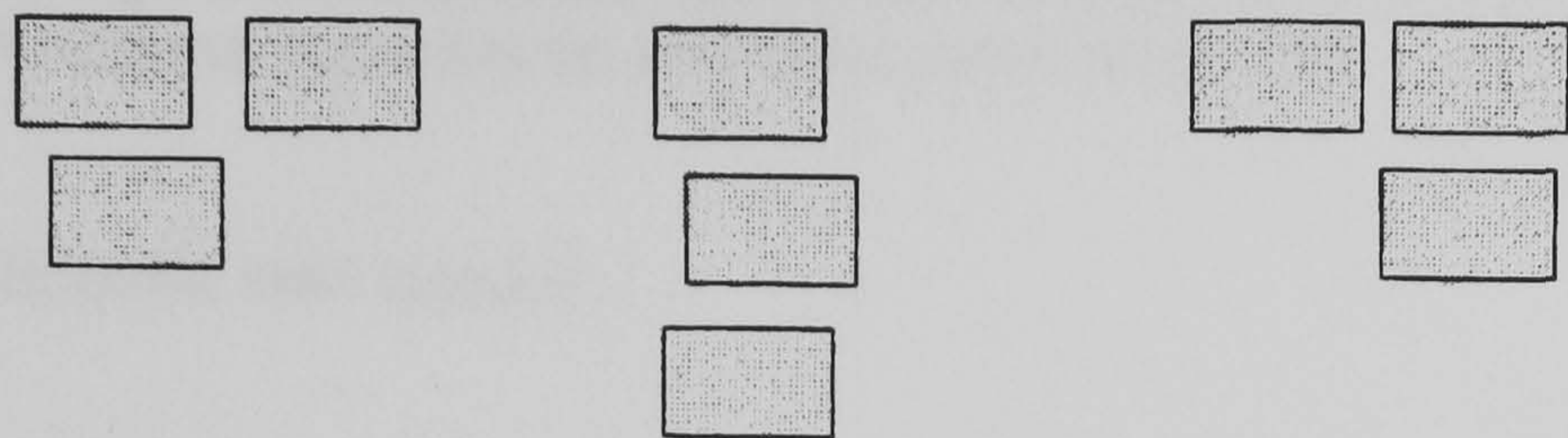
### Clustered



The layout of these cards suggest clear groups of subtask activity or function requirements but also suggest that within these groups there is not importance to the order or syntax of the tasks or functions. This lack of order or syntax could be important in the design of the proposed interface.

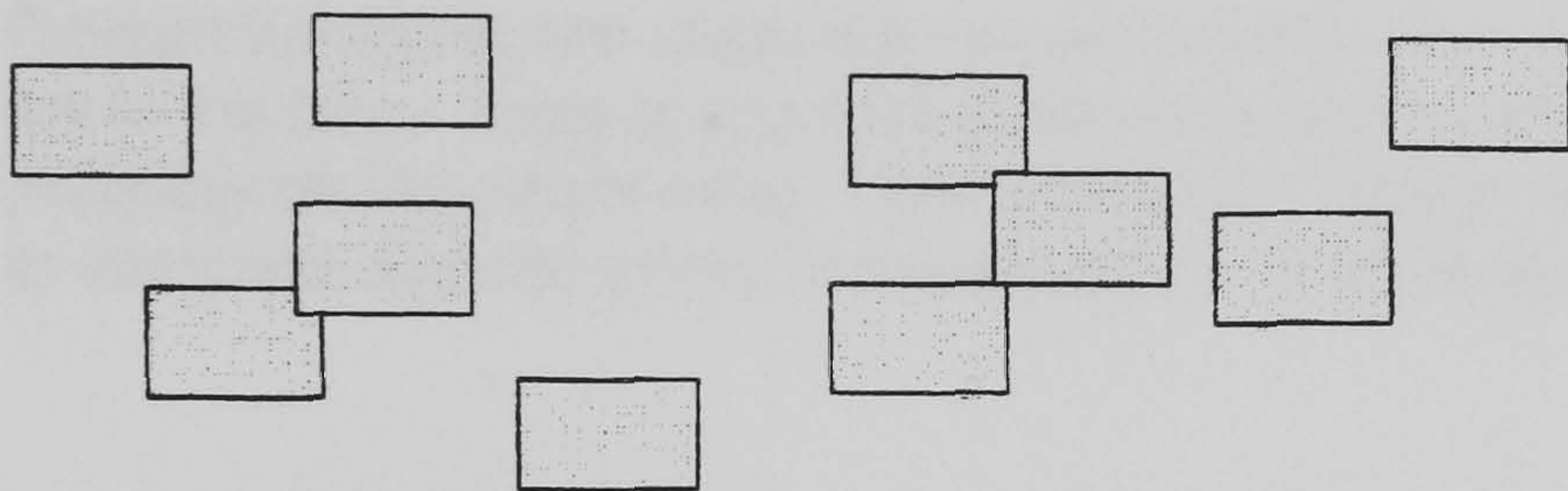


Temporal dependency



These cards suggest that the physical distances between the cards may indicate the amount of time required between tasks or function requirements. It may be possible for the interface to manage this time dependency through alarms or auto delay features.

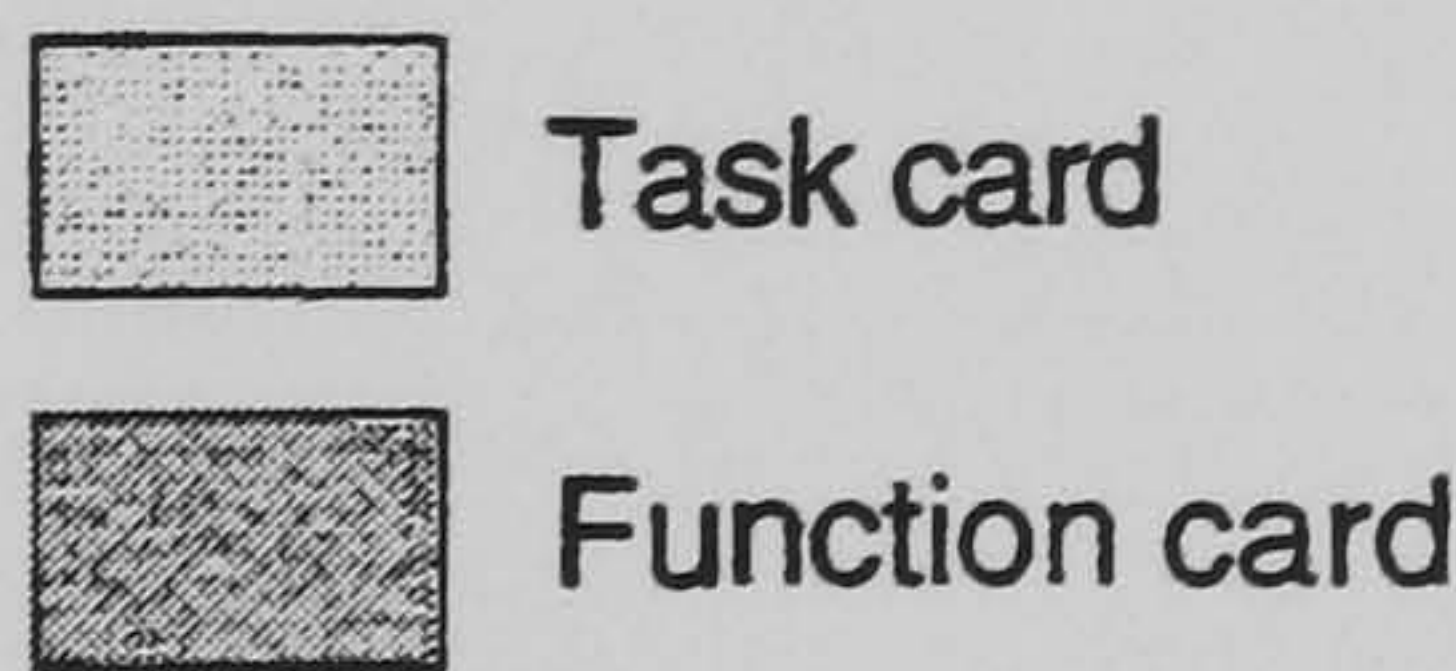
Random



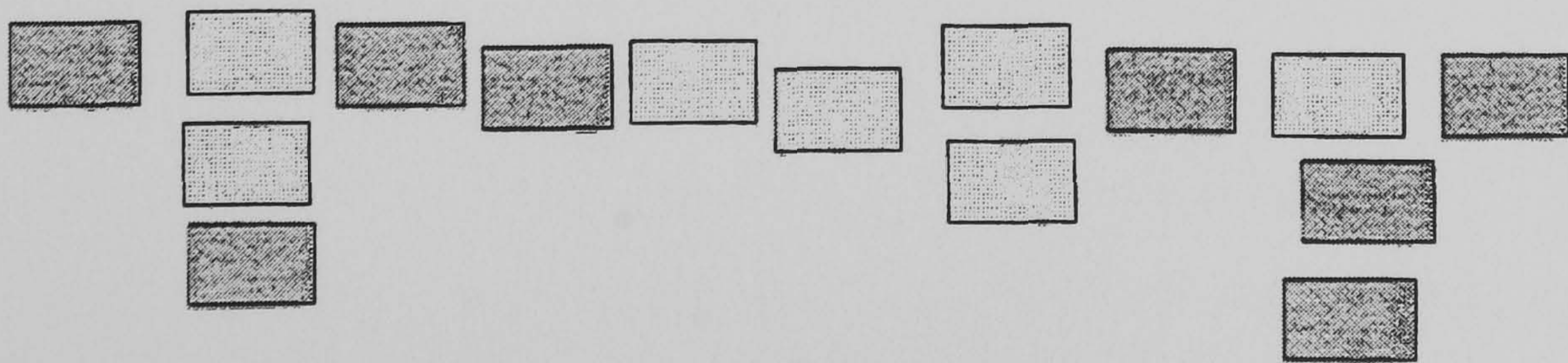
Suggests that the interface will have to support a wide range of tasks or functions with most of the functions available on one or two levels of access.

As well as the placing of the task and function cards, analysis can also be conducted on the mix of task and function cards. Again, the placement of these two types of cards can provide suggestions on interface design.

Here are some possible configurations with some suggestions for interface design.



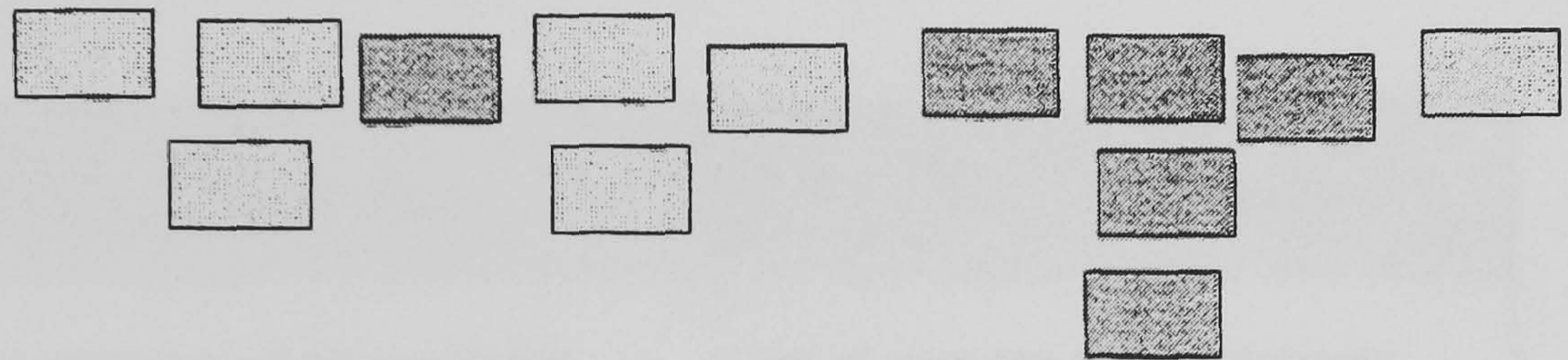
High task initiation and completion support





Product functions in this example are required at the initiation and completion stages of the task. This may suggest that interaction design should consider good checking procedures (have the functions been set up and completed correctly?).

#### Specific task support



Product functions are used at a specific maybe even critical point the in the task. Ease of use and good mapping to task activity will probably be important here. Poor interaction design here may result in complete abandonment of the product if it is possible by the user.



Event Logging

The results of the event logging form is an important source to derive design solutions. If good notes are made at the time of the workshop, then this will reduce the amount of post-event analysis. So a good recording sheet is important.

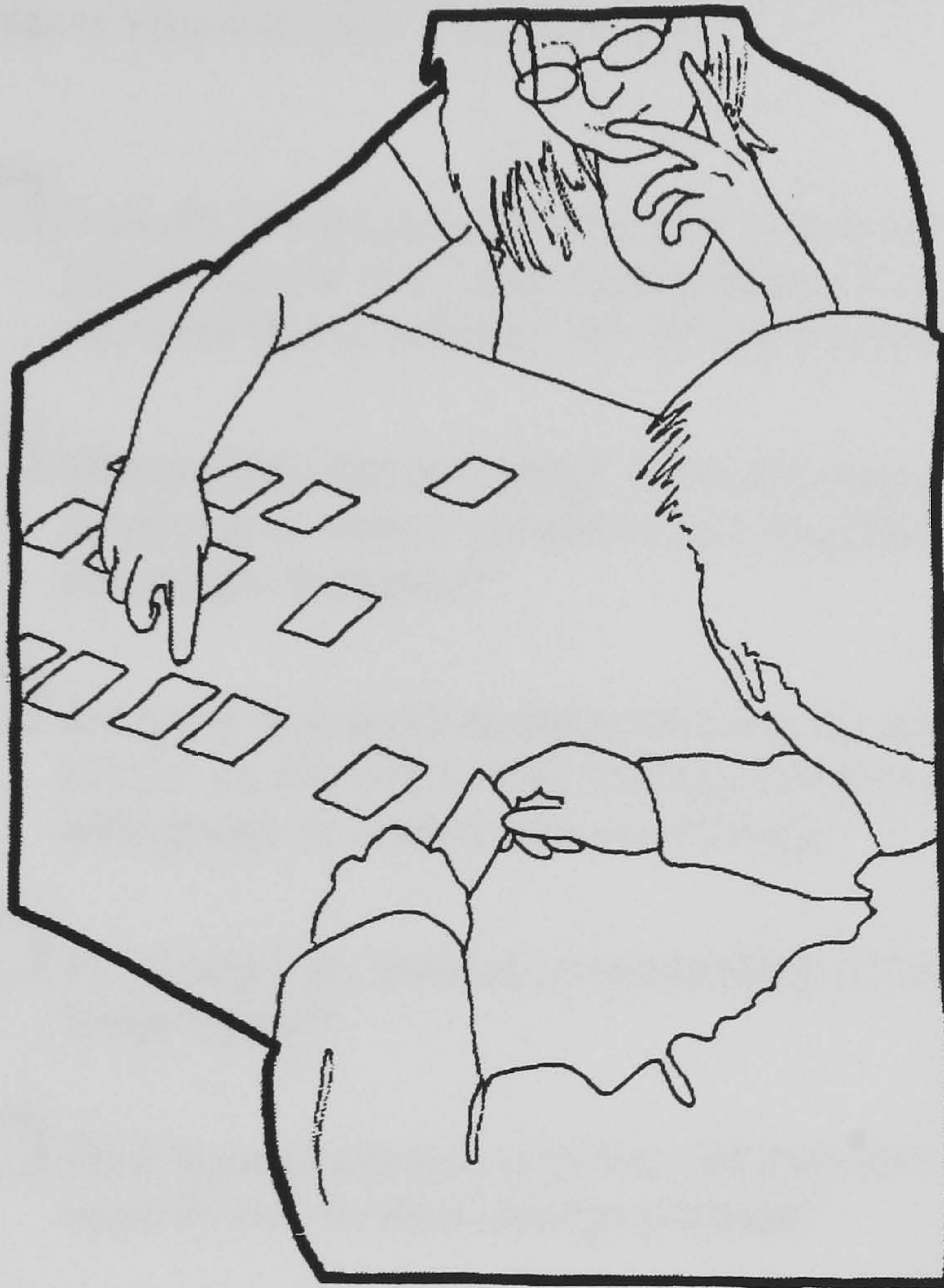
Below are some possible observations that could be made with some possible solutions.

Observation	Possible Solution
A great deal of disagreement about how a task should be conducted	Introduce more manual features, ensure that control decision making is made by the user, not the product
Little disagreement about task activity	Could introduce more auto features, have less secondary functions only need to have identified primary functions
Some tasks mentioned often and referred to frequently in discussion	Ensure these functions are easily accessible or on high level display screens
General consensus on main task activity but variation on sub tasks	Allow for personal configurations or memory keys
Planning activity plays an important part in the task	Checklist or aide memoire type interaction styles could be useful here
Participants discuss tasks objects frequently and rely on them to complete the task effectively	Could these be integrated into the interface design?
Strong agreement on the ineffectiveness of a particular function, regarded as a waste of time	Consider omitting function but beware that although it is not used it may be an important buying decision
Unconventional approaches to task activity	Consider supporting these unconventional methods in addition to normal methods



## Card laying and selection strategies

After the exercises have been completed, the designers should discuss the different card laying and selection strategies.



- ☐ What did they think of the card sorting design tool. Does this have an affect on the results?
- ☐ What type of strategies do they adopt in introducing the function cards? What does this say about their attitude to different functions and the design tool?
- ☐ Were the right type of descriptors used for the cards? Were they understood correctly or were their interpretations different? If so, how could the descriptors be improved?



## Video tape analysis

Video analysis is a very time consuming activity. To analyse 1 hour of tape effectively can often take up to 4-8 hours. Tapes are rarely analysed in any detail so consider carefully if it is required. However if it is decided to conduct an analyse, the following questions will help to view the tapes more critically.

- ☐ How did the group work together? How does this affect the type of results that have been gathered? What differences could be found between the different participant groups?
- ☐ Who participated and why? Does this say anything about group dynamics or does it go further and suggest how the interface should be designed?
- ☐ Are there any good statements made by participants that seem to sum up the event, their feelings towards the task, their willingness to accept new technology?
- ☐ What was their level of understanding of the task and functions? Is this typical?
- ☐ What type of process activities did they do? Could any of this be used in the interface design process?
  - planning
  - preparing
  - waiting
  - organising
  - teaching others
  - decision making
- ☐ What type of agreement and disagreement was there during the exercises? How should the proposed interface accommodate this?



## Producing a user requirements brief

From this analysis two outputs should be derived; a function/attribute matrix and a user requirements statement both of which should form the basis of a design brief.

Function	Attributes		
	Importance	Frequency of use	Significance to different users and tasks
Temperature controlled hob	<i>Very</i>	<i>High</i>	<i>Primary hob heating control should still be manual but should be permissible to enter desired temperature</i>
Auto - timer	<i>Generally low and mistrusted</i>	<i>Low</i>	<i>Rarely used although a minority of users use it as an integral part of their cooking and often require more than one 'auto-timer'</i>
Cooking assistant	<i>Regarded as important new feature if it supported existing cooking task methods</i>	<i>Specific to certain types of cooking</i>	<i>Regarded as good feature even by those wearing of other 'advanced' cooking functions</i>

The function-attribute matrix, an example is provided above, helps to define the priority of each function and also provide pointers in terms of interface design and interaction styles.



A user requirements statement helps provide a 'flavour' of what the design characteristics of a proposed interface could be and to help clarify the design objectives for the next stage of design activity.

Below is an example of a user requirements statement for a child's educational tutorial on the digestive system using CD ROM.

*From the card sorting exercises we found that:*

*"Children would like a colourful, funny CD that incorporates a cartoon style mystery, narrated by a child and involving a journey. There should be songs, music, sound effects and video clips. There should be a quiz to test the acquired knowledge, and an authoritative guide/friend type character to refer to".*



# Scenario Design



# Overview

## Brief description:

High level interface design proposals can be evaluated and designed further using 'scenario' based methods. By allowing users to explore different interaction styles within a pre-defined context or scenario, a richer opportunity for both designers and users exists to evaluate different design concepts.

## Purpose of the tool:

To assess initial interface design proposals and also test contextual usability problems. The use of scenarios usually produces a more insightful and perceptive examination of design proposals. A fuller description of the interface should be achieved after this tool has been used

## Resources:

Scenario environment, this depends on the type of prototype interface being designed, usually require a block model of the product or paper based 'screens' if computer based.

Participants for the scenario building exercises.

Video equipment.

## Inputs:

State transition diagram  
Visual or narrative descriptions of the interface designs and styles

Descriptors for 'tabs'

## Outputs:

One selected interface or amalgam of various proposals, possibly with new concepts included, more detailed description of proposed interface design



# Scenario Design

## What is scenario design?

In many ways scenario design is similar to card sorting. A scenario, can be defined as a 'constructed, stereotypical story based on a set of scenes'. The tool allows the participants to be immersed within a particular contextual environment. From this, more informed and realistic judgements can be made also hopefully with more insightful and creative solutions.

The key difference to card sorting is that within scenario design participants are expected to make more critical design judgements about proposed interfaces and also help design the interface from their perspective as task expert.

The key to gaining a successful outcome in using this tool is to ensure that participants undertake a scenario which is both within the bounds of the participants experiences and also as realistic as possible.

The fundamental essence of the tool is to allow participants to explore the proposed concepts while acting or role playing within the scenario. It is within the context of the scenario that participants can make more informed judgements about the match between the interface design and its fit within the task domain.



# Planning scenarios

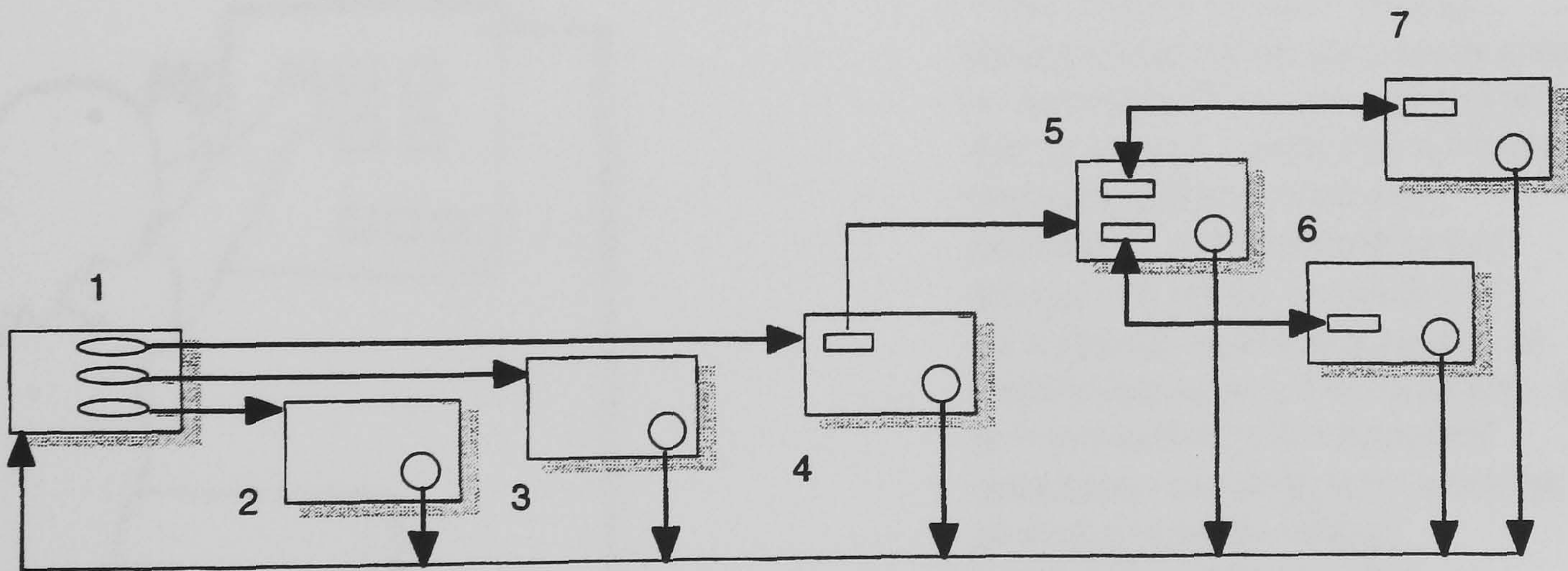
In planning a scenario design exercise, the following steps are suggested.

Stage	Activity
1	Produce a state transition diagram
2	Define interface variants if applicable
3	Design function description 'tabs'
4	Task selection

## Produce a state transition diagram

Through the card sorting exercises and subsequent design discussions, you should now have an idea of the type of functions or features which seem to be important to your proposed user population from the function/attribute matrix. Some ideas about how these functions could be used and presented through the interface should also have emerged.

From here a state transition diagram can be produced (they can be quite large). The diagram should illustrate the relationships between different states and the navigation rules.



The diagram above illustrates how a state transition diagram can be produced (there is a navigation error which has been deliberately left



in to illustrate how effective these diagrams can be in designing navigation routes). The diagram does not have to specify specific interaction styles. For example the selections that can be made in state 1 could be on a display menu or a rotary selector switch.

Each state is numbered (1-7) with state 1 being the 'home' state. All interface states can be returned to this home state. Notice that the placement of the arrows to indicate how state transitions occur can also provide some indication of their control characteristics. For example, transition from state 5 to 7 indicates that this is some form of toggle switch between two states.

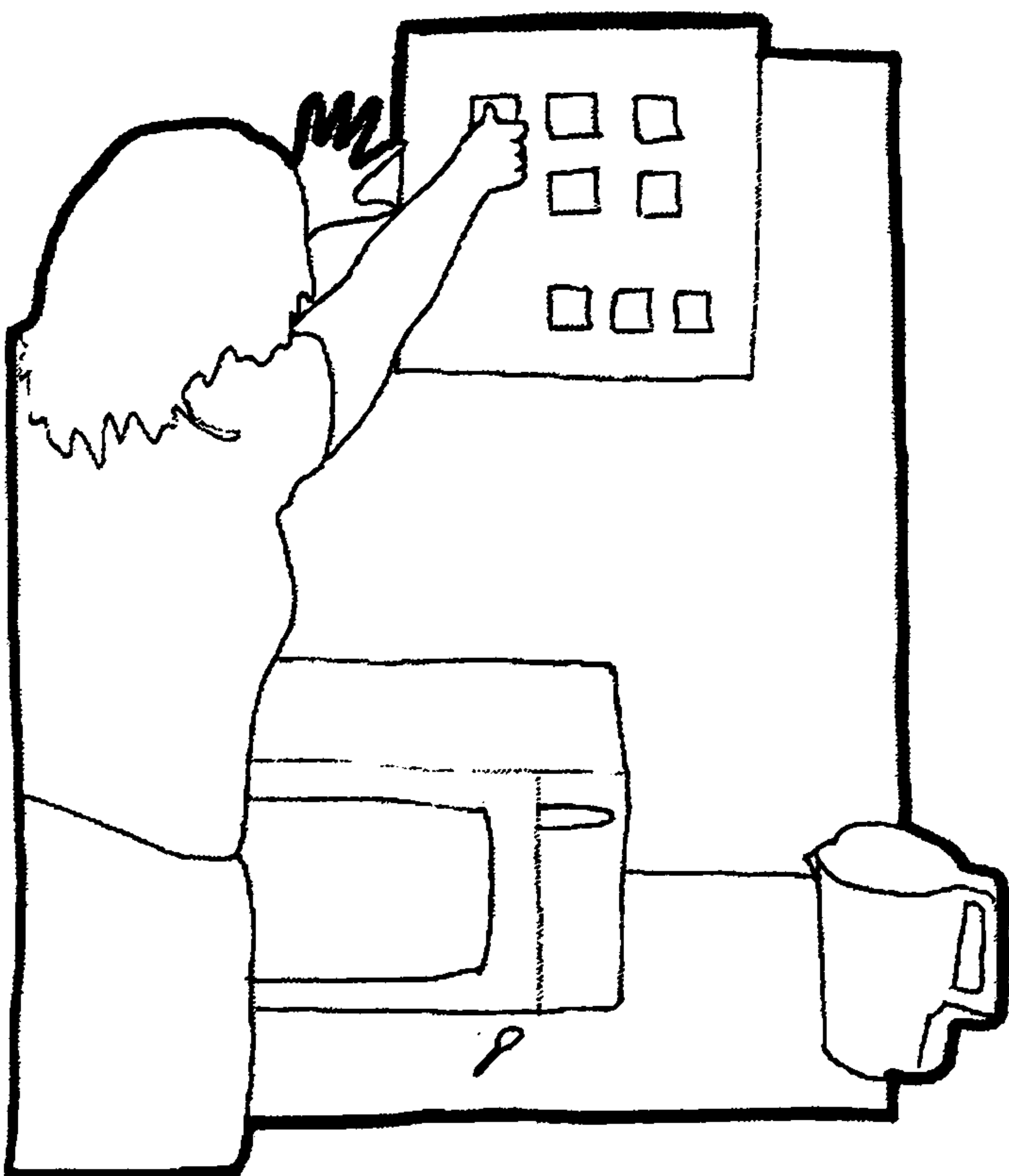
Remember that each state is not a screen state. A telephone, for example, has a 'ready state (hand set placed on the telephone cradle) and a data entry state (hand set off the hook with an accompanying dial tone).

### **Define interface variants (if applicable)**

It maybe likely that a two or three design proposals may have emerged. Each of these should be developed to the point where a state transition diagram is produced for each variant or where variants are considered within one diagram.

### **Design function description 'tabs'**

The next stage is to produce a list of all the proposed interface control and display functional descriptions and convert them into 'tabs'. These will be more detailed descriptors based on the function cards used in card sorting tool. Participants in the scenario design exercise will take off each tab from a board when they are required during the scenario task (this is described in more detail later). Post-it notes make very good tabs.



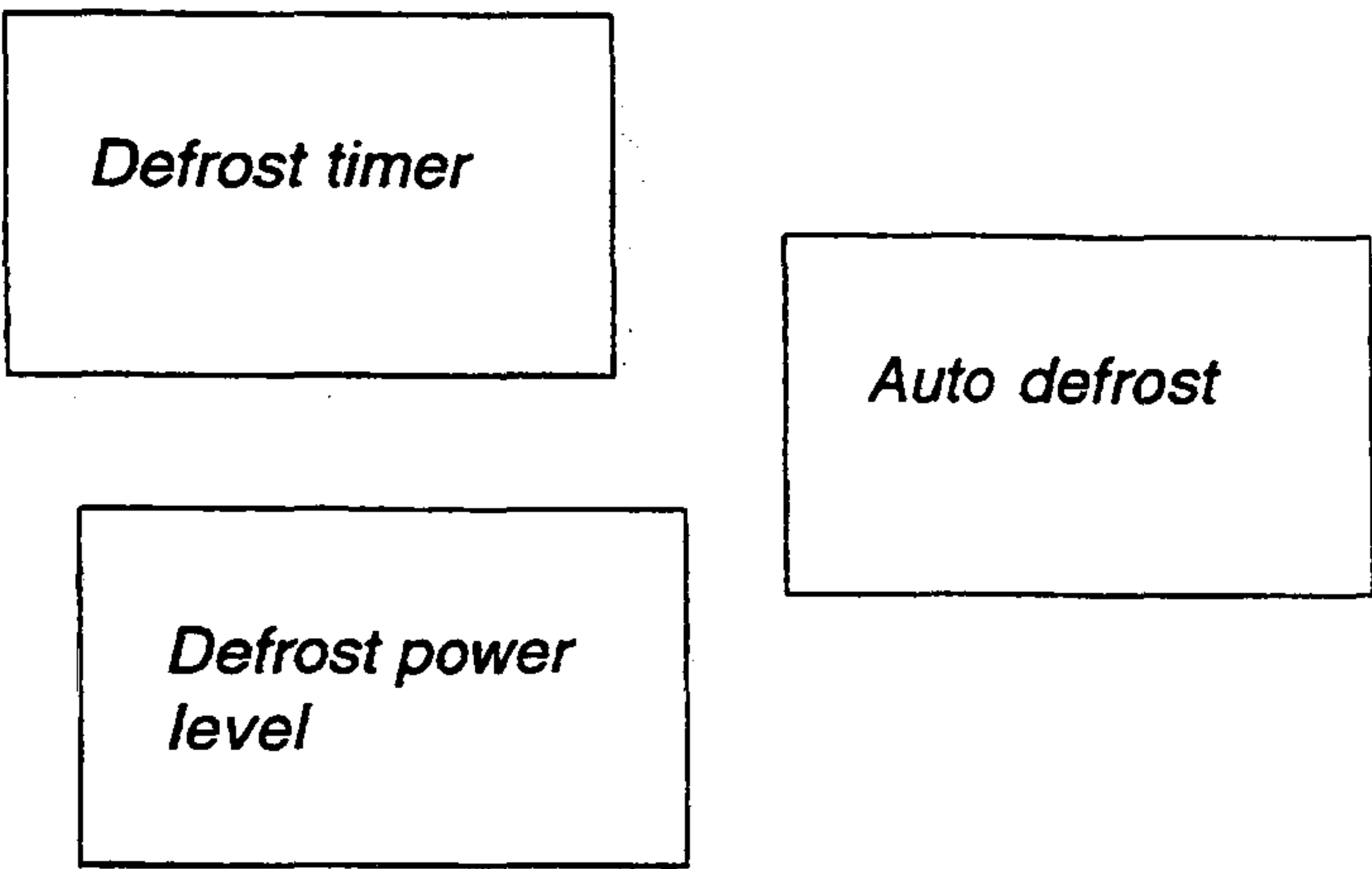
Tabs should contain enough design information for participants to understand the meaning of all the proposed functional attributes and also the structure and framework of the interface but should not be so detailed that participants view the exercise as merely fine tuning the interface. It is important that fundamental concepts and ideas are perceived as being open to critical judgement and alteration.



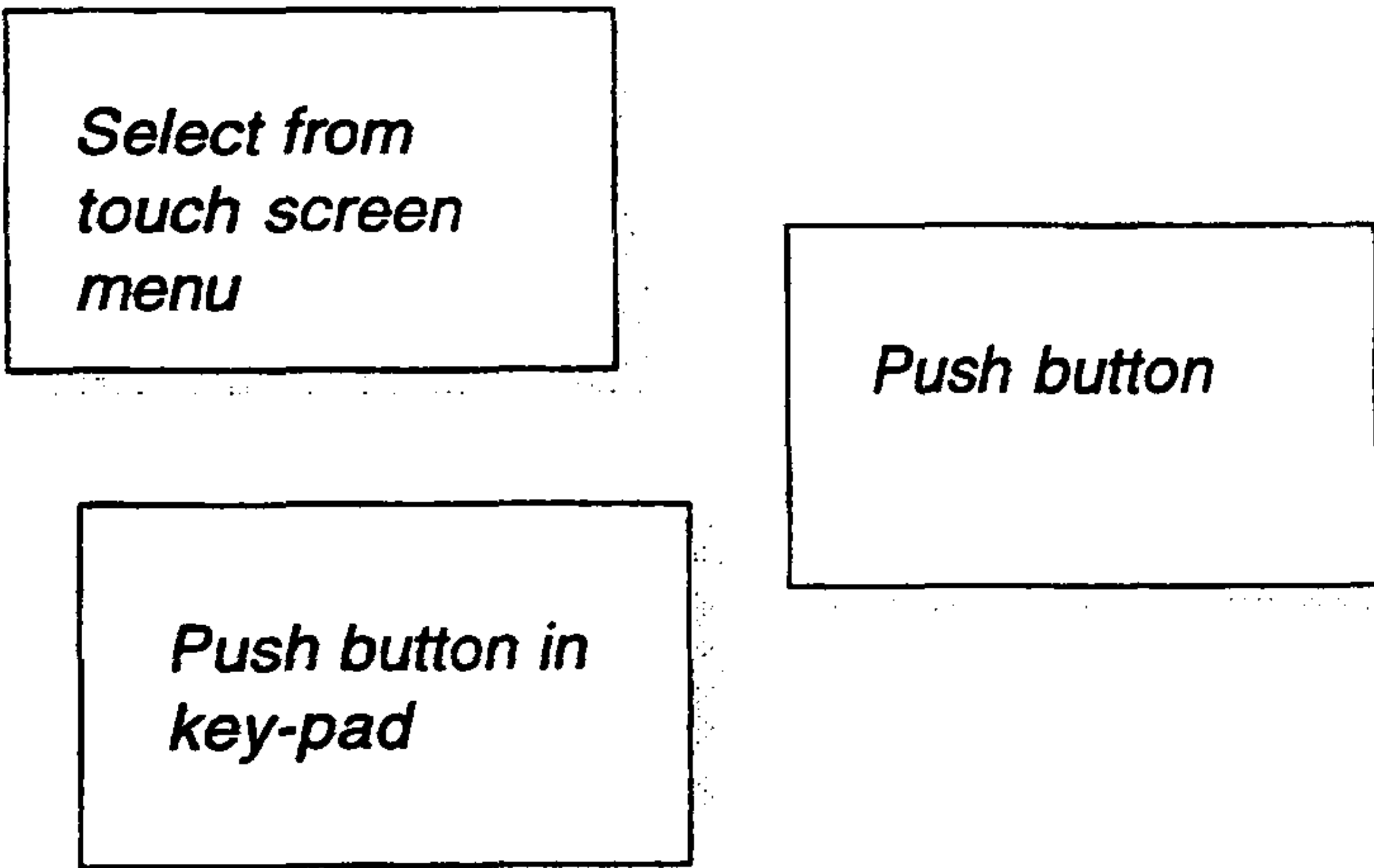
There are two main types of tabs that participants will be able to select and place on the mock-up, these are:

- function tabs
- operational tabs

Function tabs should provide the whole range of possible functions and potential variants for selection, for example variant functions for defrost could be:

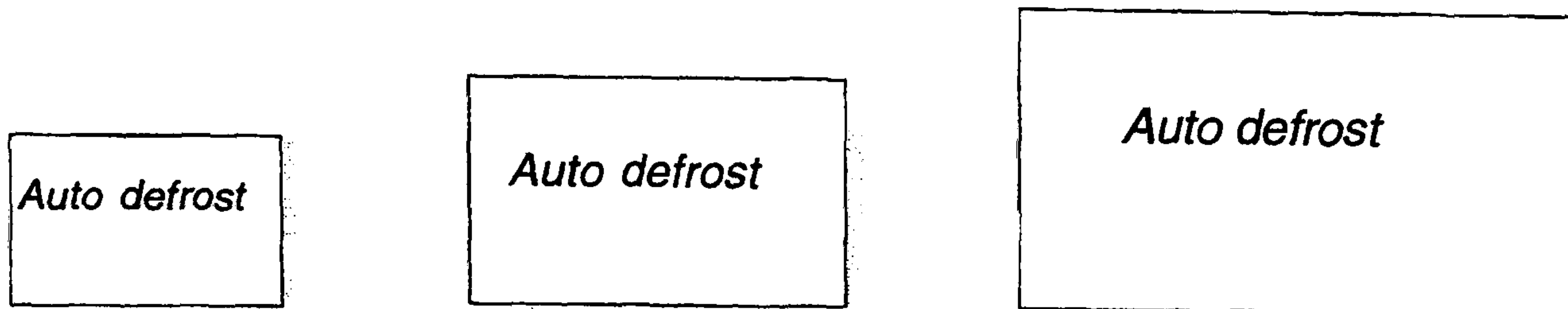


Operation tabs indicate how functions could be operated (different use of dialogue styles)

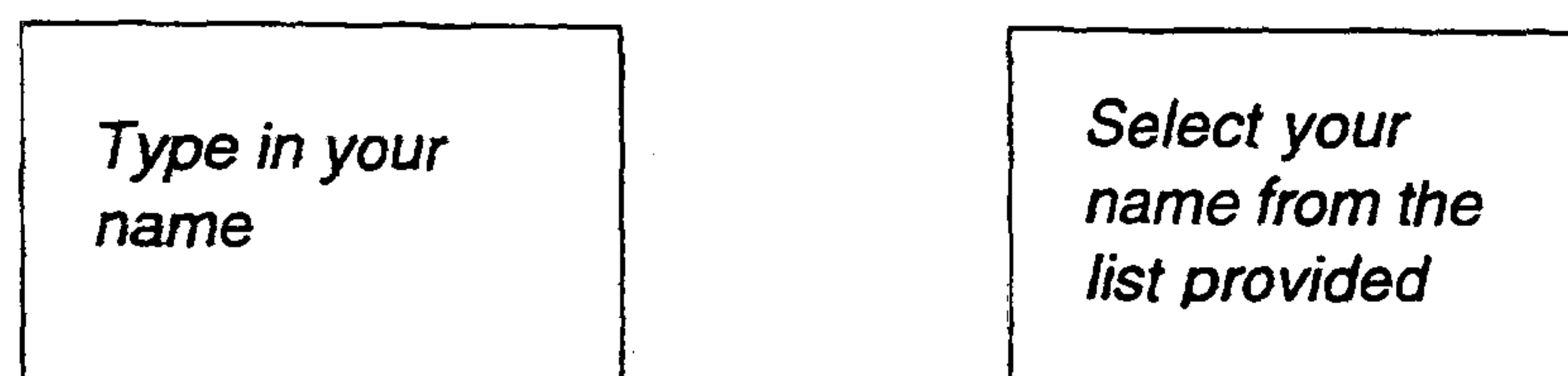




It is also possible to indicate to the participants the importance of the functions or operations by providing the same descriptor tab in different sizes.



Also, if necessary, Indicate how data could be entered or obtained from the interface.



At this stage it is important that as little as possible is graphically described. Try to express the ideas in verbal terms and ask the participants to interpret these ideas and communicate these concepts back to you. However, too little documentation will suggest to participants that little has been resolved or may suggest that there is confusion over what exactly the design objectives of the interface design proposals are.

## Task selection

The next stage is to select a series of tasks or a scenario in which these proposed concepts can be tested. A scenario should be as realistic as possible and the following criteria should be considered:

- scenarios must be familiar to the participants
- as far as possible participants should use all the accompanying artefacts that support the scenario
- it must, as far as possible, be done in situ
- if scenarios require more than one individual to accomplish the task, then this must be replicated
- scenarios must retain their contextual 'noise' such as interruptions, children or the radio

Participants should be selected who typically undertake the tasks within your selected scenario.



# Managing scenario based exercises

The following steps are suggested.

Stage	Activity
1	Setting up scenario activity
2	Using a mock-up
3	Selecting tabs
4	Controlling dialogue
5	Recording events
6	Using co-design

## Setting up scenario activity

Participants should be provided with an objective or goal that should be accomplished in less than an hour, or several goals within the hour. The description of the goal or objective should be presented in as natural form as possible. Do not make instructions prescriptive. For example, instructions should be more like:

*Cook a meal for three using food found in the freezer*

rather than

*Cook pizza at power level 3 for 15 minutes.....*

Some participants maybe required to act in supporting roles to ensure that all aspects of the scenario are played out rather than assumed. This is very important as implicit interaction details could be lost through assumptions.

It is very important that the scenario is driven by the tasks and not the product or interface.

## Using a mock-up

This may seem a trivial addition to the scenario activity, but indeed it is very important. The mock-up does not have to be particularly realistic apart from dimensional requirements. The mock-up becomes a very important vehicle and point of discussion between the participants and the designers. It is perhaps more important with hand held devices as they way the mock-up is held and used provide important indicators to design parameters.



It is important that these are regarded as design as well as evaluation studies and the exercises should be devised so that users do feel that they can actively contribute to the iterative development and selection of design dialogues.



Mock-ups help users to articulate how, where and when the interface could be used.

## Selecting tabs

The main process activity of this design tool is for the participant(s) to go through the task. While this is being done, the participant either indicates or suggests when a particular product function is required and selects an appropriate tab from the board.

For example,

*Participant: "at this stage I want to tell the microwave that I want this pie to be defrosted for 5 minutes"*

*Selects defrost tab from the board*

*Participant: "now I need a way of telling it that I want this for 5 minutes"*

*Looks a tab board for possible options*

*Designer: "from the different ways of doing this, which do you think would be the best way at this stage?"*

If the tasks involves the use of an existing product then this should be used in the scenario. In this situation, as far as possible the



mock-up and tab board should be consulted before the existing interface. This prevents the existing interface driving the flow of interaction activity.

Make sure that participants place tabs where they would like to see them on the mock-up. Operational tabs should be placed underneath the function tabs.

## Controlling dialogue

Once the scenario is underway, two types of dialogue should exist between the designers and the participants: assistive and design dialogue.

Assistive dialogue consists of matters such as help, support, further clarification and so on. This type of dialogue will be quite heavy to start with and should reduce over time.

If it persists throughout the exercise then for other exercises re-evaluate either the way in which the interfaces are being presented to the participants or the instructions given to them.

The essential activity which should be encouraged is design dialogue. Some people find this easier than others, but ideally you want to work towards participants saying things like, 'I want it to help me do this', or 'when I have finished looking at all the titles, I would like it to sort them for me'. Once this type of discussion occurs you have two choices either to record this requirement or to focus on this comment and discuss with the participant(s) how this might be designed on the interface. This involves another part of the design tool known as co-design.



Co-design should not be introduced within the scenario as this will affect the task flow.

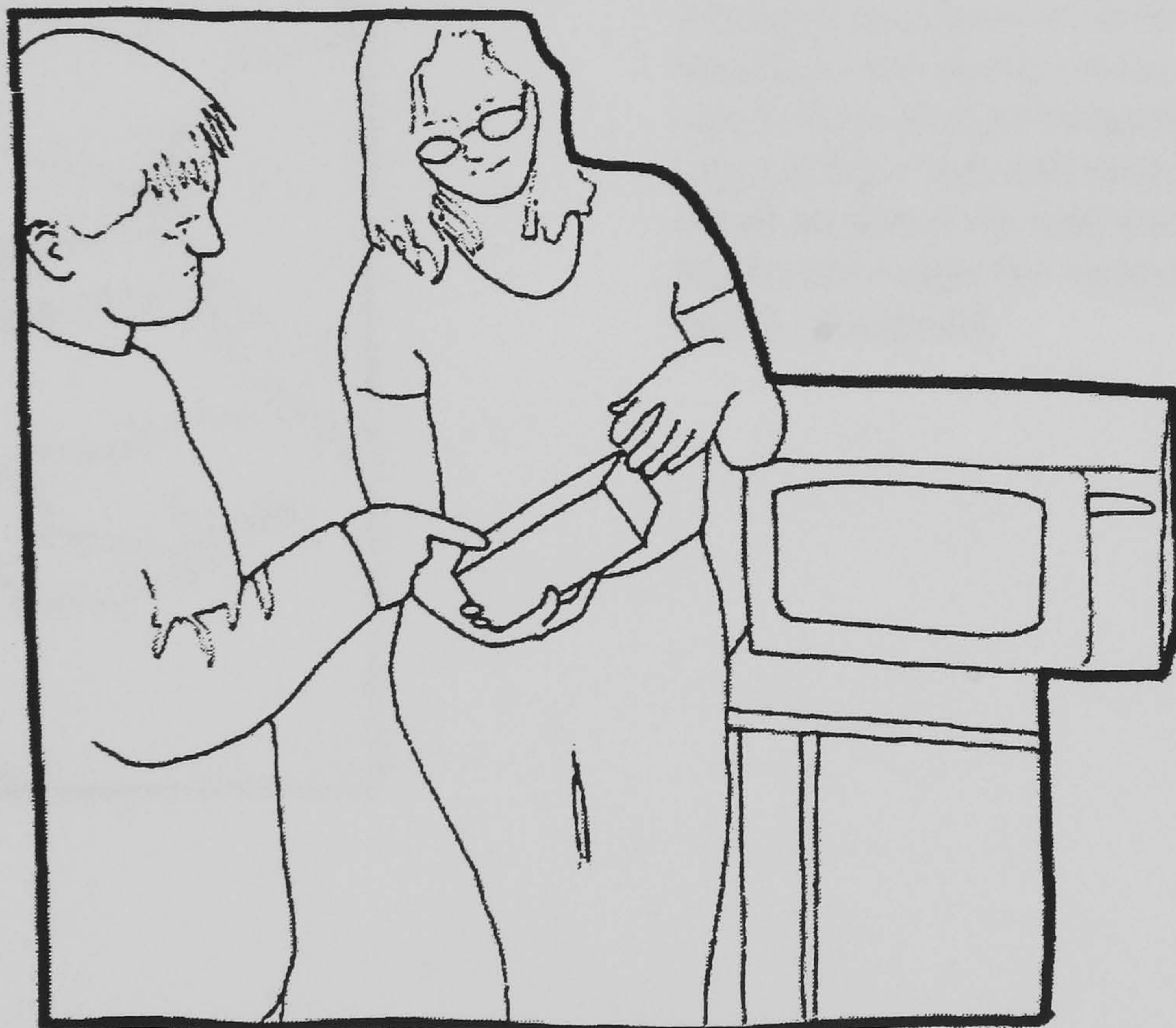
## Recording events

Similar to card sorting, one of the designers should be the designated observer and record information that will contribute towards refining interface design solutions.



To do this, a recording sheet should be prepared which identifies key discussion and action points. Some examples for an event logging sheet are:

- ☐ differences in attitude towards task design, when and how product functions should be used
- ☐ what type of strategies are adopted in using tabs
- ☐ strong points of agreement and disagreement between participants
- ☐ type of process activities discussed, e.g. planning, preparation, decision making
- ☐ type of peripheral task 'objects' discussed and frequency



Photographing scenario events from the exercises is a very useful way of remembering each participant and also acting as an aide memoire during analysis. Video is a good idea but be aware of the problems of analysis. This is normally ideal for showing good typical examples of user perceptions and needs. Give some thought for how the scenarios will be analysed. Post analysis of video tapes can be time consuming.



## Using co-design

Co-design activity should be done 'off-line' as it may interfere with the scenario activity. With co-design a designer and participant(s) discuss possible options for the whole or specific aspect of the interface. The designer draws ideas and concepts which have largely been driven by the participant. Once co-design is completed and all intended aspects of the interface have been addressed, it is important to go through the steps once more. In this situation the designer walks through the interface recounting to the participant how the he or she understands how they would like the interface to appear for their circumstances. This should be repeated at least twice more with other participants but using the same scenario.



An extended alternative to this solution is to allow a group of participants to go through the scenario either as a group or individually and then collaboratively design the interface and present their results to the design team. This can include the participants using a flip chart with post-it notes to describe how they would envisage the interface being designed.



# Analysis

Stage	Activity
1	Layout and selection of tabs
2	Event logging form
3	Card laying and selection strategies
4	Video tape analysis

Analysis is similar to card sorting with the same type of questions being asked

## Layout and selection of tabs

Reasons for selecting tabs will produce strong evidence to the type of interface that should be further developed.

## Event Logging

The results of the event logging form is an important source to derive design solutions. If good notes are made at the time of the scenario, then this will reduce the amount of post-event analysis. So a good recording sheet is important.

Below are some possible observations that could be made with some possible solutions.



Observation	Possible Solution
A great deal of disagreement about which tabs should be used	Introduce more manual features, ensure that control decision making is made by the user, not the product
Little disagreement about task activity or process	Could introduce more auto features, have less secondary functions only need to have identified primary functions
Tendency to use known proposals, not considering more radical solutions	Maybe tab descriptors did not provide enough information or were not suitable to the task. Either re-consider descriptor and/or interface design proposals or abandon proposals
Too many function variants suggested to be viable for design	Go through scenario design exercises with the most 'favourable' suggestions
Not enough tabs considered	Maybe too concerned with undertaking the task. Go through exercise again providing more suggestions or prompts during the exercise

## Video tape analysis

Video analysis is a very time consuming activity. To analyse 1 hour of tape effectively can often take up to 4-8 hours. Tapes rarely are analysed in any detail so consider carefully if it is required. However if it is decided to conduct an analysis, the following questions will help to view the tapes more critically.

- ☐ What differences could be found between the different participants?
- ☐ How well did the participants get involved in the scenarios, could this be improved ?
- ☐ Are there any good statements made by participants that seem to sum up the event, their feelings towards the scenario, their willingness to accept new technology?
- ☐ What was their level of understanding of the task and functions? Is this typical?



☐ What type of process activities did they do? Could any of this be used in the interface design process?

- planning
- preparing
- waiting
- organising
- teaching others
- decision making

## Refined prototypes

From here, the design team should be able to produce a detailed interface design proposal that best fits the requirements from all the participants. A detailed state transition diagram should then be produced and from here further evaluation can take place either using further iterative scenario design and evaluation methods or by using the next design tool which is an inspection based evaluation and design tool.



# Inspection Tool



# Overview

**Brief description:**

Designer led evaluation design tool of outputs from each iteration of the scenario design tool. Concepts are evaluated and refined using inspection based methods.

This inspection based method is divided into two parts:

The first part, context dimensions, examines broad design issues around the product's usage and considers, through checklists, task, user and environmental variation.

The second part deals specifically with interaction design issues and is based on 'cognitive dimensions'. Again, through checklists, issues are addressed based on how users process information.

**Purpose of the tool:**

To identify more systematically less apparent usability problems that have not been addressed in the previous design tools

**Resources:**

Self contained

**Inputs:**

Well defined understanding of all or parts of the proposed interface design

**Outputs:**

Possible alternative solutions and a deeper understanding of potential usability problems, amendments to interface design.



# Inspection Tool

## What does the inspection tool do?

It provides a systematic way of considering many of the factors that affect the usability of product interface and does not require the use of participants in order to evaluate proposed interfaces. One of the advantages of using this design tool is that they can be used with conceptual ideas that have little low level detail and have been designed specifically for novel interfaces. Other types of checklists exist but require the interface design to be complete.

This inspection tool is divided into three parts

- interface design criteria
- checklist references
- walkthrough evaluation

There are eight interface criteria which cover most of the key usability issues of interface design. They have been developed so that a designer can quickly review them against any proposed interface design supported by examples.

If there is uncertainty about whether or not certain design features comply to a particular criterion, then the second part of the inspection tool allows a designer to explore these concerns in further depth. Questions are posed in a checklist fashion to assist this decision making process. The checklists have also been designed to provide possible solutions if a usability problem is identified from the checklist

The third method, walkthrough evaluation, should be implemented if a potential problem cannot be resolved using the first two methods.

The intention of this design tool is that a designer, or design team, should be able to re-examine a proposed interface design and take a more objective and broader critical review of usability issues. In going through these steps, it should be possible to examine interaction issues more methodically and to consider usage beyond those considered in the scenario design and card sorting exercises.

Revised solutions should be evaluated by using more focused scenario design exercises. Some problems are, however, best resolved by moving forward to the next design tool, prototyping particularly subtle interaction activities such as feedback.



# Interface Design Criteria



# Inspection criteria

# Examples

## 1 Guidance

Do all elements or parts of the product interface adequately guide the user through different parts of interaction activity?

Scope of question:  
use of stop or exit points; use of users' language; appropriate error or progress feedback; links or dependency to other functions

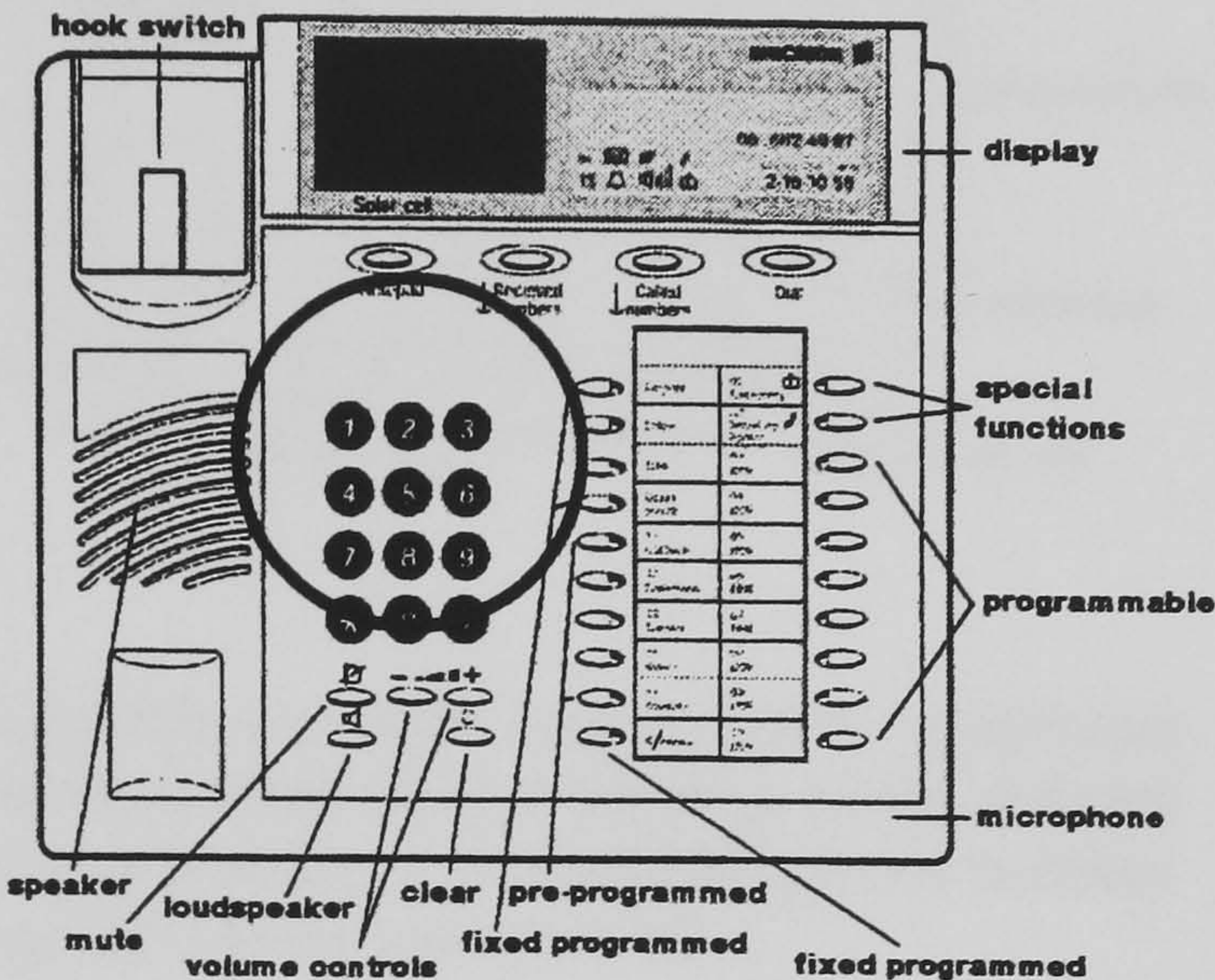
Yes ⇒ Next inspection criterion  
Uncertain ⇒ go to guidance checklist (part 2)  
No ⇒conduct walkthrough trial (part 3)

## 2 Task and user compatibility

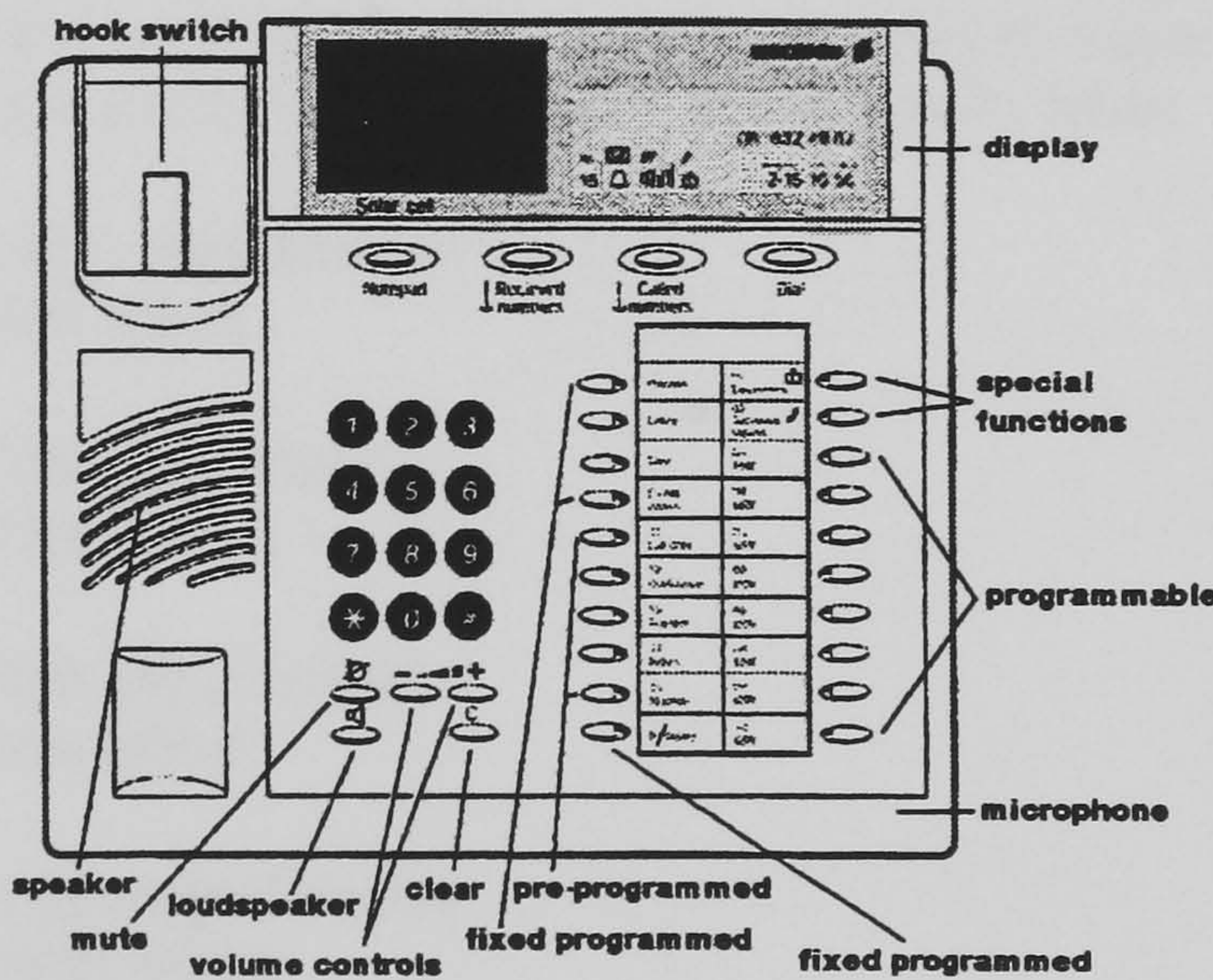
Do you think that the interface will be compatible with different types of users and with different task situations?

Scope of question  
User profiles such as children, elderly and people with special needs; tasks should include set-up, maintenance, intermittent use, panic or stressful situations; change in usage behaviour; change in needs from product

Yes ⇒ Next inspection criterion  
Uncertain ⇒ go to guidance task and user compatibility checklist (part 2)  
No ⇒conduct walkthrough trial (part 3)



The numeric keypad has a clear and obvious purpose while the 'hash' and 'star' keys are less obvious.



Features on this phone which use executive control are: transferring from notepad, transferring from received numbers and transferring from called numbers. These programs or executive controls are defined and pre-set by the user to allow quick activation of sequenced based tasks.



### 3 User control

*Do you think that users will feel confident to initiate or intervene during different types of interaction activity?*

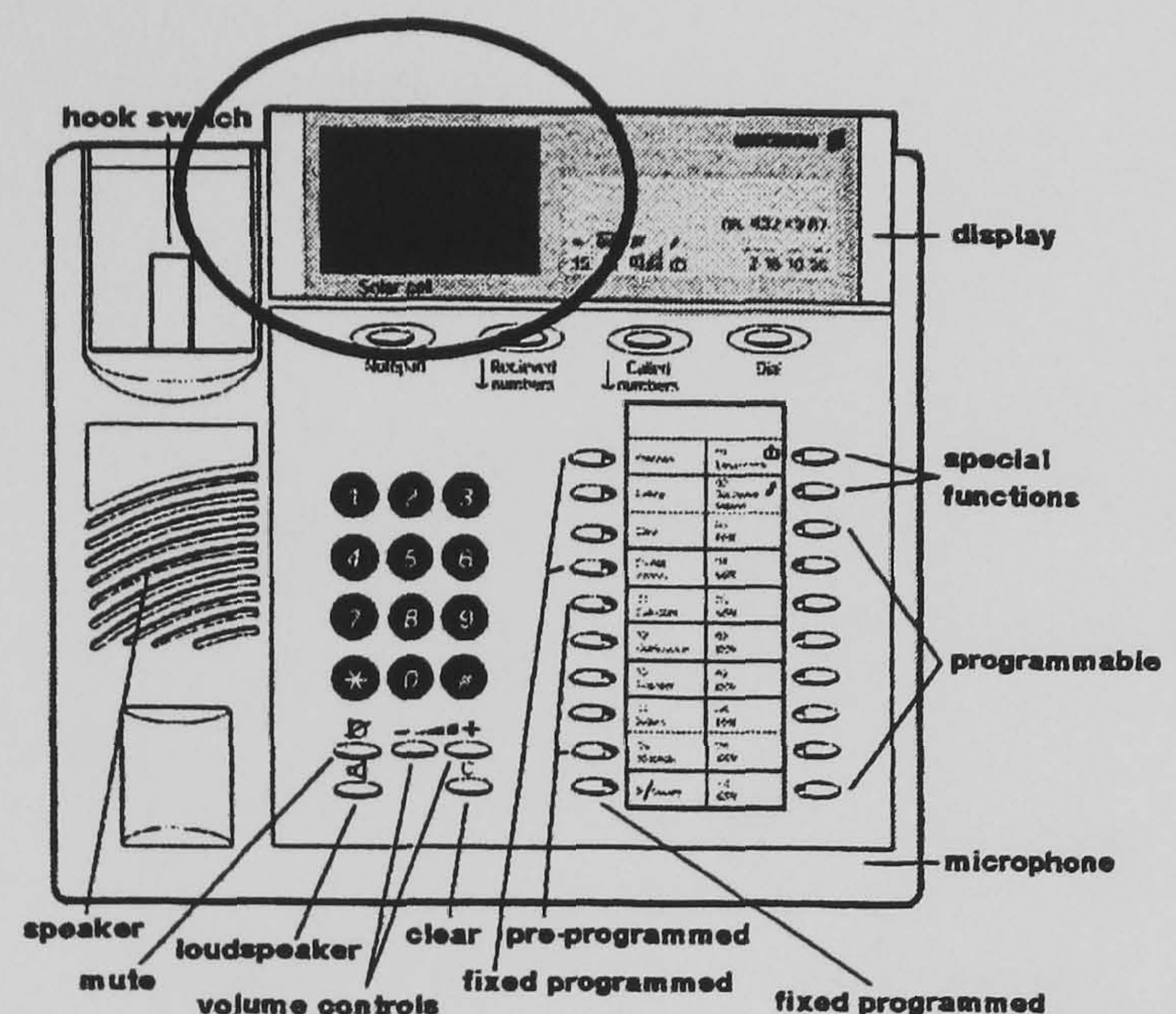
Scope of question

Shortcuts would be used easily; awareness of current mode or stage in interaction process; would user appear hesitant at any stage

Yes ⇒ Next inspection criterion

Uncertain ⇒ go to user control checklist (part 2)

No ⇒conduct walkthrough trial (part 3)



Like this example, many modern telephones have number dialling displays which reduces the possibility of a wrong telephone number by increasing user control.

### 4 Error management

*What type of errors do you think users could make? Do you think that the interface can manage different types of error?*

Scope of questions

Does the interface prevent all or some errors from happening; does the interface adequately explain what errors are; does it allow users to correct their mistakes

Yes ⇒ Next inspection criterion

Uncertain ⇒ go to error management checklist (part 2)

No ⇒conduct walkthrough trial (part 3)

Moving from one interface state to another can be made difficult deliberately to prevent errors. Error prevention can be measured using two dimensions: *significance* of change and physical or mental *effort* required to make the change. Therefore it is possible to have:

high significance  
low effort

low significance  
high effort

low significance  
low effort

high significance  
high effort

An example of high significance with low effort on the example telephone is the ability to be able to dial the emergency services even when the telephone is electronically locked.

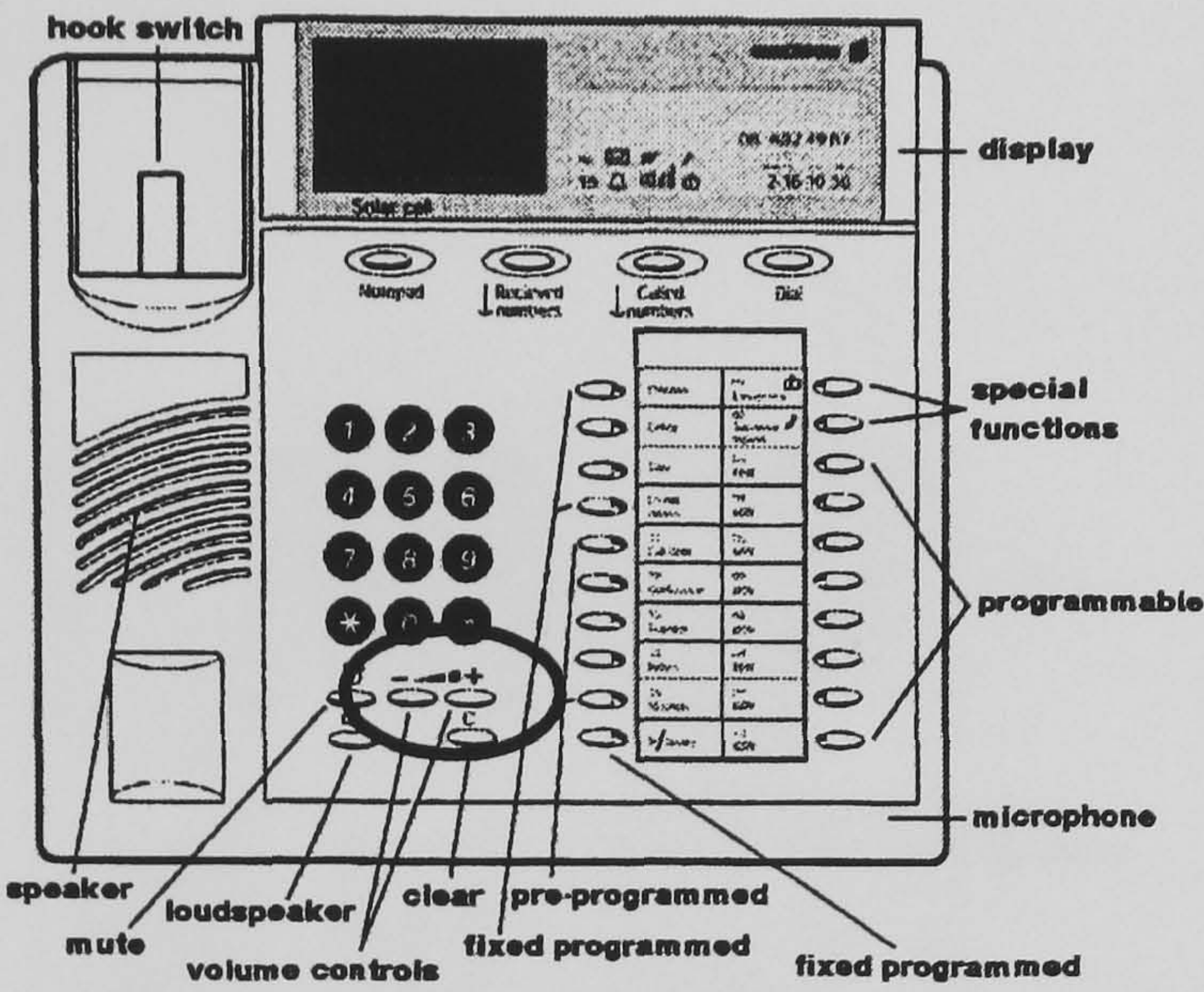
An example of high significance with high effort is the ability to reset the telephone pre-programmed settings. Three very deliberate interim states are required before arriving at the state of resetting the memory.



5 Meaning of codes

Do you think that users will understand codes used in the interface?

Scope of question  
Understanding of icons, modes, labels, graphics in context or out of context



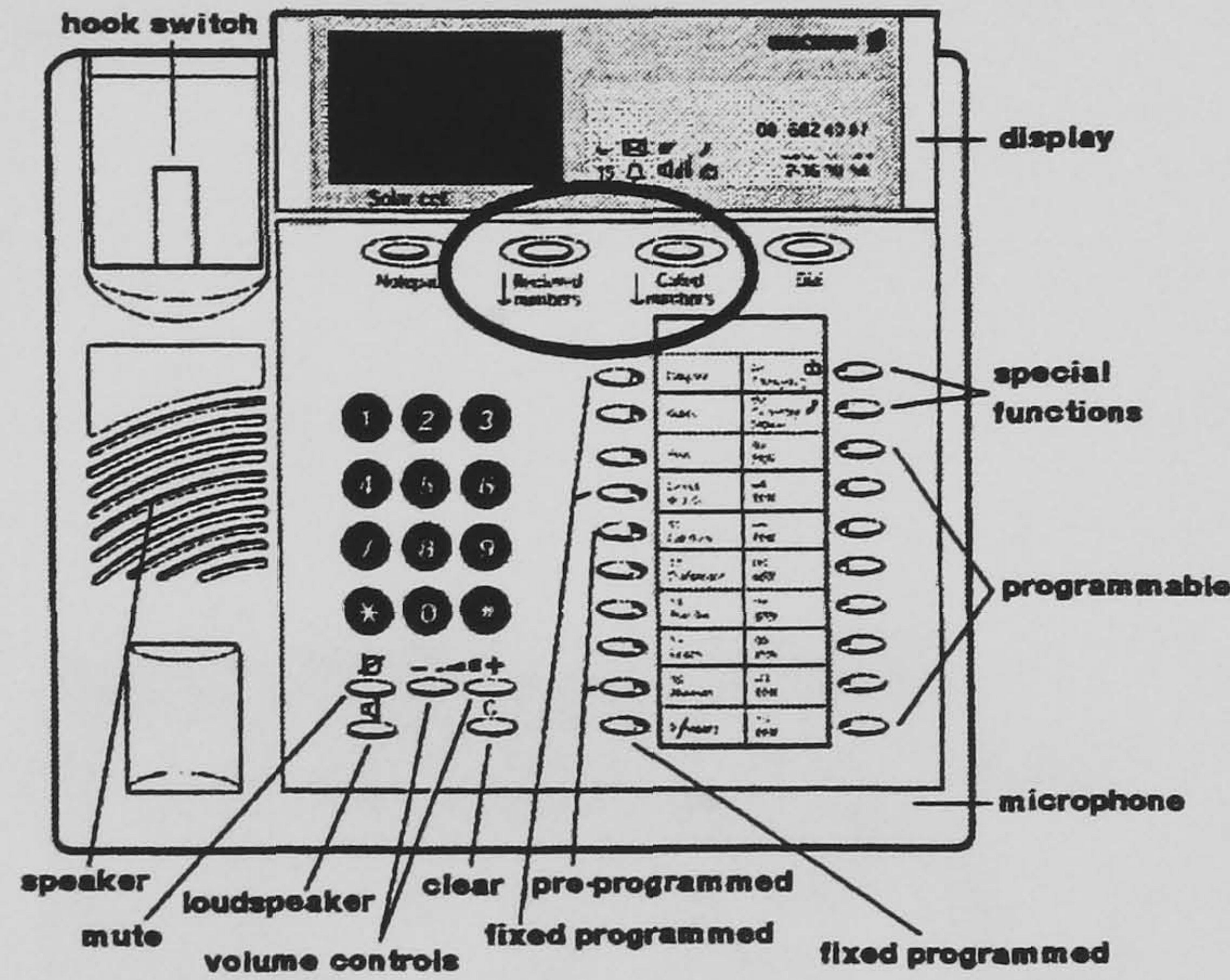
Yes ⇒ Next inspection criterion  
Uncertain ⇒ go to meaning of codes checklist (part 2)  
No ⇒conduct walkthrough trial (part 3)

The volume control uses a mixture of coding to express the concept of increasing and decreasing volume control by the use of '-' and '+' and the 'wedge' icon.

6 Consistency

Do you think the interface offers information in a way that a user will find consistent with the task in hand or with other similar products for example in the use of codes, labels and procedures?

Scope of question  
Consistent use of shape, form colour, displays throughout the interface



Yes ⇒ Next inspection criterion  
Uncertain ⇒ go to consistency checklist (part 2)  
No ⇒conduct walkthrough trial (part 3)

Selecting or scrolling through received or called numbers is activated in a consistent manner.



## 7 Workload

Do you think the product interface:

a) allows or supports situations where users have to think hard about the task in hand or using the product?

b) is designed to minimise the amount of information the user needs to take in or provide?

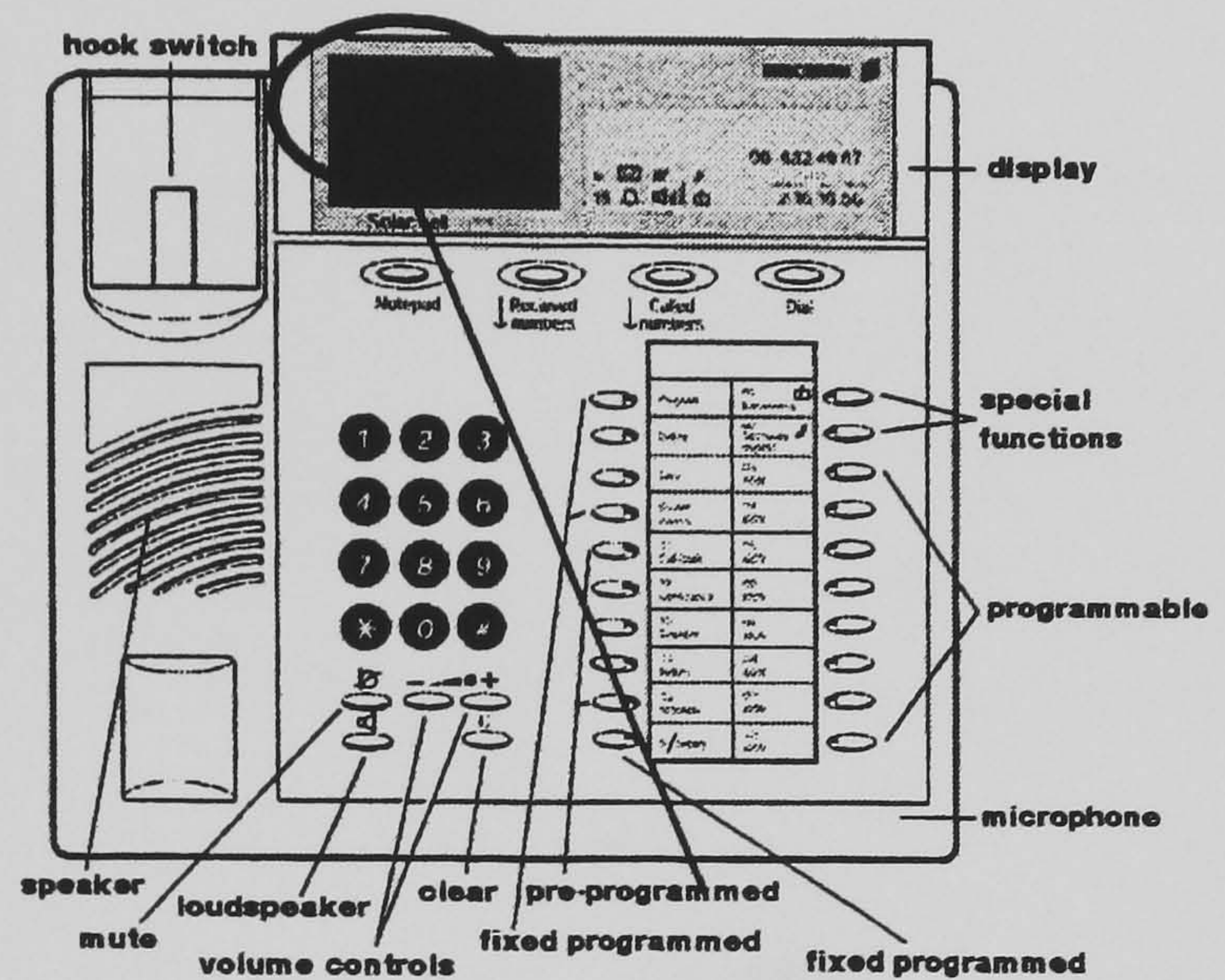
Scope of question

Would user manuals be referred to; would there be situations where the user would need to consult other users; possible forgetting interaction procedures; making notes

Yes ⇒ Next inspection criterion

Uncertain ⇒ go to workload checklist (part 2)

No ⇒ conduct walkthrough trial (part 3)



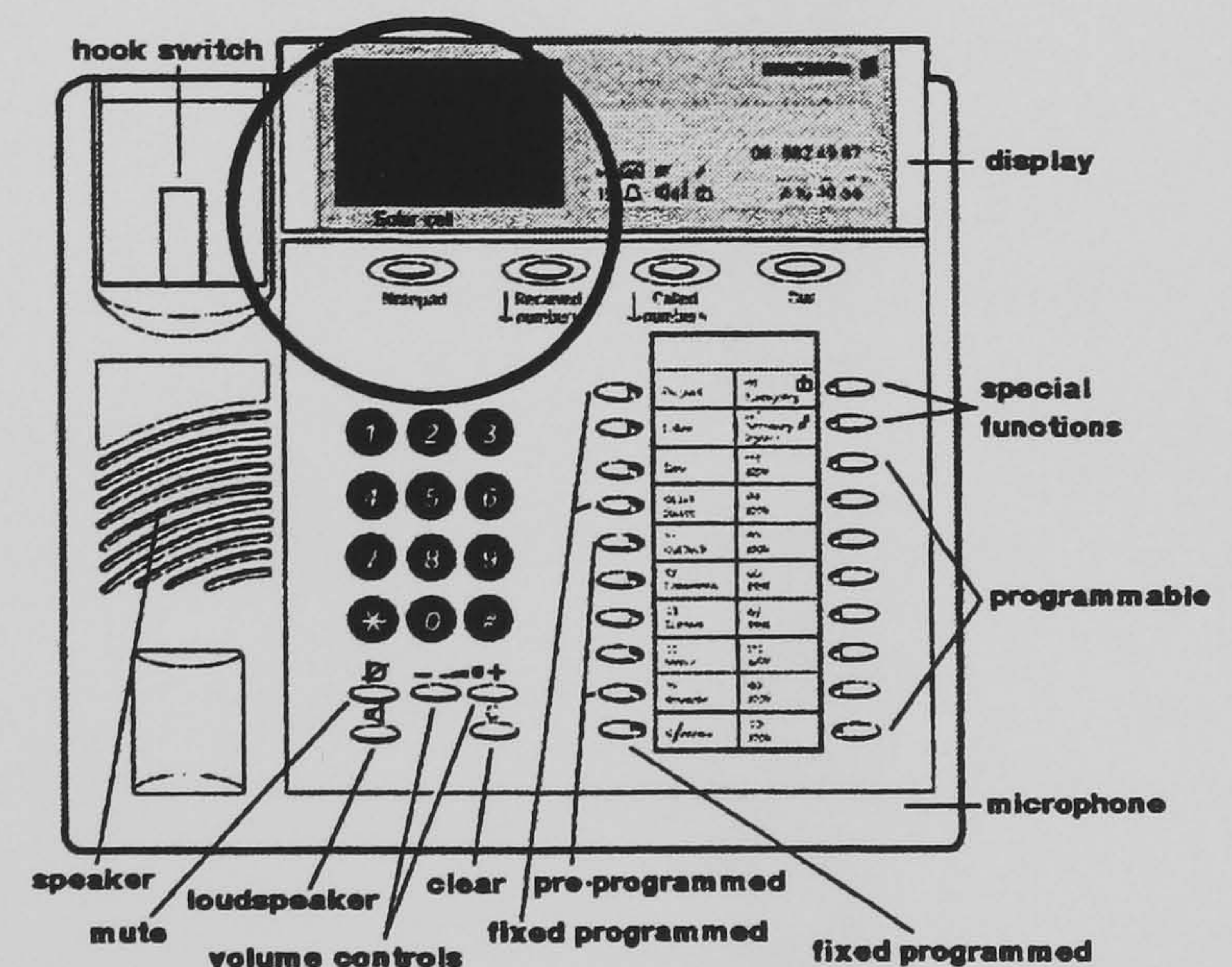
This telephone has a notepad facility to allow telephone numbers to be stored during a telephone conversation.

## 8 Adaptability

Do you think that the interface is adaptable to different task and environmental situations?

Scope of question

Has there been a consideration of all scenario usage;



Yes ⇒ Finish

Uncertain ⇒ go to adaptability checklist (part 2)

No ⇒ conduct walkthrough trial (part 3)

The use of telephone number key press patterns when dialling a number (using number keys that make the shape of an 'L' for example) and hearing the sound of the telephone number by listening to the tone dial can help provide feedback that the correct telephone number has been dialled.



# Checklist reference



# 1 Guidance Checklist

Interfaces that provide good guidance allow the user to follow the consequences of their actions in moving from the current state to the next state.

Interaction guidance can be broken into three stages: being able to adequately assess the current state; review of any interim states; and adequately assess the actioned state. This process can also be described as 'closure' where actions have a beginning, a middle and an end. That is to say that, at each stage of the interaction process, it should be apparent to the user where to begin, what the product has undertaken in terms of instruction and whether the product is carrying out the task. It should be apparent when the action is complete.

Dimension values	✓	✗	n/a	Design issues
Is the user aware of state and mode changes?				Feedback mechanisms are often difficult to replicate in scenario building activities and will probably have to be evaluated during prototyping. However, list or recount situations during the scenario design activities where users became confused or misunderstood the meaning of interface elements
Is the feedback informative?				Are your proposed feedback mechanisms appropriate for a wide range of users and usage scenarios?
Is it possible for the user to exit or to stop a function or procedure?				Exit or stop feature should be available during step-by-step procedures and should be placed in a consistent location on the interface
Is adequate support provided when things go wrong?				What type of error messages or codes are proposed and will these allow users to learn from their mistakes?
Do users have to remember data from one state to another?				To be avoided if possible, provide electronic notepad facilities or allow information to be retained or stored by default
Do help systems provide relevant and timely support?				Help systems in consumer products usually come in the form of an operator's manual which is rarely kept with the product
Is all relevant information presented to enable an action to be completed?				One problem to avoid is where the user assumes a move from one state to another when in effect the product has arrived at a different state although it may appear similar to the user and indeed confirm their assumption.



Things  
to think  
about

Progressive evaluation is complex in that it is dynamic and multi-modal making it difficult to measure the effectiveness by which users understand different feedback mechanisms. As product functionality becomes more abstract and removed from physical actions, feedback mechanisms need to be deliberately designed into the product. Many studies suggest that tactile feedback is a highly rated feedback mechanism. Be also aware that too many feedback mechanisms can be annoying and even over bearing.

It is also possible to control and display data and functions in more than one way in order to move from the current state to the actioned state?

Dimension values	✓	✗	n/a	Design issues
Do different users want information presented or feedback to them in different ways?				What type of information do users look for or need to confirm that their actions are correct? If there are different user needs then these could be offered in terms of redundancy
Would redundancy confuse users?				Warning beeps are a useful way of getting attention or notifying the user that something is wrong. Too many will only result in annoyance with the product
Have you thought about different dialogue styles to accomplish the same task?				Examples of different interaction styles are:  Coding in terms of colour, spatial layout, labelling, size etc.  Good mapping between task and interface  Auditory displays  Graphical representations of product states and state changes  Animation  Tactile feedback



An action may also have an effect elsewhere which is unknown to the user or during an action the user discovers that additional information is required, these are know as hidden dependencies.

Dimension values	✓	✗	n/a	Design issues
Do you think that hidden dependencies are possible?				If so, is there any easy way to identify them. Two possible solutions are through prototype testing by 'walking through' all possible interface states or drawing a state transition diagram
Have any positive hidden dependencies been designed into the interaction process?				If not, could there be. This requires an understanding of the typical errors that users could make that could be anticipated and dealt with implicitly by the product
During the interaction process, is the user have to provide unexpected or complex information?				If so, can the interface 'carry' or hold this information for the user?
Are users informed of hidden dependencies?				Usually not, hence being hidden. Most are discovered by trial and error. Is this acceptable?



## 2 Task and User Compatibility Checklist

Use the checklists below to review the possible variety of tasks and behaviour patterns.

Dimension values	✓	✗	n/a	Design issues
Has the allocation of functions between users and the product been adequately considered?				Decisions about who or what should perform a function should take these skills into account. For example humans are good at discriminating signals from high levels of visual or auditory noise and making complex decisions using past experience, whereas machines are good at counting or measuring physical quantities and for literal reproduction.
Does the interface fit normal task patterns?				If a product is not usable and acceptable, this may be due in part to an incompatibility between the designer's and user's understanding of how to use the product

Psychological factors that may need to be considered in the design of the product interface include:

Dimension values	✓	✗	n/a	Design issues
Has stress been considered				Products such as burglar alarm control panels, are sometimes used in stressful conditions. People under stress are more accident prone and tend to revert to rehearsed and stereotypical behaviour.
Have all possible social environments been considered?				Consider that products may used while the user is in a 'transitory state' such as tiredness, fatigue, drink and drugs  Social and cultural factors may determine the usage of a product such as meaning and emotional response to products.



Dimension values	✓	✗	n/a	Design issues
Does the interface conform to stereotypical behaviour?				Generally, when control-display arrangements conform to population stereotypes there are distinct advantages in reducing errors and learning times
Does the interface accommodate different types of users?				User requirements will vary substantially depending on different user populations. Users can also be distinguished by psychological attributes as well as physical attributes. Design issues that consider different types of users are discussed in detail below.
Does the interface accommodate for the changing skills that the user may develop over time?				A simple step-by-step introductory procedure may become annoying and frustrating later to a skilled user.

Physiological factors that may need to be considered in the design of the product interface include:

Dimension values	✓	✗	n/a	Design issues
Has the ambient noise level been considered?				The level of ambient noise that the interface may have to compete with. Noise can be defined as unwanted sound and it is important that any auditory displays are designed to be discriminable from the environmental noise but also that auditory displays are discriminable from each other.
Has climatic conditions been considered?				If this is so, ensure that controls can be operated whilst wearing gloves in cold conditions and that the panel does not become too hot to touch in hot conditions.
Have lighting levels been considered?				Display and control panels do not potentially present glare that may inhibit the use of the panel and consider how product interfaces can be used in extremely bright or light environments.
Have unusual environments been considered?				Unstable conditions, for example a car radio where fine adjustments can be difficult, the environmental factor of instability would therefore need to be considered.



# Further Information

## Allocation of function

As consumer products become more complex, issues of how, when, who or what activates or controls a function becomes increasingly difficult to specify. Allocation of function can be defined as explicitly stating the functions between the user and the product. Humans and machines have very different skills and abilities. Decisions about who or what should perform a function should take these skills into account. For example humans are good at discriminating signals from high levels of visual or auditory noise and making complex decisions using past experience, whereas machines are good at counting or measuring physical quantities and for literal reproduction. However, these distinctions are very broad and do not help more subtle design decisions.

People are good at	Machines are good at
Tasks that require constant adjustment, reappraisal and creativity	Routine and repetitive tasks
Gaining access to information from a range of sources	Remembering literal data and information
Error correction	Entering data with little or no errors
Working with one channel of information input	Working with many channels of input

## Examples of good and bad allocation of function

Advanced photocopiers take some of the copying decisions away from the user by preventing copying if the original overlaps the designated format size. The system function has been increased by allowing the machine to make copying decisions. This function can be overridden by keeping the 'copy' button depressed. Many users, however, are unaware of this because the communication concerning the transfer of function between the machine and the user has been poorly considered by the designer.

Telephone directory services in the UK have been re-designed with improved allocation of function between the operator and the telephone computer system. Operators initially answer the call and deal with the caller's request for a telephone number. Once a number has been identified the caller is handed over to an automated voice message system which provides the caller with their telephone number. This increases the number of calls the operator can deal with and reduces the repetitive elements of the task.



## Things to think about

While the use of intelligence is still not used comprehensively in products, it raises some important issues regarding the allocation of function between the user and the product as this could in theory shift more towards the product. Considerable research needs to be undertaken to investigate the consumers' perceptions and understanding of intelligent products. For example, consumers can exercise a high level of discretion in both purchasing and using consumer based products and may be highly wary of devolved responsibility. A recent study illustrates this point very well. In the introduction of an adaptive interface for an auto-teller machine, researchers found it was important that users were made explicitly aware that they were using an adaptive interface for the interaction with the product to be successful. This suggests that the introduction of intelligence into products will probably be evolutionary and incremental to accommodate user acceptance.

### **Design the product to fit normal task patterns**

Products are not designed intentionally for the wrong user population. If a product is not usable and acceptable, this may be due in part to an incompatibility between the designer's and user's understanding of how to use the product. It is a common failing to assume that everyone's experiences are the same as one's own. Product designers should therefore develop a comprehensive picture of the different types of user/product interactions that may exist and ensure that the product design allows for this diversity. This should be achieved through the use of the scenario design tool.

In a study examining the operation of new vacuum cleaners researchers found a number of operational difficulties such as being able to operate the mechanical (where some users had difficulties in placing their hands in their preferred position) or electronic suction power regulators (where users did not understand the purpose of the feature and also how to operate it once they were familiar with the feature). The researchers state, "regularly subjects could be seen to apply ways of operation they were used to, thus bypassing poor design qualities such as in the operation of the nozzles".

This example demonstrates how important it is to consider how users traditionally use existing products as these methods will be enforced by the user on the new product.

## Things to think about

Applying these types of guidelines is particularly difficult with novel products or interfaces. Subjects used in user trials normally find it difficult to appraise novel solutions objectively and are usually anxious to appear supportive and positive about the design. One way of getting round this is to place the trial in context by using the scenario design exercises.

For example, during scenario design or prototyping evaluation, suggest to the participant that they explain how to use the design to a friend. This often exposes gaps in their understanding of the interface or task.



**Stereotypical behaviour**

A stereotype belonging to a particular population can be defined as a commonly expected relationship between a control action or display and the resultant product action. For example, most people assume that green means 'start' and expect that when a control knob is turned clockwise, it will move an object from left to right.

However, although these stereotypical actions are widely adopted, some caution must be exercised. Stereotypical behaviour is dependent on experience which is often culturally related. For example, in one study, it was found that Chinese subjects did not have the same colour associations as the Western population. Red for 'stop' and green for 'go' was not so strongly associated.

Culture	Red	Blue	Green	Yellow	White
USA	Danger	Mascu-linity	Safety	Criminality	Purity
France	Aristo-cracy	Freedom Peace	Criminality	Temporary	Neutrality
Egypt	Death	Virtue Faith	Fertility Strength	Happiness Prosperity	Joy
India	Life Creativity		Prosperity Fertility	Success	Death Purity
Japan	Anger Danger	Villainy	Future Youth Energy	Grace Nobility	Death
China	Happiness	Heavens Clouds	Ming Dynasty Heavens Clouds	Birth Wealth Power	Death Purity

Generally, when control-display arrangements conform to population stereotypes there are distinct advantages. It has been found that reaction or decisions times are shorter, the first control movement made by the user is more likely to be correct and learning times are reduced.

**Different user types**

In general terms user characteristics are usually grouped and described under the following headings

- Age, gender and other demographic data
- Physical characteristics such as visual and auditory characteristics, body dimensions such as height and weight and reaction time
- Cognitive characteristics such as problem solving and decision making
- Attitude such as motivation, personality and initiative
- Skills and training such as educational background
- Experience with product or range of products



User type	Suitable design considerations
Children	Some interfaces may require tamper proof features
Elderly	Provide larger controls, good tactile feedback, use well established metaphors and analogies
People with special needs	
Visually impaired	Don't rely solely on colour cues but if unavoidable avoid shades of blue
Hearing impaired	Auditory tones should be less than 900 hz in frequency
Wheel chair bound	Commonly used controls should be accessible from a seated position

**Considering the environment**

Environmental issues that may be relevant and affect the use and therefore the design of an interface can be divided into two broad areas:

- Physiological
- Psychological

The physiological factors that may affect the usability of an interface and therefore should be considered are noise, illumination, climate, and motion. Psychological factors include stress, social interaction and mental workload. If these factors are ignored and are not included in the interface design specification, there may be situations where the product may be dangerous or difficult to use.



### 3 User Control Checklist

Psychological distinctions can also be made between users and the table below provide some broad differences.

User type	Suitable design considerations
Expert or frequent user	Provide short cuts for frequent tasks
Novice	Provide a step by step interaction style and consider the type of mental model that users might adopt
Intermittent	Provide easy access to reminders or aide memories

### Further Information

#### Things to think about

Some products such as washing machines require anti-tamper devices to prevent accidental or mischievous use by children. Whilst some products are designed specifically for their use, there is not a significant body of knowledge about characteristics and abilities of children which can be translated into design criteria. Some development work on a communication tool, however, called PenPal suggests that children prefer products with physically manipulable interfaces and a 'fuzzy boundary' between the physical and software elements of the product. Products should be fun to use and it should be possible to customise the interface.

Products have traditionally been designed for use by people during 'active adulthood' although there is increasing recognition of the elderly user. Elderly users require a different type of interaction support.

Some research investigating an elderly user group and their opinions on consumer products and found that they liked using instructions to learn how to use the product although they complained about the clarity of the instruction material. It was also found that the size, number and spacing of the buttons greatly affected ease of use.

For most disabled users, it is the variety of controls found on the product that cause concern. Furthermore, if one key control is inoperable by a user, the product may be unusable for that person. A preferred method for designing for the disabled is to use less variety in the selection of controls on each product.



Other factors that determine differences in aptitude are: experience, both personal and culturally; ‘technical aptitude’ defined as spatial and reasoning aptitudes and task specific knowledge. However, it has been argued that other personality based characteristics are weak and inconsistent predictors of performance.

**Changing user skills**

Designing a product interface that is easy to learn can be counterproductive when users become more proficient with the product or related tasks. A simple step-by-step introductory procedure may become annoying and frustrating later to a skilled user.

The fundamental difference between a novice and expert user is in their level of knowledge and experience of the system. Therefore ensure that the interface permits different routes and paths to the same goal, including short cuts. Skilled users prefer a higher level of control of the system.

Expert user needs	Coded commands Access to settings
Novice user needs	Context setting Clear navigation

Very occasional users of mobile phones tend to dial the whole number when making a call. However, if the user changes their frequency of usage, recall and looking-up telephone numbers can hinder speed of use. In this situation the user is likely to invest time in learning how to use memory functions that dial frequently used numbers automatically.

**Things  
to think  
about**

When trying to understand and monitor changing needs, many users of unfamiliar products tend to be very bad at predicting their future behaviour or needs. Also in a different way users with familiar products tend to have very specific or non critical viewpoints. In this situation, card sorting exercises (Section 2) can be a very useful method to anticipate future usage.

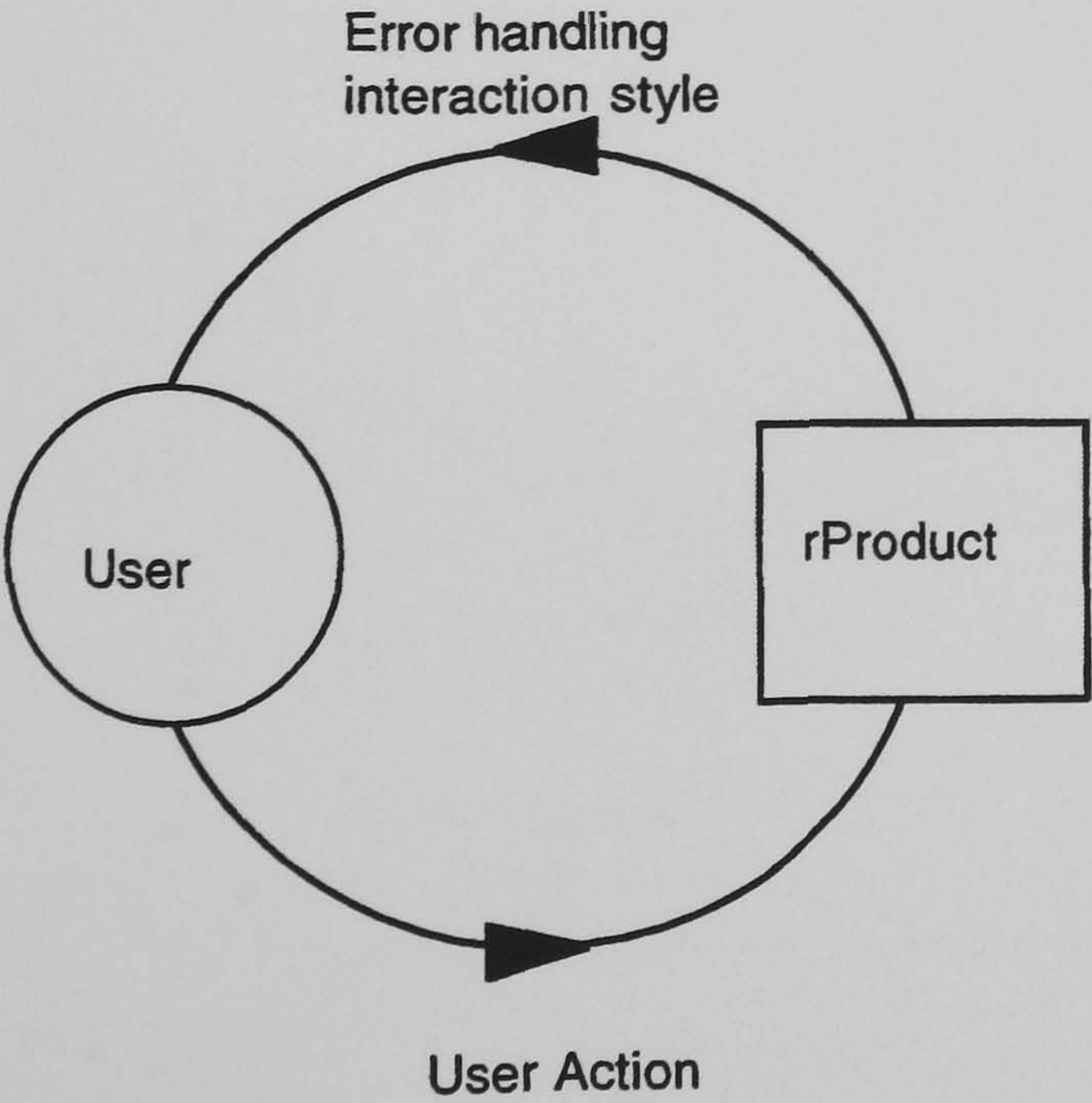


# 4 Error Management Checklist

A key rule is to always allow the user the ability to ‘undo’ a command. This cannot always be achieved in consumer products as they tend to have more actions that have a permanent and irretrievable effect, for example selecting record on a tape recorder. Therefore, associated cues or warnings should be provided to prevent accidental error but also allow the user to learn by experimentation.

Dimension values	✓	✗	n/a	Design issues
What typical errors could occur?				In order to allow for mistakes, common errors that may occur need to be known. The scenario building exercises should identify errors and provide some ideas about how to accommodate them.
What type of errors could be made?				Identify errors and classify them as either semantic or syntactic. Semantic errors are those where the error is based on a misunderstanding such as the task process, interface functions, representation of interface functions or control feedback. Syntax errors are based on a misunderstanding of the order in which actions have to be performed
Does the interface allow for error handling interaction styles?				Design error handling interaction styles that handle both syntax and semantic errors
Is there redundancy in the interaction process?				Redundancy allow users to confirm their progress by using different interaction styles. Remember that too much redundancy can be annoying to the user
Do actioned states appear to be similar?				To be avoided if possible as this may lead to errors where the user may misinterpret their movement from the current state to an (incorrect) actioned state

## Further Information



There are three types of interaction styles that can help prevent errors. Preventative errors simple do not allow actions to be carried out in certain system states, for example the use of locking devices, ‘greyed-out’ menu selections and controls under concealed covers. Consultative dialogues provide some form of warning or advice before the product will carry the action such as help systems or warning sounds or text displays. Retrieval dialogues allow the user to ‘un-do’ their error in some way.



Predicting human error is very unreliable and it is wiser to make observations of typical user-product interactions. In doing this important lessons can be learnt about the design of the interface. In a study observing users of ticket vending machines, the following type of errors were noted: information presented by the system may not be noticed by the user; users may not have all the information to hand to complete a transaction; the system may not clearly explain the tasks; or the user may not perform the tasks in the correct order

**Things  
to think  
about**

Simple intelligence can be incorporated into the interaction dialogue by logging and therefore learning where errors are constantly made. The interface could perhaps suggest ways in which the user could reduce these errors.



## 5 Meaning of Codes Checklist

Dimension values	✓	✗	n/a	Design issues
<p>Will the correct action be sufficiently evident to the user?</p> <p>Will the user select the correct action based on what the user is trying to do?</p> <p>Will the user interpret the product's response to the chosen action correctly?</p> <p>Will the user's mental model be affected by new concepts being added or existing concepts being lost?</p> <p>Have all the interface objects been tested for 'meaning' with users</p> <p>Do objects require a contextual 'frame' before meaning is understood?</p> <p>Are there alternative ways in which semantic clarity can be improved?</p> <p>How well do interface objects conform to standards, cultural values, task patterns, stereotypical behaviour and the product range?</p> <p>Does aesthetic design override semantic clarity?</p>				<p>The interface should always provide cues about what can be done next (See guidelines on Getting attention for example)</p> <p>Users think in terms of completing a task not in terms of working through an interface; as far as possible the structure and meaning of the interface should be the same as the task. Task based metaphors may help, some concepts are presented below</p> <p>This is related to another CD - progressive evaluation</p> <p>Analogies or metaphors are useful mechanisms to imply the functionality and meaning of an interface. They do have their limitations though - see table below</p> <p>Scenario design will have probably on addressed specific tasks. It is important that all task activity is tested when an interactive prototype is developed</p> <p>Be aware of interface elements or objects which rely on other parts of the interface for their meaning. Warning beeps, for example, should also provide some form of visual cue to the problem</p> <p>If problems are identified, think of other ways of improving semantic clarity. For example: breaking one visual image into a series of different representations; providing redundancy; adding text; conduct more specific scenario or prototyping evaluation trials; or use stronger analogies.</p> <p>If this is a problem there are specific texts that address these problems - (See references in section 7)</p> <p>Remember that semantic clarity can often conflict with clean aesthetic form</p>



# Further Information

Metaphorical models are used where the interface presents an interaction style that is similar to another type of mental model that the user will very likely be familiar with. A good example of this is the CD player where many of the controls are still analogous to an audio tape recorder.

Here are some metaphors to describe interaction concepts, some of which also provide natural relationships between components.

Concept	Metaphor	Components of metaphor model
Organising	Desk	Drawers, files, folders, papers, note cards
Navigation, layout	Publication	Books, newspapers, newsletters, articles, figures, forms
Navigation, Categories	Television	Programs, channels, networks, commercials
Navigation, Categories	Music	Tracks, CD, Tapes, Music charts,
Rules	Games	Boards, cards, game pieces
Navigation, Categories	Film	Rolls of film, slide holders, still and moving images
Organising	Storage	Shelves, boxes, filing cabinets, folders, paper clips
Navigation, Hierarchy	Trees	Branches, trunk, leaves, roots

Here are some examples of action metaphors, which are often more difficult to select and describe.

Action	Types of metaphor
Browsing	Window shopping, thumbing through books
Selecting	Touching items, place boundaries around items
Deleting	Putting items in a waste bin, rubbing-out
Assigning values	Rotate knobs, move sliders, selecting items over time



Things  
to think  
about

The use of metaphor does have to be used with some degree of care. The table below describes some of the problems with this approach as well as the benefits

Advantages	Disadvantages
Can convey functionality and relationships quickly to the user	Interpretation of metaphor may be taken too literally
Easy to learn and remember	A mixture of metaphors may build in contradictory cues
Can simplify the interface	Limits of metaphor may be difficult to discern
Invites exploratory learning	Mapping between the product functionality and the metaphor may be too weak to understand
Reduces anxiety	Difficult to describe abstract concepts such as pre wash or reheat



## 6 Consistency Checklist

It is relatively easy to evaluate the consistency of interface elements in terms of the physical attributes by listing all the interaction states and noting the different descriptive attributes. Use this checklist to quickly check interface consistency. It is more difficult to evaluate the consistency of the interface in terms of the expected user/product behaviour. Some of these issues are considered in the 'things to think about' section.

Dimension values	✓	✗	n/a	Design issues
Do all coloured elements have the same meaning throughout the task or function?				See also guidelines on 'Using Colour'
Is all the text written in the same style and does it use the same terms?				See also guidelines on 'Alphanumeric displays'
Are all graphical elements or descriptions mean the same to a wide range of intended users?				See also guidelines on 'Graphics/Symbols and Icons'
Are the feedback mechanisms always understood in the same way by the intended users?				Although some evaluation work can be done with scenario design, most of the problems that are identified will have to tested with interactive prototypes
Is data always entered in the same way?				Check across different task activities or functions for consistency
Do any instructions contradict each other?				Always use someone who has not developed the interface to answer this, as it more difficult for the design team to find these type of inconsistencies



Things  
to think  
about

The following considerations are also related to other, more broader, consistency issues that may have to be taken account of:

	✓	✗	N/A
Ensure compatibility with other products that users may have experience of or would expect to function in a similar way			
Consistency with user stereotypes, many of these are discussed in more detail later			
Consistency with the user's mental model of the product, task or relevant experiences			
Ensuring that the product does not counteract other related tasks that may be associated with the product			



# 7 Workload Checklist

The design of an interface should not unduly force a high mental workload to use the interface, although, paradoxically, in some circumstances this can be important.

Dimension values	✓	✗	n/a	Design issues
Does the user have to configure or remember settings from one task to another ?				Establish which settings are most commonly used and provide these as default settings
Does the interaction process fit the task?				Present sequences of actions in task or analogous form For example, provide time settings that adopt the analogue clock format
Can the user get lost in menu structures?				Provide clear signposting and navigation through menu structures Use coding mechanisms such as colour, visual maps or use designated parts of the interface for particular functions
Does the user have to remember many categories?				Keep categories or classification structures to single figures See 'Things to think about' below
Does the user have to perform many sub goals to achieve the main goal?				Allow the use of default settings to reduce the number of sub goals that have to be performed
Are there points in the interaction process where high cognitive demand is important?				Particularly useful for security or for functions that have irredeemable impact on the product



# Further Information

**Things  
to think  
about**

Research on an information retrieval system for a video library found that subjects preferred to classify video tapes into nine categories as opposed to the 29 found in video shops. Cognitive loading can be reduced by providing the right type and level of functionality to suit the task in hand. Many products offer a wide range of functions which are perceived as being useful by buyers. However research suggests that very few of these functions are used because they are difficult to use or remember.

Many faxes have an array of set-up and configuration options. Navigating through the menu option is difficult because of these small alpha-numeric displays. The cognitive demand on remembering selection options could be reduced by taking a non-numeric approach. For instance, instead of nominally numbering menu options to set up and configure a fax machine say from 1-6, these could be related to the alphabetic labelling associated with each key. For example, instead of assigning the '1' key to return a 'no' statement and use the '2' key to return a 'yes' statement which both have no meaning to the user; a better and less cognitively demanding solution would to use the '9' key for 'Yes' which is labelled with the letters 'WXYZ' and the '6' key for no (MNO). This principle could be used for more complex applications.

space	ABC	DEF
1	2	3
GHI	JKL	MNO
4	5	6
PQRS	TUV	WXYZ
7	8	9

Providing easy to remember interfaces is useful for occasional or intermittent use. However, remember that if an interface is going to be used frequently, users may find a step by step interaction dialogue frustrating. If this type of use is envisaged then provide other quick interaction dialogues that allow functions to be performed quickly.



# Walkthrough evaluation



## Walkthrough evaluation

**1** Define a range of tasks or scenarios which you feel exposes some areas of concern related to the relevant inspection criteria. These maybe scenarios that were not used in the card sorting or scenario design tools.

*For example:*

*Setting up new default modes*

*Setting up memory keys*

*Cancelling infrequently used functions*

All these are tasks that would be undertaken infrequently and would test the effectiveness of the interface to guide the user through such tasks

**2** Define each step or sub task that needs to be accomplished in order to complete the task.

*For example*

- 1. Cancel active function*
- 2. Select mode key*
- 3. Press three times to call up 'settings'*
- 4. Press 'Select'*
- 5. etc.*

**3** Define a particular type of user that would undertake such a task

*For example*

16 year old girl with little interest in using the product and only having clear task objectives in mind

72 year old man weary of technology with poor eyesight



**4** Select and try to think through the eyes of one of the anticipated users and then within each step ask yourself the following questions

'What are the possible actions that could be selected at this step?'

'How likely or unlikely is it that the correct next step would be taken?'

'How likely or unlikely is it that an incorrect step would be taken?'

'What factors would affect either a correct or incorrect action?'

'If an incorrect action was taken - how likely is it that the user would know and be able to recover?'

'If a correct action was taken - how likely is it that the user would know this?'

Assume that the user has arrived at the next stage successfully and go through the questions again until complete.

Repeat the exercise with another anticipated user until complete

**5** Note down possible problems and solutions from these questions and use as discussion points to further refine and develop the interface



# Prototyping Guidelines



# Overview

Brief description:

A set of guidelines are presented here which allow the combined and effective use of high and low level prototyping

Purpose of the tool:

To guide designers in the use of different prototyping methods both in terms of design and evaluation

Resources:

Prototyping software such as Authorware, Director, Visual Basic, Powerpoint, Supercard or HTML

Participants for user trials

Inputs:

Interface specification based on previous design tools

Knowledge of appropriate software

Use of interface design guidelines

Outputs:

Fully developed and evaluated interface using user participative methods



# Prototyping guidelines

These guidelines, fundamentally, deal with an approach to the design and evaluation of a proposed product interface using rapid prototyping methods. As the design proposal begins to mature, there are more 'established' design and evaluation methods which have been successfully used in many computer and consumer based products.

These guidelines are based around the using high and low level prototyping. High level prototyping provides a great deal of the 'look and feel' of the proposed interface with many of the interface elements being interactive. While low-level prototyping models a specific element of the proposed interface, this could be the appearance of the interface or interactivity of a small part of the interface. Both have advantages and disadvantages.

	Advantages	Disadvantages
High level prototypes	<div>Potential for high quality user feedback</div> <div>Full interactivity of different interface elements can be tested</div> <div>Design thinking clearly visible</div> <div>Credibility</div>	<div>Time consuming to build</div> <div>High level of commitment to design decisions</div> <div>Higher demand on prototyping development skills</div>
Low level prototypes	<div>Quick and easy to build</div> <div>Test novel solutions</div> <div>Design proposals can alter more radically</div> <div>Design thinking maybe less obvious</div>	<div>Lack contextual relevance in user trials</div> <div>Findings from user trials maybe confounded when introduced to other parts of the interface</div>



## Design methodology guidelines

We suggest the following steps in using software based prototyping to further develop your proposed product interface specification.

Develop a fully interactive, high level prototype based on the findings from the previous design tools

When design problems occur, consider the problem in terms of questions, options and criteria.

First consider the problem in terms of a question e.g. how should a 'select' button offer multiple selections (selecting one, two or three potatoes to be cooked in a microwave oven).

Then present a range of options that may answer the question. Then either consider or establish the criteria for each option. Options and criteria can be established using the following approach.

Can options and criteria be established through conventional guidelines?:

☐ Yes - then use guidelines supplied in Section 6

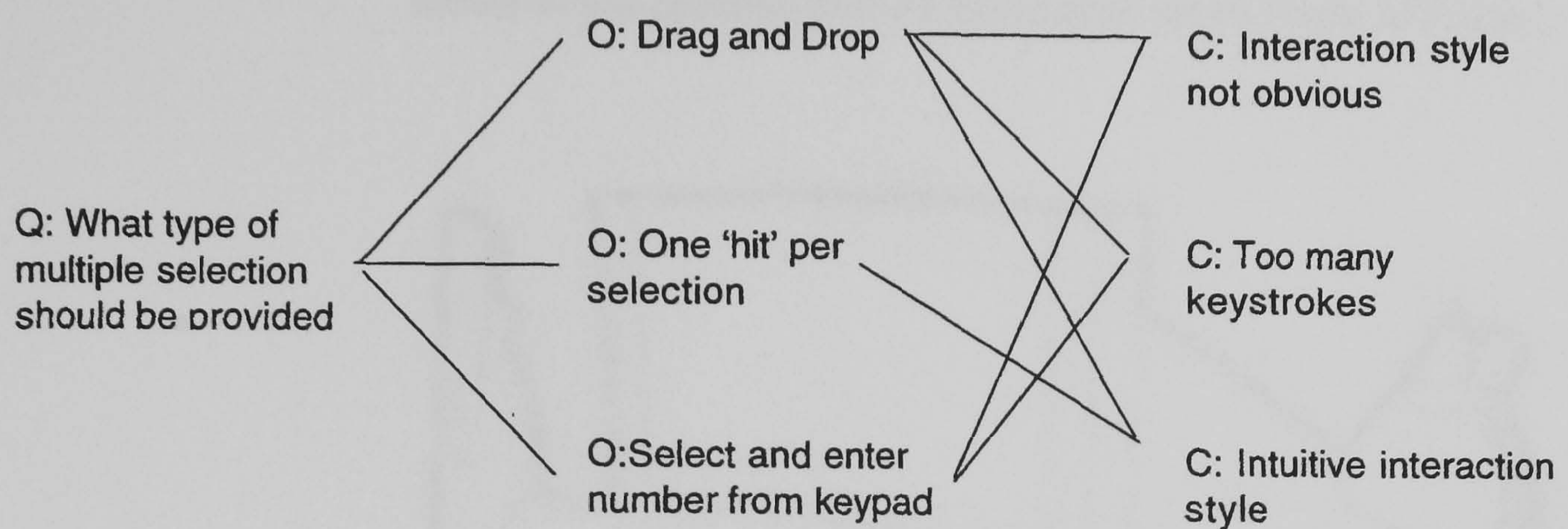
☐ No - Next question

Can options and criteria be established by the inspection tool?:

☐ Yes - then go to Section 4

☐ No - Then build a low level prototype to options and/or criteria

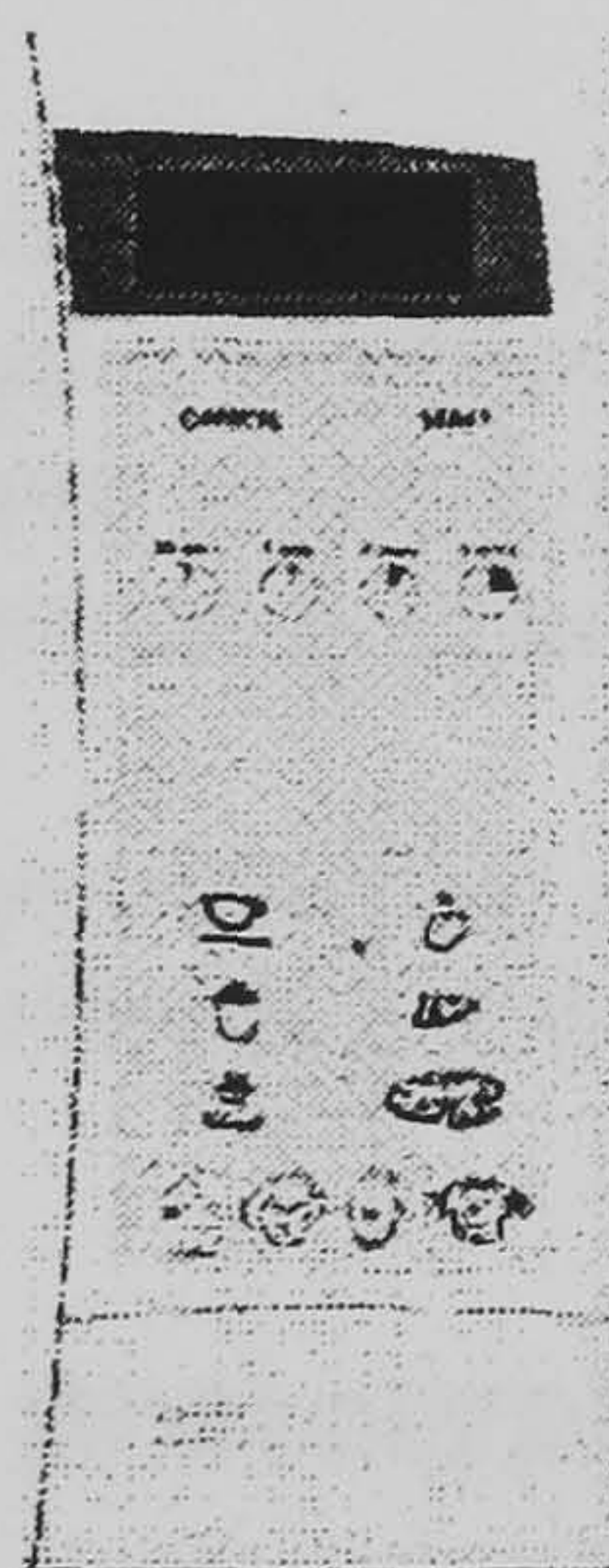
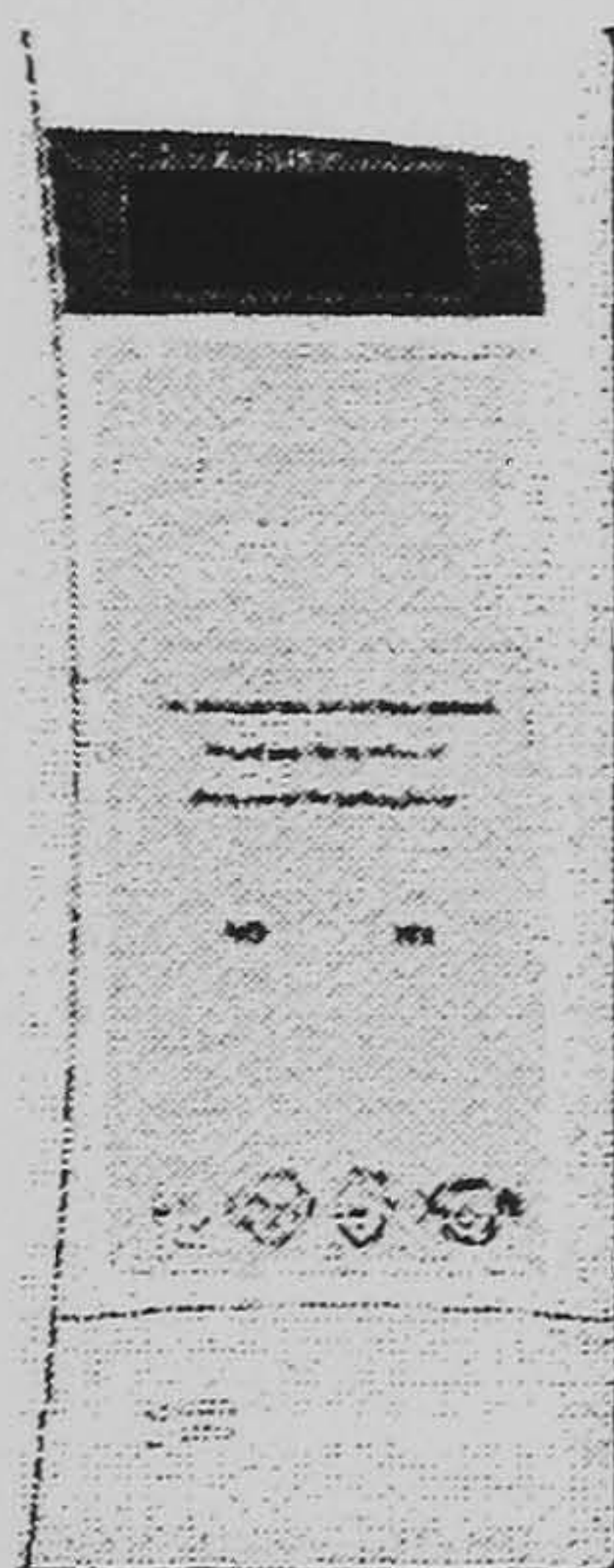




Generating the options and criteria can be done through a number of ways but we suggest the design path described above.

## High level prototyping design guidelines

The diagrams below illustrate different screen states for a touch screen microwave oven. This prototype provides visual cues and interaction behaviour for a proposed interface.



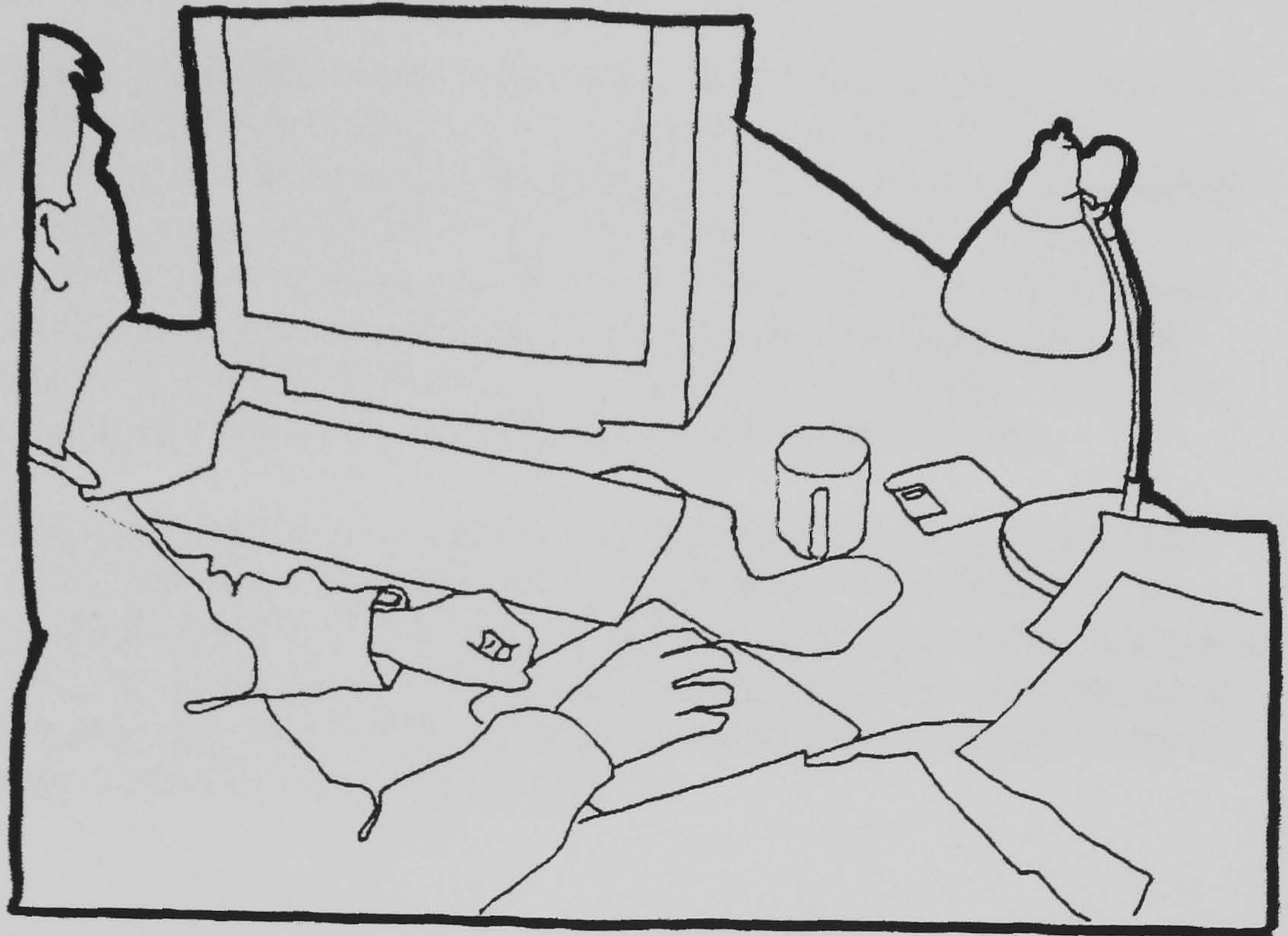
Produce prototype design and development 'stopping rules'. High visual accuracy or interactive fidelity does not always have to be a pre-requisite. In many situations proving a concept conforms to usability criteria can be done with approximations to the final proposal.

Be clear about what aspects of the interface or interaction styles really need to be truly novel. Is it possible to justify the development time?

However, conversely don't be constrained by conventional interaction styles. Obviously manufacturing and marketing criteria will determine much of the interface character, but ensure that user needs determine design specifications as much as possible.



Try to be aware of implicit organisationally based design culture - how things have always been done. It can be difficult to think outside the 'organisational box'. The participative design tools used earlier in the process should help break down these mindsets.



In more complex interfaces, consistency between interface states and the behaviour of control and display devices can be difficult to manage. One way of overcoming this is by keeping the state transition diagram up to date.

Make sure that you are fully aware of the many situations or the 'contextual environment' that a product interface maybe operated in.

### **High level prototyping evaluation guidelines**

Decide early what type of evaluation methods will be adopted. They always take longer than expected and often identify difficult problems that were not anticipated.

Think stakeholders not end users. There are usually many different types of people who may have an involvement in the product, for example,

- children
- maintenance engineers
- purchasers
- salesmen

Think about whether or not the programmer's or designer's evaluation skills will affect or inhibit the integration of good usability



principles. Very often user testing is not implemented because it is thought to be ineffective, but that the design team do not think there are any usability problems to assess.

Don't wait until the prototype is complete before conducting user trials. Evaluators are usually good at suspending judgement on incomplete or vaguely defined elements of the prototype interface.

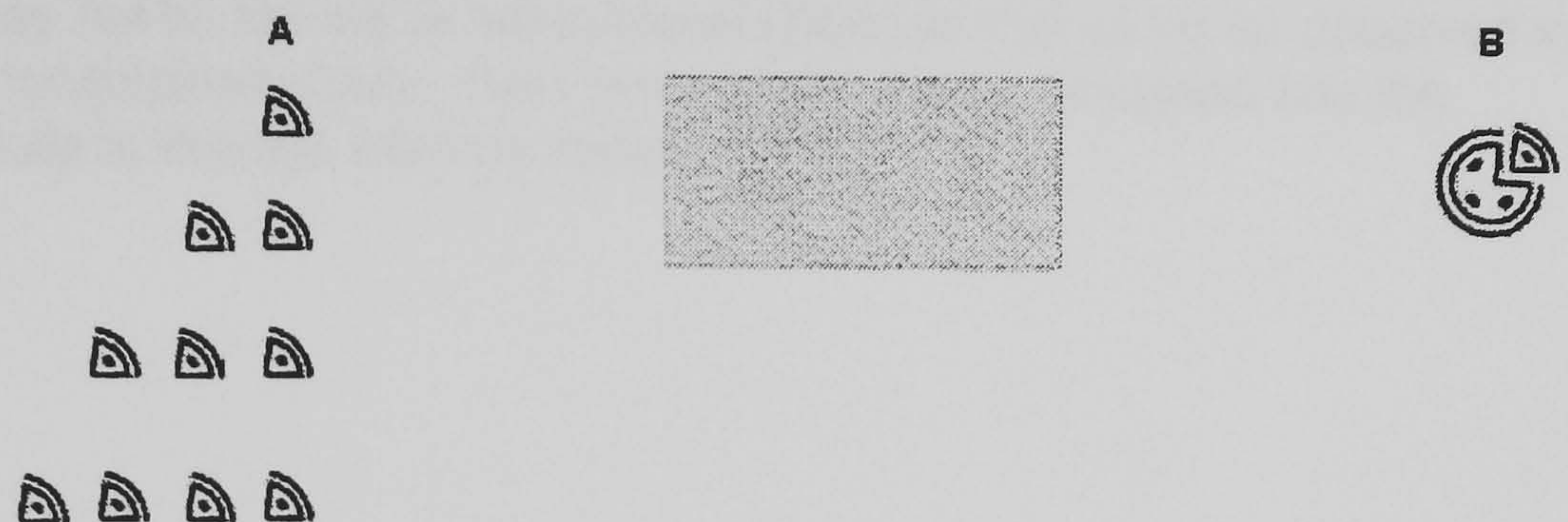
Design tasks that, as far as possible, reflect typical usage. This can often be difficult where many consumer products are used intermittently and product knowledge is built up over a long period of time. Also remember that users tend to learn the minimum procedural knowledge possible when they first come into contact with a new product and resist learning new knowledge after this. This sort of behaviour should be replicated if possible. This often require studies to be carried over a longer period of time.

One approach to evaluating the prototype interface is to ask the users evaluating the interface to 'teach-back' the interface to an imagined friend. Let them describe how to conduct a task in anyway which is comfortable to them, either by writing down instructions or drawing diagrams. This provides you with a documented model of their understanding of the product.



## Low level design guidelines

An example of a low level prototypes which were developed to test different methods of making multiple selections for a pizza.



Try to maintain 'fluidity' of design as long as possible. Low level prototypes are very good at preserving this.

Make sure that the design problem is properly understood by the designer and this is modelled by the user. You want to avoid situations where users are basing their judgements on, for example, visual appearance when in fact icon behaviour is being assessed.

If the interface relies on some form of metaphor or analogy, make sure this is tested at a low level to ensure that the correct meaning is being conveyed.

## Low level evaluation guidelines

Participants often have difficulty in evaluating low level prototypes as they are often presented out of context. If possible set them within a task that is familiar to the participant.

Probably small groups of participants will be used, but try to avoid using the same participants for each trial.

The level of real informative feedback that can be gained from a low level evaluation is usually limited.

### Things to think about

Understanding changing needs requires a slightly different approach to the conventional user trial which places a heavy emphasis on the immediate impact of the interface. To find out how a user's needs may change as they learn the interface requires a study that allows formative learning to take place. There are two methods that can be adopted: a longitudinal study or repeating tasks over an intense period.

Most consumer products tend not to have interfaces that require lengthy and intensive usage. If this is the case a longitudinal study should be conducted. Longitudinal studies usually take the form of



providing the user with access to the product over a extended period of time which can be over days or even weeks. Users are observed or interviewed during this time to build up knowledge of how the user's needs and behaviour change.

The repeated tasks method requires that similar types of tasks are repeated over an intense period of time of usually an hour . This approach can often reveal changes in behaviour or needs but these may not be the same behavioural changes that could be observed in a longitudinal study. Rest periods should be designed into the study to monitor memory recall.



# Interface Design Guidelines



# Interface design guidelines

These guidelines are intended to support your interface design proposal as it moves from a conceptual to a clearly defined interface specification. The guidelines have been drawn from a wide range of sources and include design advice on contemporary interaction styles and devices.

The guidelines have been divided into two sections:

- control
- display

Only common interface design guidance has been selected, addressing common interface design issues. Design issues related to novel interaction styles should be developed through the design tools.

## Control design guidelines

Control Design.....	6 - 2
Rotary controls.....	6 - 7
Touch Screens .....	6 - 11
Key pads .....	6 - 18
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## Display design guidelines

Display design.....	6 - 38
Menus.....	6 - 40
Alphanumeric displays.....	6 - 44
Graphics symbols and icons .....	6 - 49
Indicator lights.....	6 - 53
Use of Colour.....	6 - 55
Use of Animation.....	6 - 58
Auditory displays.....	6 - 60

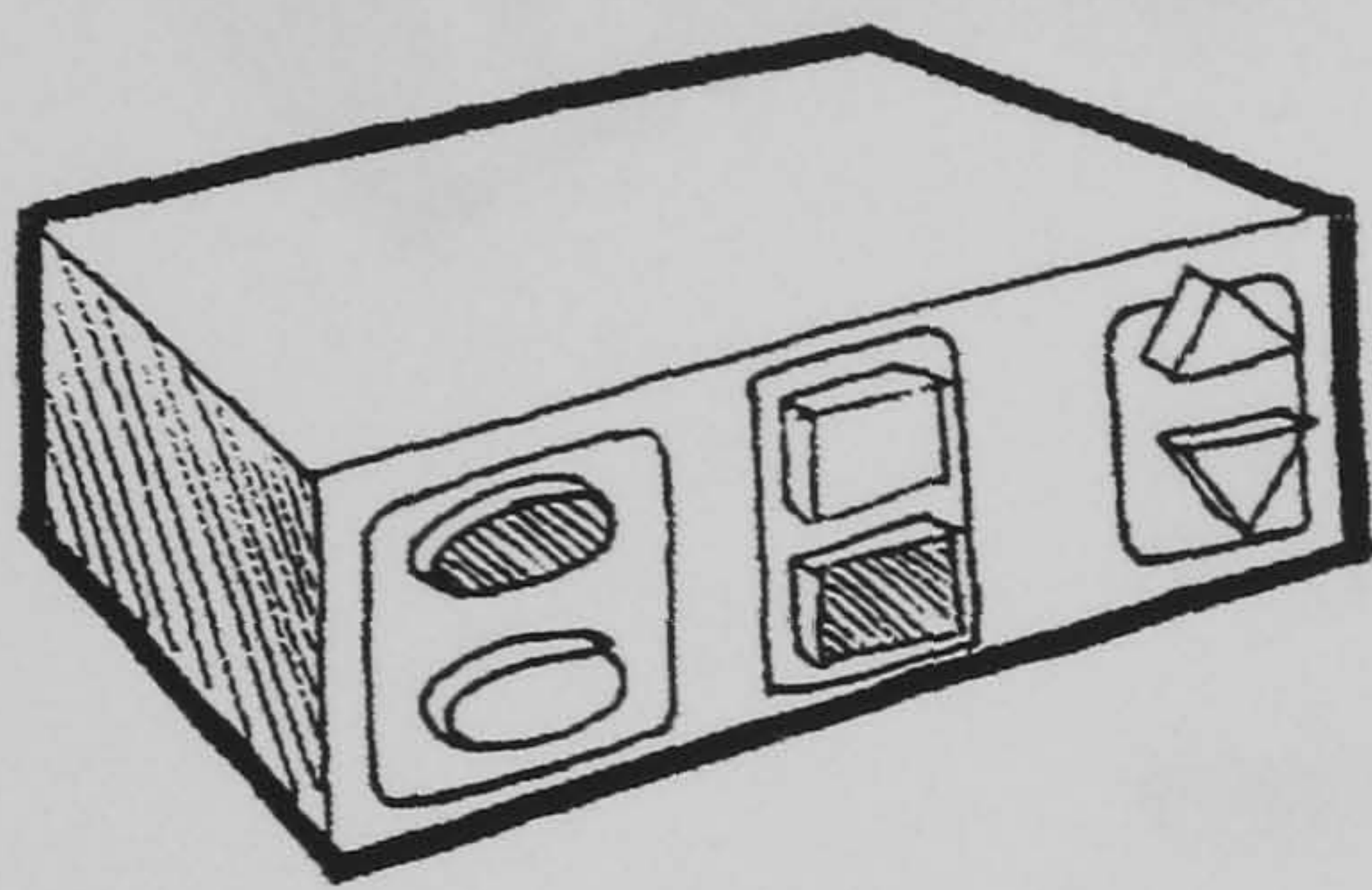


# Control Design

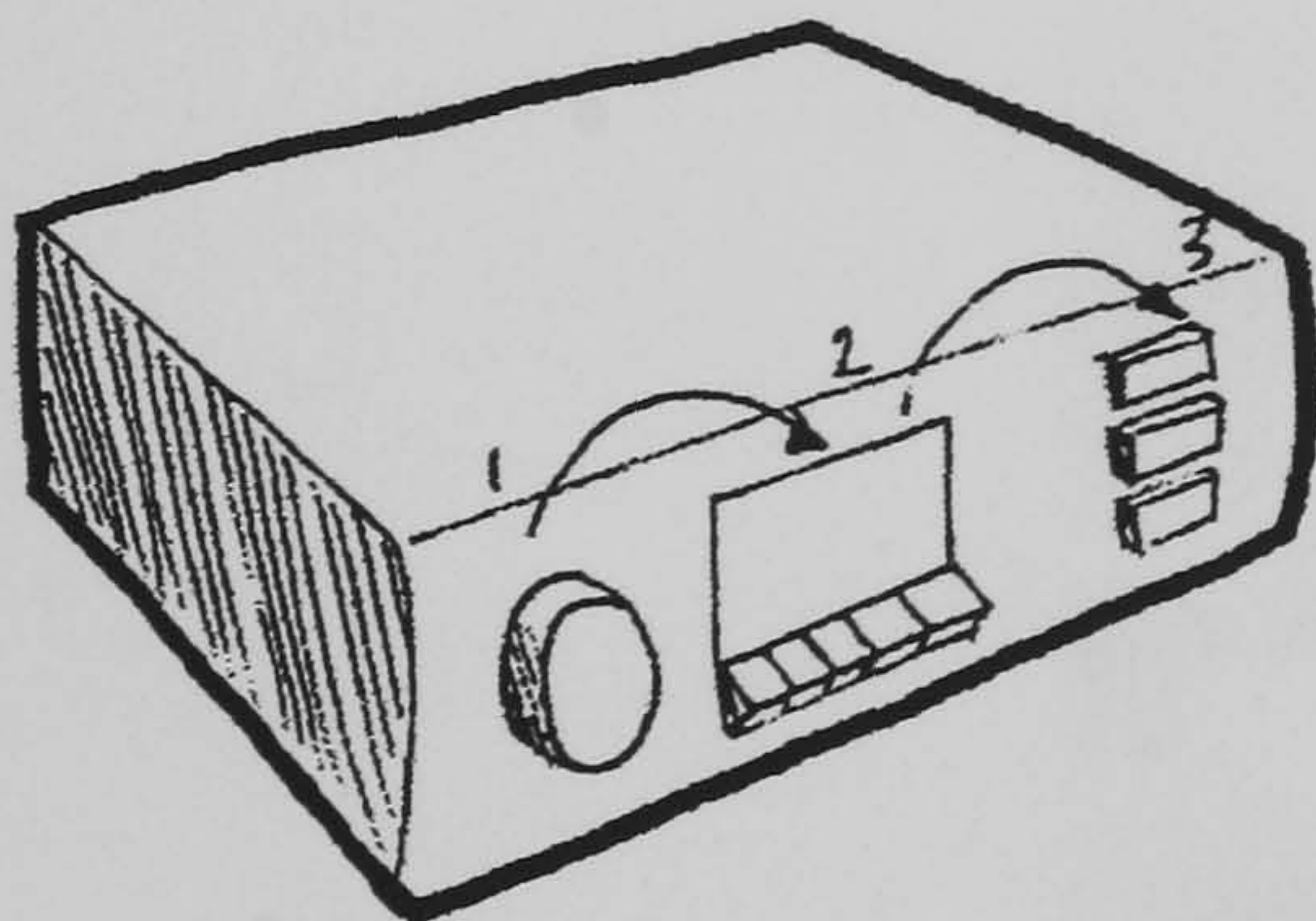
The use and design of specific controls are discussed later on, here some general guidelines are provided which should be adopted as far as possible in any product interface proposal.

## Design guidelines

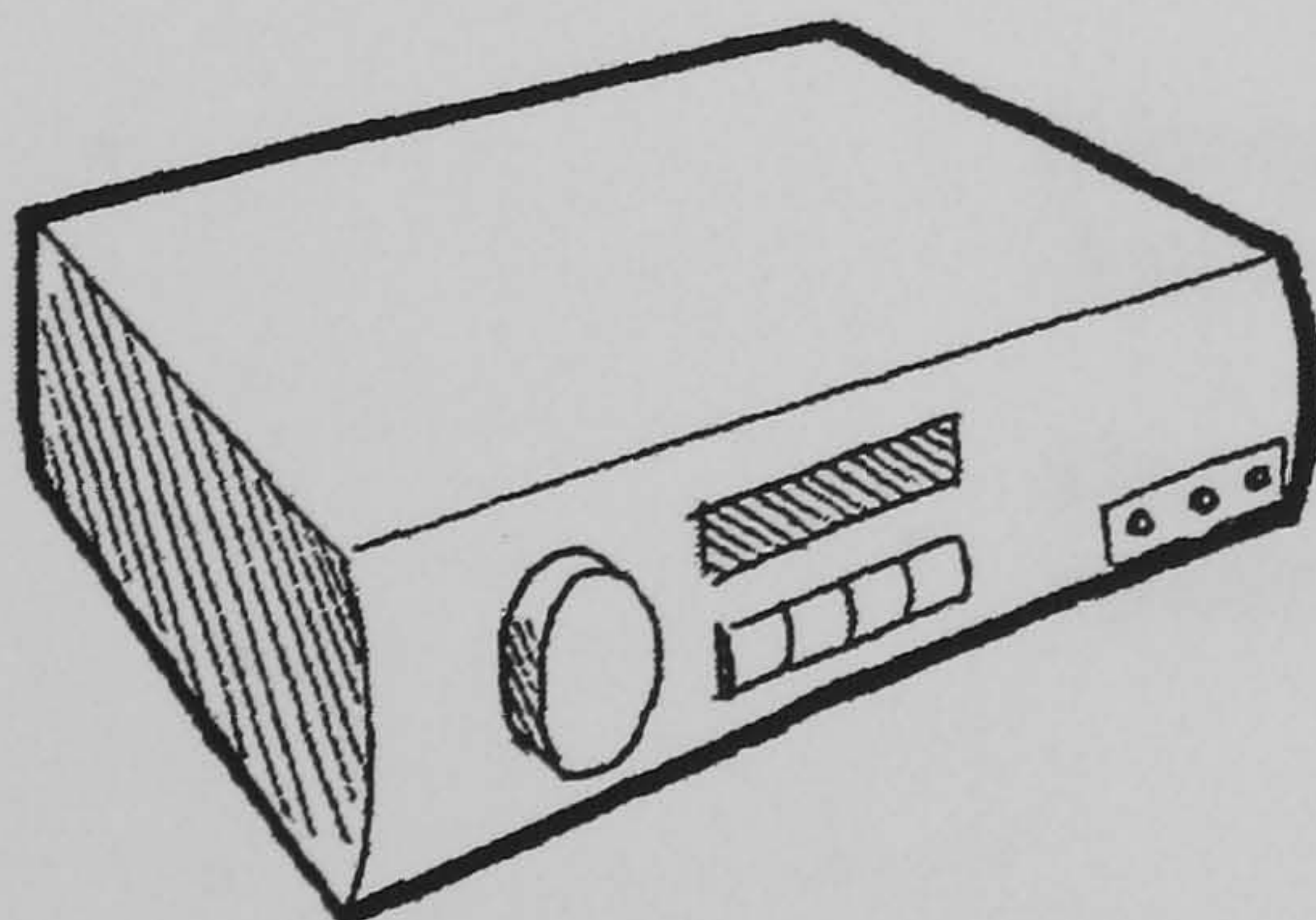
Controls should be:



Functionally grouped where possible

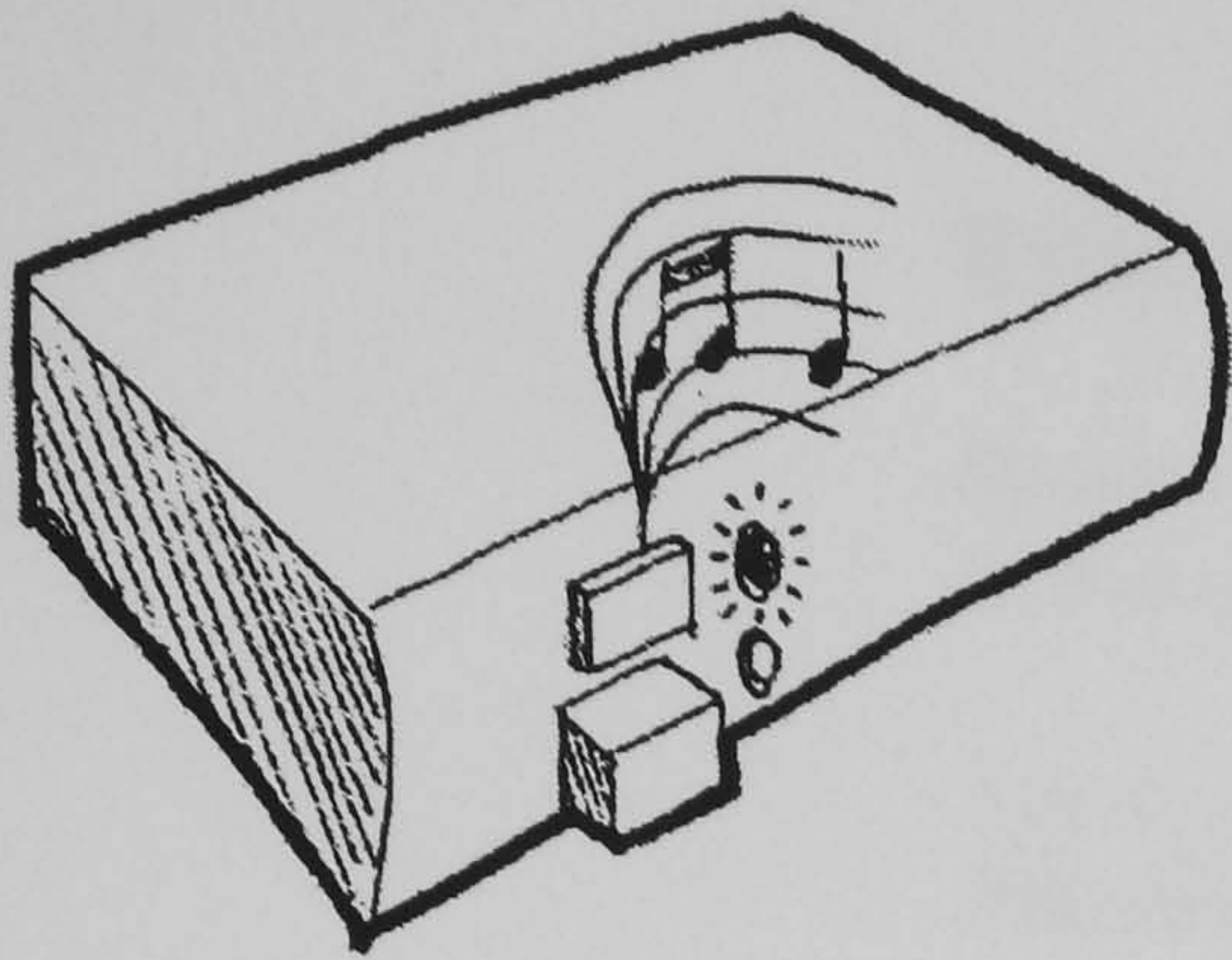


In sequence of use

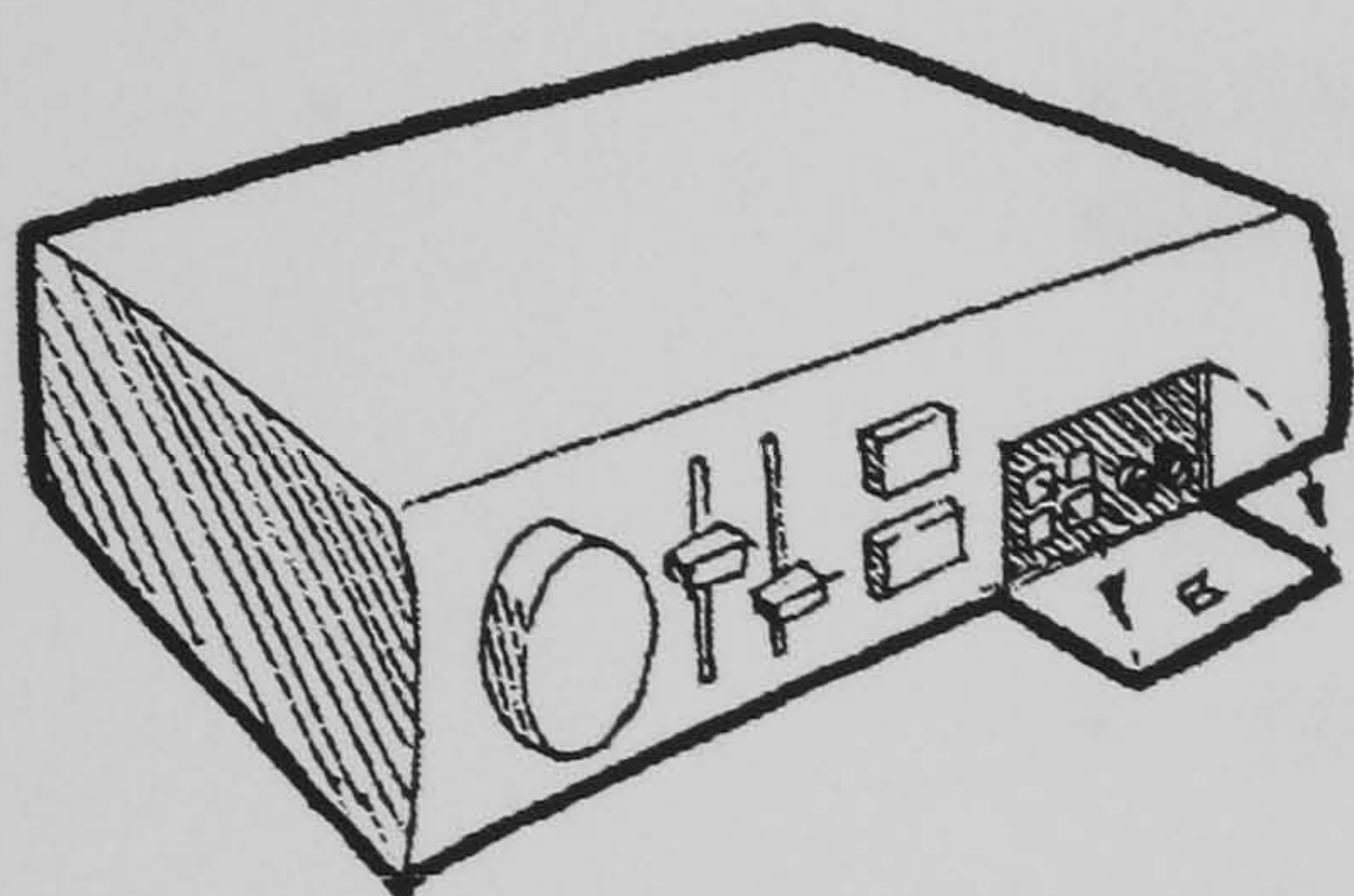


Most critical and most frequently used controls should be most accessible





Provide feedback on status and on the result of operating a control

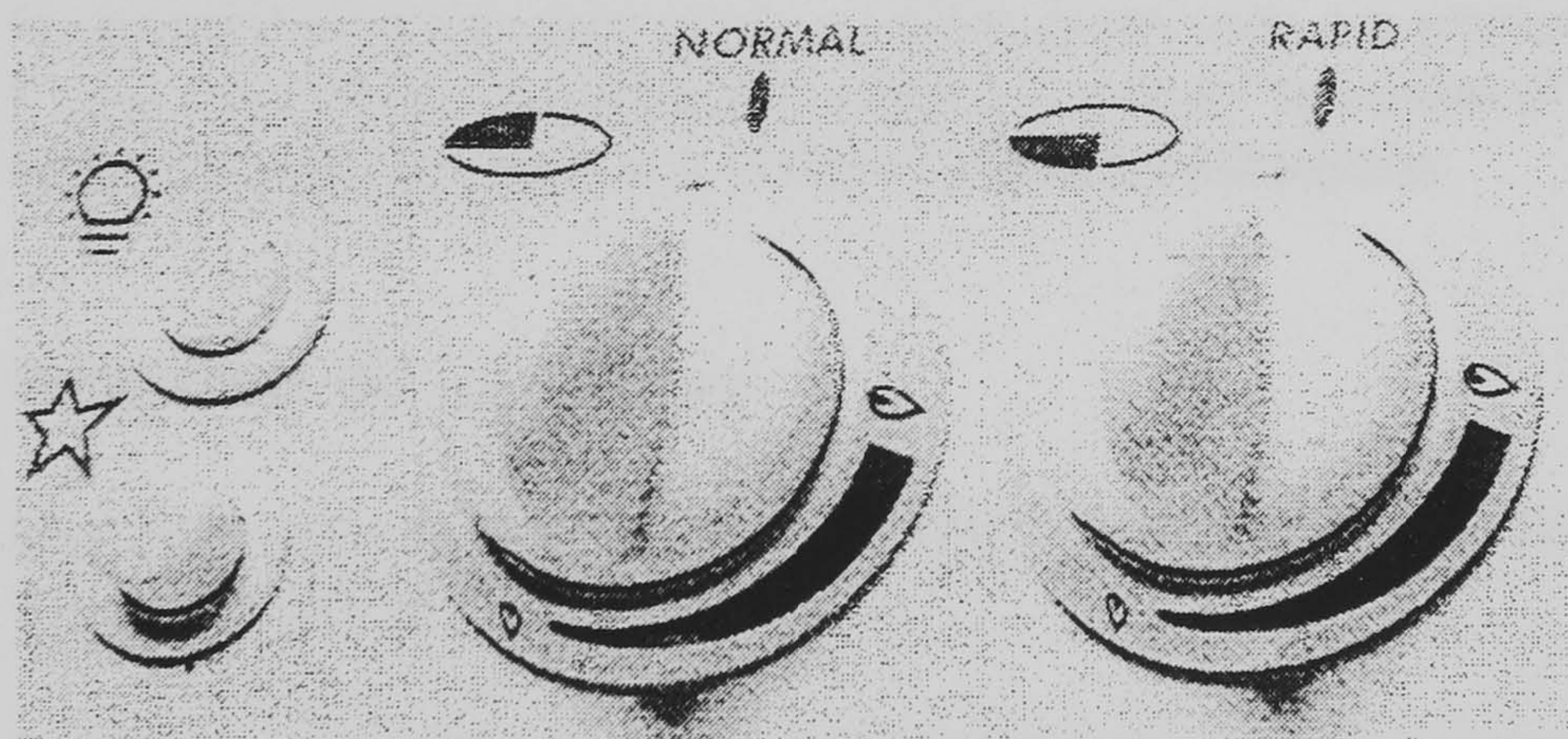


Keep number of controls to a minimum and conceal infrequently used controls

Controls should be positioned and labelled in such a way that the relationship with the associated display is obvious

Each control should be identified unless its function is obvious

Design control surfaces to prevent slippage



Directional movement of a feedback display should be in the same direction as the movement of the control

Labels on controls should not be obscured by the user when operating them.



## Entering data

Ensure that if the user has to enter data or information, it is achieved in a consistent manner.

Try to reduce the amount of data input required of the user, often this can be done by the use of default settings.

Try to avoid data entry tasks that require the user to mentally recall large amounts of data.

It is important that there is consistency between the way that data is entered and the way that it is displayed.

A good data entry interface should provide

- provision to undo the last action
- good feedback
- confirmation of extensive, final or permanent changes
- consistency

*See cognitive dimensions tool for further and more detailed examination of this topic.*

Research suggests that users perform better with an unknown task if they are offered instructions which provide an overview of the whole device and then are shown detailed instructions.

## Position of controls

Control buttons such as 'Cancel', 'Start' or 'Off' should be placed in the lower part of the control panel

Ideally controls should be positioned closely to the associated display or to the object under operation. If this is not possible then ensure some form of consistent 'mapping' between the two. Gas burners or hobs with 'mapped' control knobs is a good example.

Analogies or metaphors can be used to reinforce a relationship between an abstract or 'isolated' control device. An example would be the use of 'tortoise' and 'hare' icons to indicate speed.



# Labelling

Labels should be positioned above the control or display element if control moves to the left or right and to the left if control moves up or down.

Obviously avoid areas where the hand may hide the label while it is use. This maybe difficult to establish if left or right handedness is an issues. If this is the case, then the left hand should be given greater importance.

# The use of modes

Using shared and separate control and display modes should be avoided if at all possible

	Separate controls (modeless)	Shared controls
Separate displays	Highly recommended	Recommended
Shared displays	Allowable	To be avoided



Below is a summary of recommendations, advantages and disadvantages of more unusual controls and where they could be used.

Control Device	Uses	Disad- vantages	Recommended for	Not recommended	Comments
Touch Sensitive panel (touch screen)	Selection	Accidental activation; tired arms	Infrequent use; Coarse pointing	Continuous use; Precise pointing	Increasingly popular interaction style
Numeric Keypad	Enter numbers (keypunch)	Limited value for other tasks	Fast entry of massed numbers; calculations	Provide for left handed users	
Fixed function keys	Frequent or critical functions	Keyboards space permits limited number of keys	Continuously available, important functions	Seldom used, non-critical functions	Label keys with function names
Program function keys	Application-specific functions	Meanings change; no direct labelling	Frequently used or critical functions	Seldom used, non-critical functions	Define keys on display screen
Voice control	Enter numbers; Initiate predefined actions	Requires step-by-step confirmation of entries	When hands or eyes are not free	Noisy or stressful environments	Recognition of fluent speech not practical



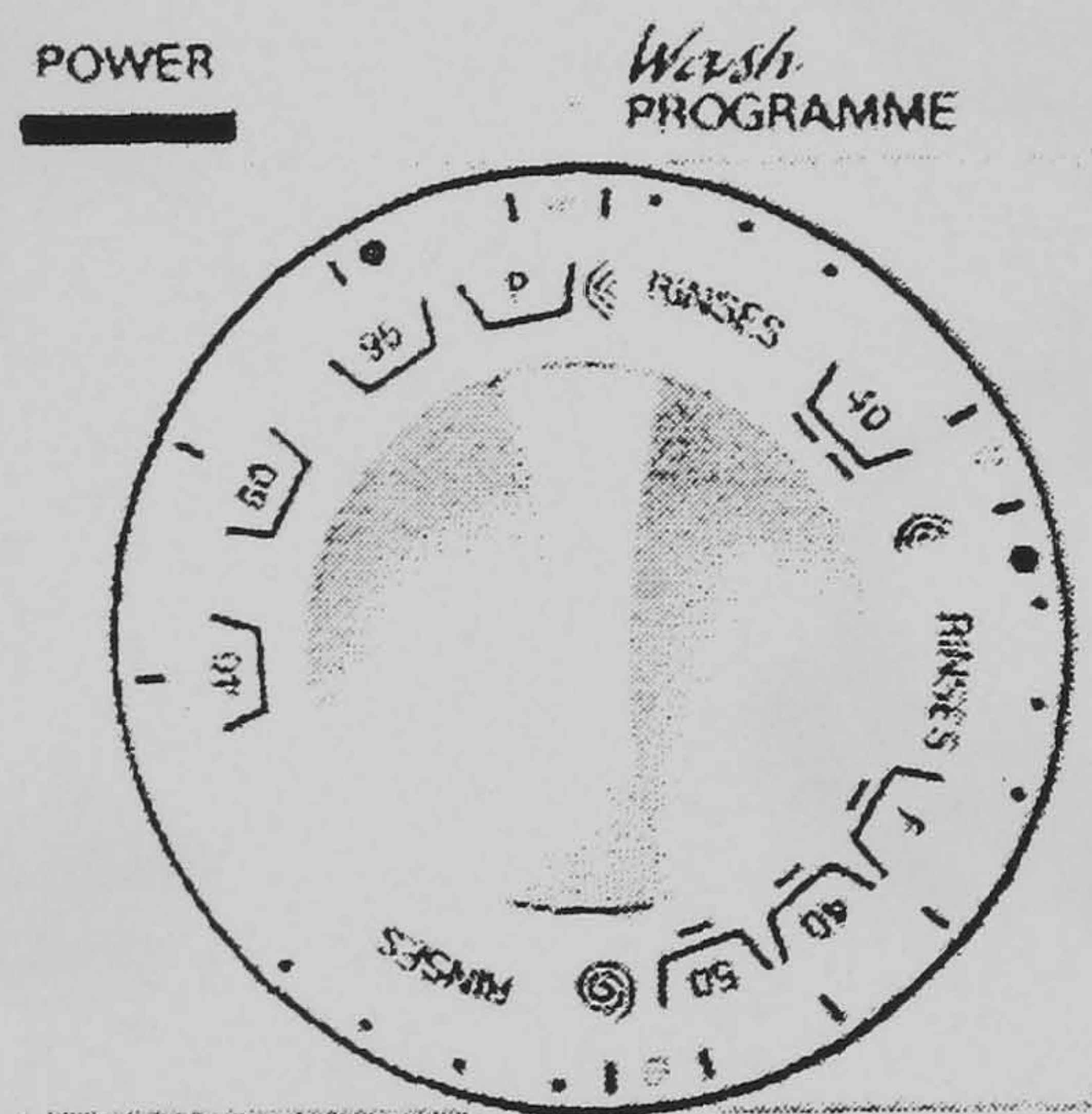
# Rotary Controls

Most ergonomics guidelines for rotary controls stem from studies using industrial machinery where design considerations for grip and torque are more important.

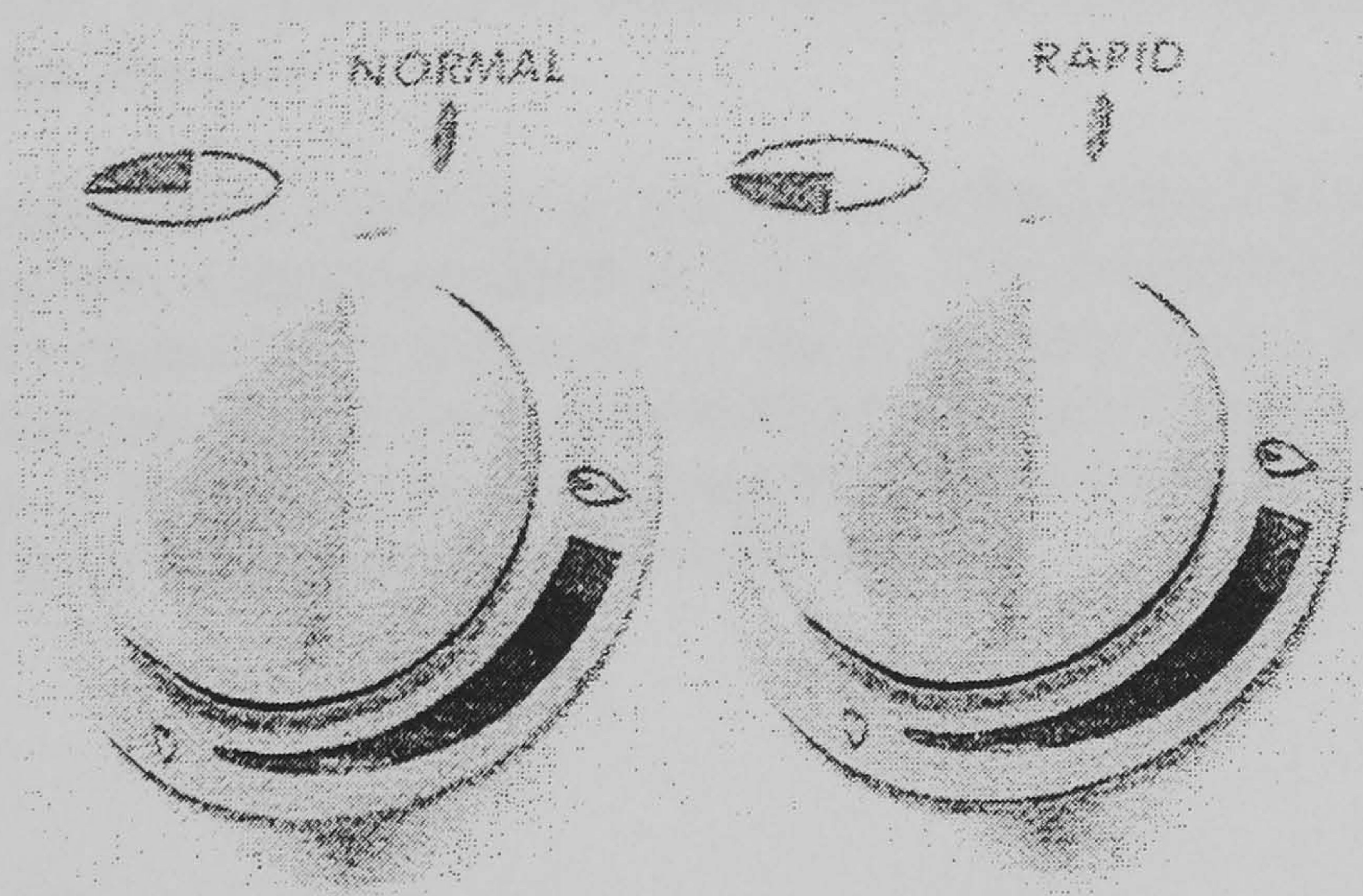
## When should they be used?

Rotary controls can be used for two types of control:

- discrete control where there are set, pre-defined settings



- continuous where the control has variable control such as volume or temperature control

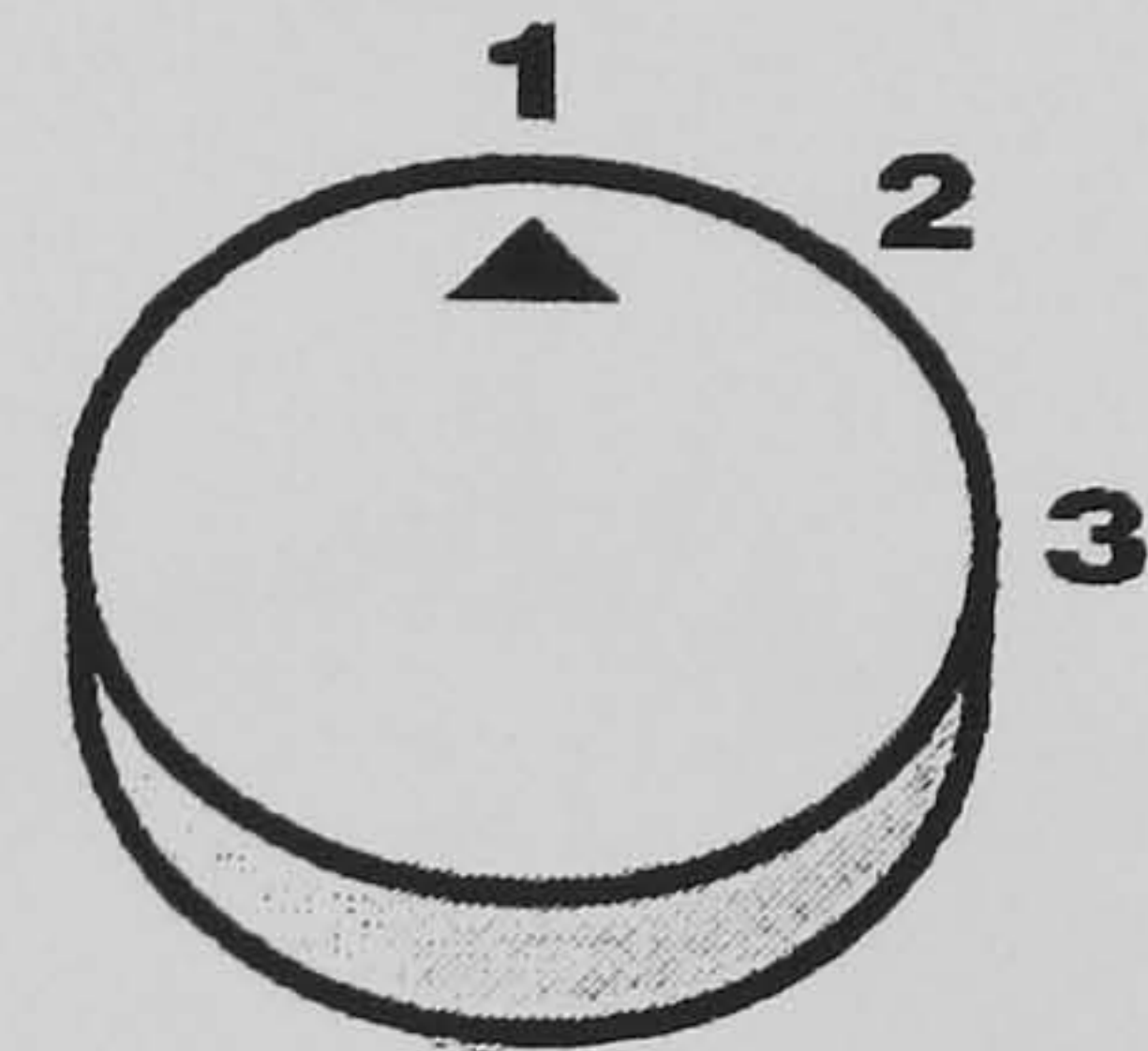




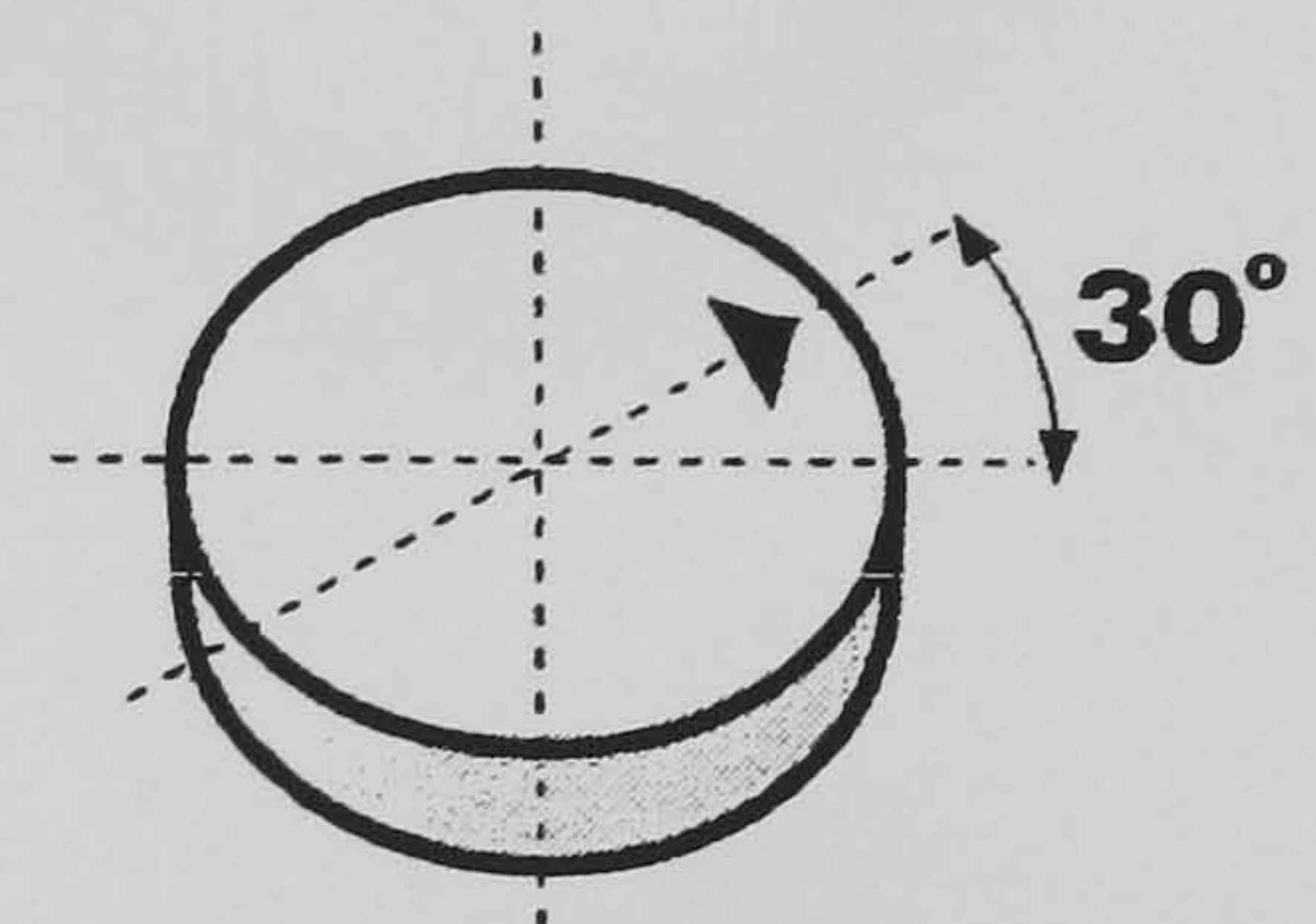
## Design Guidelines

Studies have shown that when visibility is limited, rotary controls are more popular than other controls. Users favour rotary knobs with feel (i.e. resistance within the control).

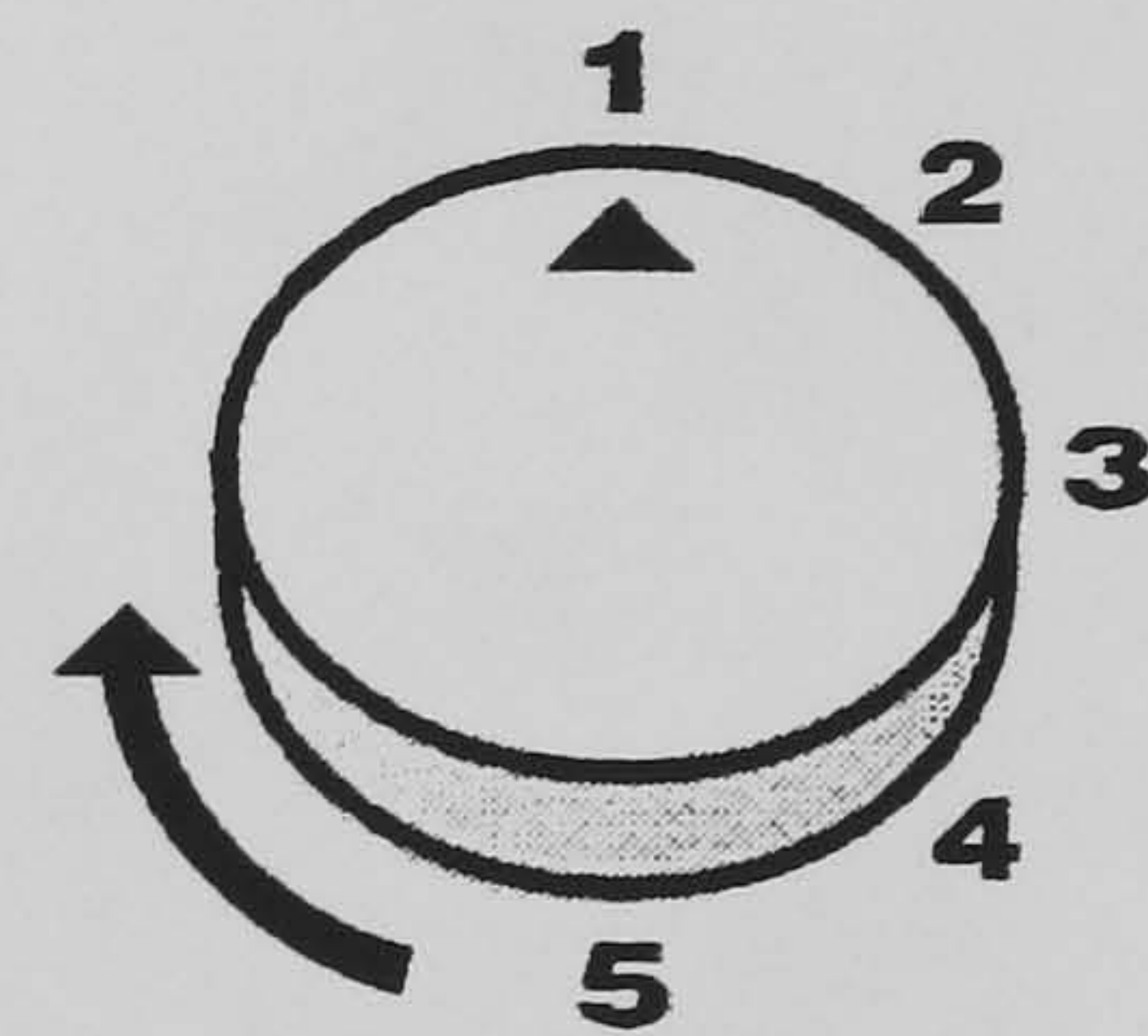
Selector switches should have fixed scales and moving pointers



When few settings are required the settings should be separated by about 30 degrees



Settings should increase with a clockwise rotation

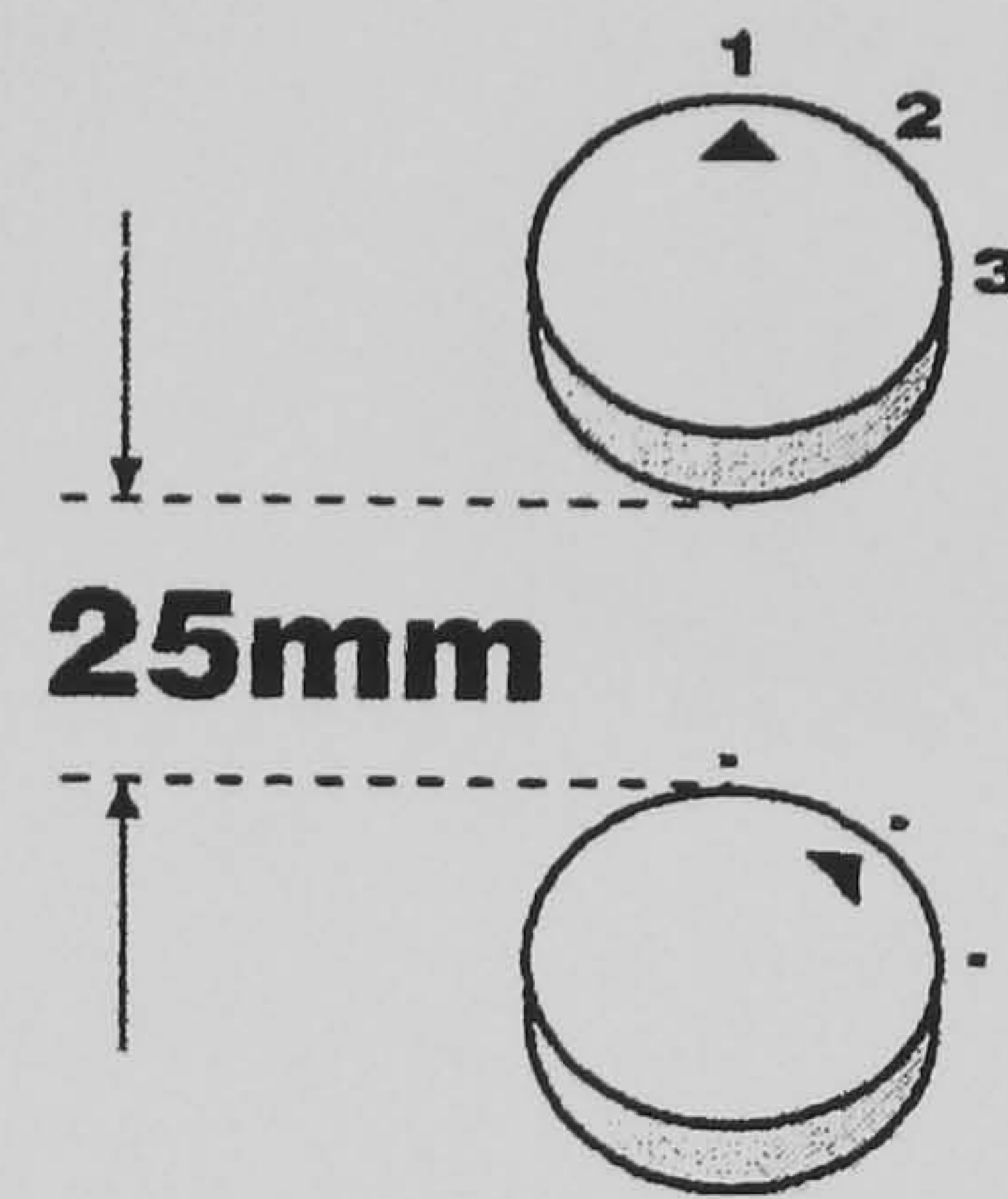


Each discrete position must be labelled to indicate the position of the control, if numbered then these markings should increase in a clockwise direction.

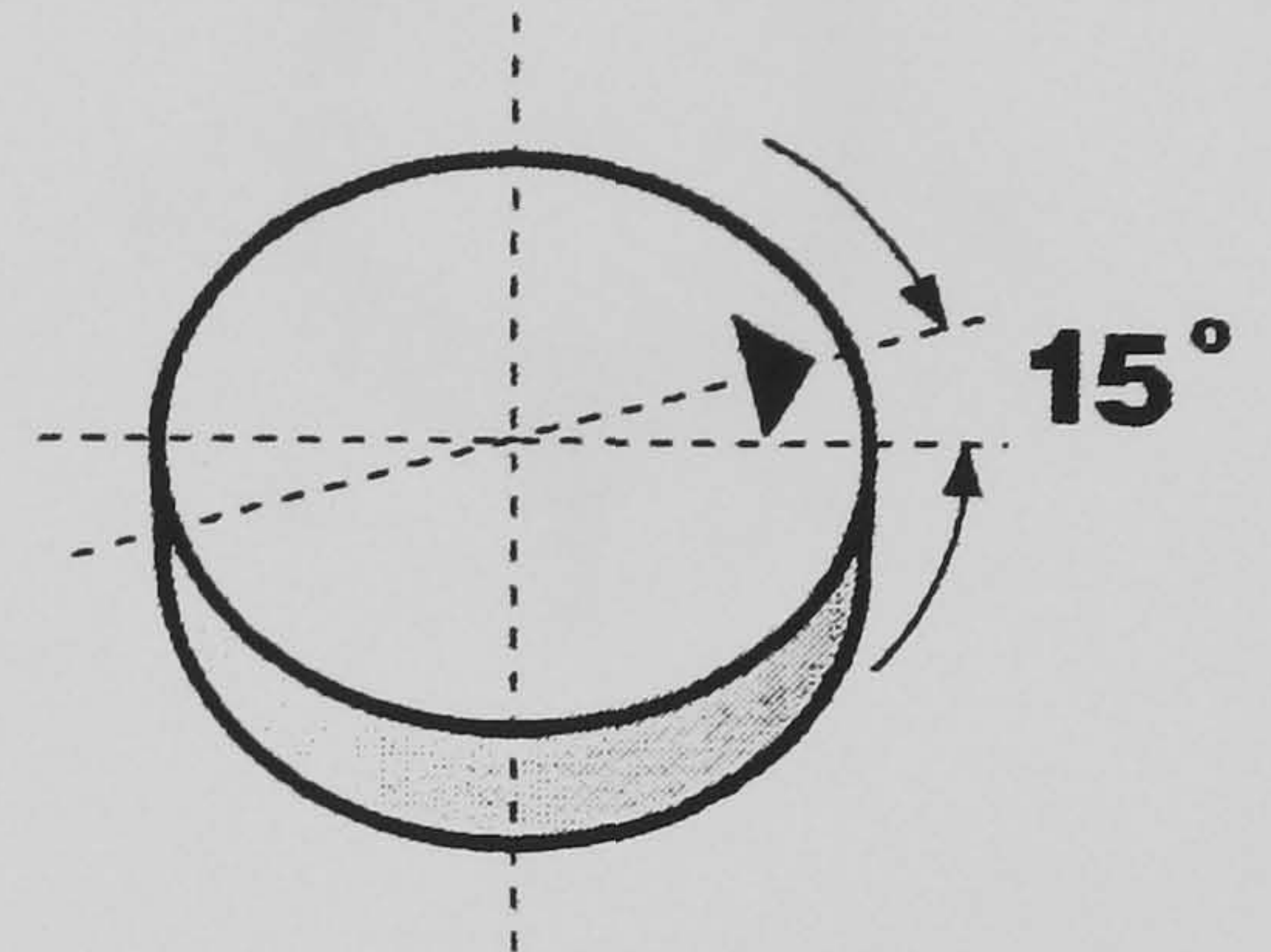
The smallest dimensions for a rotary control should be 6 mm in diameter with a minimum depth of 7.5 mm. The preferred minimum size for a control knob is around 13 mm in diameter and in depth. Small controls should have some form of serrated or textured surface. If the knob is to be tapered, then the outside diameter should be 5 - 8 degrees less than the outside.



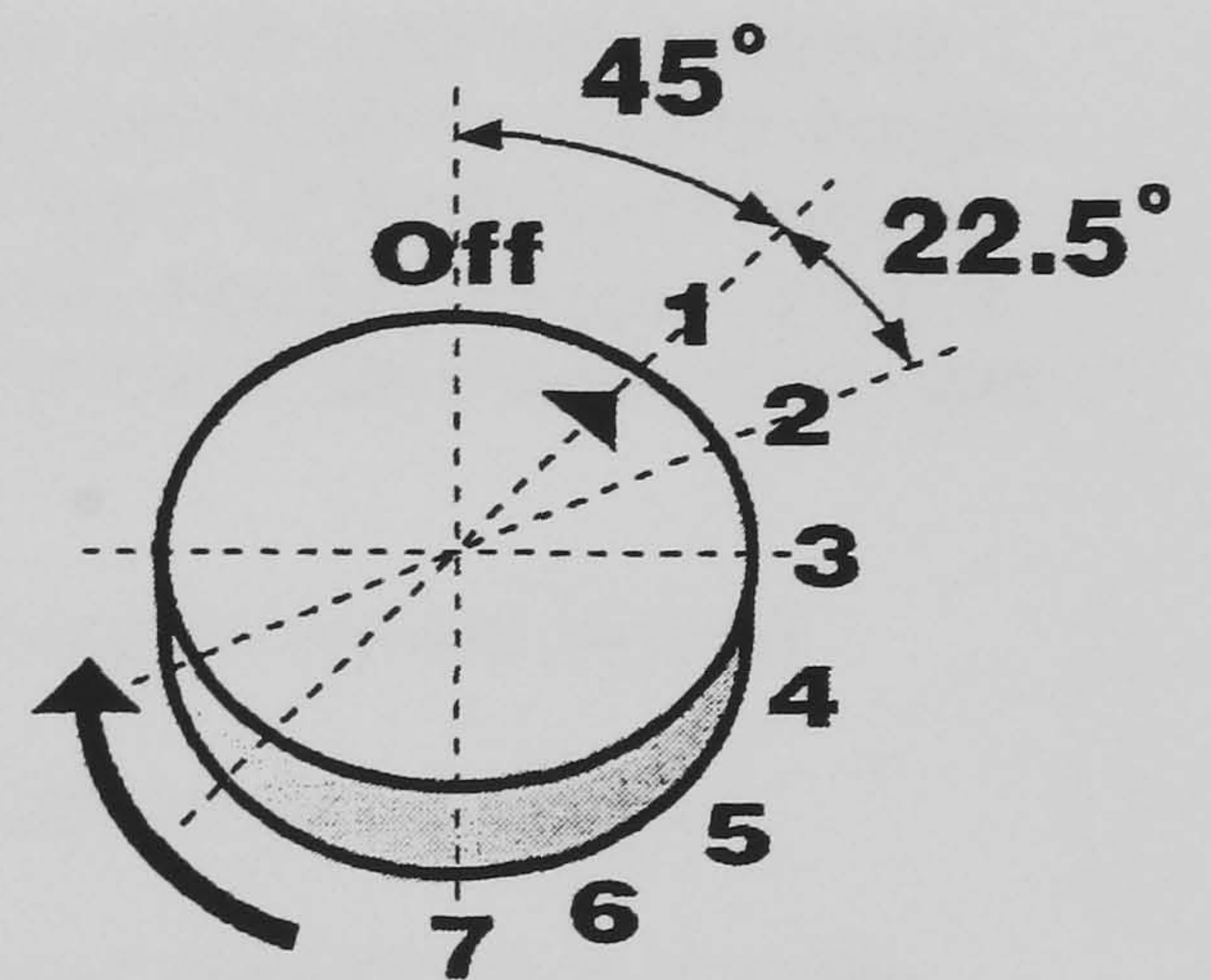
Minimum recommended spacing between rotary selector controls is 25 mm



For speed and ease of operation there should be no less than 15 degrees between settings



When less than 24 settings are required, then the beginning and end of the scale should be separated by a gap larger than the displacement between the adjacent positions

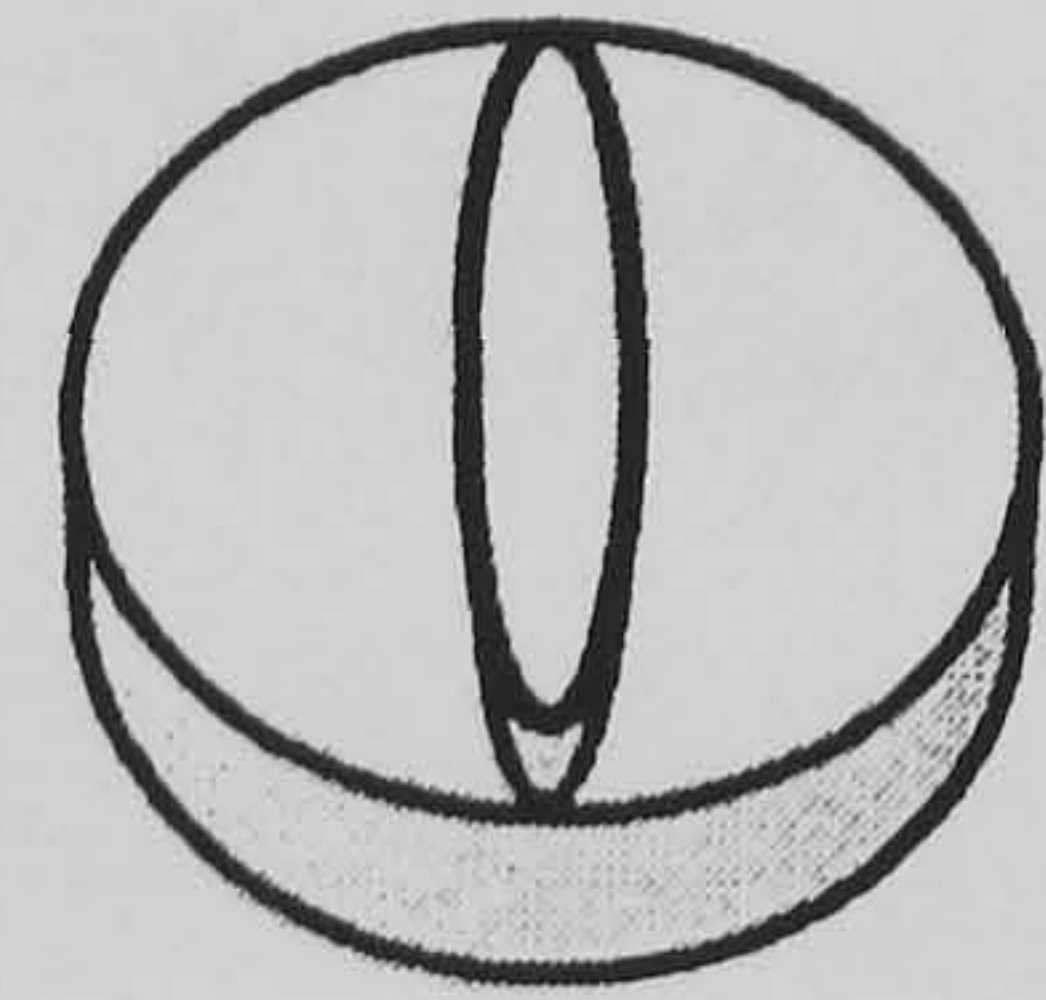


The recommended dimensions for a rotary control in frequent use is between 25 mm and 50 mm in diameter and should have a depth of least 20 mm.

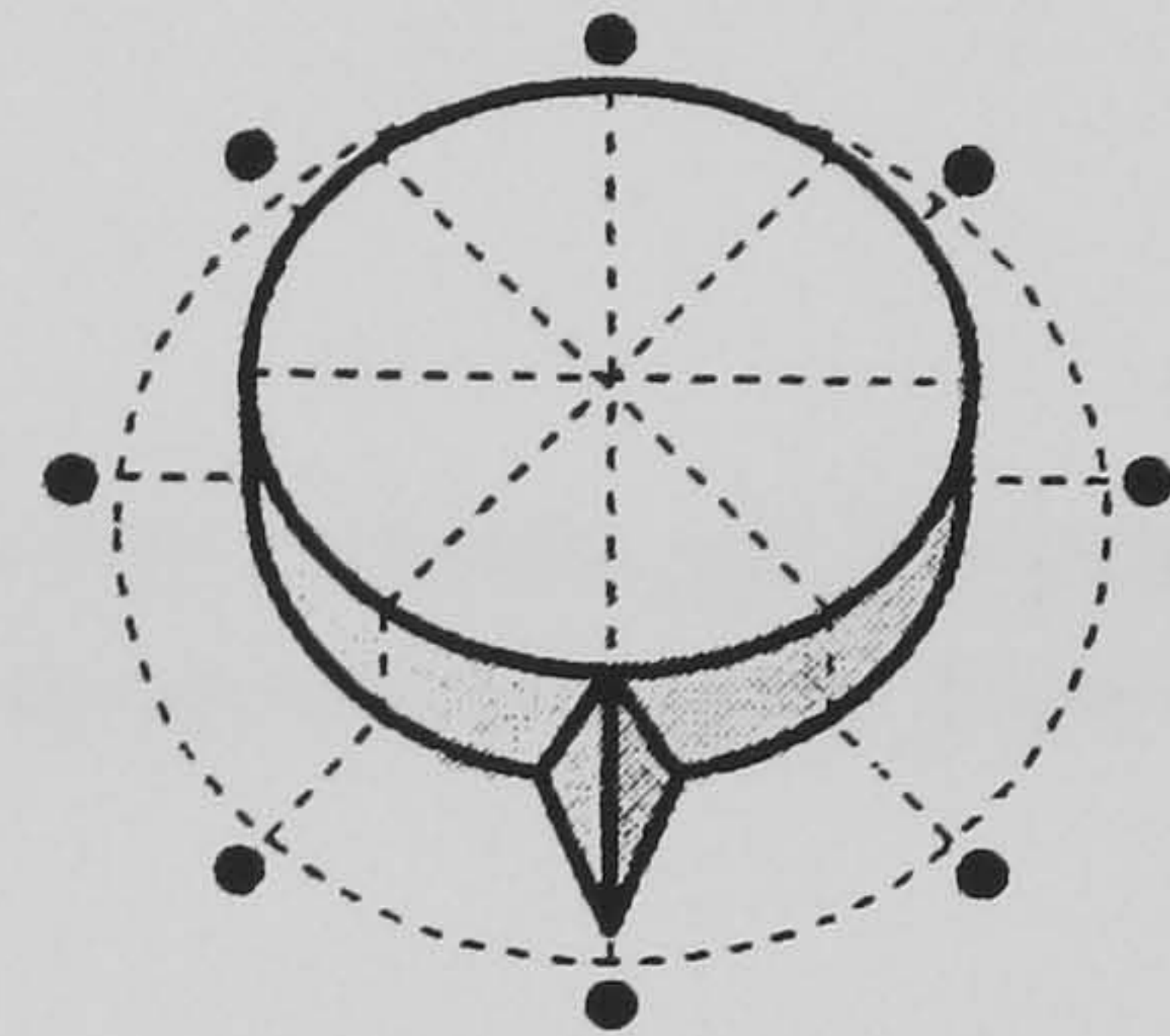
If precise movements are required a larger control knob will be required (40 mm - 75 mm)



Grasp area should have some method of increasing friction to prevent fingers from slipping



Minimise parallax by designing the end of the pointer to come close to the scale index



The simplest rotary control design is a circular knob with a notch or dot on the outer edge to indicate the position of the control, though it can have a raised bar that extends upward at least 13 mm from the base of the control, with one end usually tapered to a point. If this is the case then the length of the pointer should be at least 19 mm and the width at least 3 mm.

Detents should be provided at each control position (setting)

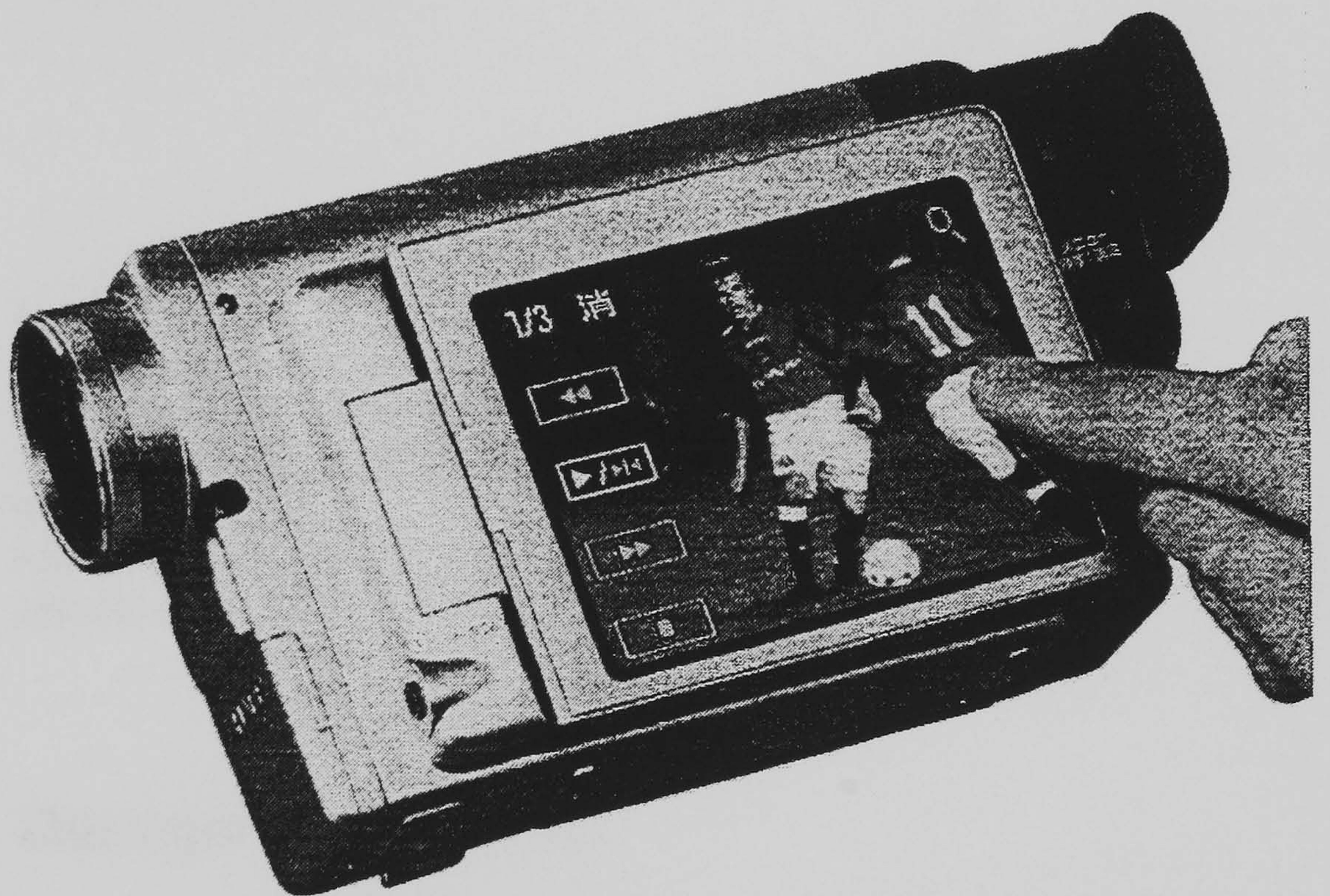
Audible clicks should be provided to give users feedback

Index numbers should not be obscured when the hand is on the control



# Touch screens

Touch panels are a 'natural' input mechanism. Users usually prefer and respond faster with a touch screen as an input device than with other types of input devices.



## When should they be used?

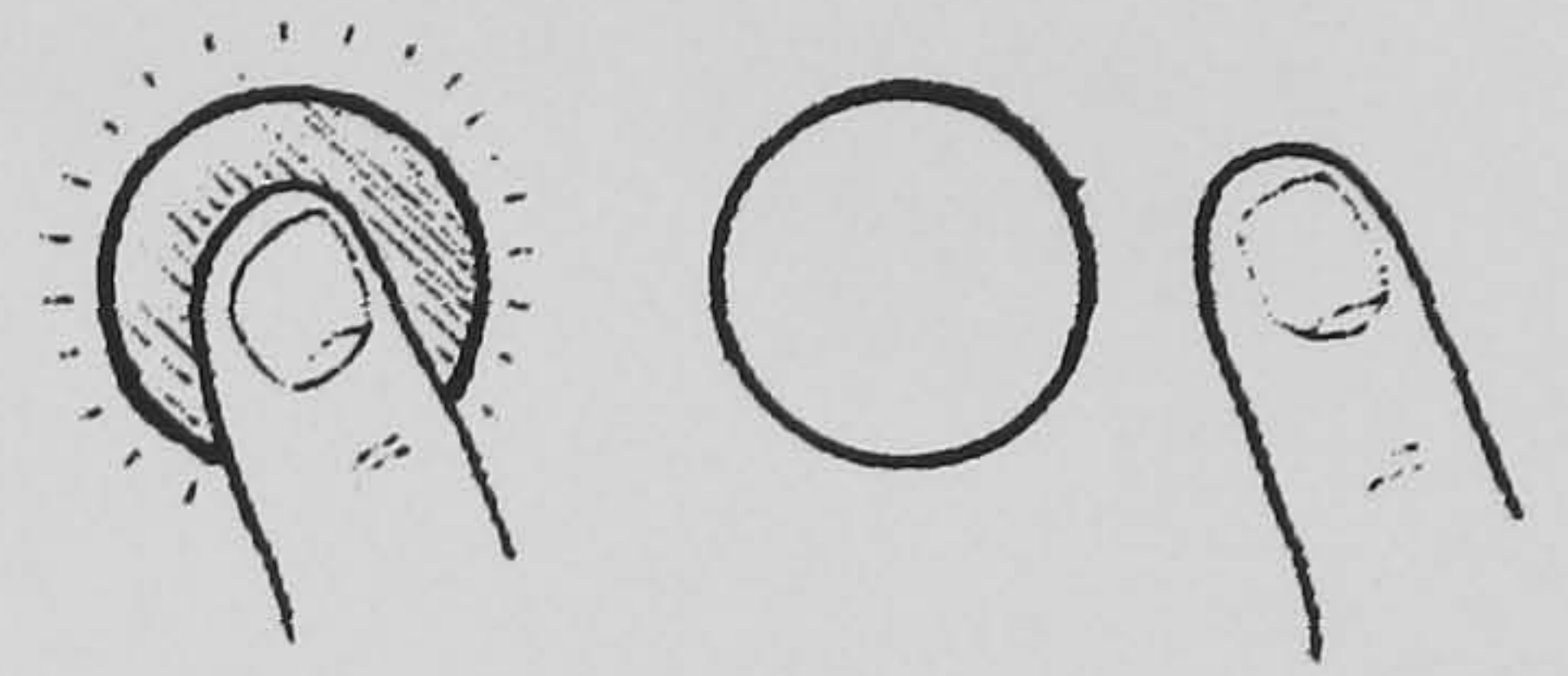
The benefits of using touch screens are

- uses a natural interaction style
- little or no training required for a user to operate a touch screen
- are easy to operate for both experienced and inexperienced users
- have a familiar action for users
- however, when using touch screens there is an increased level of hand-eye co-ordination.

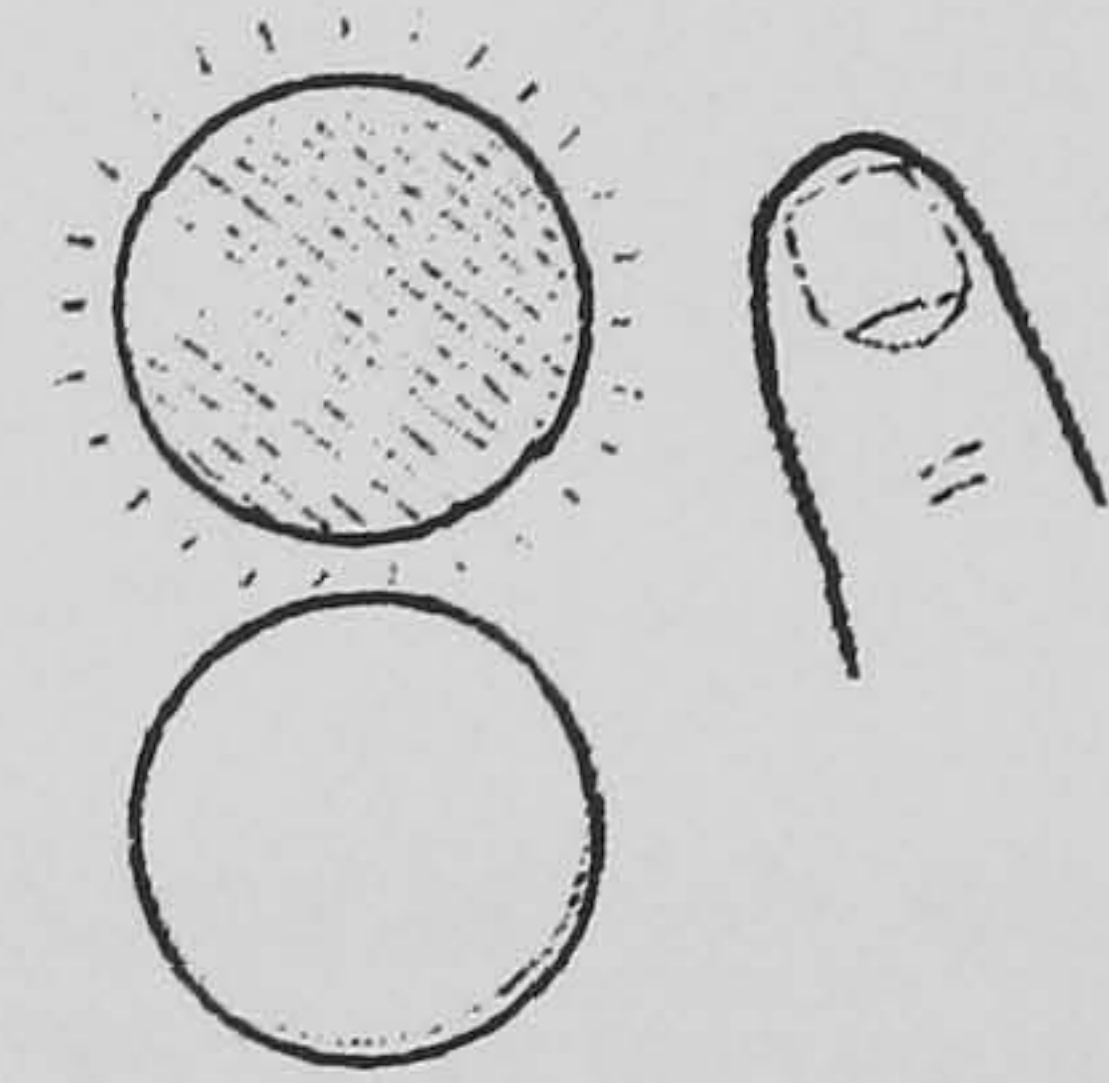


## Type of activation

**Land on:**  
finger must land directly on  
specified target.



**First contact:**  
first active area of screen  
touched is selected.



**Take off:**  
last active area of screen  
touched before removing finger  
is selected. Users may move  
fingers round the screen.  
Needs to have a small cursor  
placed slightly above the finger.



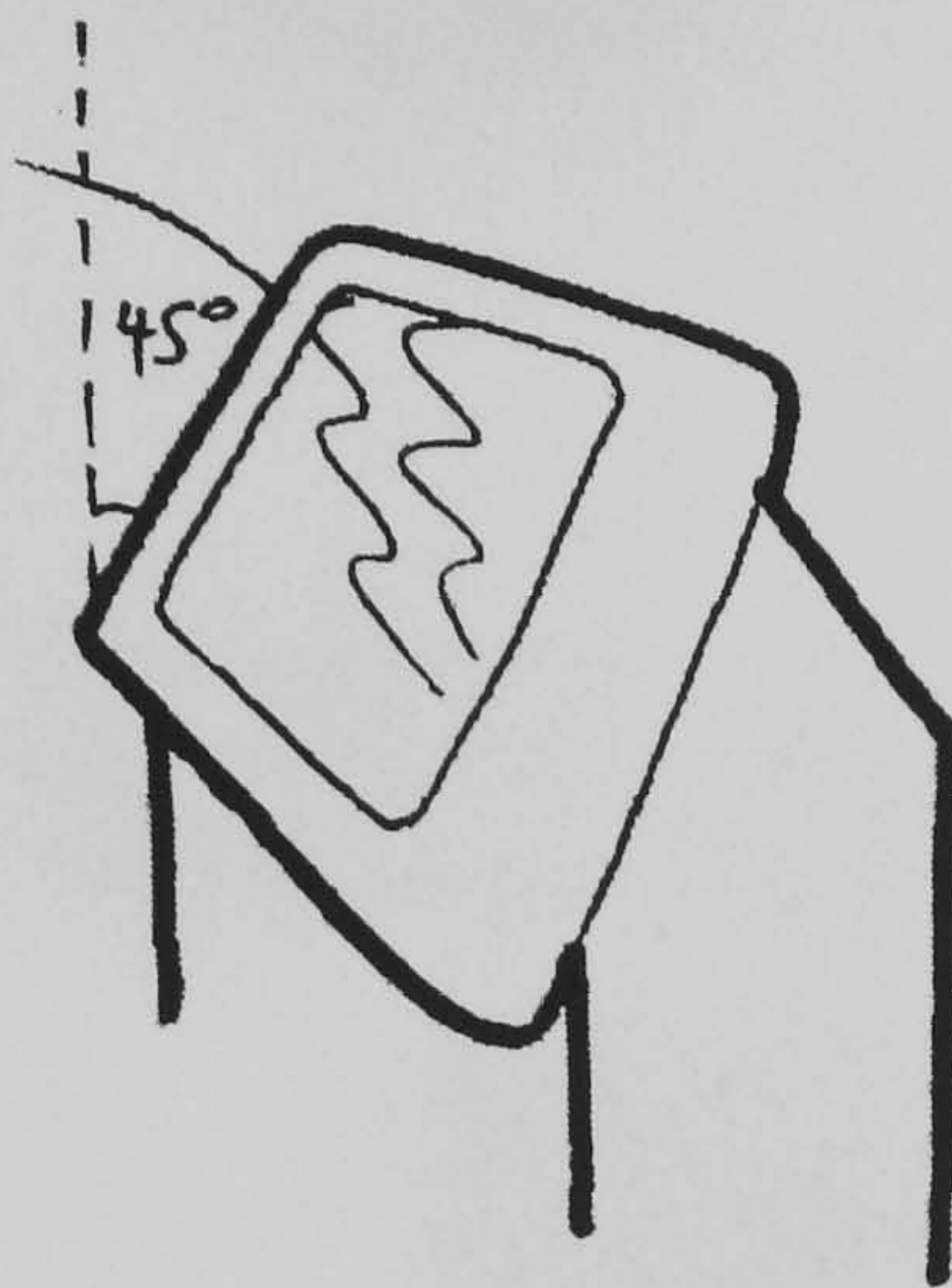
## Design Guidelines

Parallax between the touch screen surface and the display surface can cause users to misinterpret where their finger is actually touching by a significant amount. A small cursor can be employed which appears just above the user's finger. This device provides continuous feedback about the position the user is pointing to. This method tends to be needed more in a finger off selection strategy.

For most touch screen devices, use first contact as it has a lower error rate than land on selection and faster to use than both land on and take off selection strategies.

Take off selection strategy produces fewer errors in items selected than first contact selection and can be used for considerably smaller targets. Take off strategy is also considerably slower to use than the other methods.





Users who are standing to operate touch screens prefer them to be at an angle of 45 degrees provided that the glare onto the screen is controlled.

More errors are made at the top of a vertical computer screen (at eye level) than at the bottom. This is caused by the relative positioning (extension distance) of the hand/arm and parallax.

Objects in the lower section of the screen are more likely to be obscured by hand when selecting objects from upper region of screen.

Users are more likely to hit just below a target on a screen positioned at an angle of 45 degrees.

Smearing can be a problem but this can be overcome if the screen used is lightly ground.

### What is parallax?

This occurs when a pointing device e.g. the minute hand of a clock or your finger appears to be in a different position. This is due to the viewing angle making the pointing device appear to be in a different place to the background.

Arm fatigue is a problem if the device incorporating the touch screen will be used for long periods of time.

## Feedback

A major problem with touch screens is the lack of tactile feedback to the user. This lack of feedback can lead to errors. Good feedback increases user accuracy.

Auditory feedback can be used and shown to make reactions of user faster and more accurate. Some research suggests that touch screen buttons should beep and change in appearance from hollow to solid when active.

Use visual cues such as buttons changing colour, shape, position, etc. to convey function.

Coding and labelling can be achieved by label size, colour, brightness and backlighting effects and also to indicate state changes.





Indicate the state of the device unambiguously, for example 'greying out' a button suggests that it can not be used

Try to suggest to the user how a change in state can be achieved or what the function is doing, for example auto defrost can be represented as a three frame animation.



The active area must acknowledge the action of the user, for example by making the button appear to depress



## Touch screen based interaction devices

Interaction device	Ease of use	User preference
1 button *	very easy	high
2 button (e.g. On/Off)	moderate	high
rocker switch	moderate	high
words only (ON/OFF)	difficult	moderate
slider	difficult	low
lever	difficult	low

\*The major problem with using a one button device is that it is sometimes difficult to determine whether the device is on or off.



## Size of target areas

For take off strategy this can be accurate to a level of 4 pixels by 4 pixels provided that the screen is stabilised. A first contact touch screen works best for 16x16 pixels.

For first contact and land on strategies, the touch area must be larger than 20-30 mm<sup>2</sup>. The touch area works most efficiently when it comprises of the whole button and not just a small part of it.

Users will operate the device more efficiently if buttons to be used look familiar (e.g. light switch, rectangular buttons with icons within them. Ideally the touch area should encompass the entire target choice or object plus one character space surrounding it

## Colour of the touch screen interface

Choose colours which contrast the text colour well - for example

Text	Background
white	magenta red green blue
yellow	blue
cyan	blue
green	yellow white
magenta	blue white
red	white yellow cyan green
blue	white

Try to avoid bright backgrounds with dark text as bright colours appear more dominant.

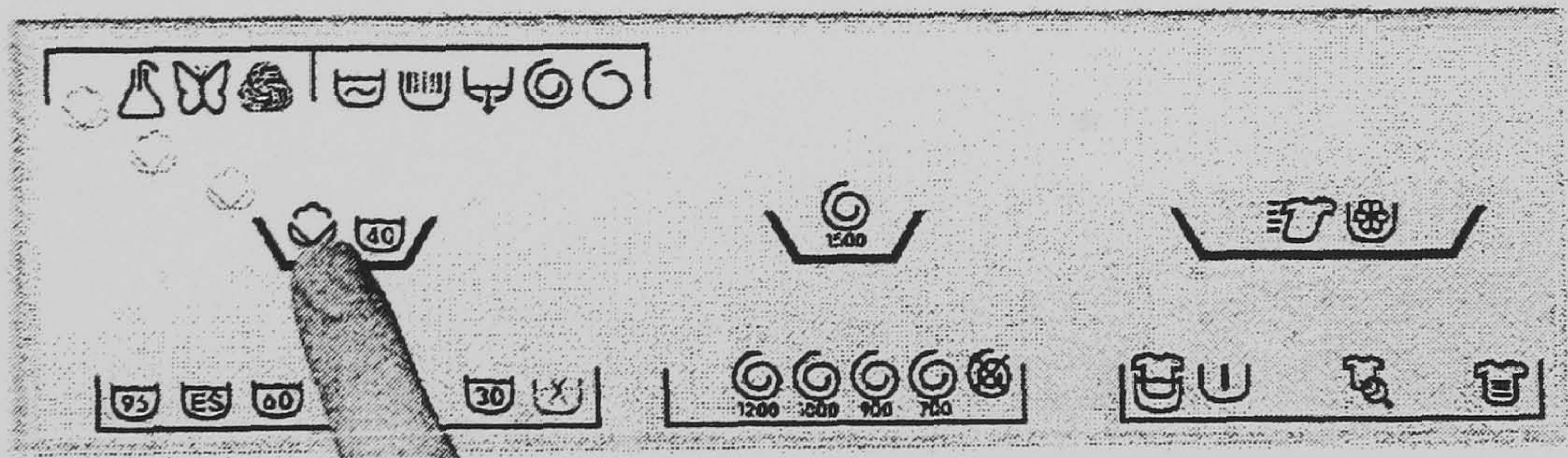


Direct Manipulation

Direct manipulation is the ability to select an object on the display and perform an action on that object either by moving or selecting it. This tends to be an 'intuitive' interaction style as it is analogous to moving 'real' world objects also a familiar concept used with computer interfaces.

Advantages	Disadvantages
Easy to learn	Direct manipulation usually relies on some form of metaphor or analogy to convey the relationship between the objects and their functionality, selecting an appropriate metaphor can be difficult
Intermittent users remember operational concepts	Describing actions or relationships between objects can be difficult
Less need for error messages	The use of metaphors and analogies could constrain design thinking and innovation
Moving from one interface state to another is usually explicitly presented	

In the example below, icons are moved around the touch screen with the finger, allowing the user to select and spatially build up a washing programme





# Things to think about

Below is a checklist to ensure that good design principles have been considered.

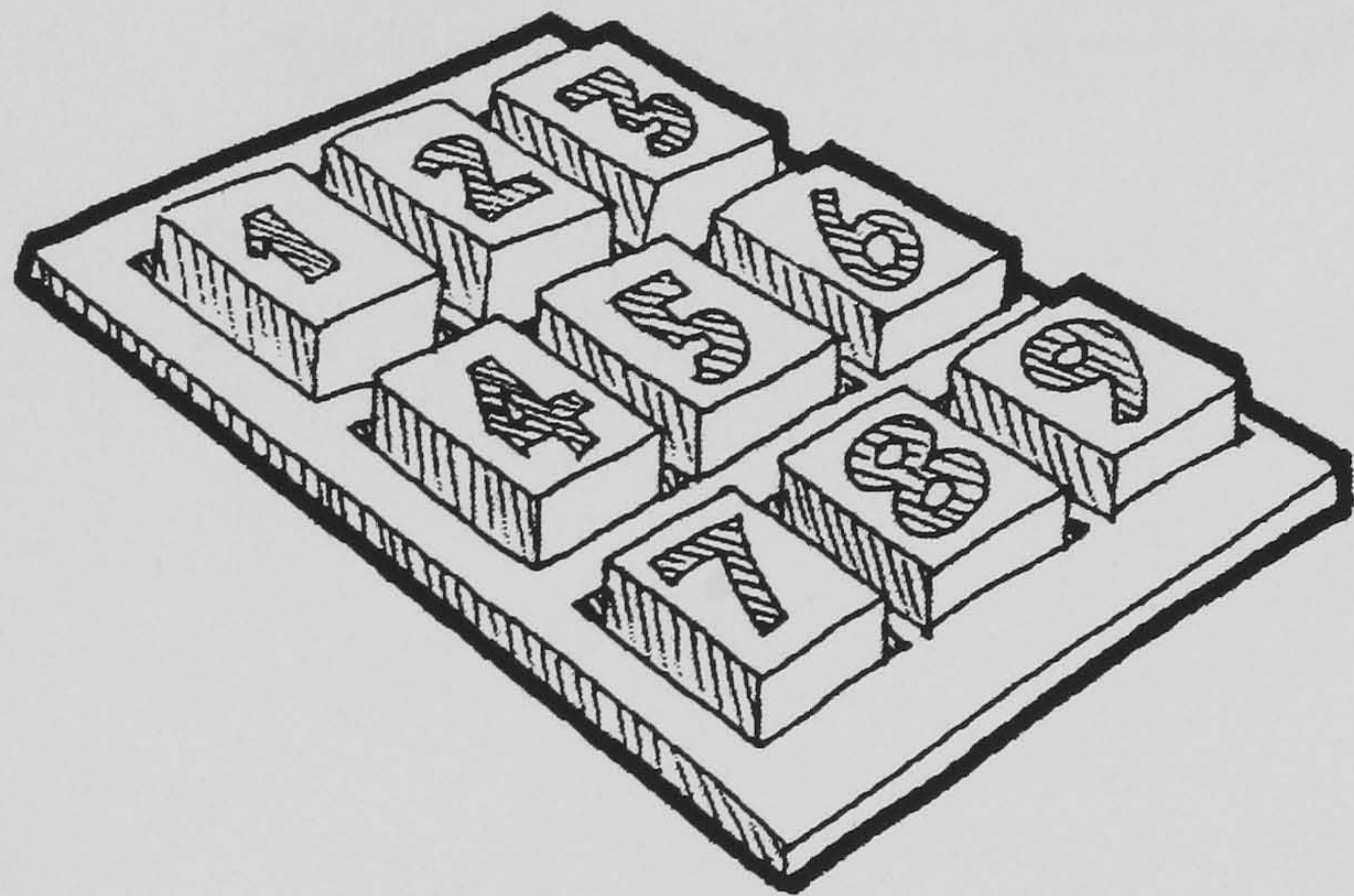
	✓	✗	N/A
Can the user control the control the type of information which is displayed?			
Are users given feedback that lets them know where they are in the system?			
Is the method of moving from one screen display (State) to another consistent?			
Is it easy to return to the main or home screen at any time?			
Is it possible to 'undo' any accidental errors?			



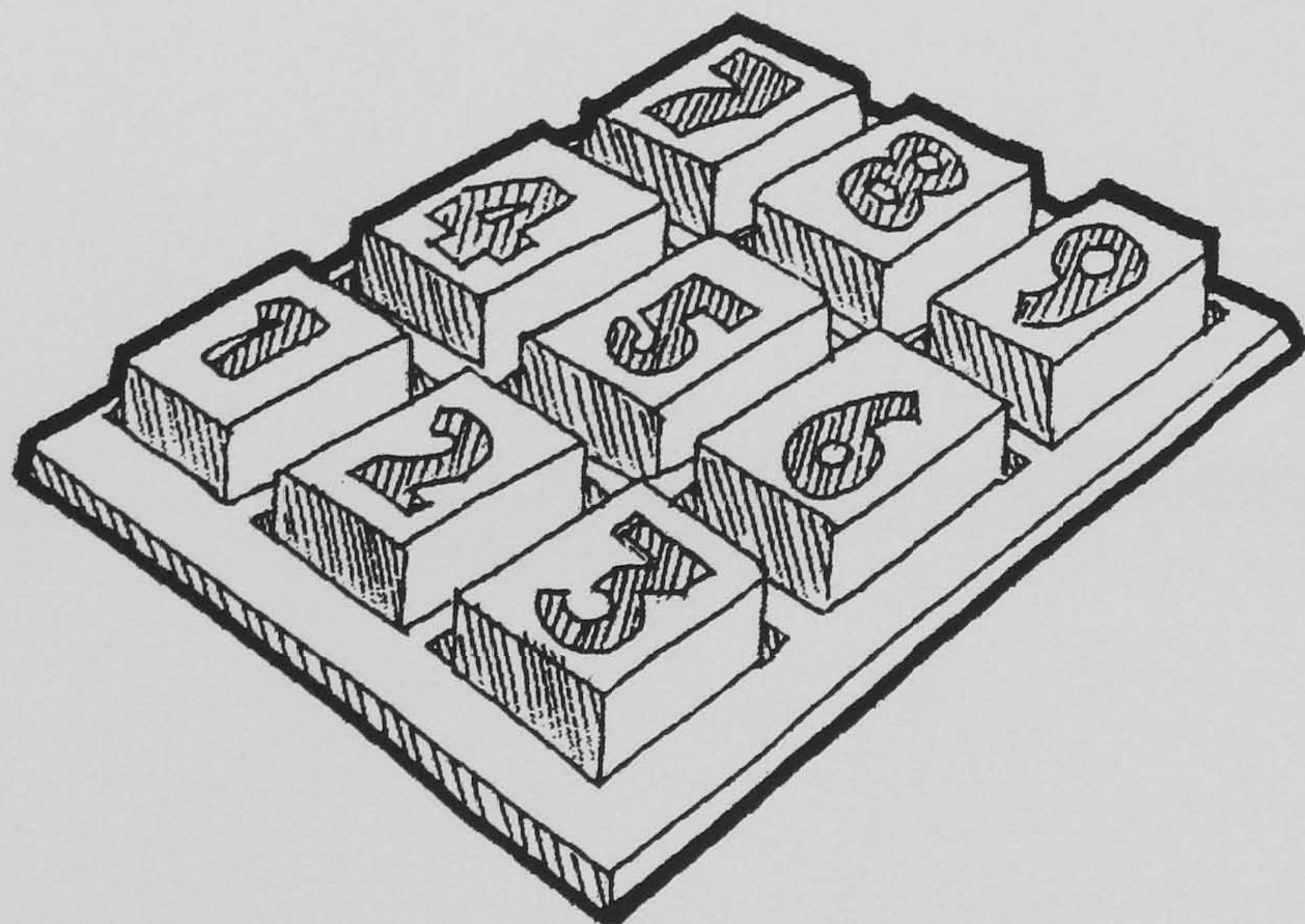
# Keypads

Keypads are defined broadly here as a group of push buttons which are normally used for numerical data entry but can include other data entry tasks such as mode or option selection, for example a microwave keypad panel.

There are two layouts for numerical data entry, these are the calculator and telephone layouts. Studies suggest that user preference for keypad layout is task dependant. However, studies also suggest that when the two formats are compared, there is a significant advantage for the telephone layout. This may be due to the familiarity and frequency of use for this type of format.



**Telephone layout**



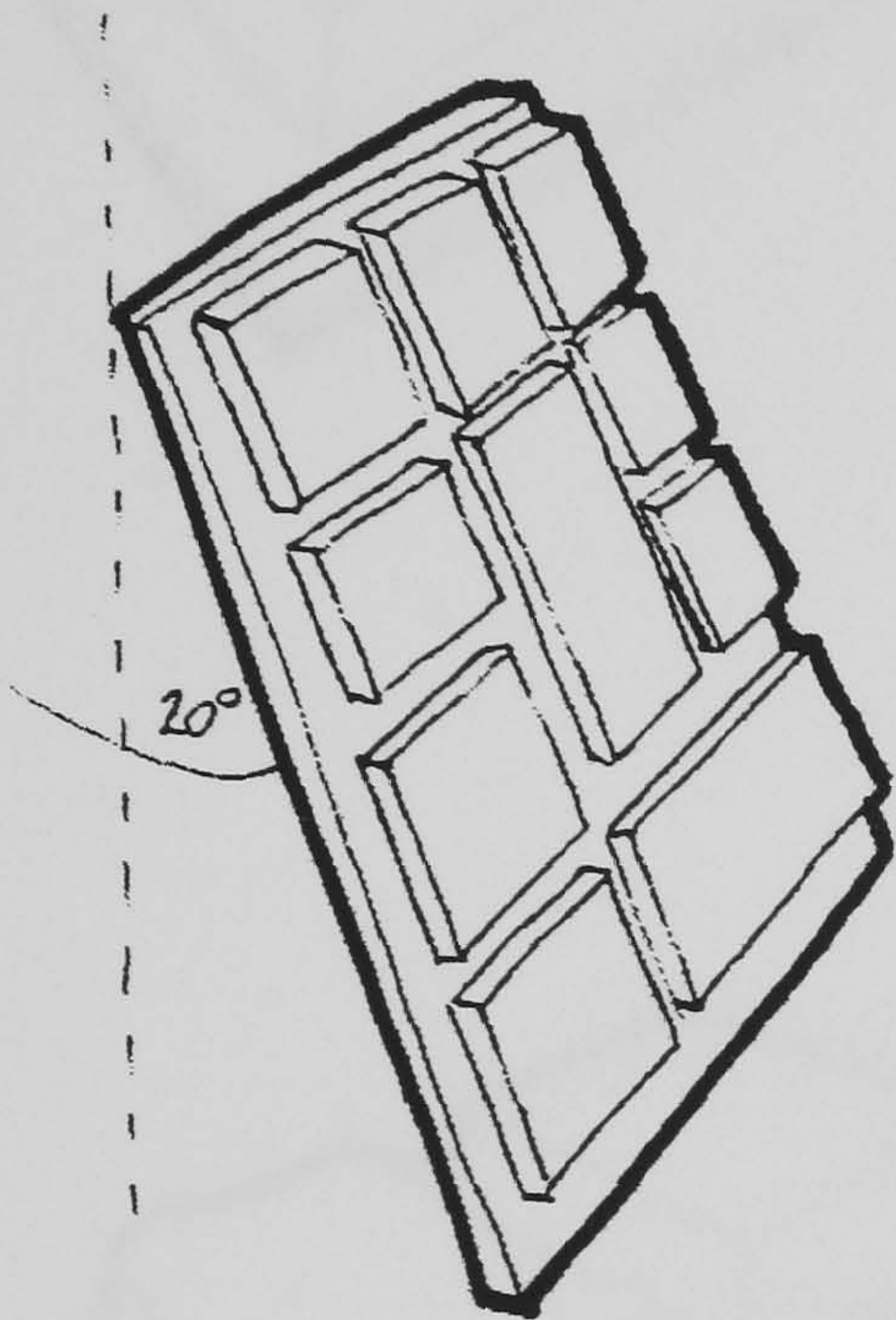
**Calculator layout**



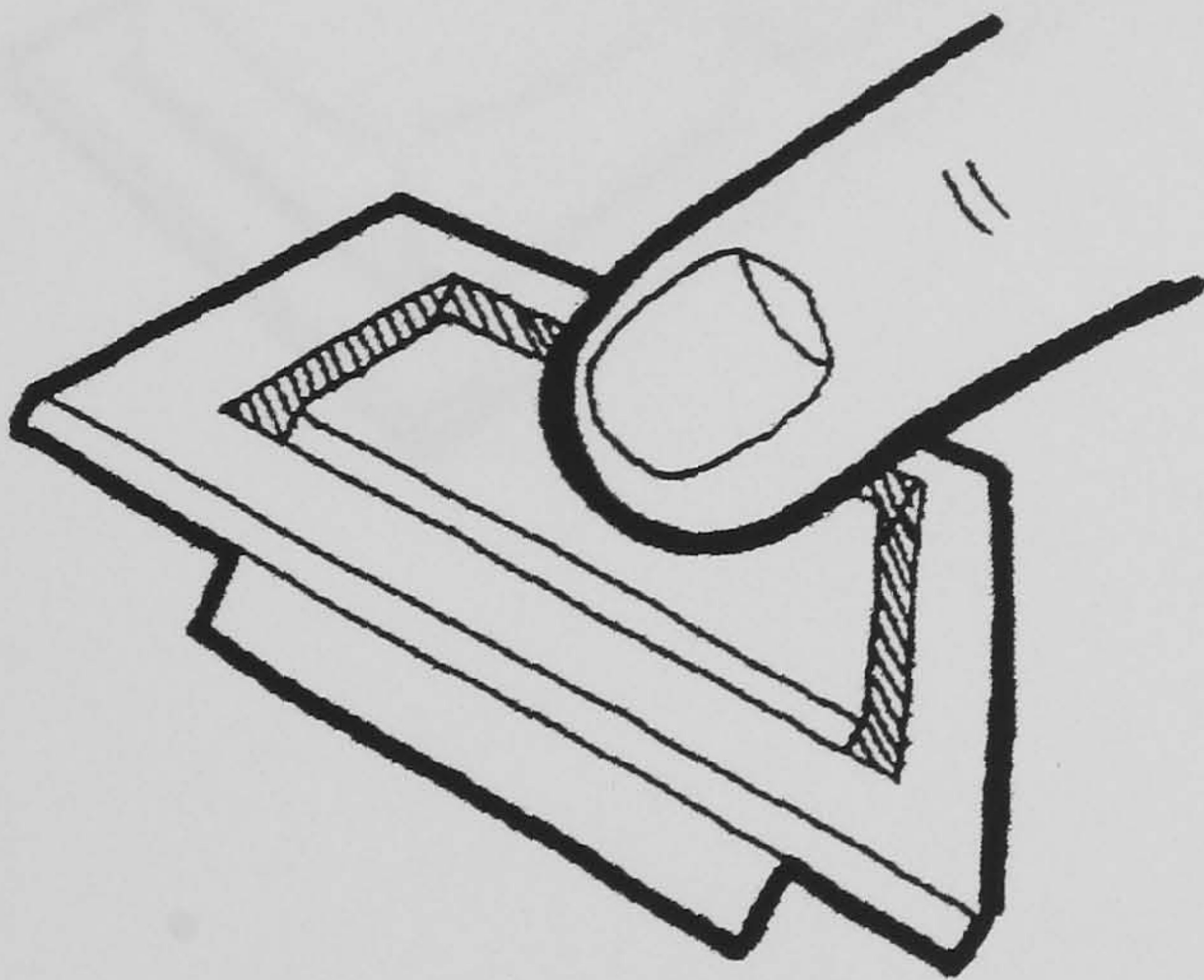
## When should they be used?

Keypads should be used for reasonably frequent data entry tasks (at least more than once a day) and where data entry error can be hazardous (Cash machines are a good example).

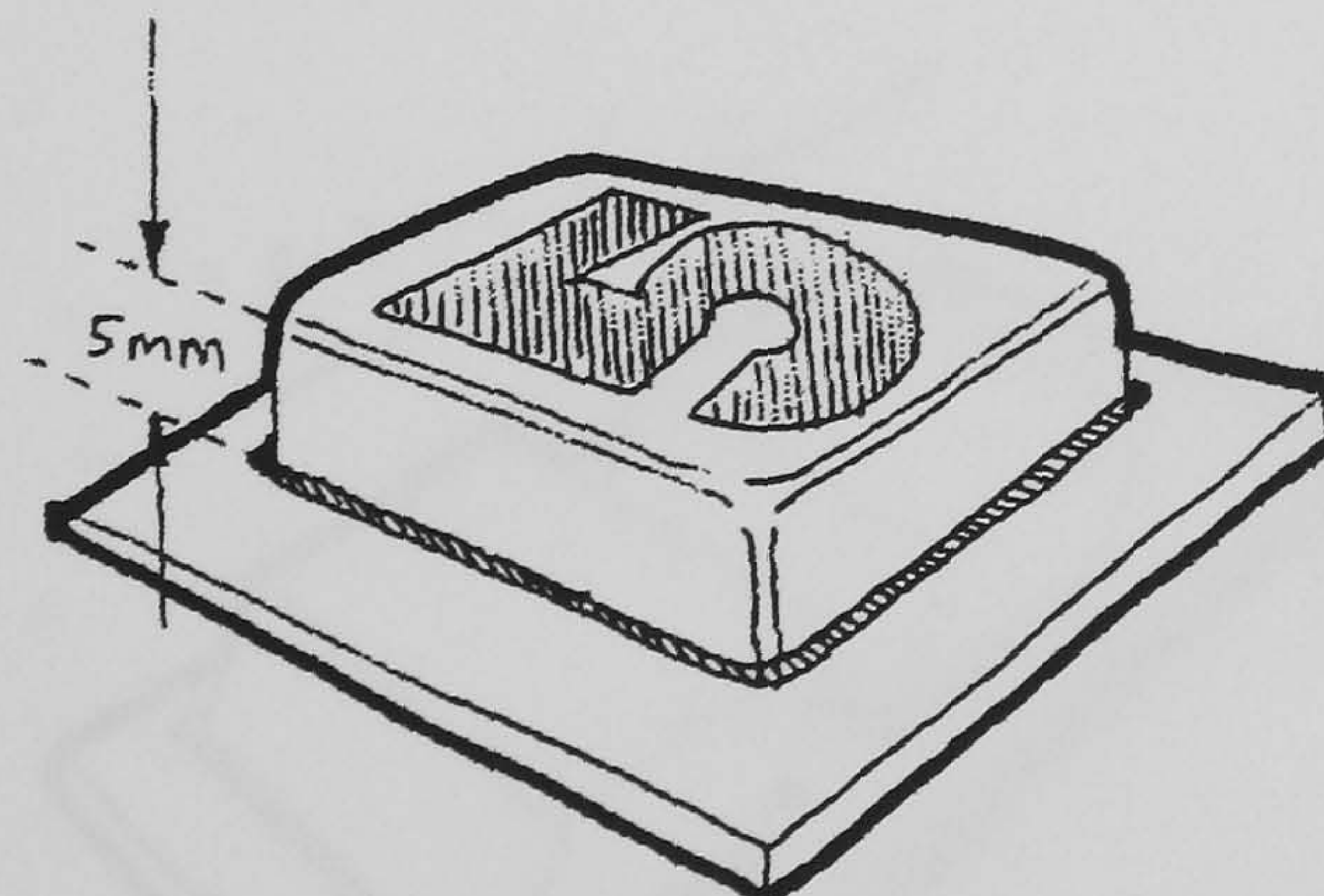
## Design guidelines



If keypads are on a vertical surface, they should ideally be at an angle of 10 to 20 degrees

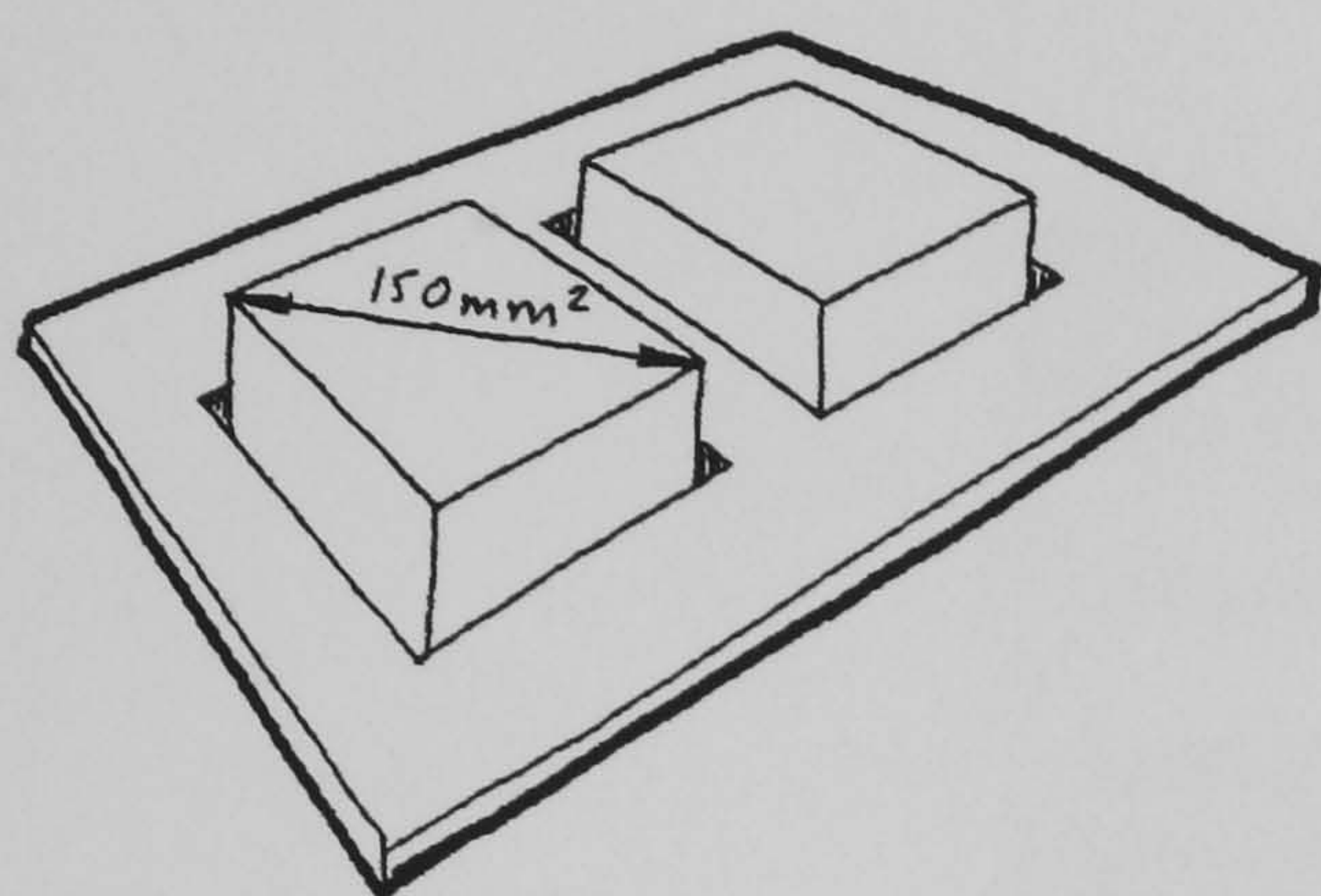


It should not be possible to press keys down further than the panel



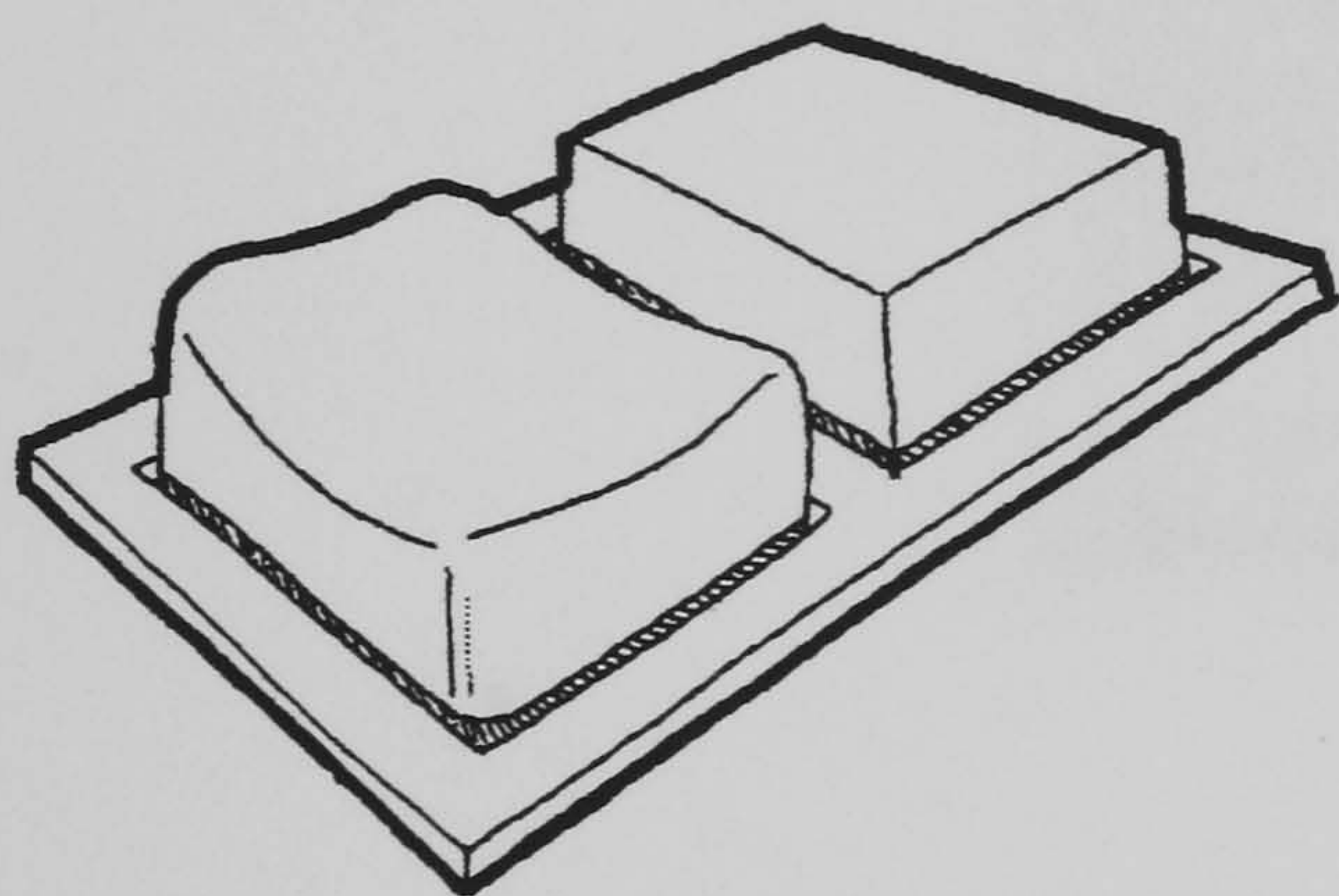
Keys should be raised at least 5 mm above the control panel



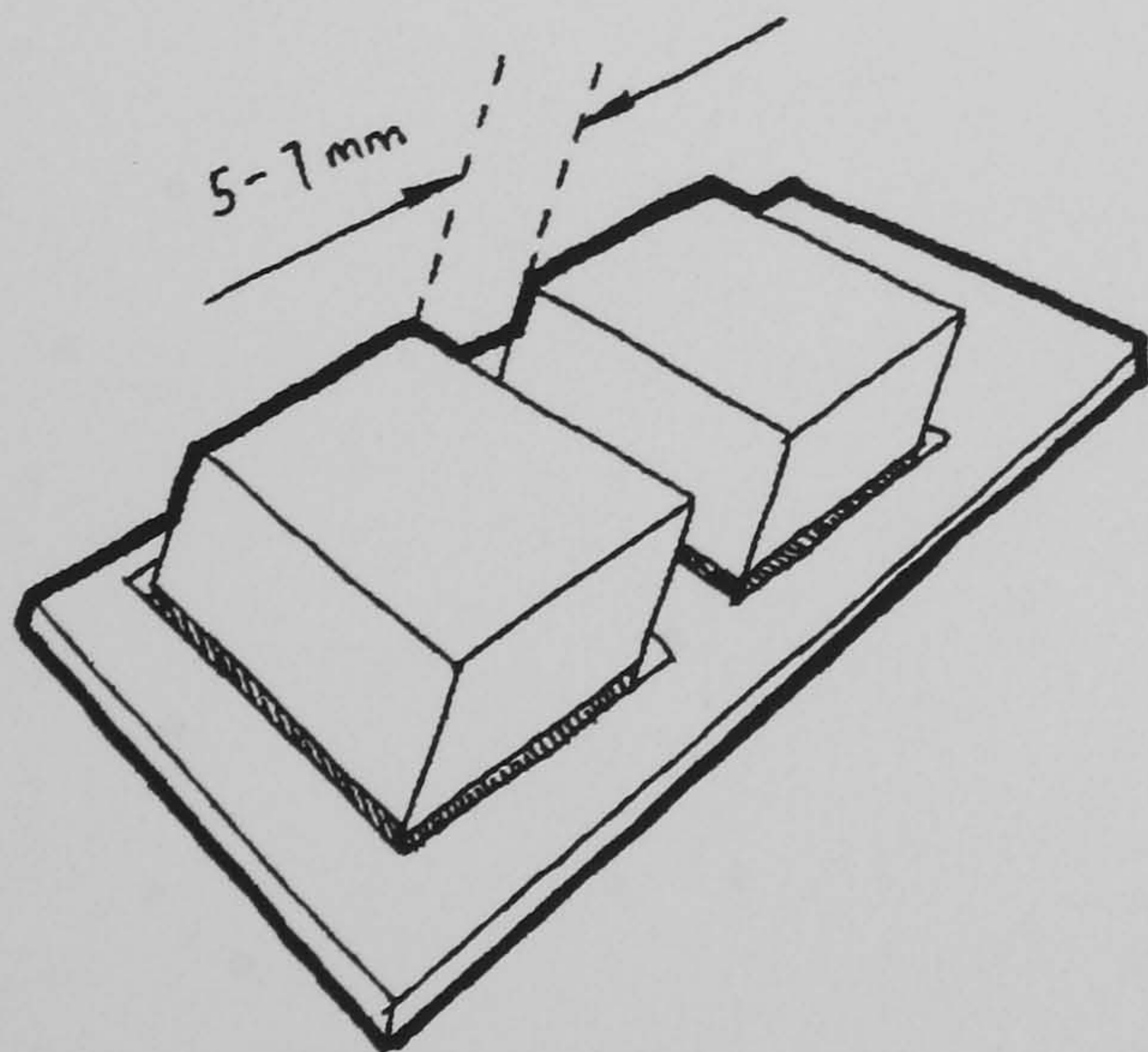


Surface area of numeric keys should be approximately 150 mm<sup>2</sup>

Surface area of other types of keys should be 151-350 mm<sup>2</sup>



Tops of keys should be flat or concave



There should be 5 -7 mm between each key in a key group



# Things to think about

To ensure that key pads comply to good interaction design principles, use the checklist below. All questions should be answered positively.

	✓	✗	N/A
Does key travel have a vertical action?			
Is it possible to jam the keys?			
Can the labelling of the keys be easily read when being used?			
Is possible to activate the keys by pressing the edges of the keys?			
Are the key symbols easily understood by a wide range of potential users such as the elderly and those from different cultures?			
Is it possible to accidentally press any of the keys while carrying out other tasks with the product including picking up or carrying the product?			
Are functionally related keys distinguishable from each other?			



# Switches

Switches are being used less and less on consumer product interfaces. However they provide good visual feedback to their status while also providing good tactile feedback. There are a wide range of switches, but only two of the most commonly found switches on products are discussed here.

## When should they be used?

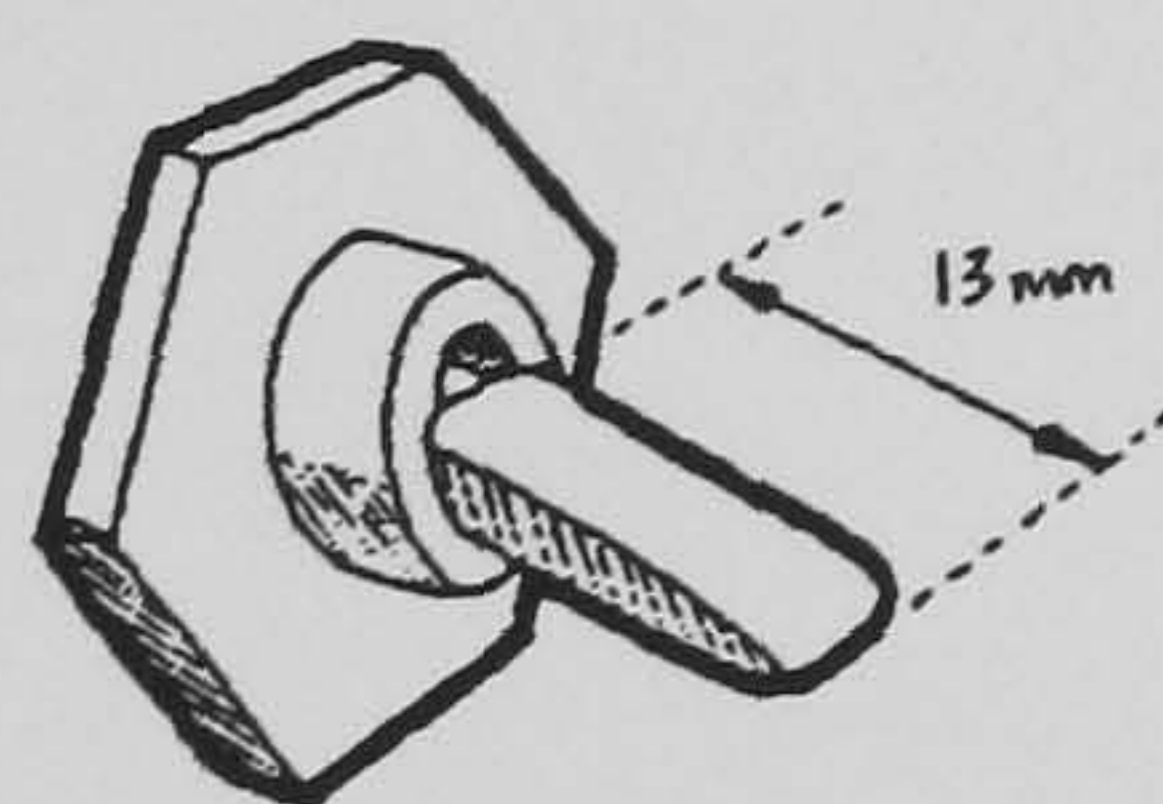
Should be considered where clear visual information is required about the status of two different states, for example as a power 'on/off' device.

## Design Guidelines

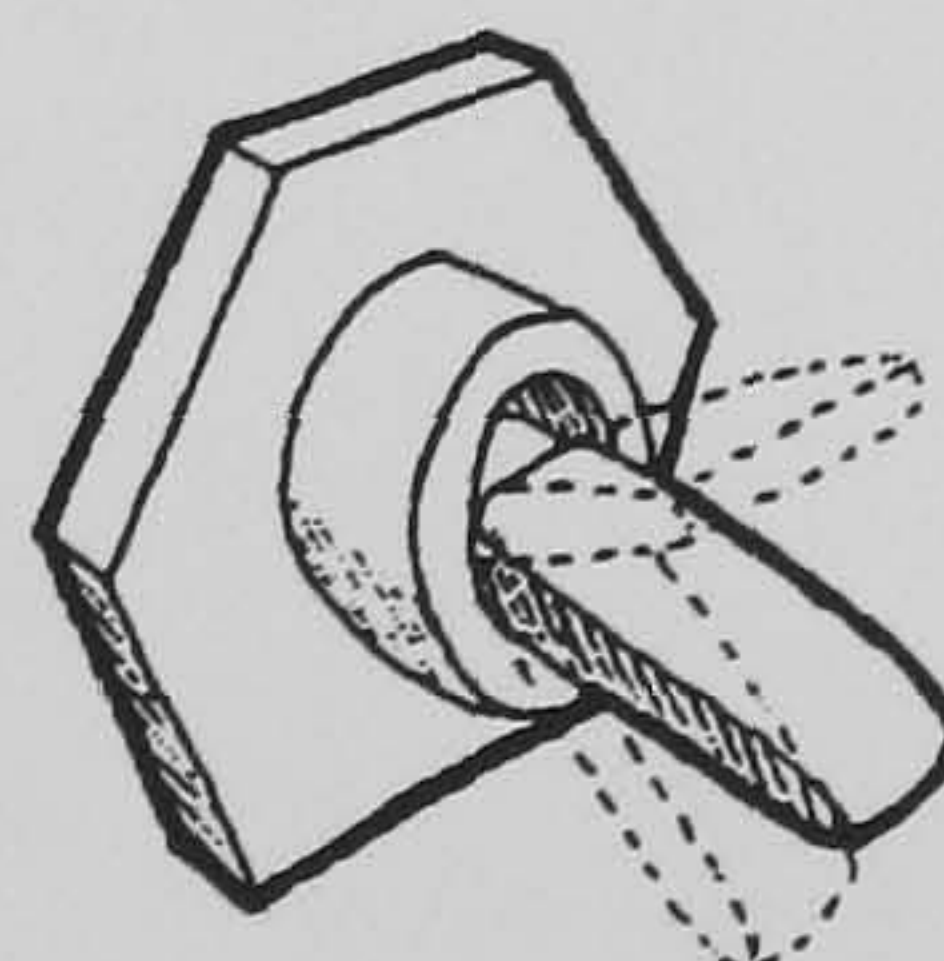
Switches should be designed to snap into position with an audible click.

Try not to mix toggle switches and rocker switches in the same panel area, use one or the other.

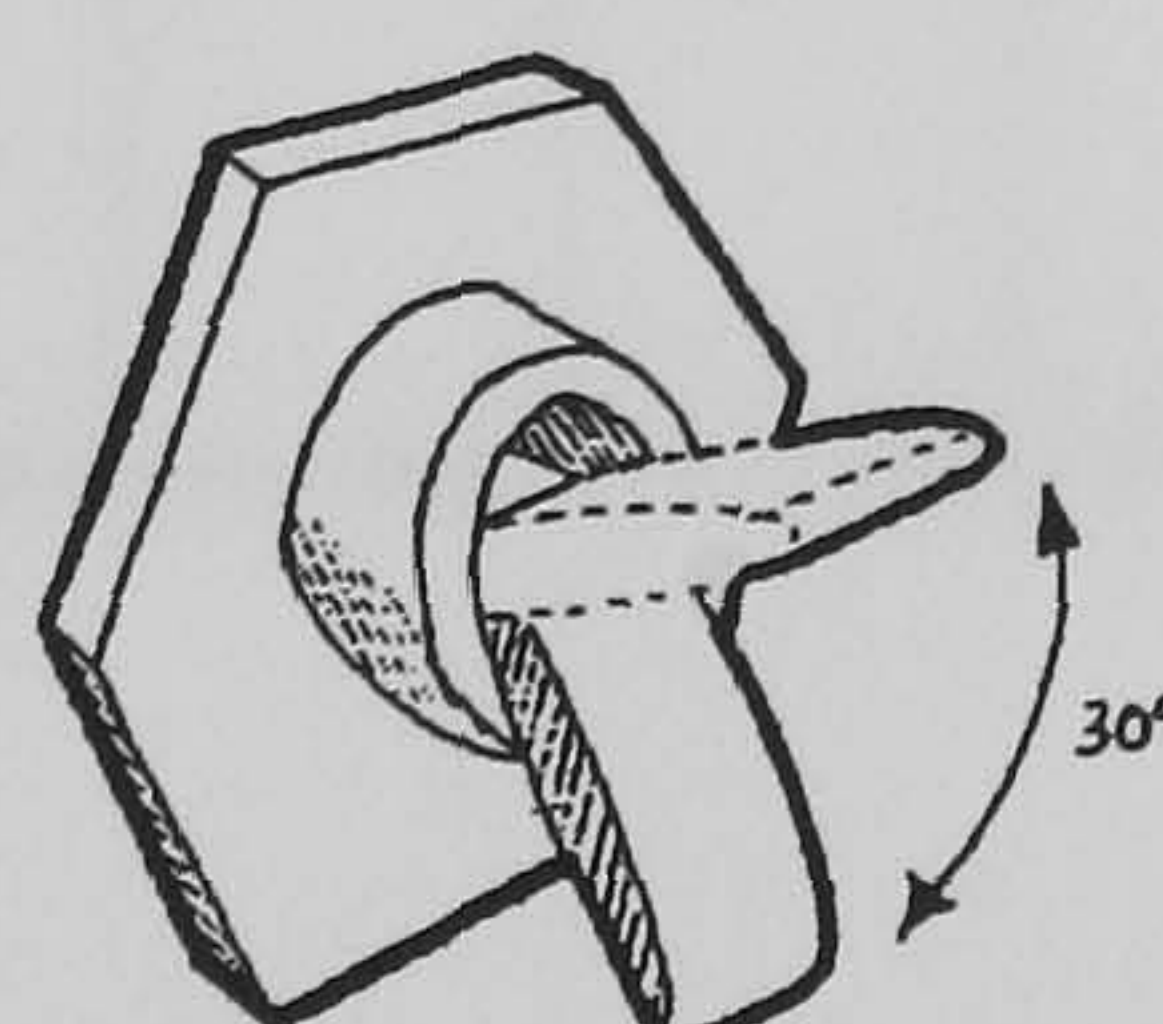
### Toggle switches



The length of the toggle switch handle should be about 13 mm



Toggle switches with more than two positions should be avoided.

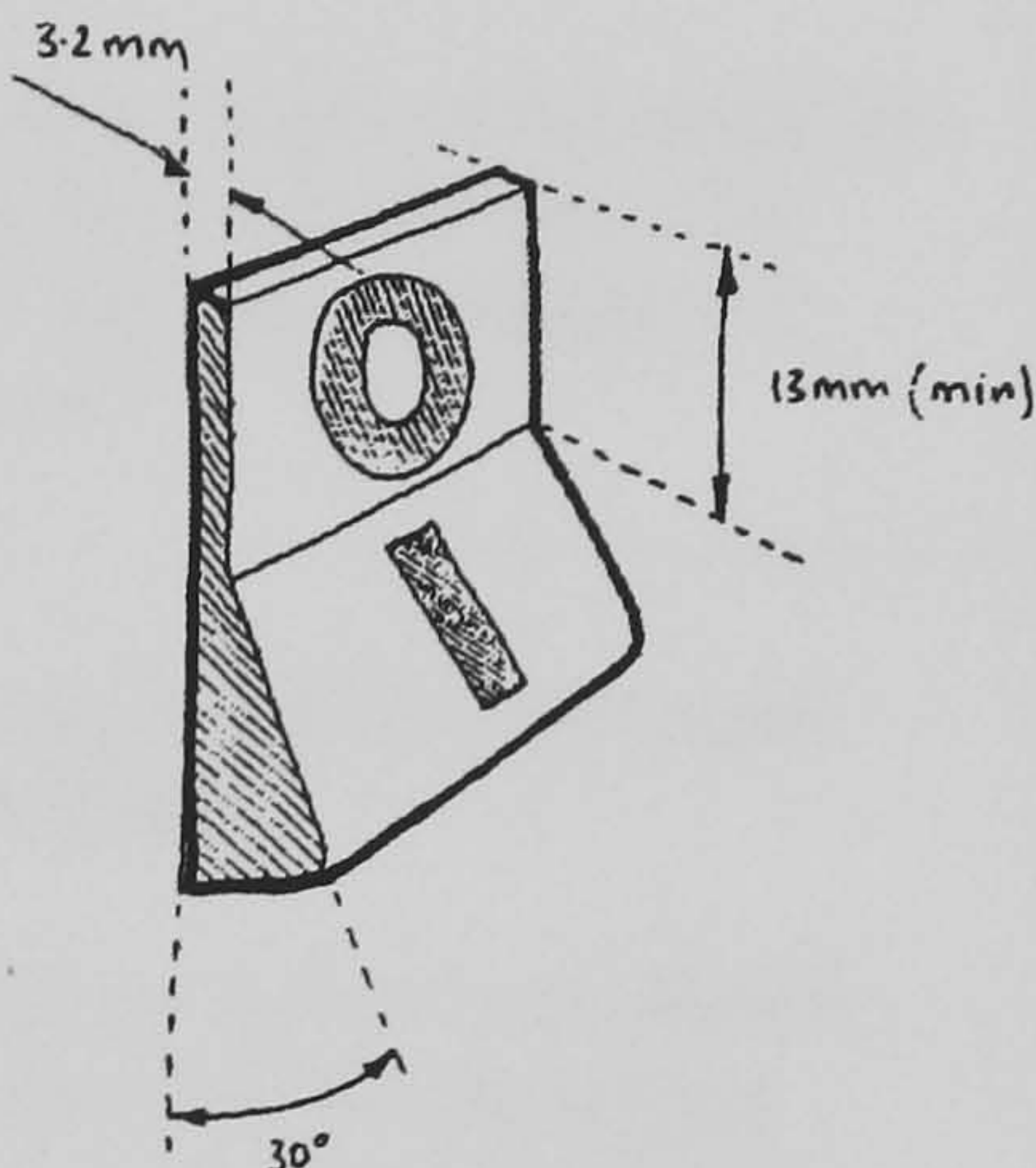


Toggle switch handles should move through at least 30° to allow visual identification of its position.

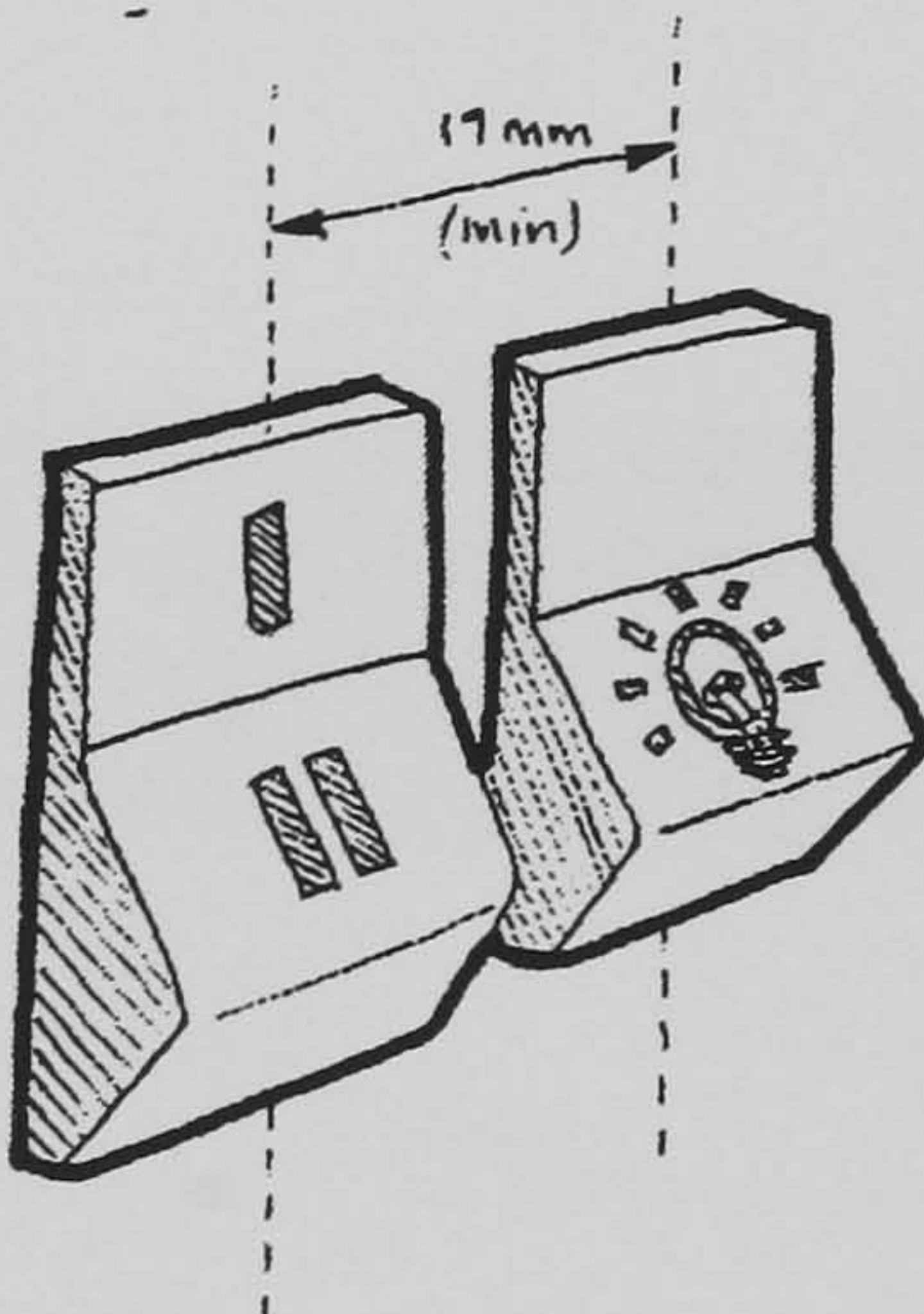


Rocker switches

Rocker switches can be broad in width and therefore allow labelling on their surfaces.



Multiple switches should be mounted so that switch centrelines are no closer than 19 mm.



OPTIONS

Crease Care	Deep Wash	Energy Save	On Off

Rocker switches can easily be colour coded and are preferable to using the toggle switch on horizontal surfaces for safety purposes.



Control Type	Selection Criteria
Toggle Switch	<p>Use a standard two-position toggle switch for START/STOP, ON/OFF etc.</p> <p>If a three position toggle switch must be used try to combine alternatives of a single function such as AUTOMATIC, MANUAL and OFF.</p>
Rocker Switch	<p>Use where a toggle switch may cause accidental activation</p> <p>Use an illuminated rocker if conditions make it impossible to see the toggle position, assuming this requirement is critical.</p> <p>Use when panel space is inadequate.</p>

## Things to think about

Some products have four or multi-directional rocker switches which have very small displacement angles (cursor control devices for example) and are activated by pressing the edge of the device. Currently there are no ergonomics design recommendations on these.



# Push Buttons



Push buttons are the most commonly used control device on consumer products. Most push buttons have a two state action such as 'ON' and 'OFF'. However, they have other functions such as:

- selecting and de-selecting a function or mode
- re-setting
- cursor control

## When should they be used

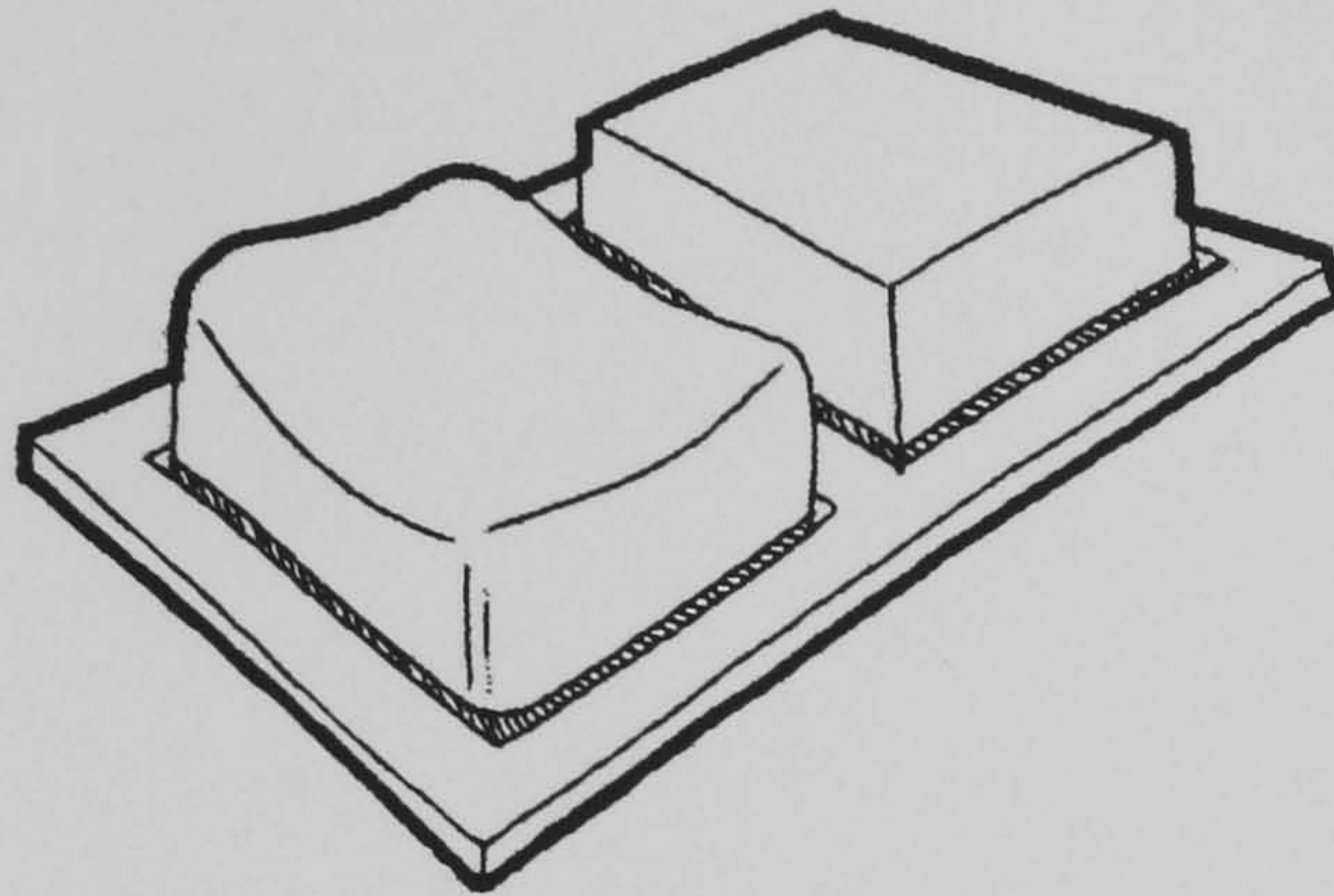
There are four major types of push buttons

- push-on, lock-on - good design should be achieved by a sudden drop in resistance and if possible an audible click. These type of push buttons are good for critical functions or buttons located in dimly lit areas
- push-on, release off - A re-set button is a good example
- push-on, push off - where the position of the button returns to the original position after each activation
- matrix system - providing a 'menu' selection between a range of push buttons where only one button can be selected, pressing another button cancels the previous selection



## Design Guidelines

The curvature of the button/keycap should also be taken into account. Buttons should be designed so that fingers will not slide off. The surface can be made concave or have some form of surface friction



The button should present a certain resistance to the movement of the finger, the resistance should be reduced somewhat when the operating point is reached. An alternative to this is to add a sound signal.

Activation forces of controls should be low enough that the least capable user (person with 5th percentile strength) can manipulate them without difficulty

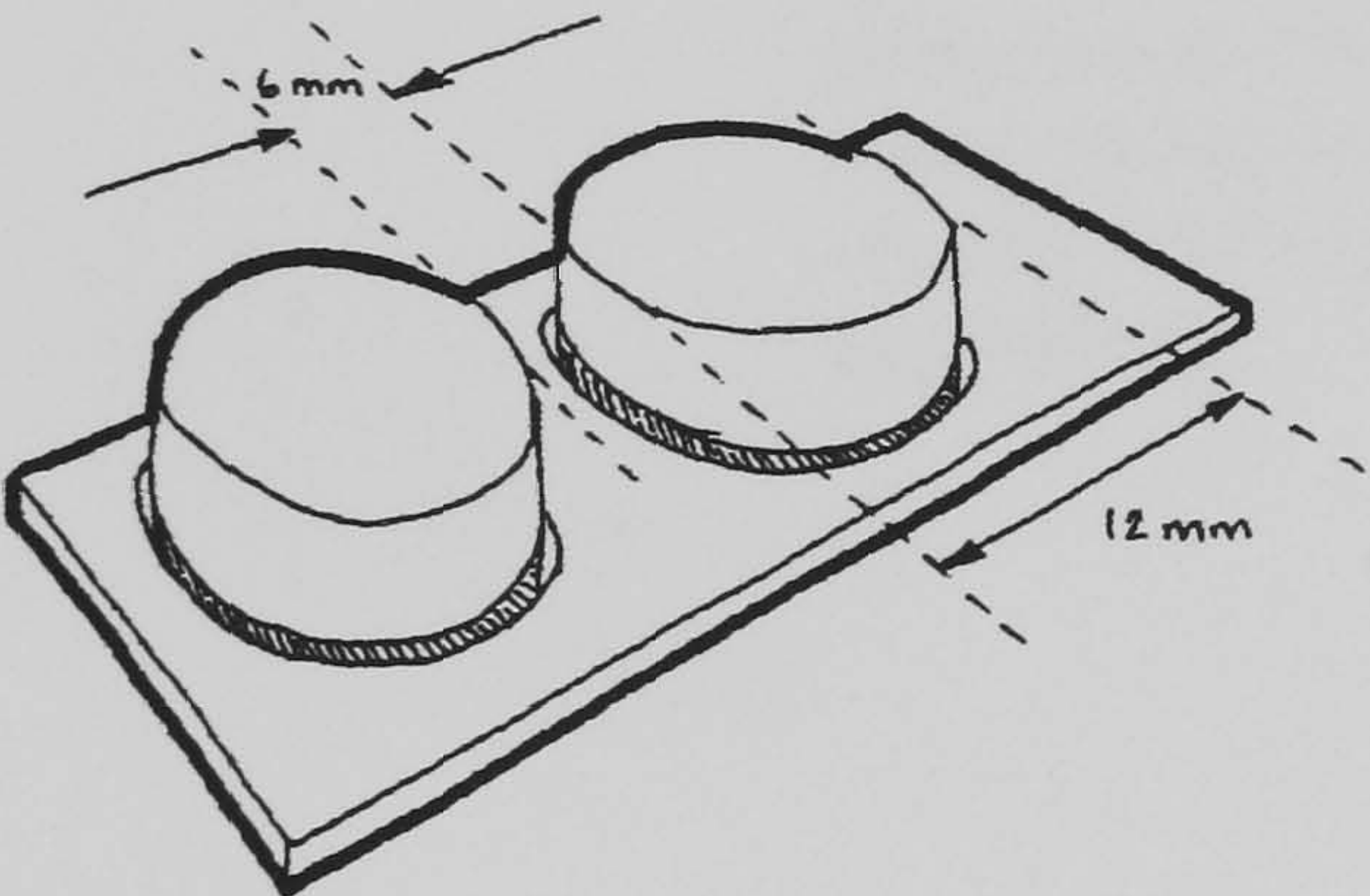
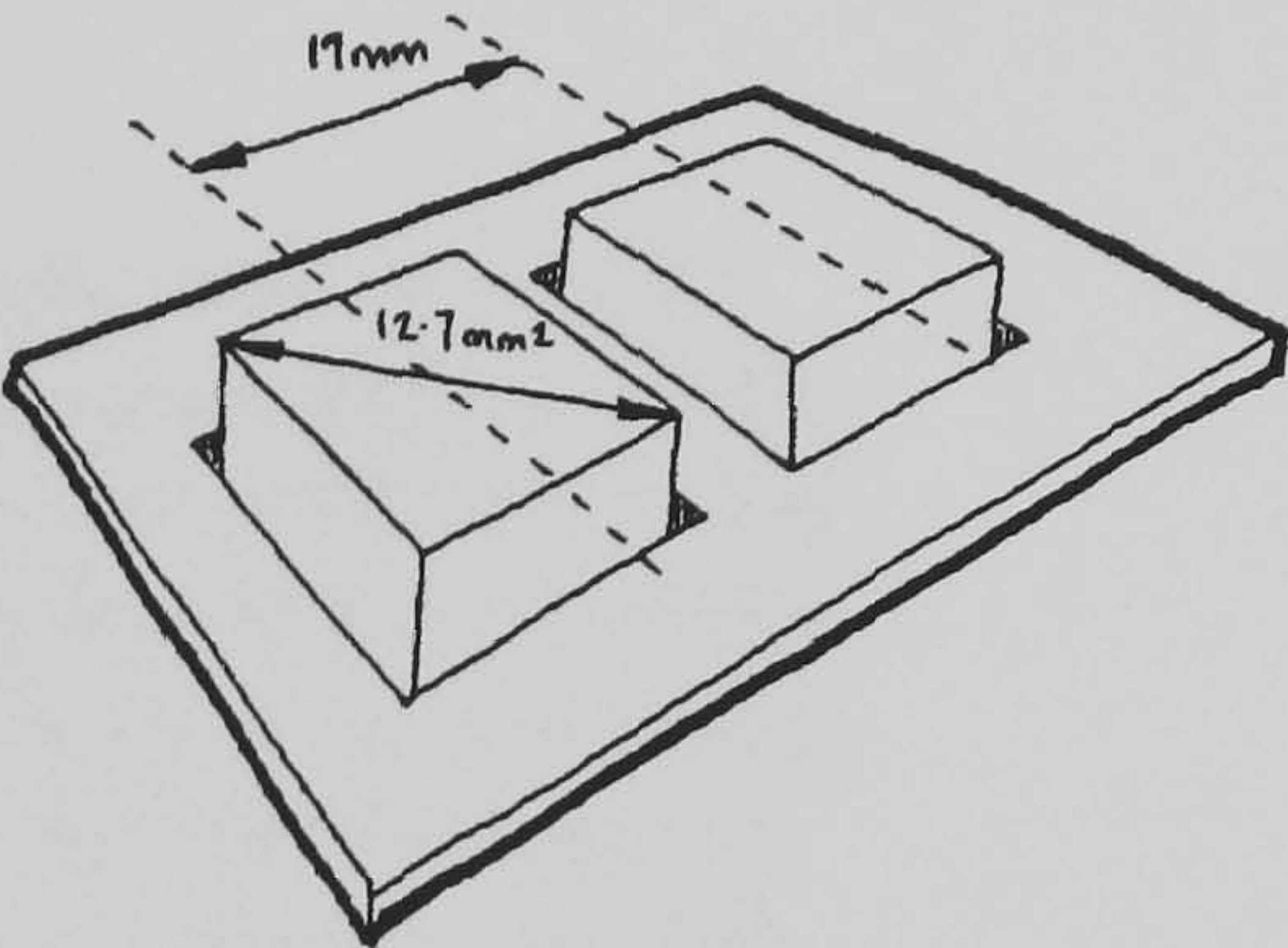
Design parameters which can be considered are

- dimensions
- form and shape
- grouping
- guarding
- forces required

In some situations, more buttons rather than less can be preferable, for example situations where buttons are used infrequently and also help to express the task procedures more explicitly. It can also be preferable in situations where the user may be under stress.

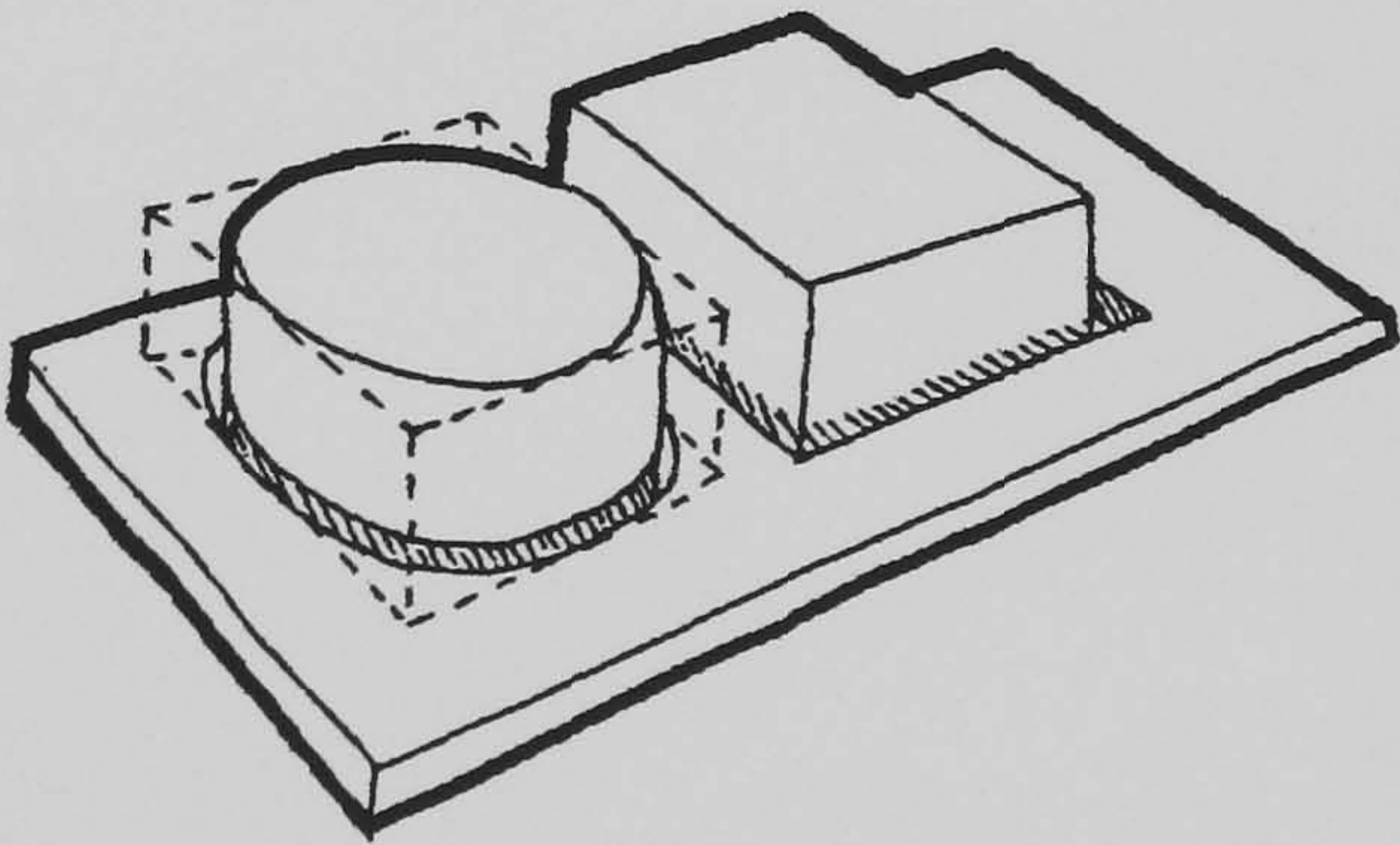


Buttons should have a minimum size of 12.7mm<sup>2</sup> and have a centre to centre key spacing of around 19 mm.



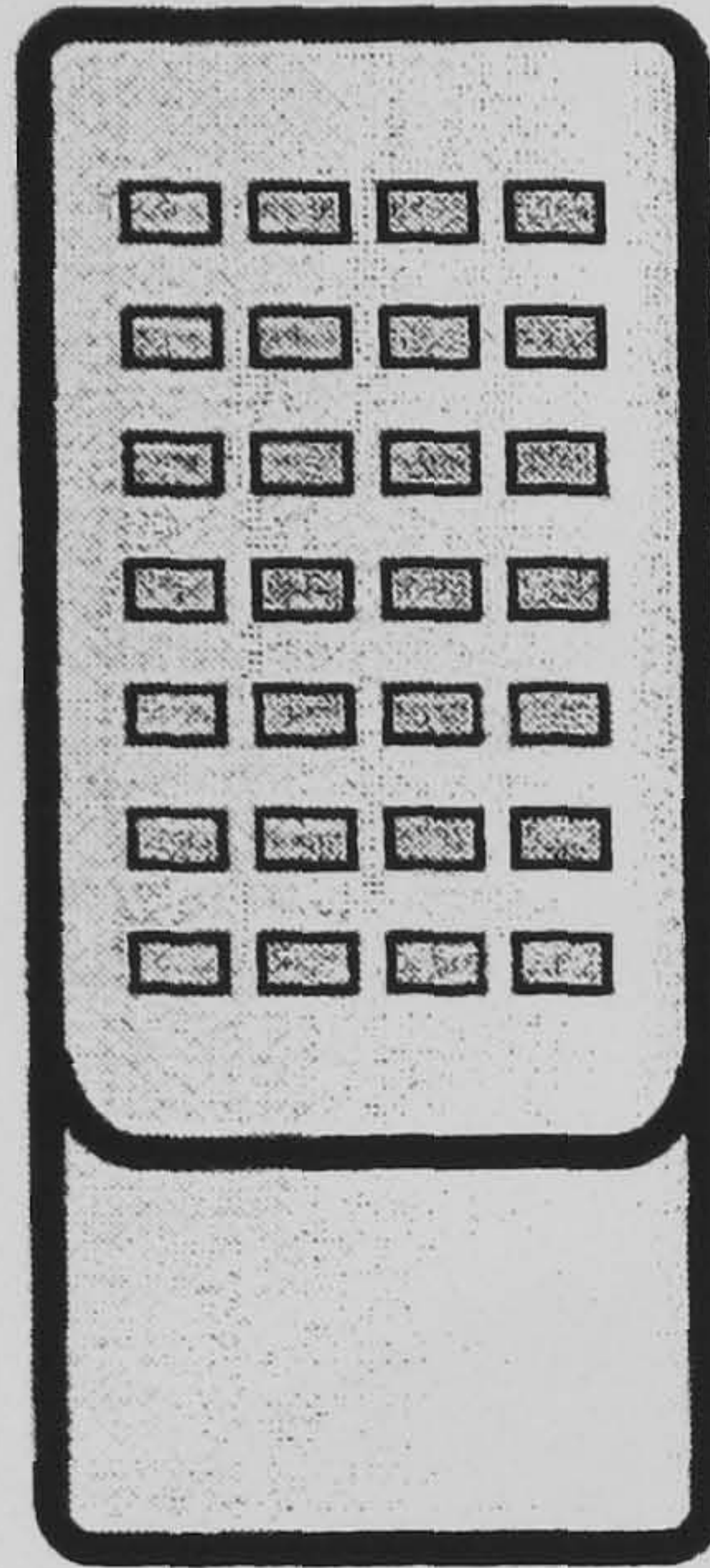
Round buttons should be 12 mm in diameter with 6 mm spacing between them

Square keys/buttons are the best shape for inputting data as they provide more surface area within the same amount of space between keycaps.





## Things to think about

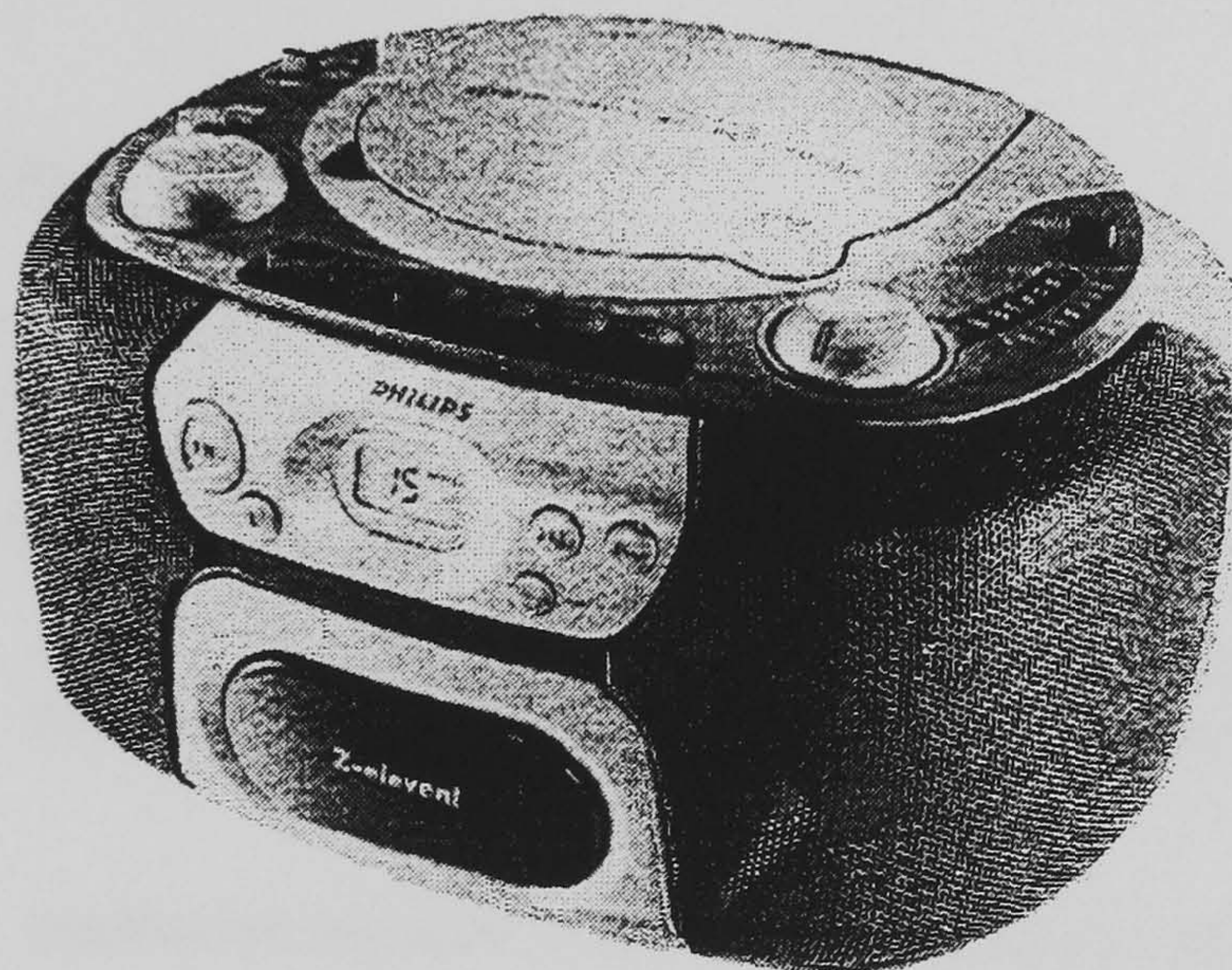


There is quite often a conflict between product styling where the uniform arrangement of the buttons on the interface where uniformity is regarded as being important against the need to make buttons distinguishable from each other. Very often buttons are designed in uniform grid patterns having similar form and colour. This makes it difficult for the user to quickly identify one button from another. Users generally like the use of colour, spatial layout and shape to understand the different button functions, despite the usually less 'aesthetic' appearance.



# Function Controls

These guidelines make a distinction between single and multi function keys. Single function keys provide a pre-defined and unchanging function. Multi-function keys can either provide a fixed number of functions or vary depending on the system state.



Both single and multi function keys can be presented in either a hardware format (a switch for example), in a software format ( a touch screen button) or a hybrid ( a button placed next to a display which changes the function of the button depending on the system state).

## When should they be used?

Function keys provide quick and ready access to a wide range of functions but at the same time reducing the number of available controls within any state. Function control provides quick simple action, providing the function control is well labelled and the user understands their meaning



## Design guidelines

Aim to position function keys according to their function

When a button is pre-defined and unchanging in function, the name or symbol should be permanently printed on or next to the key. These type of controls are best used for frequently used functions.

Backlit keys can also indicate if a particular function is available or not.

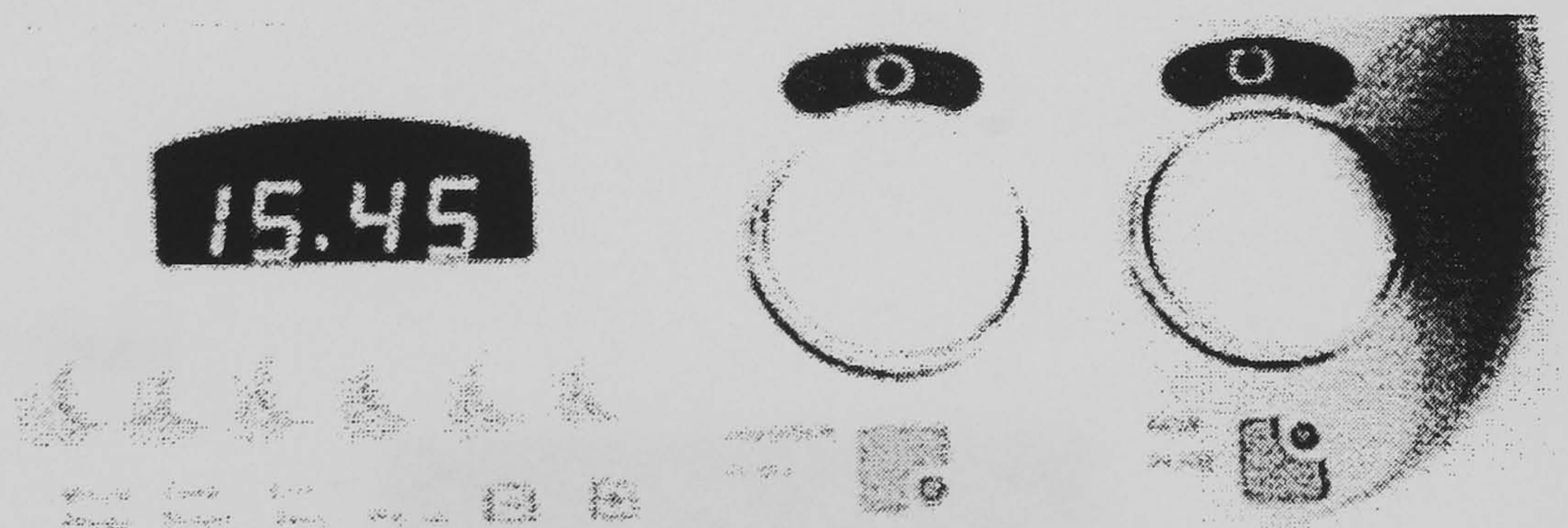
Many guidelines are dependent upon their specific use, therefore some frequently used function controls are discussed in detail here.

### Using timers

Timers are used to set-up pre-designated mode at a pre-set time determined by the user or by using default settings.

Timers are commonly used for :

- remotely switching a device on or off at a time predetermined by the user, such as would be found on a central heating device
- stating the amount of time which a function has been active



- alerting the user to the fact that a pre-determined event has passed





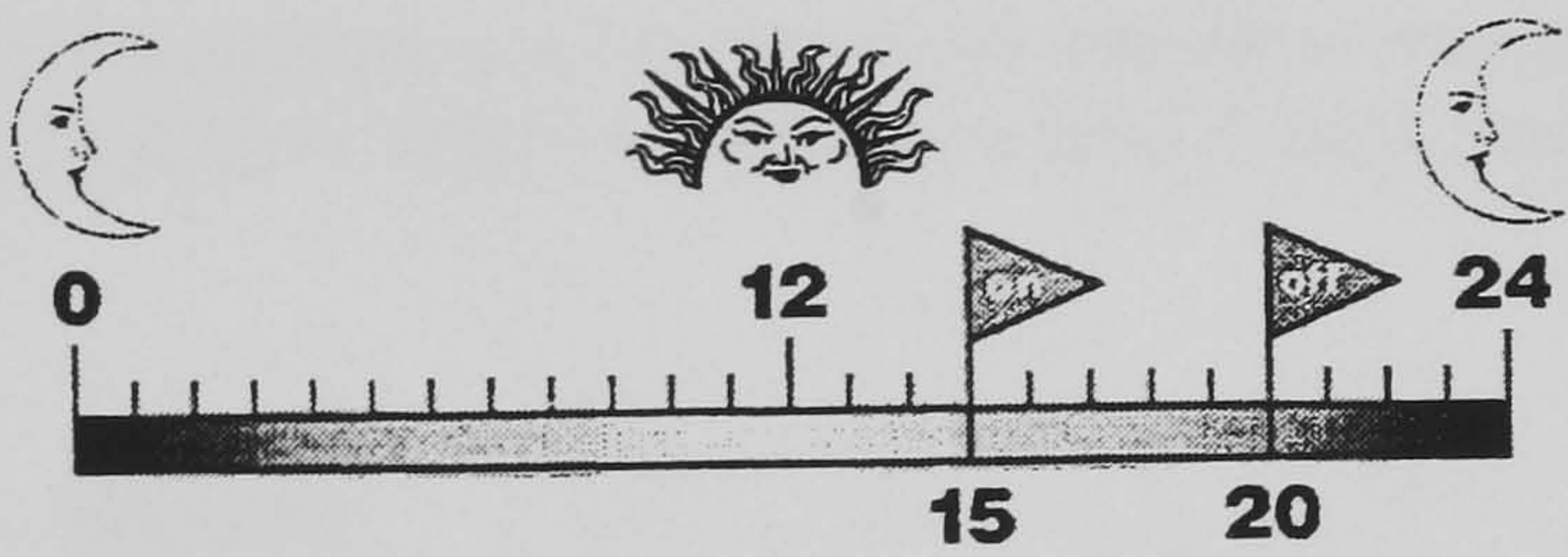
*Interaction styles for timer devices*

There are three basic timer styles.

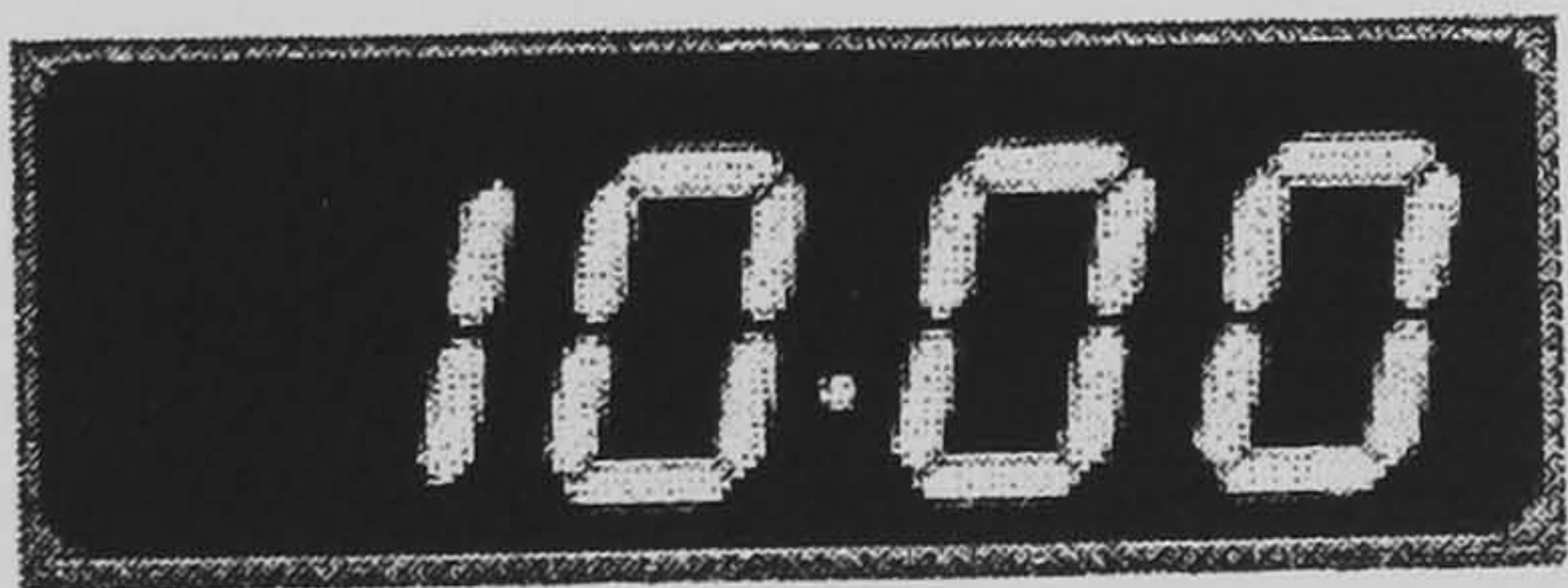
- Analogue



- Linear



- Digital



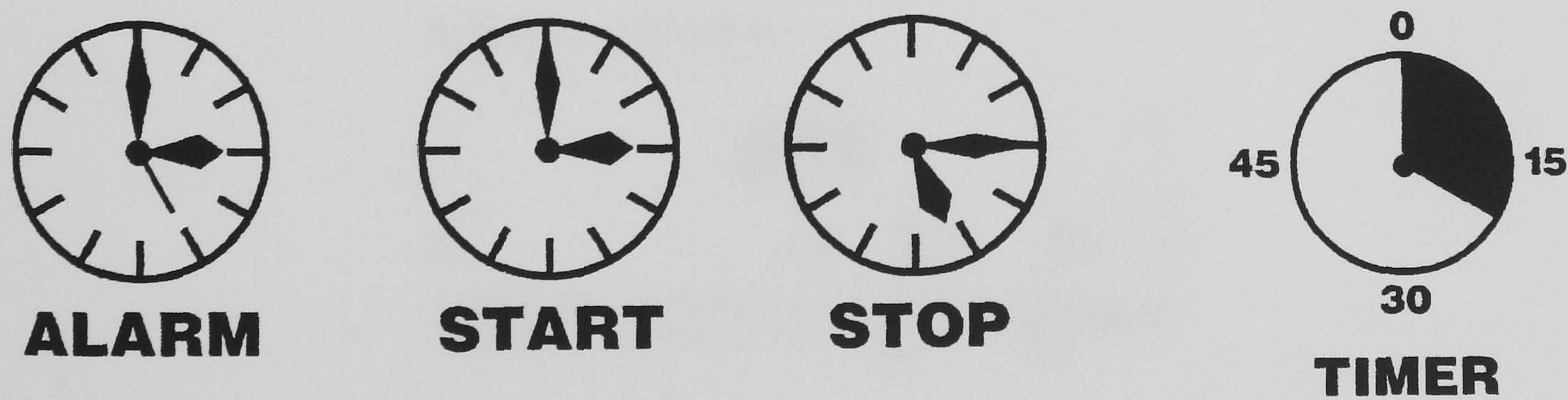


	Analogue	Linear	Digital
Time coverage	12 or 24 hours depending on style of interface	24 hours to unlimited	Unlimited
Number of timed settings which can be set-up	Single	Multiple	Multiple
Precision of timer	Not good	OK	Very good
Timer settings	Generally simple	Simple	Generally more difficult
Example devices	Alarm clock, timer on cooker	Computer scheduling devices	VCRs
Use when	Time setting does not have to be accurate	Visual plan or representation of time in important	Critical time values are important

If the timer is to be set using a touch screen interface then a “take off” selection strategy is the most effective (see Touch Screen Guidelines)

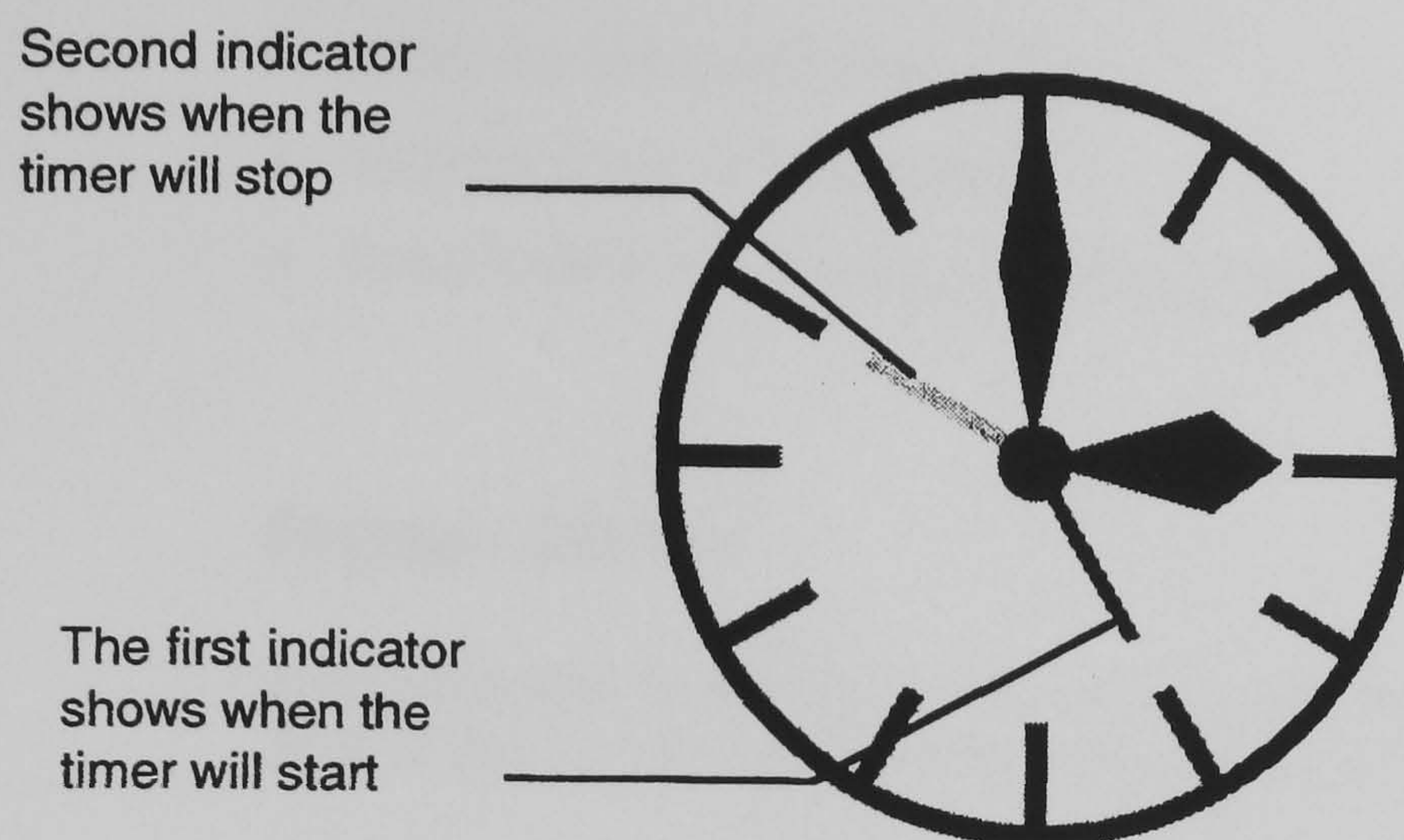
### Analogue timers

Ensure the user is aware of AM and PM settings, otherwise it may be possible for the timer to be set incorrectly.



If more than one alarm is available on the device the user must be able to easily distinguish between these alarms.

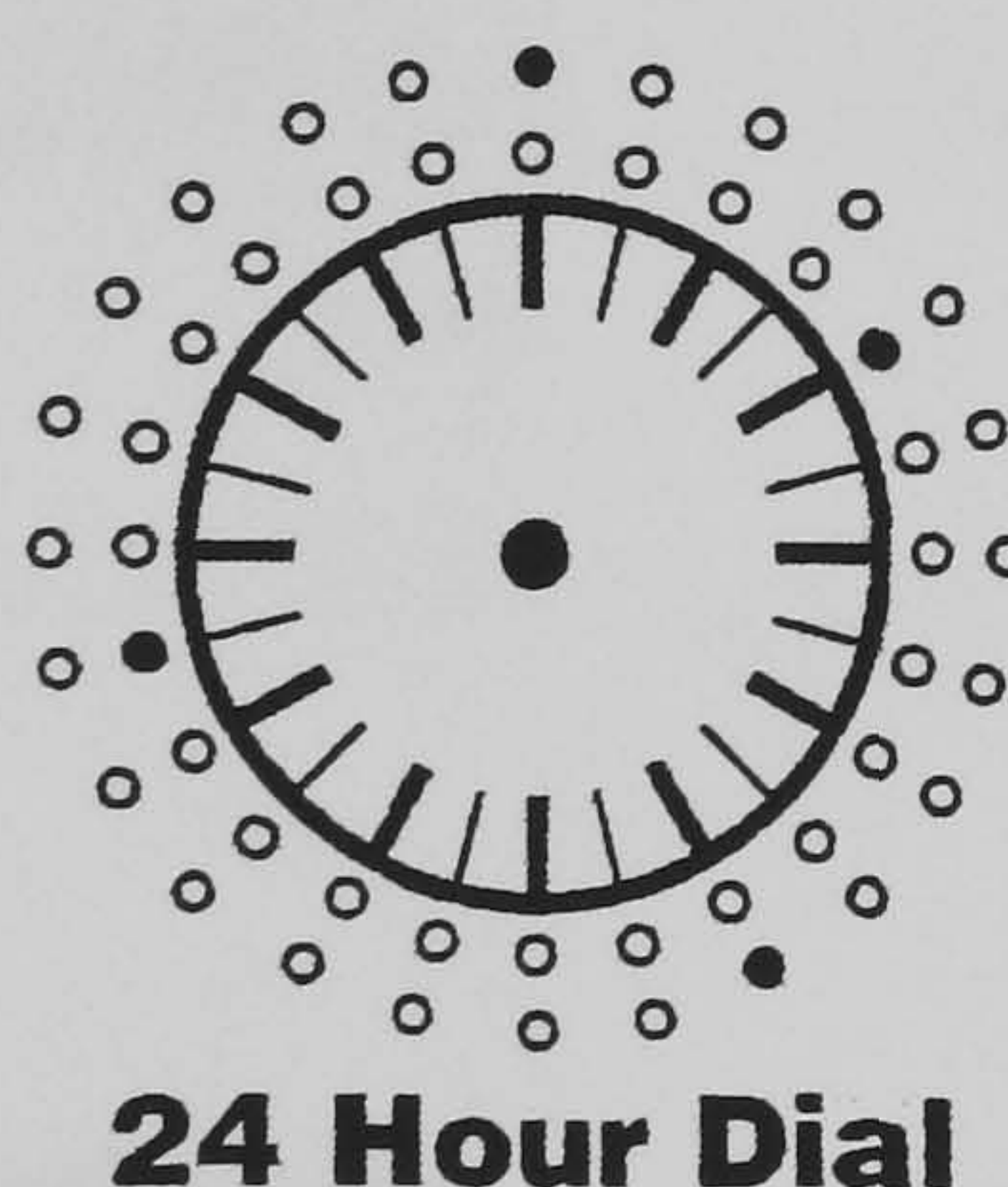




It must be clear to the user how the device is to be set

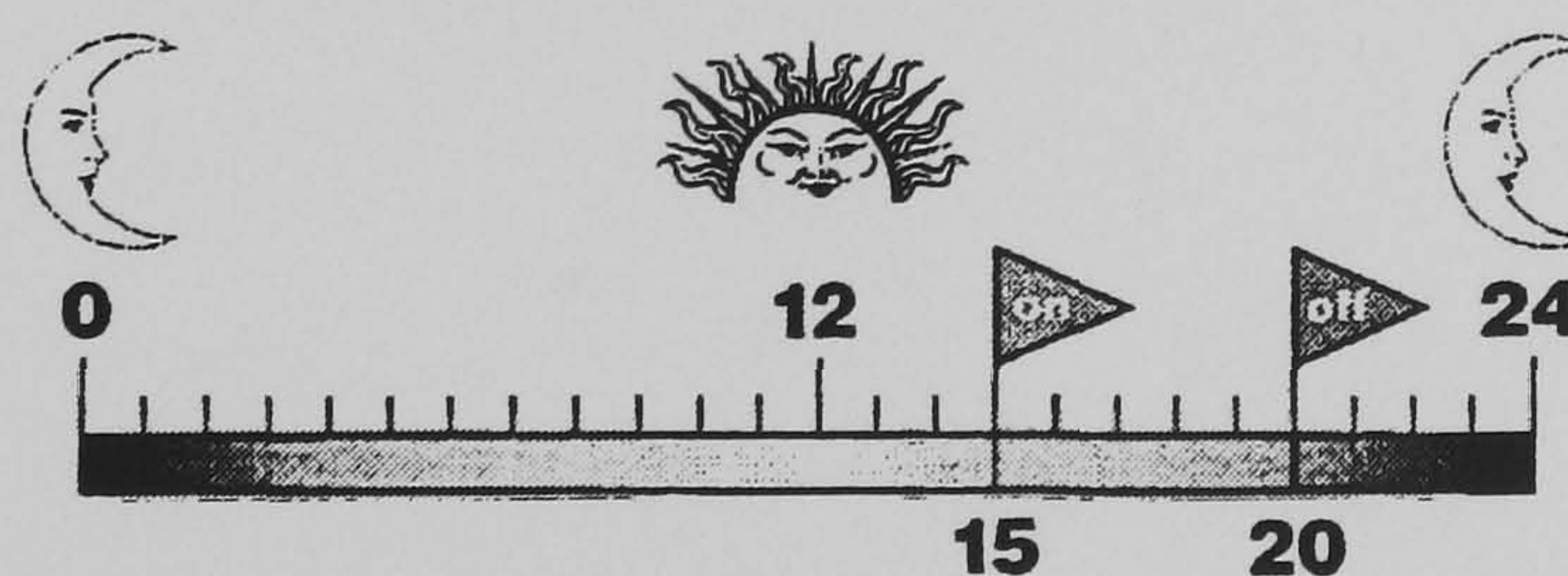
## 24 hour dial

The 24 hour clock is commonly used in European countries and less known in the UK and USA.



24 hour timers can be more difficult to set than 12 hour timers.

## Linear timers



Linear representations of time are useful as users are able to conceptualise them. Day and night can be graphically illustrated providing a stronger context to time setting.



Linear timers have the following advantages over other timer devices in that:

- users do find them easy to set
- settings are visually explicit
- It is possible to set-up and adjust multiple settings easily

**Digital timers**

It is preferable to set time settings by absolute time designation (e.g. time of day rather than making a setting for 2 hours time)

When time is set by elapsed time designation using the present time as reference time, immediate starting is preferable (for example set the video to record two hours starting from now)

Ensure that the user cannot set the stop time of a device before the start time.

Standardise expressions used in absolute time designation and elapsed time designation.

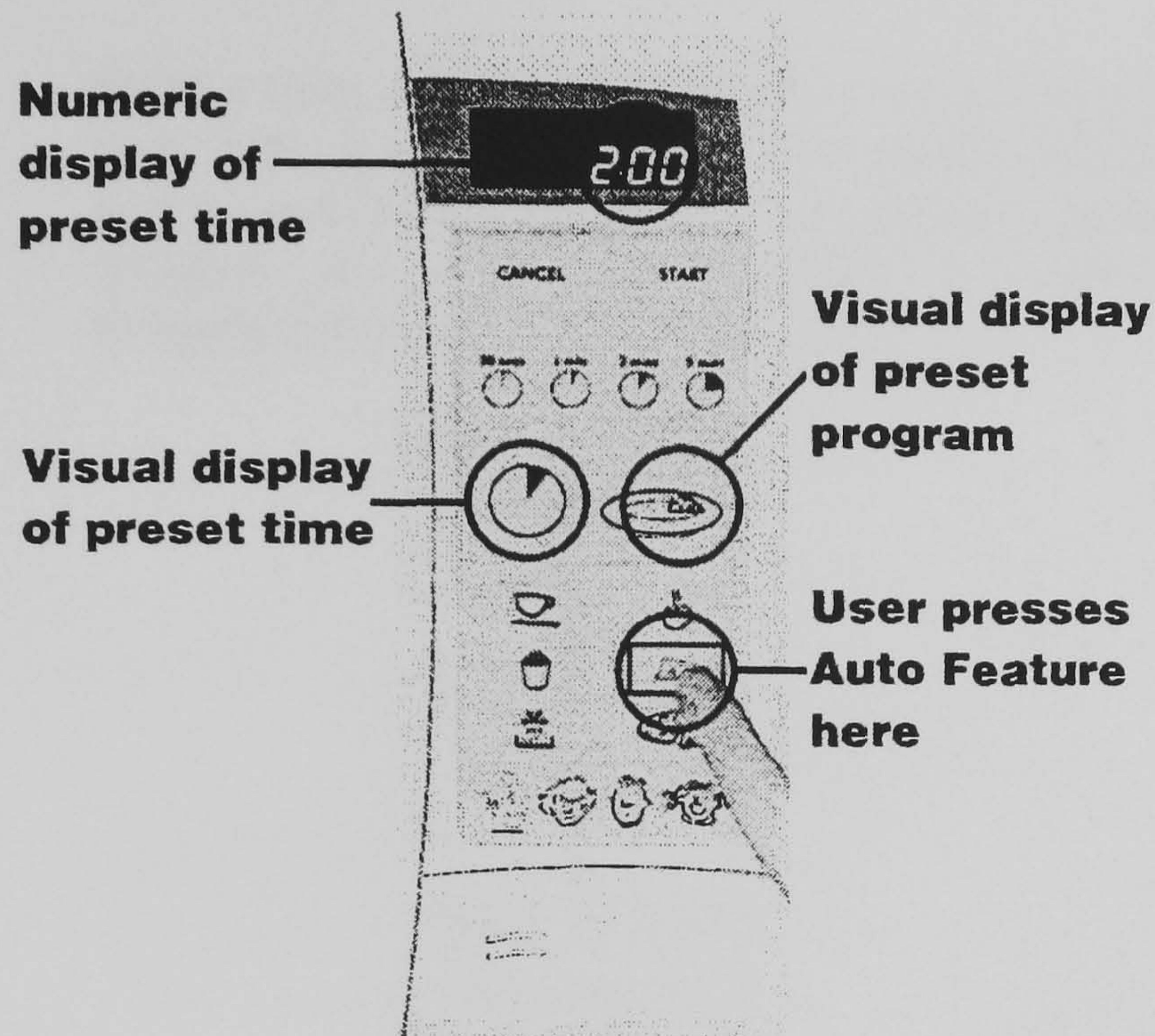
Good		Bad	
Start	12-45	Start	12-45 am
Finish	13-55	Finish	1-55 pm

**Auto features**

When activated, auto functions are able to complete, with one button, press series of actions which are either predetermined by the manufacturer or user of the product. They are useful in that the can compile a series of functions. Auto features can be viewed as product macros, performing a set series of actions upon activation.



### *Pre-set Auto functions*



In this micro-wave example, the user is able to use pre-set functions to cook set amounts of food using defined time and power output.

Make sure the user is aware what the features are and what the consequence of selecting the button will be.

Names or icon used for auto features should properly convey the meaning of the function.

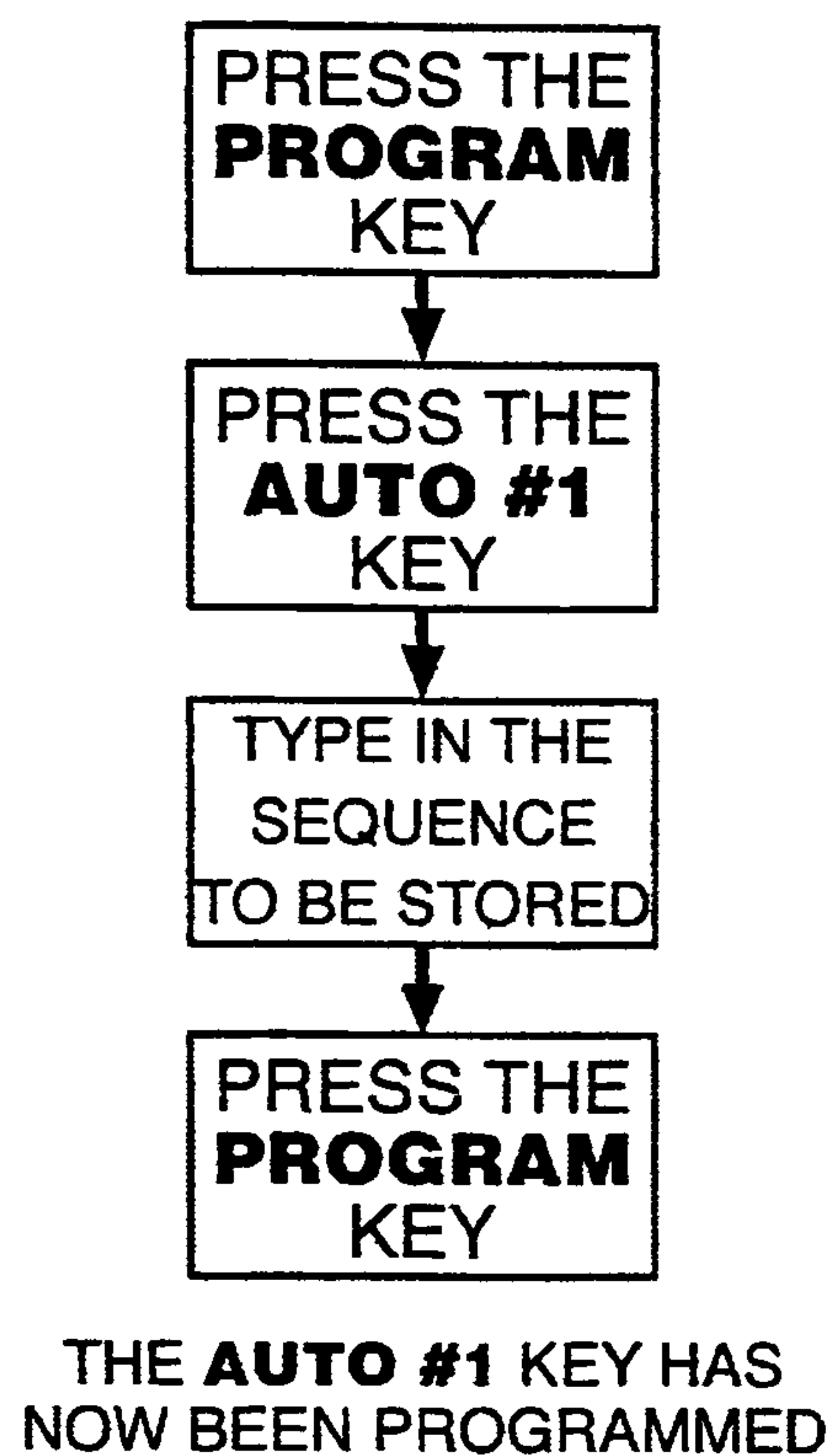
Auto features should fit around tasks rather than technological innovation.

Feedback should be provided on activation, progress and completion of the function.



## User defined Auto functions

Setting auto features - should be easy and straight forward for the user to do. It should be possible to easily remember how to set-up and cancel auto-functions. In this example, abstract terms such as 'program' and auto 'hash' 1 are used. If possible relate these terms to tasks not to technical terminology.



## Child safety locks

Child locks can take one of several forms

- Key required to operate the device
- Password protection - by entering text or by sequence of key presses
- Device has controls which are difficult to operate if users hands are small - example - large rotary dial on washing machines.
- User is required to complete complex procedure before device is operational - for example the user may have to simultaneously press two buttons at opposing ends of a device in order to switch the power on.

When a child lock is included on a device, it is advantageous for the device to be made inactive for users without children.

When lock is activated instructions should be given to the user about how to disable the lock.



## Time-outs

A 'time-out' returns the control from a non-stable state to a stable state. The switch should return to the stable state after a predetermined period (for example 10 seconds). Generally the non-stable state is ON and the stable is OFF though this can vary.

There are two types of time-out switches:

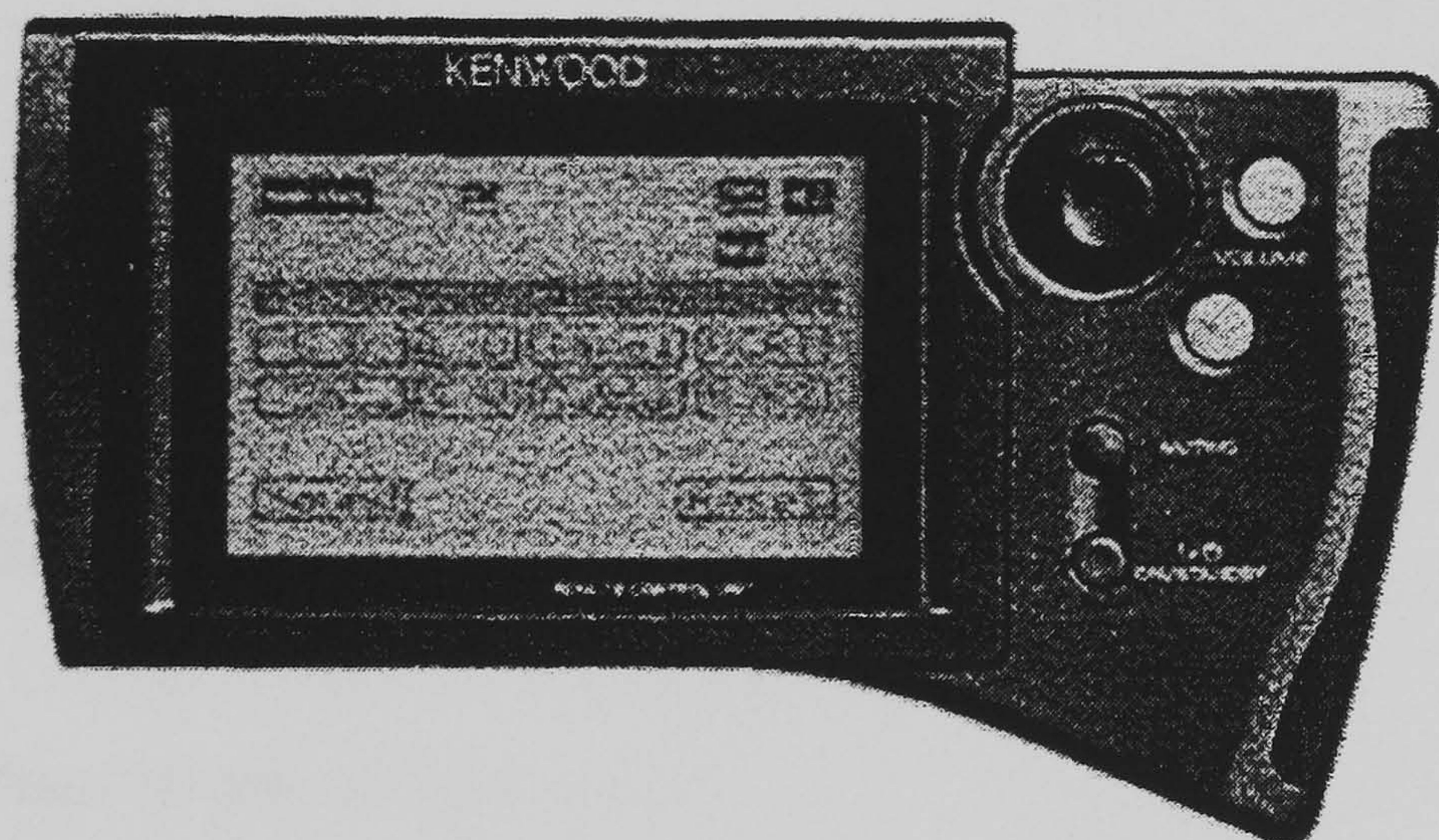
- Momentary switches - when it is again touched it continues in a non-stable state for a pre-designated period
- Set-up switch - when touched again it discontinues the non-stable state and returns to the stable state, even if the pre-defined time has not elapsed.

While the system is in a non-stable state, the user needs to be given feedback indicating that the non-stable state is active. This can be given in the form of feedback on a LCD or the appropriate use of indicator lights. The user should be given advance warning that the status of the device will change after a set time. On LCDs this can be in the form of a text message or indicator light.



# Display Design Guidelines

Large high resolution displays screens are becoming increasingly popular on a wide range of consumer products. Therefore, issues of screen design are a vital and important aspect of product design.



When developing a screen for a device it is important that the following points are considered:

- what the user is hoping to achieve by interacting with the interface.
- what information the user will need to input into the system and the feedback which the system will give to the user
- are there any special usability considerations (such as the need to consider visually impaired users)



If the interface is intended for:	Then the display screen design should be:
Learning and retraining information	The interface should be simple and clear with good navigational cues. It should be possible to review and undo activities easily
Fun	The display should be amusing, have unusual and unpredictable events, maybe have humour
Understanding	Clear explanation should be given with plenty of examples and 'scene setting'
An enjoyable experience	Should be provided with realism with good visual and sound quality with a high level of interactivity
Getting answers	Provide many ways of accessing the data or information such as indexes, frequently asked questions, topic lists, make use of cross referencing

## Design Guidelines

Good display screens should

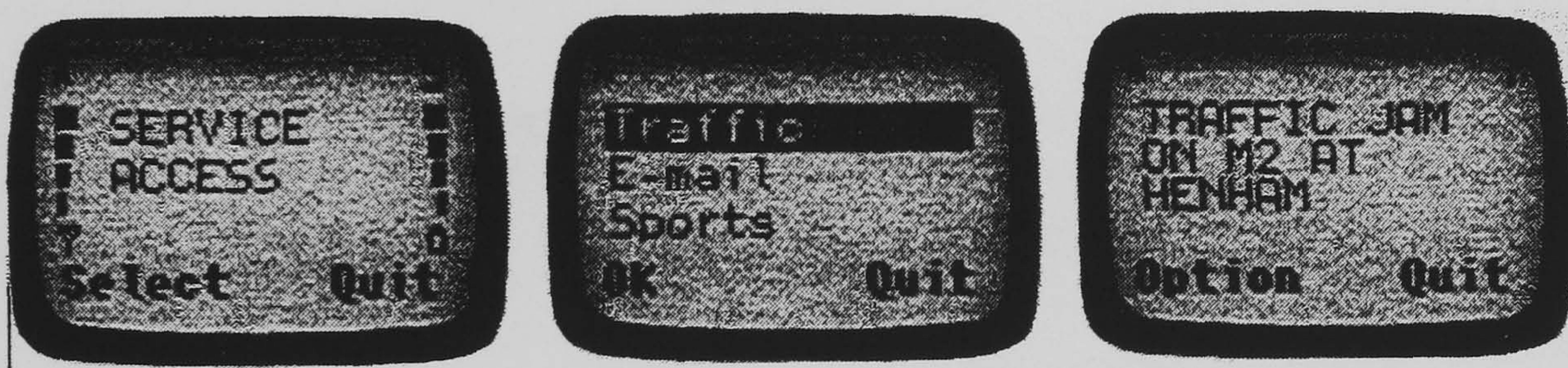
- be orderly and clutter free
- obvious for the user to understand the meaning of and how to operate the interface with information where it should be
- provide an indication of relationships e.g. by colour coding
- data should be presented in a consistent fashion with regard to abbreviations and formats. The form which the data is presented in should be the most convenient for the task being undertaken. When possible try to use plain, simple English.
- use simple input and output procedures
- clear indications of which actions will make permanent changes in system, and how these changes will affect the user
- When using the device the user should not have to remember a great deal. . . . (minimal memory load on the user)



# Menus

Menus are an excellent way of displaying a great deal of information on a small display or screen.

Electronic displays on products tend to be small and therefore offer limited space for menus. This sometimes presents problems as the user has restricted visibility of the whole menu. Therefore abbreviations are often used and users often have to scroll up and down a menu a few times to determine the contents of a menu. Users often have to rely more heavily on memory.



## Design guidelines

Menu structures should be hierarchical, this improves navigation and memory performance.

Deep menu structures should be avoided as users may forget where the target item is or may forget the menu path. Users usually find it difficult to remember a lengthy menu path if they only use menus occasionally.

## Menu dimensions

The depth and breadth of the menu are a critical factor in how well the user is able to navigate through the structure





4 x 4 x 4 Structure

Studies have also found that in providing 64 items, a 8 x 8 structure is the most effective although a 4 x 4 x 4 was also good as well. Menus with more than 6 levels should be avoided. Speed and accuracy is improved as a function of menu breadth.

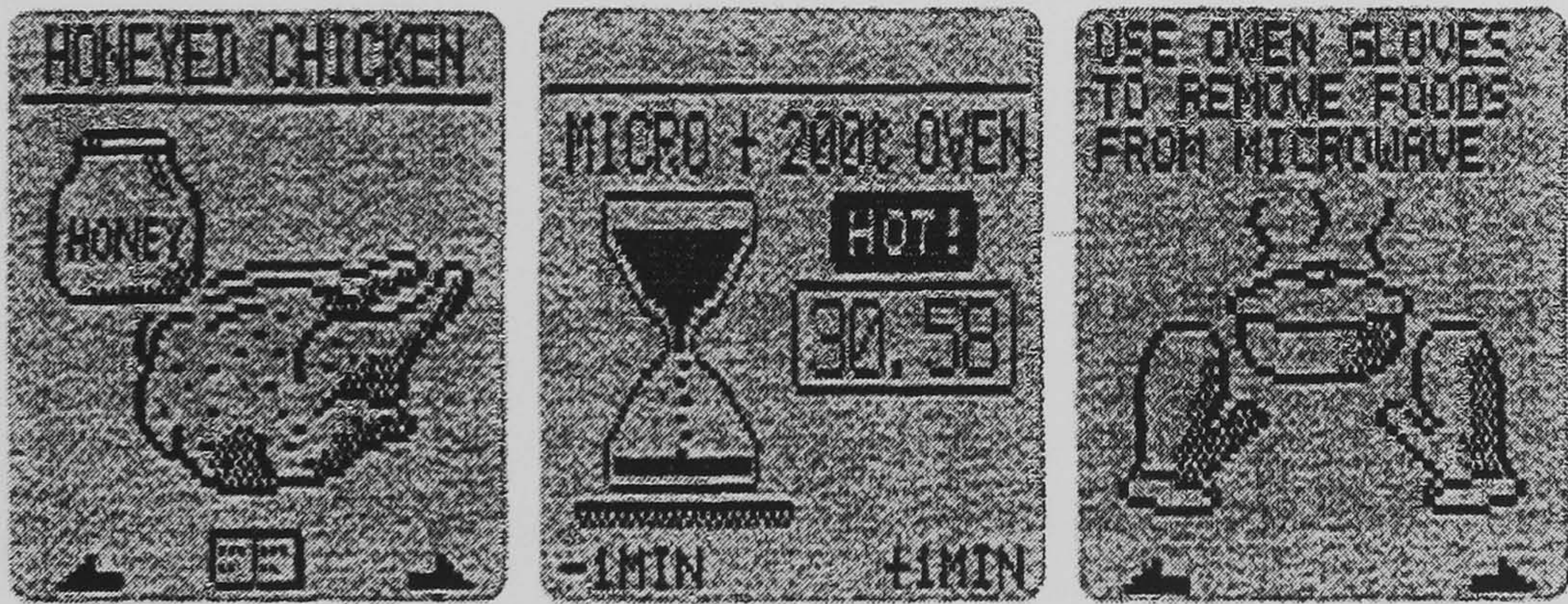
There are three kinds of forgetting which might lead to lower accuracy of target search of deep menus,

- forgetting target word
- forget the pathway
- wrong association with target and items displayed

Place frequently used items in extreme locations such as at the far left or right of menu lists and at the top and bottom of menu lists.

Faster and less errors are made when users utilise a tree structure approach to sequences of buttons (making four decisions one after the other) as oppose to a matrix structure where users must make two binary decisions at the same time.

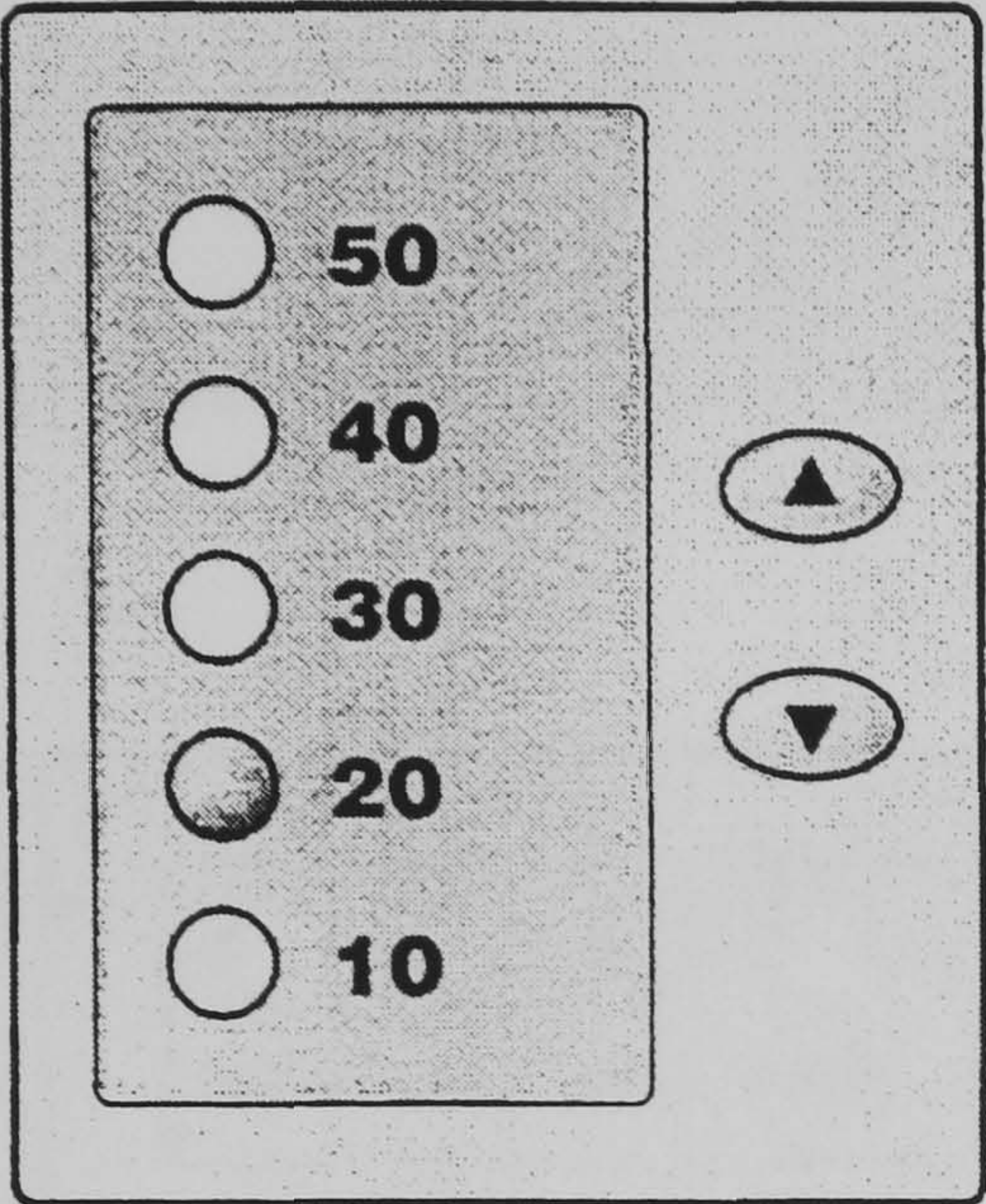
Users do not perform any quicker when menu information is presented with graphics, however there is an effect on how accurate the user is in their selections when graphics appear alongside choices.



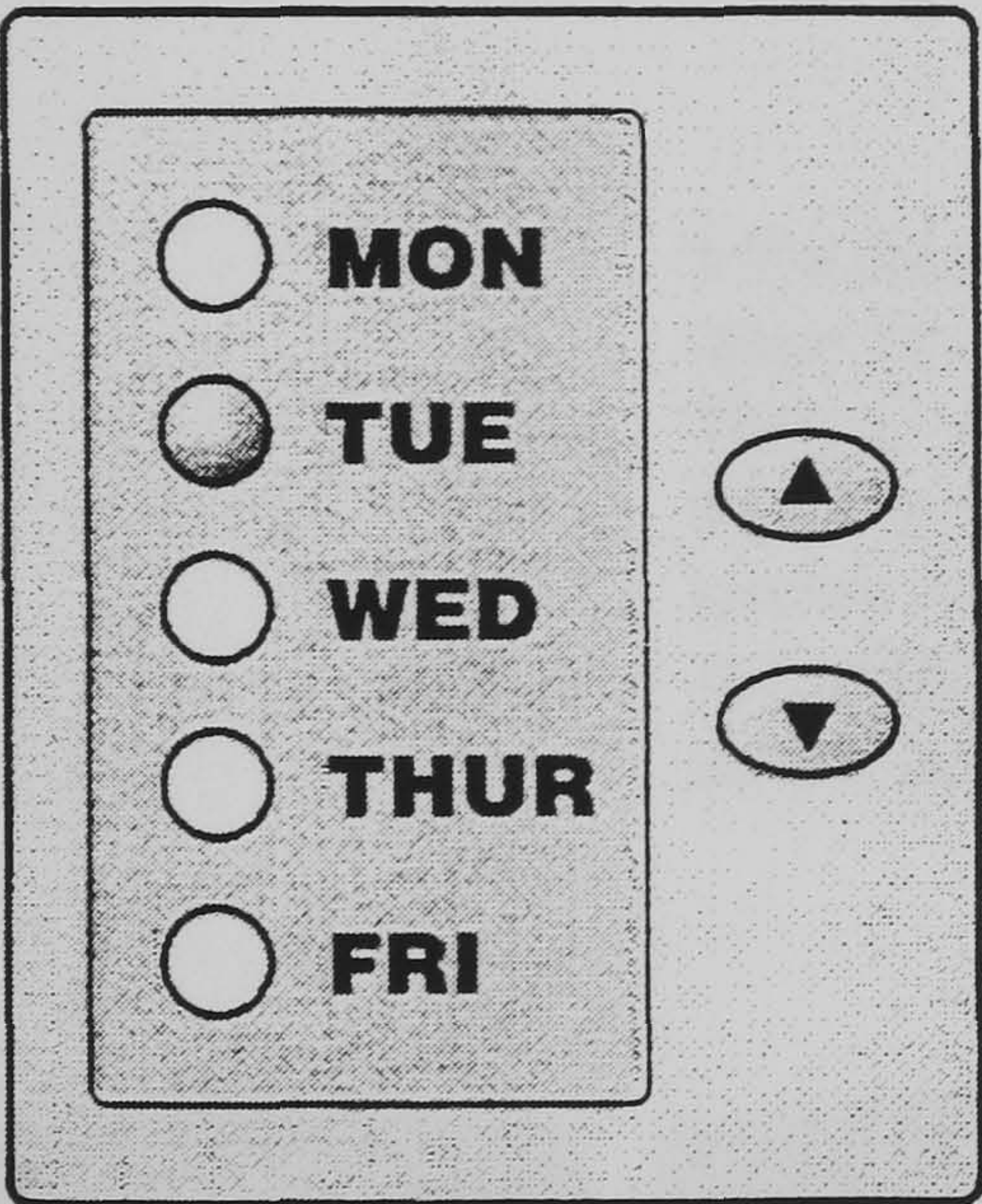


**When scrolling through menus**

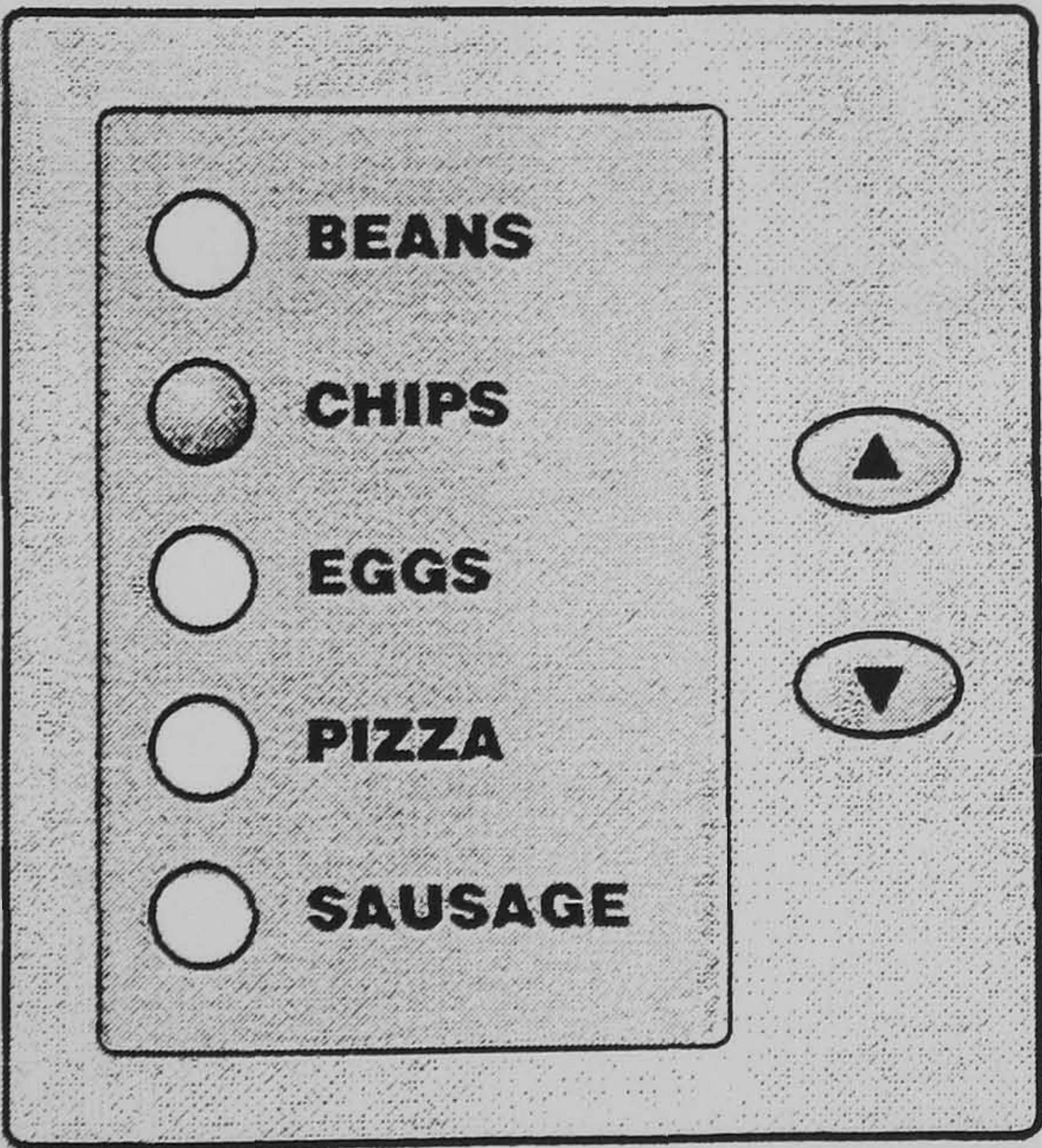
If items are to be arranged vertically.



If the items in the menu are quantitative then the one of the most value should be placed at the top and the minimum value at the bottom.



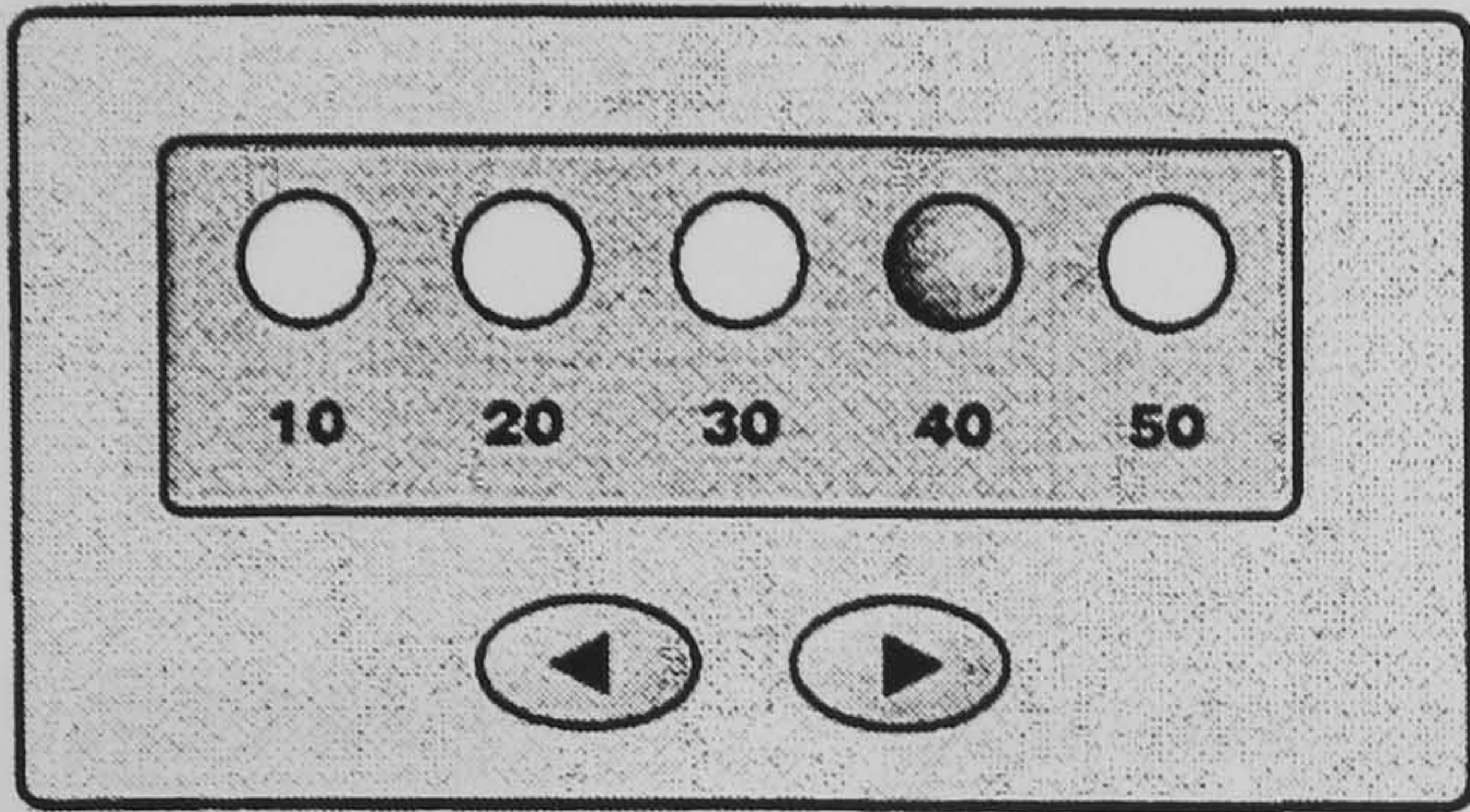
If the choices are sequential then the first choice should be at the top and the last at the bottom (e.g. Monday at top and Friday at bottom).



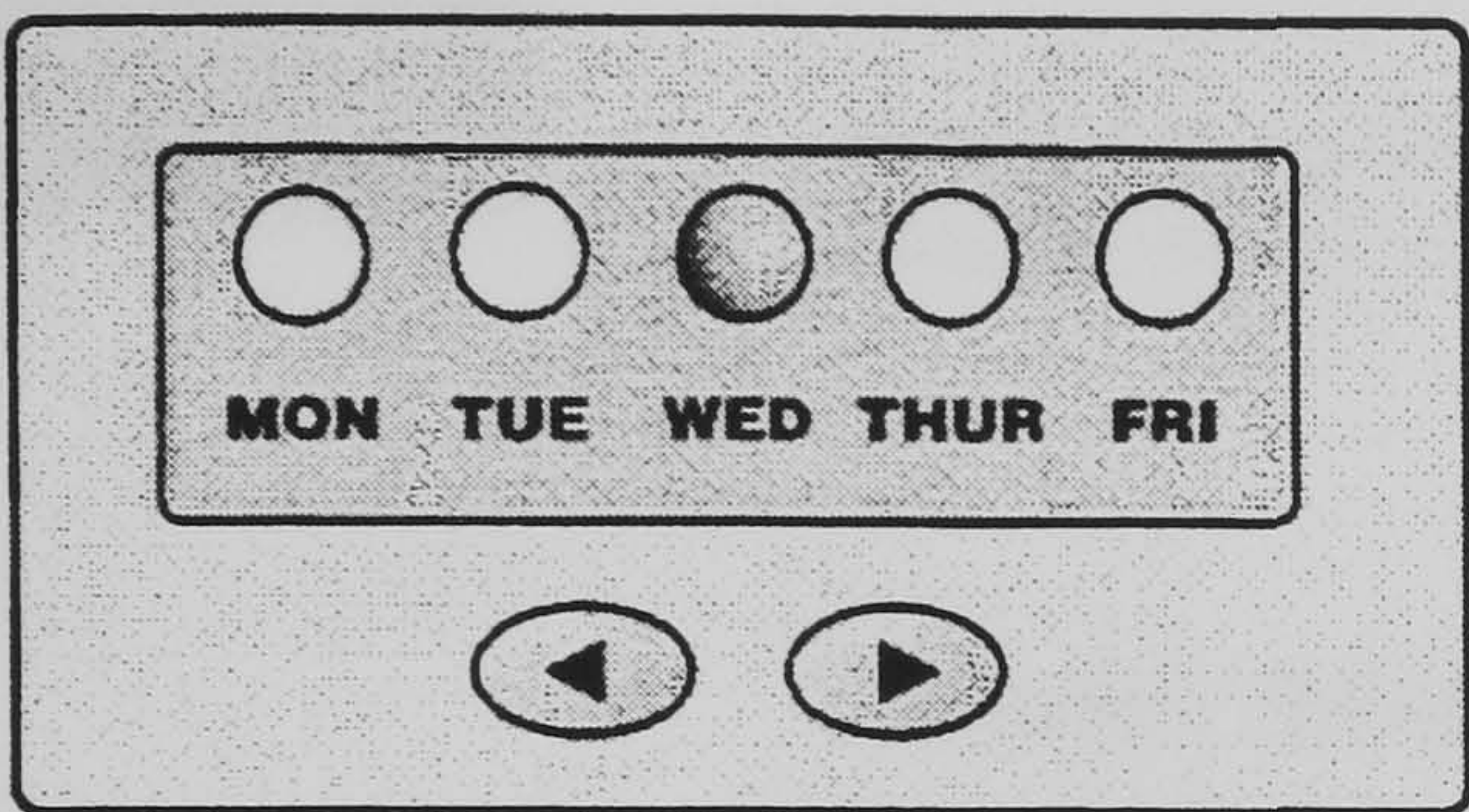
If all other factors are not appropriate then items should be arranged in alphabetical order.



If items are arranged horizontally

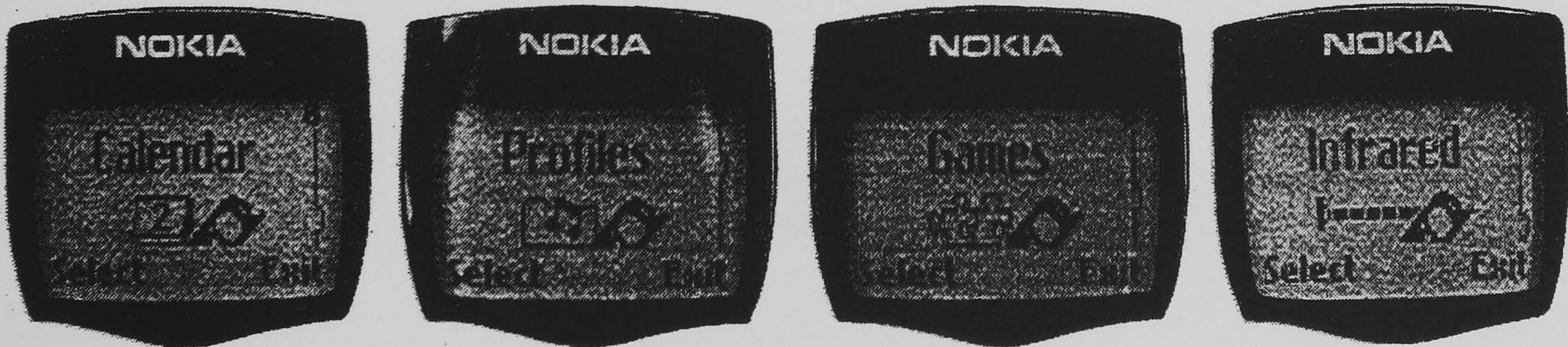


If the items in the menu are quantitative then menu choices should read from left to right, lowest value to highest value.



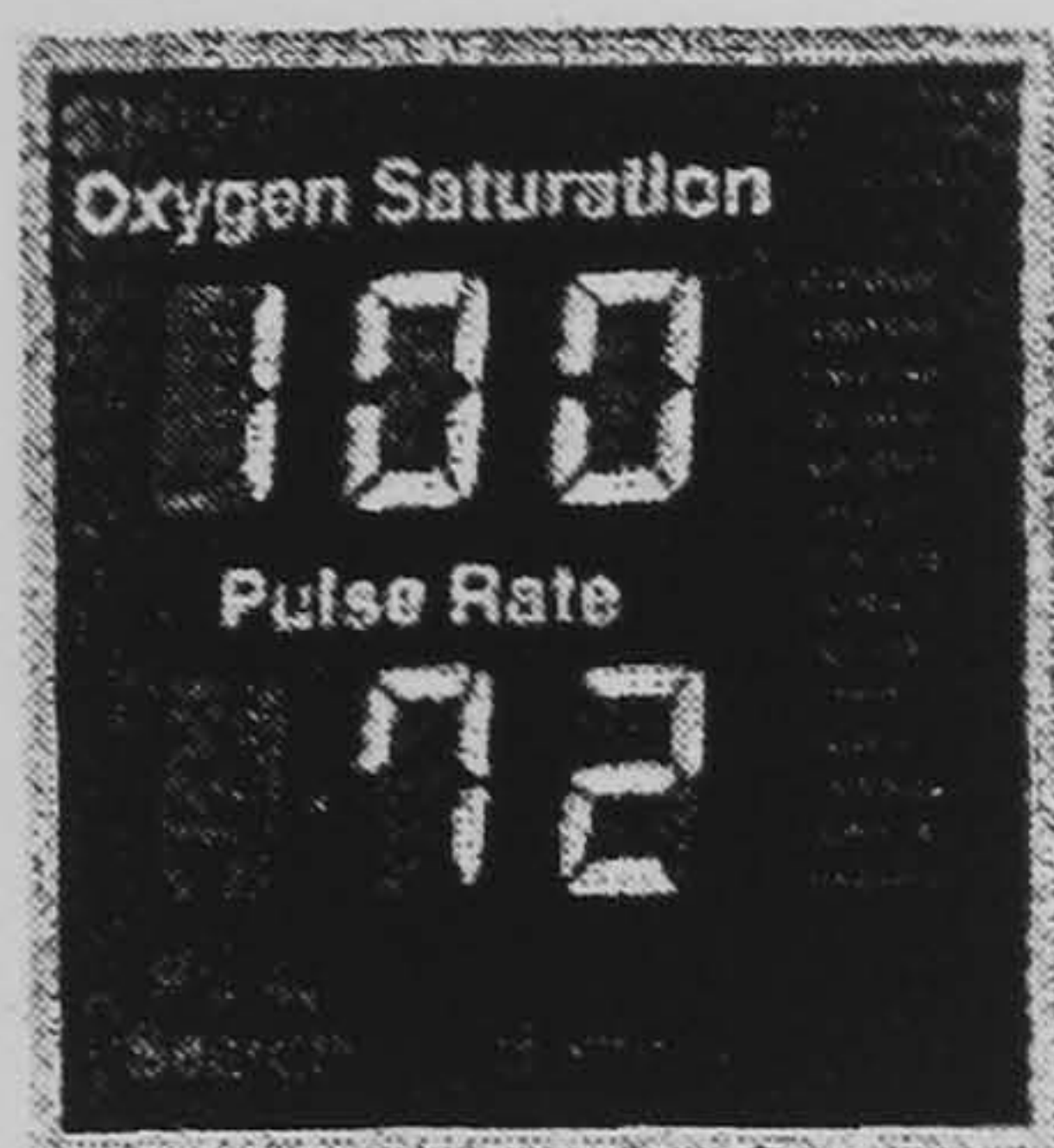
If the choices are sequential then the first choice should be at the top and the last at the bottom (e.g. Monday on left and Friday on right).

If the two menu scrolling buttons must be arranged in a way that does not correspond to the direction of an indicator movement, then consider the up arrow to be the “positive” direction. As such this should be placed on the far left of the display. Likewise if the arrows are pointing left and right but have to be placed one on top of the other, then the arrow pointing to the right should be considered as the positive and placed on the top of the display.





# Alphanumeric Displays



Alphanumeric displays are defined here as being either 'print' or 'electronically' based. Print based displays cover any text or numerical information (but excludes graphically based information) which is permanently fixed on the interface. Electronically based information is contained within an electronic display.

Most of the guidelines presented here refer to both media but specific design issues are indicated if necessary.

## When should they be used?

Some products require instructions either to describe how they should be used or to provide safety information. Static information tends to be quickly accepted as part of the product interface and therefore not discriminable when required. The placement and design of instructions, particularly warning signs should be considered with this in mind

## Design guidelines

### Text

Headings set in capital letters are significantly less legible than those set in lower case. Slightly condensing headings makes them easier to read. Settings between 70 and 90% of natural width appear to be optimal.

**Heading**

**Heading**



Generally in printed text you should use a maximum of three typefaces with a maximum of three font sizes.

Lines of text should be between 40 and 60 characters in length.



A long number or sequence can be split on two keys. Numbers may be transferred from the Notepad. Received numbers and Called numbers memories. All digits and \*,#,R/Inquiry key, Time key and Clear key can be stored. Time key indicates a pause of 2.5 seconds. Clear key at the end of a sequence indicates 'on hook'.



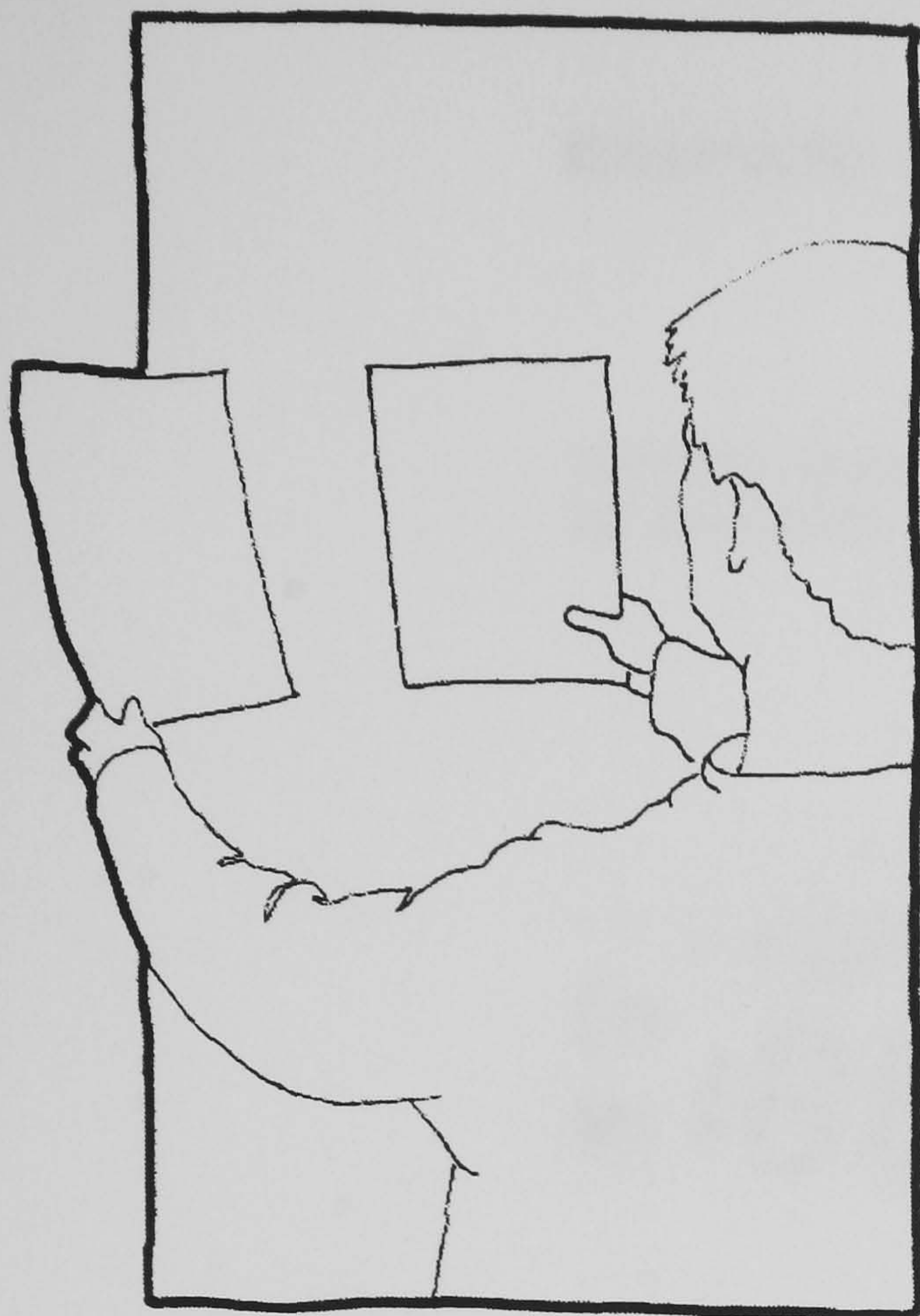
A long number or sequence can be split on two keys. Numbers may be transferred from the Notepad. Received numbers and Called numbers memories. All digits and \*,#,R/Inquiry key, Time key and Clear key can be stored. Time key indicates a pause of 2.5 seconds. Clear key at the end of a sequence indicates 'on hook'.

Before deciding on the content and placement of instructions, make sure that

- you have an understanding of how the product will be *typically* used. Don't assume you know this.
- Ideally you should gather a representative sample of potential users and conduct some form of user trial or scenario building activity.
- If this is not possible, ask someone who has no experience of the product to use the product and keep a note of where they look for information
- From this, decide what key information should be conveyed
- Consider the limitations of size or space.
- Always walkthrough the instructions while using the product

Certain words convey certain feelings and messages. For example DANGER, WARNING and CAUTION convey decreasing levels of hazard respectively.





To test the legibility of your proposed printed text, conduct a comparative test with a benchmark font such as Helvetica or Arial.

For safety information and special instructions, try to describe

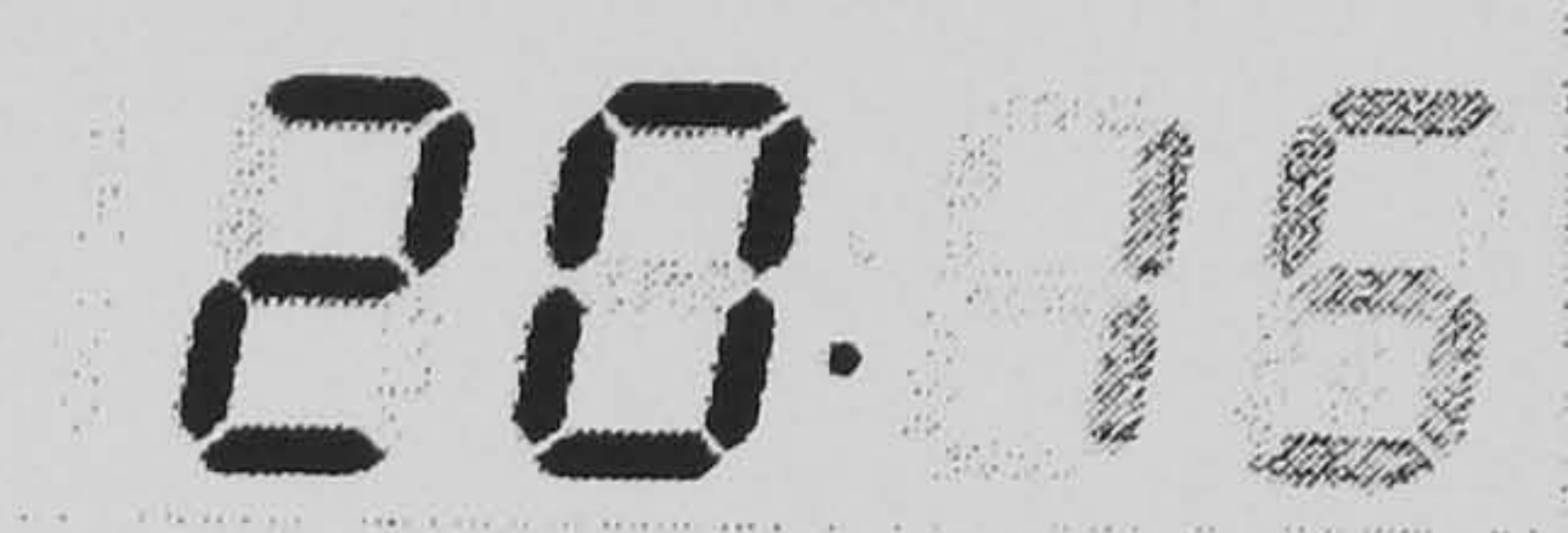
- specify level of hazards on equipment
- describe hazard
- state when product is at its most hazardous
- how to avoid hazards
- what to do in the worst outcome

If possible, use flow diagrams and illustrations to express information.



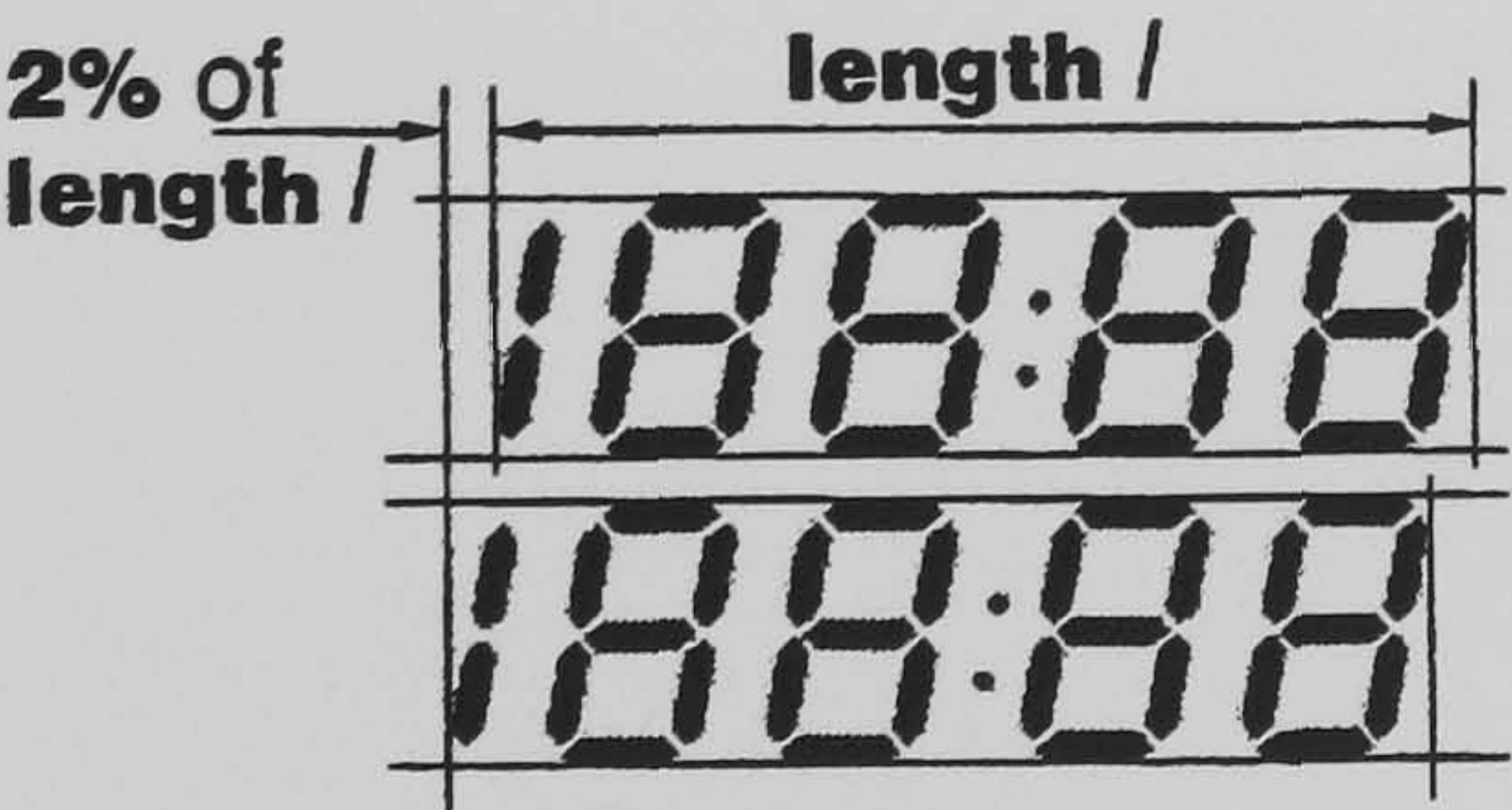
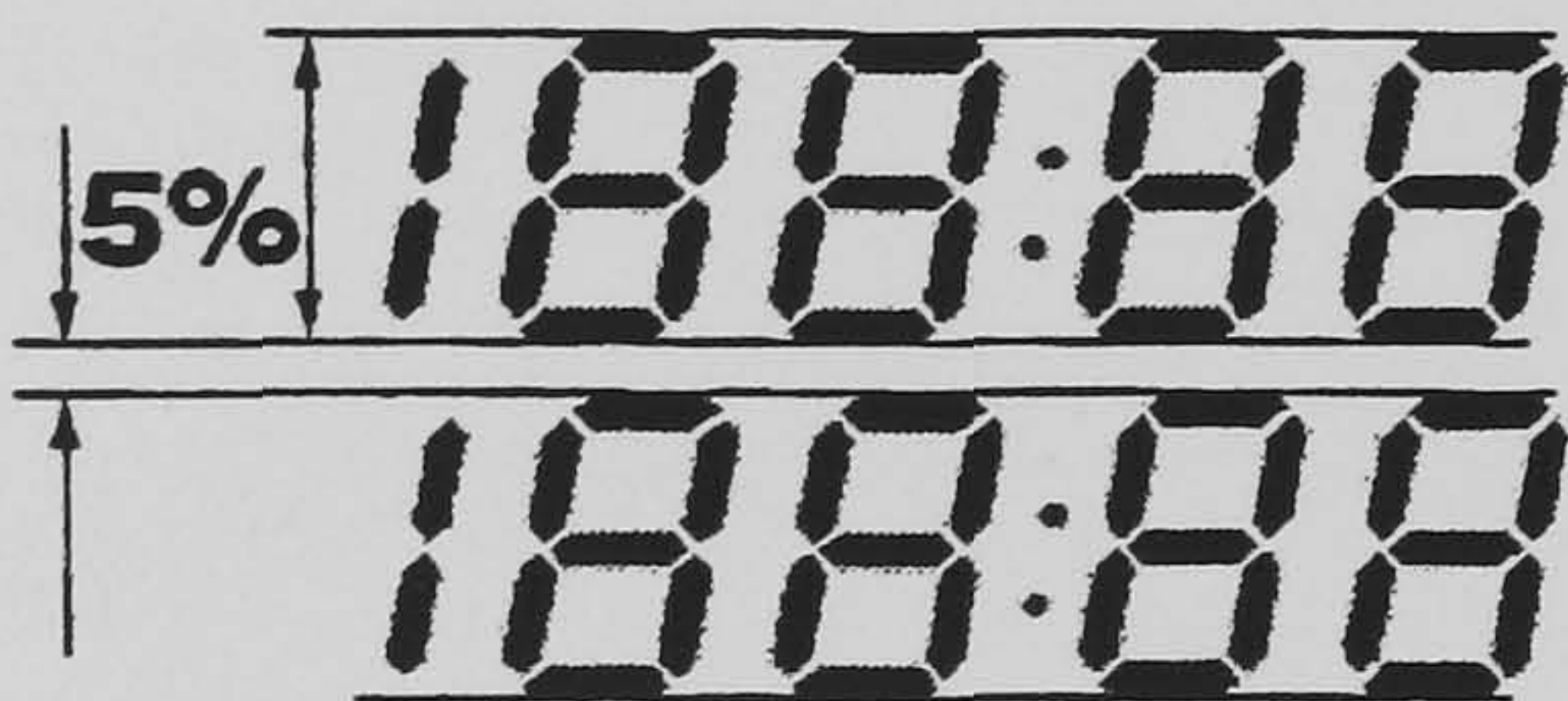
Electronic displays

Inverting display brightness can be used to highlight critical areas



Dark characters on a light background can reduce distraction because of reflections from display surface

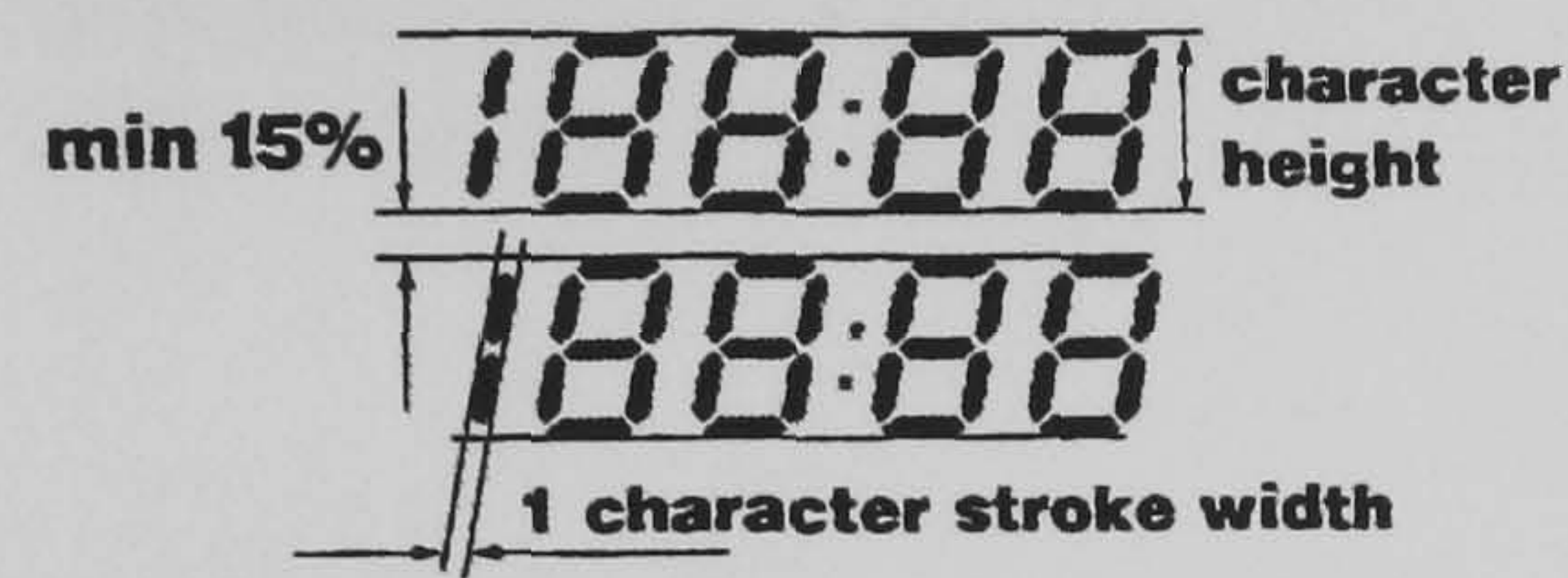
Distances between rows of characters should not vary by more than 5% of the characters height characters



A row or column of characters should not vary from a straight line by more than 2% of the length of the row or column



For hand held devices, character height should be not less than 2 mm in height



Between line spacing:  
minimum 15% character height or 2 character stroke widths, whichever is greater and between word spacing should have a minimum of 1 character width

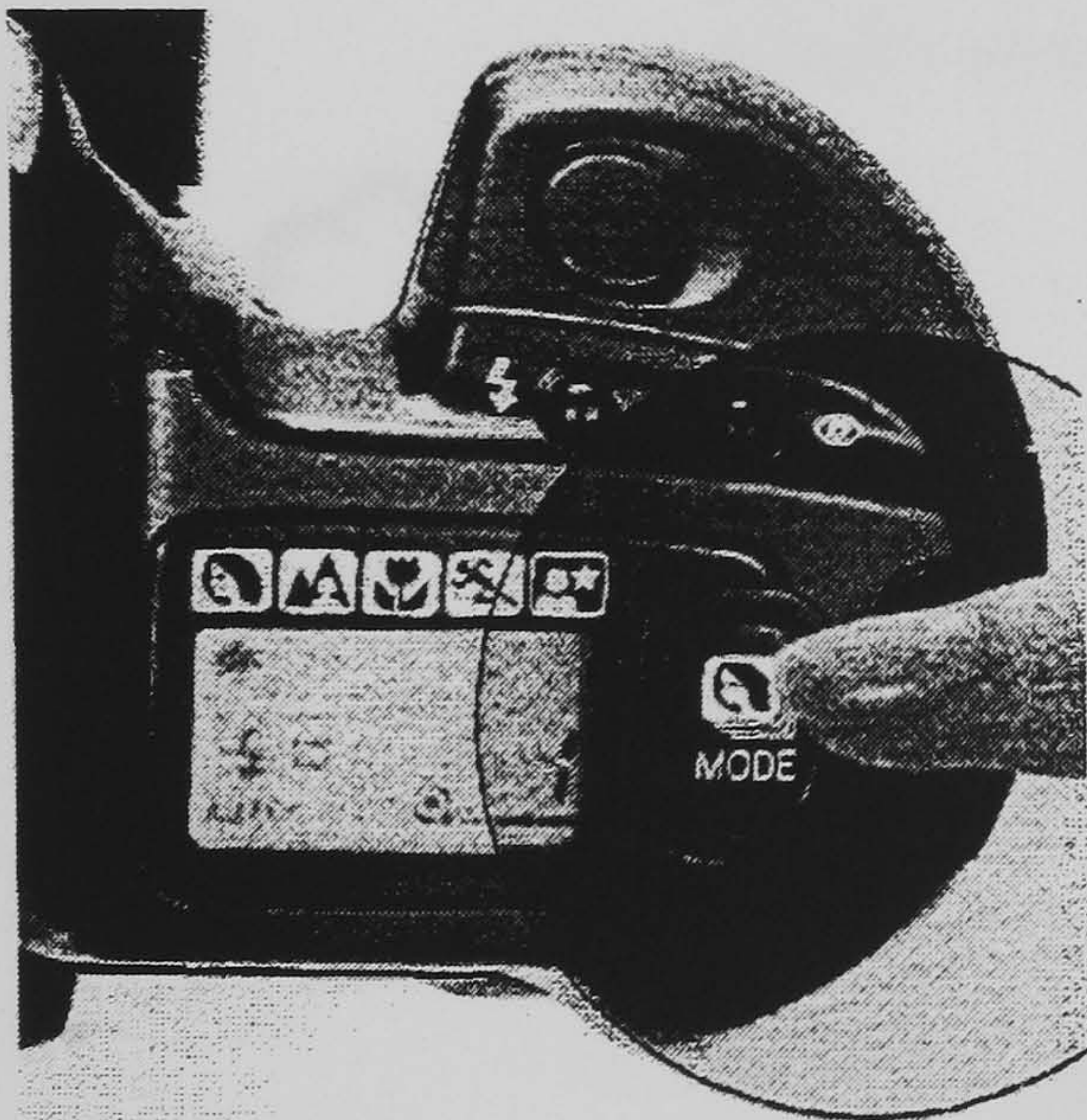


# Graphics Symbols & Icons

These guidelines deal with any graphical or pictorial representation used on a display. This is broadly defined as being either electronic or print based product graphics. Also these guidelines address static images, see Animation for moving images.

## Guidelines

### Icon design



When selecting or designing graphics, keep them as simple as possible while also retaining the meaning of the message. Excessive detail should be avoided.

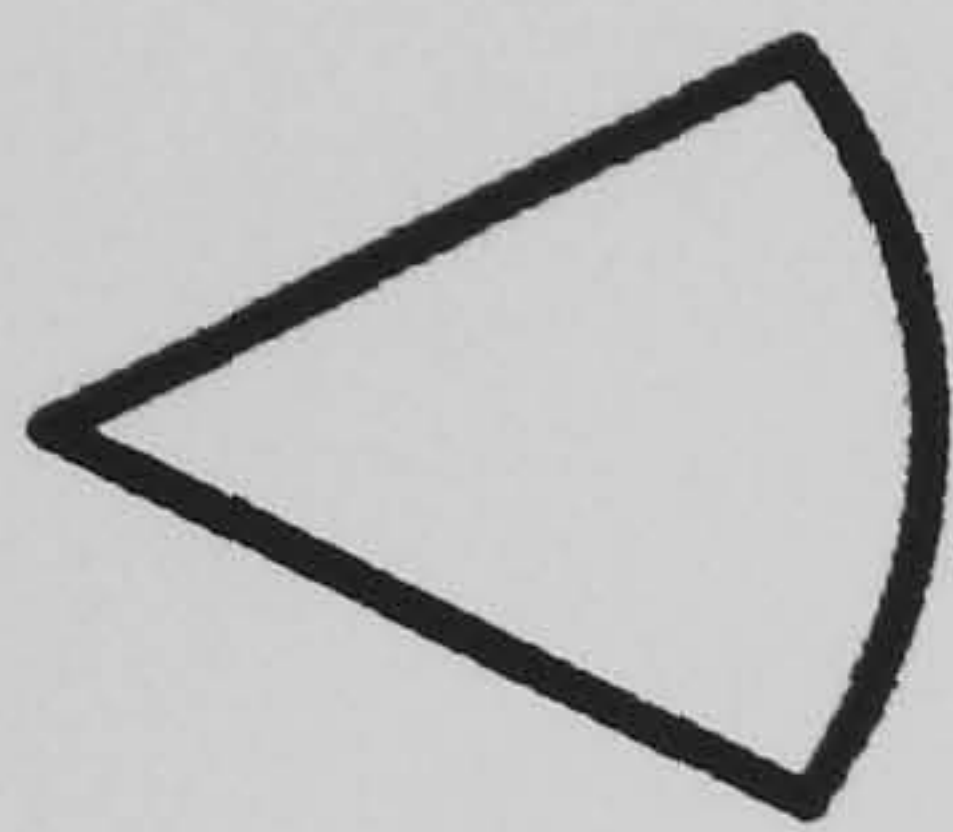
More attention will be given to parts of a graphic which are, solid, well defined and appear to be in the foreground.

Colour, contrast and bold outlining should be used to differentiate different graphics or to draw attention to specific graphic elements, critical and frequently used elements should be very conspicuous.



Schematic representations of objects offer a good way of presenting the important information to the user without visually bombarding them with excessive detailed information.

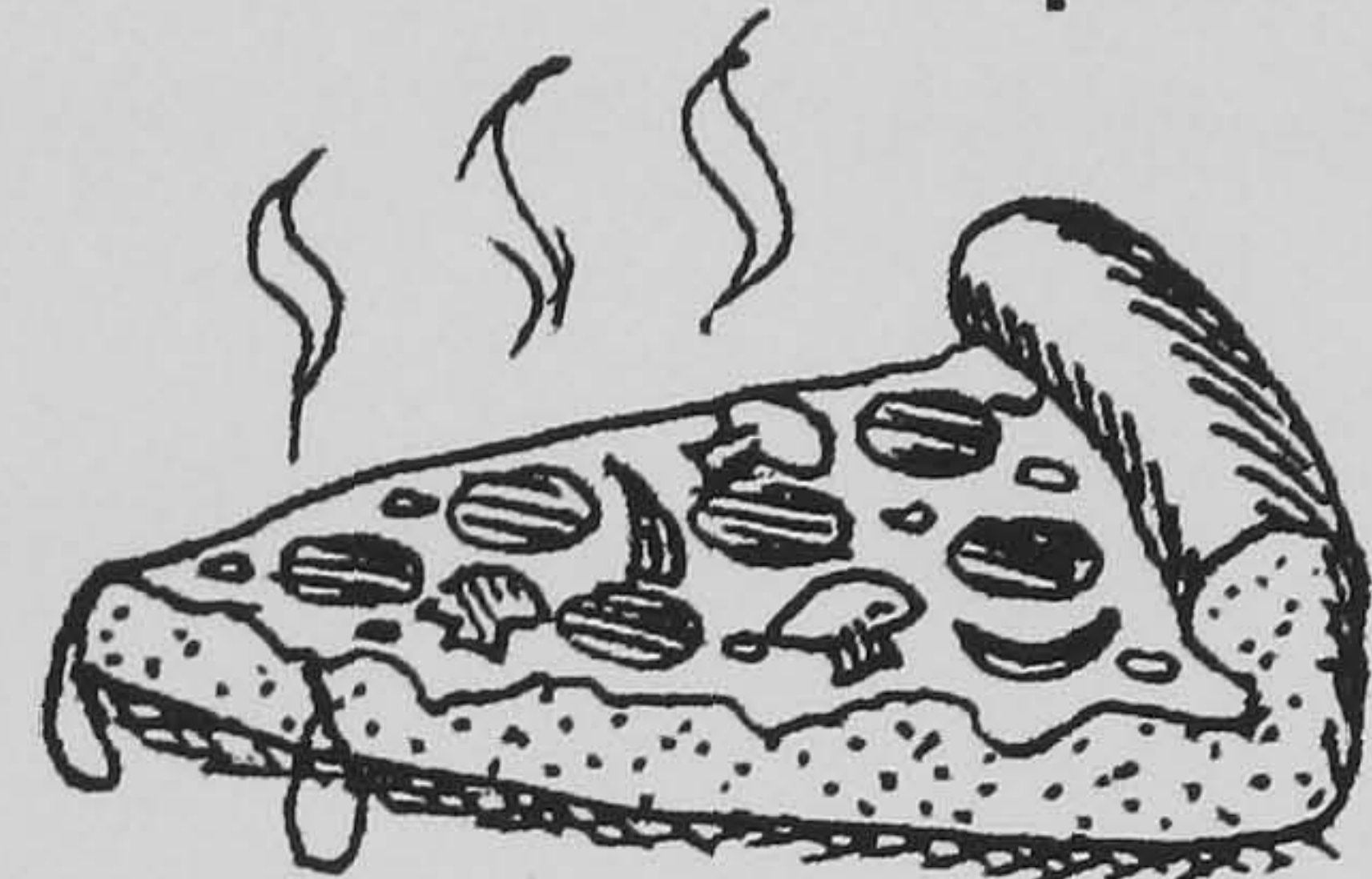
**Too simple**



**Good**



**Too complex**



Objects and pictures of objects are more easily remembered than their names.

Exaggerate critical features of an object or a graphic to draw the users attention to the more important elements of the icon. This method can also be used to draw the users attention to novel features.

Make sure that graphics/icons are consistent in their meaning have a similar structure



Movement can be conveyed by 'speed-lines', though this is not a familiar concept in all cultures.



Tests should always be undertaken on icons which have been produced for a product to ensure that users are able to fully comprehend their meaning

Be aware of cultural differences in understanding and meaning of different graphical images.

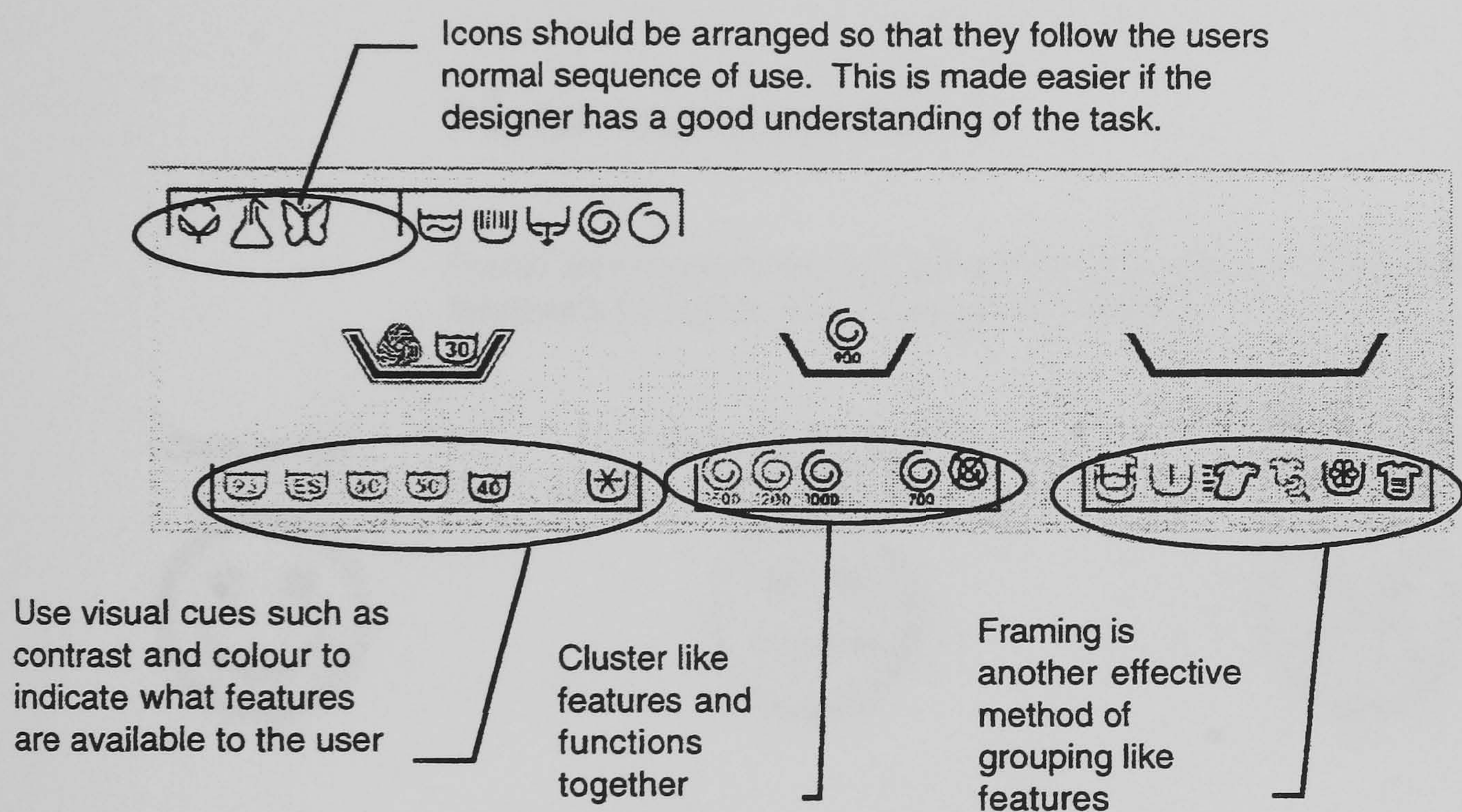


## Organisation of graphical elements

Organisation of graphical elements is important and should be considered in two different ways

- Between different graphical elements within the same display screen or interface panel
- Graphical elements between different screen states

When organising and designing within the same display state, consider the following guidelines:



Do not put more than 7 elements in a group.

## Instructions

If text and graphics are to be used together then ensure that they both have the same associated meaning and it is obvious that they belong to each other.

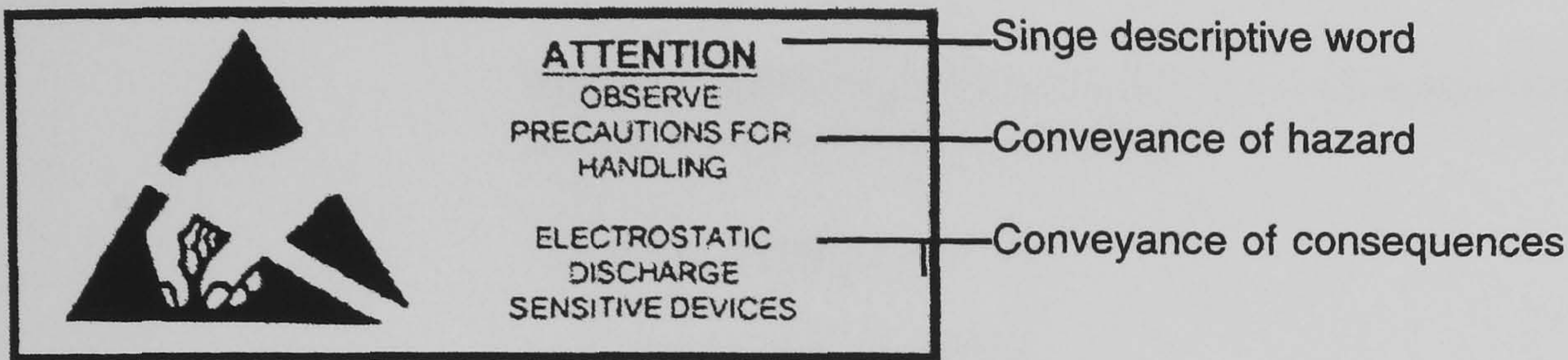
Graphical images are very strong when there is a strong associative link between the image and the message. This usually occurs when the message is related to a concrete concept such as a clock or a timer, but is less powerful for abstract concepts such as 'reheat'.



# Warning graphics

Warning graphics should be legible from a greater distance than any other adjacent graphics.

Warnings should ideally contain clear, concise instructions near to the warning graphic if appropriate, set out in the following manner:



# Facial representations

Facial representations can be useful as a method of providing feedback for users as to the systems status.

Device OK



Possible problems



Device fault



In general the discriminating variables of the face must be clearly visible to the user so that they can make out the meaning.

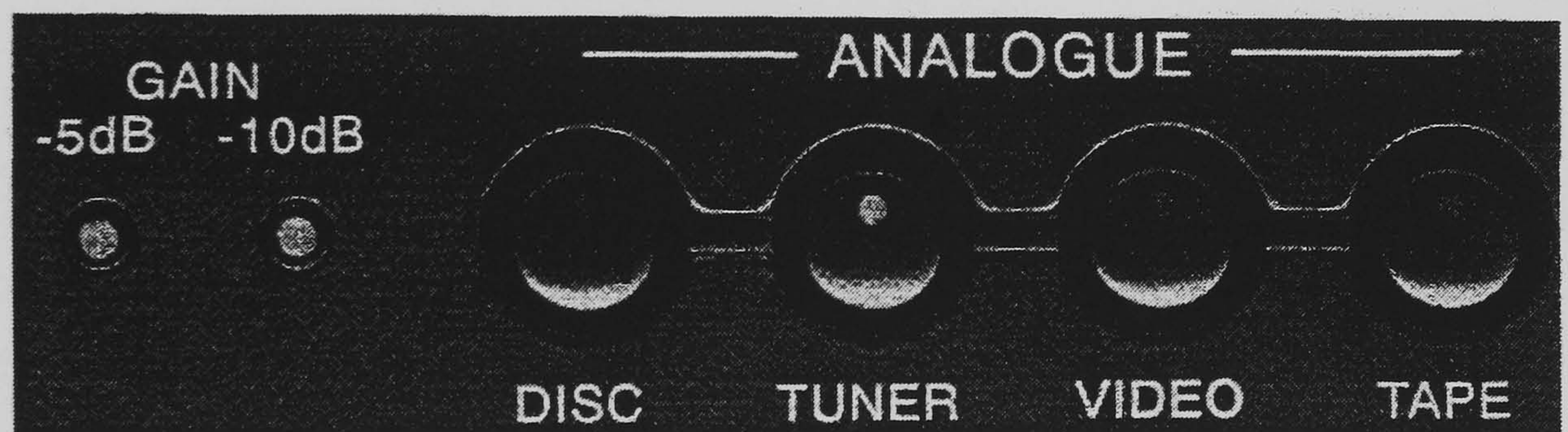


# Indicator Lights

Indicator lights should have some form of adjacent text or graphic element indicating the meaning.

Display variables can be:

- levels of brightness
- shape of light
- colour
- rate of flashing



Flashing can be used to:

- attract attention
- suggest that immediate action is required
- indicate that there is a discrepancy between the required state and the current state of the product
- indicate that some form of processing or transition is taking place

Frequency of flashing should be between 2 -5 Hz. The 'on' time should not be longer than the 'off' time.

Only one indicator light should be flashing at any one time

A red flashing light is normally used for important alarms.

Consider the rate of flashing as a coding method. This could indicate either the degree of progress between one state and



another (the closer to the intended state the faster the flashing), and it could also be used to indicate the level of urgency of the warning.

Colour	Meaning
Red	Conventionally used for danger or alarm but less so for consumer products
Yellow	Caution
Green	Safety
Blue	No specific meaning
White	No specific meaning

Indicator lights that are associated with control switches or buttons should be placed either at either in top or left positions.



# Use of Colour

Colour is a good coding mechanism provided it is used carefully and consistently throughout the product interface.

## Design guidelines

### Colour selection

Avoid pure blue lines for text, thin lines and small shapes. However blue does make a good background colour.

Avoid red and green in the periphery of large-scale displays. Yellow and blue are good peripheral colours.

Opponent colours go well together - e.g. red/green, yellow/blue. Not all colours are equally readable or legible. As a general rule the darker, spectrally extreme, colours (red, blue, brown etc.) make better background colours whilst brighter spectrum centred colours and de-saturated hues give more legible text.

Warm and cold colours should indicate action levels. Traditionally warm (long wavelength) colours are used to signify an action or the requirement of a user response, cool colours indicate more status or background information. Warm colours draw attention, cool reduce attention.

### Users of colour

Older viewers need higher brightness levels to distinguish colours. Bare in mind that colour appearance changes depending on the ambient light levels. When designing think about the type of light the display will be viewed under (fluorescent, incandescent or daylight).

Colour deficiencies are more common in men than in women

Most common is loss of discrimination between red and green colours. People with this defect can still see greens but confuse certain reds with greens and some reds and greens with grey. There is a deterioration in yellow-blue discrimination as people get older, and colours are also perceived as darker and less saturated



In these situations good colours to use are: red, yellow, green, blue, brown. Other acceptable colours are: orange, yellow-green, cyan, violet, magenta

Interface design and colour

Avoid the need for colour discrimination in small areas. For fine detail it is better to use black, grey and white and reserve chromatic colours for larger panels or for attracting attention.

Colour does not affect icon recognition time however designers of icons should select appropriate colours for icons which allow colour discrimination.

Displays should be designed with a strong contrast between background and display colour.

Use colour sparingly. Displays should be limited (at most) to six different colours.

Group related elements by using a common background colour.

Use similar colours to convey similar meanings.

Design considerations	✓	✗	N/A
Is the use of colour consistent through the different elements of the interface?			
Have more than five colours been used?			
Has colour coding alone been used in physically small parts of the interface?			
Have warm colours been used in drawing the user's attention			
Have familiar or cultural colour coding been used?			
Have you made sure that subtle differences in colour have not been used for coding purposes?			
Have dark background and light foregrounds been used?			
Was the interface designed in monochrome first?			
Have the different lighting environments which the interfaces will be used in been considered?			



# Colour coding

Colour coding indicators on devices have to follow existing conventions. In this way the status of a device could be shown using a colour coding method in the following ways

Colour	Conventional meaning
Green	On  Indicates that an item chosen from among multiple choices on a selector is active  Low temperature
Amber	Off Standby Warning Recharge Medium/ Transient or suitable temperature
Red	On Danger Low power High temperature
Yellow	Caution
Blue	Advisory status

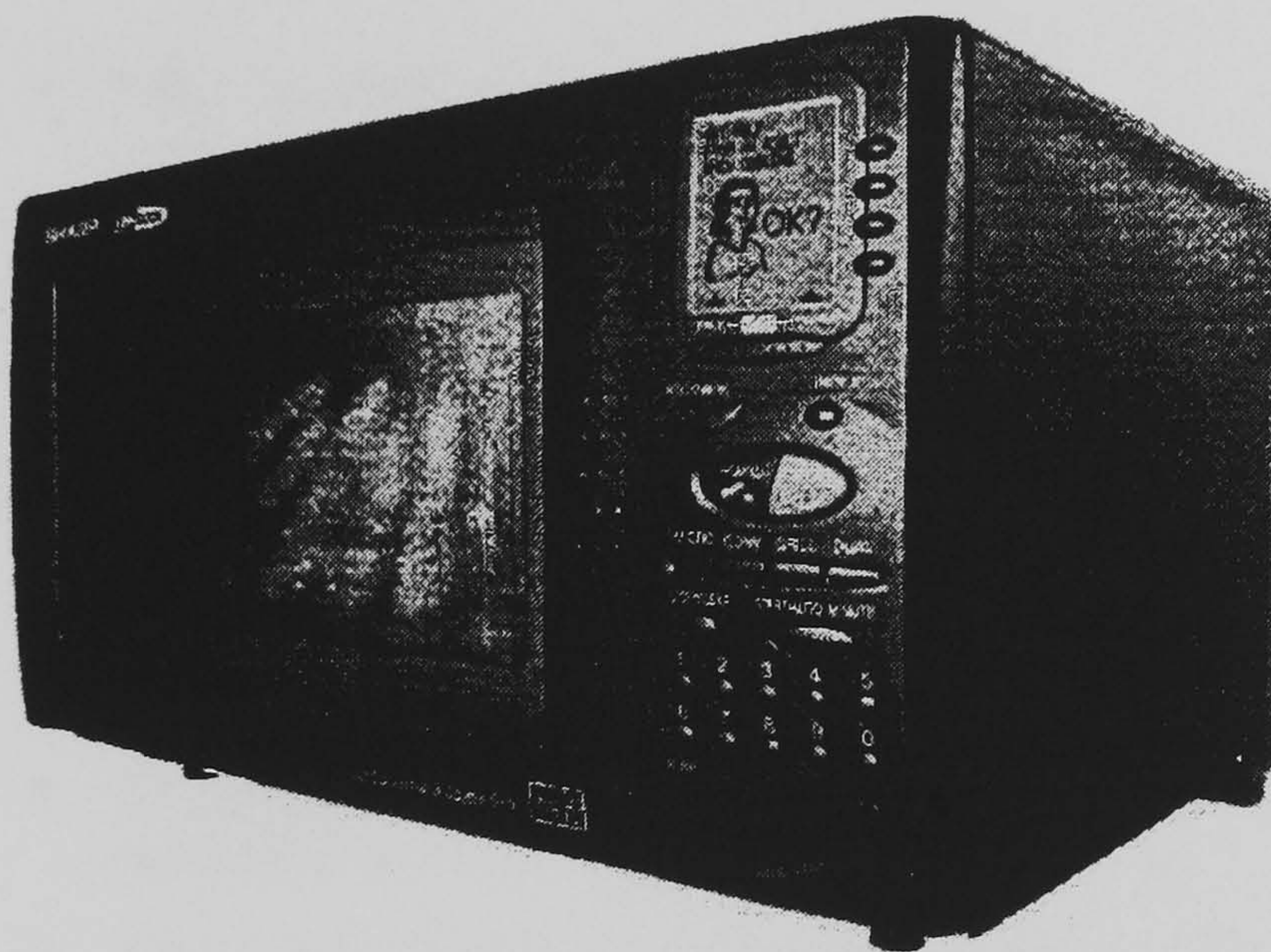
It must be noted that there is little adherence to these guidelines in many products.



# Animation

The use of animation on the interface helps to communicate several styles of messages. Animation can be used to:

- Show a sequence of actions which the device or user should undertake
- Create an emphasis
- Creates a visual 'navigational bridge': moving users gracefully between system states



The Sharp microwave (pictured above) utilises animation to assist the user to use new features

Animation is particularly effective in the following situations:

- showing if a part of the device is active or at fault
- showing that a transition from one state to another is taking place, particularly when they are lengthy (film rewind)
- showing how to complete or start an action
- as descriptors of abstract or time based functions
- to attract attention
- to convey hidden information

Only one element or area of the display should be animated at any given time, other wise the uses attention will be drawn away from the active part of the display.



For animation's to be useful and meaningful, it should be the transitions between frames that convey a large part of the meaning rather than the design content or style of each frame.

## Guidelines

When designing an animation, thought should be given to designing the animation rather than designing an image which is then animated. Animation's are only successful if they increase the level of information conveyed to the user beyond a static image.

Animation should not be used gratuitously as they can become annoying, particularly if they are in peripheral view.

- Keep animation's as simple as possible

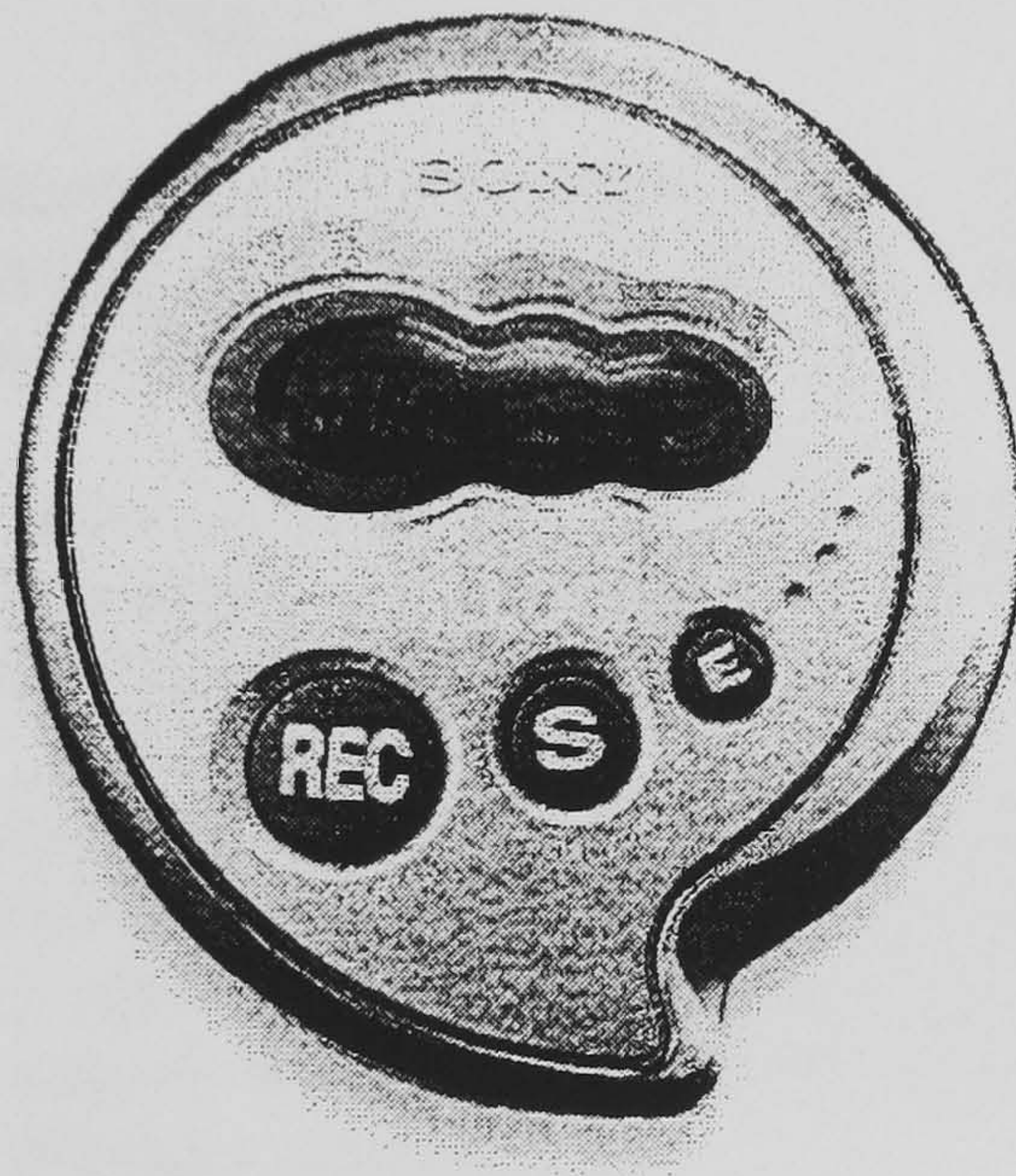


- Simple animation's should be at least 5mm square, more complex animation's should be at least 10mm square
- Trails should be conducted on animation icons to ensure that the meaning of the icon is efficiently conveyed to the user



# Auditory displays

Use of auditory displays allows the designer to represent device information in auditory form, which in turn frees up space on the interface to allow for more important graphical information to be displayed without causing visual overload.



There are three main types of auditory display which are used on devices:

- alarms
- auditory icons and earcons
- spoken language

Each of these has their own, specific application to the user interface.



## Alarms

Signals which are designed to interrupt an on going task to indicate that something requires immediate attention.

## Auditory icons and earcons

Auditory icons use appropriate sounds to convey a message. There are three main classes of auditory icons

- symbolic - rely on social convention for their meaning (e.g. applause for approval)
- gnomonic - the same as physical sounds (for example using the sound of a metal filing cabinet closing to illustrate the symbolic closure of a computer file).
- Metaphorical - for example falling pitch to represent a falling object

Audio icons do not have to be a realistic representations of the object sound but must capture the essential features of the object (as with visual icons).

Users are only able to differentiate between a relatively small number of sounds. For this reason auditory icons should be easily distinguishable

Earcons use music and abstract sounds to convey meaning. Humans are able to recognise sounds more by rhythm (a succession of different sounds) than they are by pitch (frequency) for this reason, audio output should consist of a discontinuous pattern of different sounds.

## Spoken language

A way to provide speech distinctions is to alternate between male and female voices.

The use of spoken language on interfaces means that they do not transfer as well across cultures.

### *Benefits of auditory feedback*

Quality	Application/Advantage
Eyes free	User does not have to be attending the object to receive the feedback
Rapid detection and altering	Good for monitoring; high stress environments; general interfaces.
Orienting	Indicates where the user should be attending
Backgrounding	Monitoring device. Can also listen to more than one device at any given time.
Temporal resolution	Auditory feedback can give information with respect to time
Affective response	Ease of learning; engagement; convey subtle qualitative information.



*Disadvantages of auditory displays*

Quality	Application/Advantage
Low resolution of auditory variables	Difficult to use sound to represent absolute values
Annoying	No “ear-lids” so the user cannot casually tune out the display.
Not bound by line-of-sight	Sound bleeds to nearby listeners, which can lead to a loss of privacy.
Absence of persistence	More difficult to compare two auditory signals than it is to compare two visual ones.
Not constant	Once sound is played there is no lasting impression of what it was

*Advantages and dis-advantages of auditory and visual displays*

	Auditory display	Visual display
Complexity	Simple	Complex
Length	Short	Long
Later reference	Cannot be confirmed later	Can be confirmed later
Contents	Output items relating to time	Output items relating to space
Relation to action	Requires immediate action	Does not require immediate action
Relation to other display	When visual display is overloaded	When auditory display is overloaded
Operational environment	Too bright or too dark	Noisy environments
User’s situation	Mobile	Stationary

*Volume of auditory output*

Volume is also dependant on the function of the device. For example the volume of a telephone ring has to be loud as it has to draw the users attention towards the object. In contrast, the sound of the “beeps” when the user enters information into their microwave is relatively quiet

In general, the sound emitted from a device must be loud enough so as to be heard above the ambient sound of the devices surroundings, especially if the sound is being used attract the users attention.



When a sound is 10 dB above the ambient sounds around it, it is easy to hear. When it is 15dB above the background sound, it is very difficult for the user to ignore.

It is useful, where possible, to include a control for the user to adjust the volume of the auditory feedback of their device. The user must also be able to switch none essential auditory displays off as sounds can be very annoying.

Excessively high and low frequencies should be avoided. Sounds should be presented within the range of up to 3kHz

In general sounds used on devices should be fairly short in duration, no more than a few seconds at the most. Feedback that a button has been pressed should be very short where as alarms and alert sounds should be longer as short sounds may go unnoticed.

Sudden bursts of sound may startle the user and cause reflex action. Unless the sound is being used as an alarm this should be avoided.

As with colour, sound should not be totally relied on as a method of feedback.

Provisions should also be made for hearing impaired users.

Auditory cues used should not be humorous or emotionally loaded.

Auditory displays should not interfere with speech communication.

#### *When should auditory displays be used?*

Auditory displays should be used when

- Visual displays are not appropriate (e.g. when driving a car and trying to tune in the radio).
- To enhance visual displays and make their operation more memorable.
- When visually disabled and blind are needing to use a visual based interface.
- When there needs to be a reduced load on visual channel, or when the visual interface would otherwise be cluttered and more difficult for the user to read.
- When the reaction to a stimuli must be fast (reaction to auditory stimuli is faster than reaction to visual stimuli).
- To represent relative values not absolute values.



## Things to think about

- What each individual sound means to the user.
- The way the user remembers the relationship between the auditory message and the action which it is being used to represent.
- The effect of adding auditory cues to the interface, will they be annoying, obtrusive or distracting at all for the user?



# Appendix 13.6

Internal Electrolux design  
report



Microwave

Interface Project



 **Electrolux**  
Industrial Design Centre UK

compiled April

26<sup>99</sup>





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- ⑩ card sorting (workshop 1) illustrated
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- ⑮ **information gathering**
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This report details the research undertaken to investigate microwave oven interface design from a usability perspective.

The broad aim of the project was to explore what people will perceive as useful, desirable and beneficial in a microwave product.

This required a new approach to discern what the latent needs and aspirations of people are, and in particular, what qualities they would value in the next generation of microwave products.

In order to stimulate and facilitate this research a range of Design Tools developed by the Human Machine Interface (HMI) Laboratory at Teesside University were used in a series of workshops with users.

Using a team of people to work through exercises in a workshop format gives us the opportunity to attain useful feedback. Specifically to identify and prioritize existing functional needs for a microwave interface, whilst establishing at a high level how users would like to use the interface.

This material not only provides us with a broad usability picture but also highlights specific issues, helps us to address them, and achieve differentiation on a functional level.

The material presented in this document is of a general nature and tries to accommodate feedback on all current function types, as well as speculative functions, the aim being to gain the maximum feedback from the Workshop exercises.

The intention for the findings is to present workable information which can be modelled and adapted to suit a multitude of interface requirement levels. The material should be used in such a way that it is of a 'working' nature and not be viewed as offering definitive solutions.

The research culminates in a set of four speculative solutions which look at ways to break away from the conventional routes of differentiation, with the emphasis on employing a 'back to basics' approach to future product development and stressing the need to get the fundamentals right.





## background

- Cost has become one of the key driving forces in the MWO market.
- Product innovation is confined to minor repackaging activities and is not fulfilling its potential as a differentiation factor.
- Differentiation has been limited to aesthetics and the number of cooking functions offered by each product.
- This report investigates microwave oven interface design from a usability perspective, to determine:
  - What functions users perceive as useful, desirable and beneficial in a microwave product.
  - The latent needs and aspirations of microwave users.
  - What qualities users would value in the next generation of microwave products.





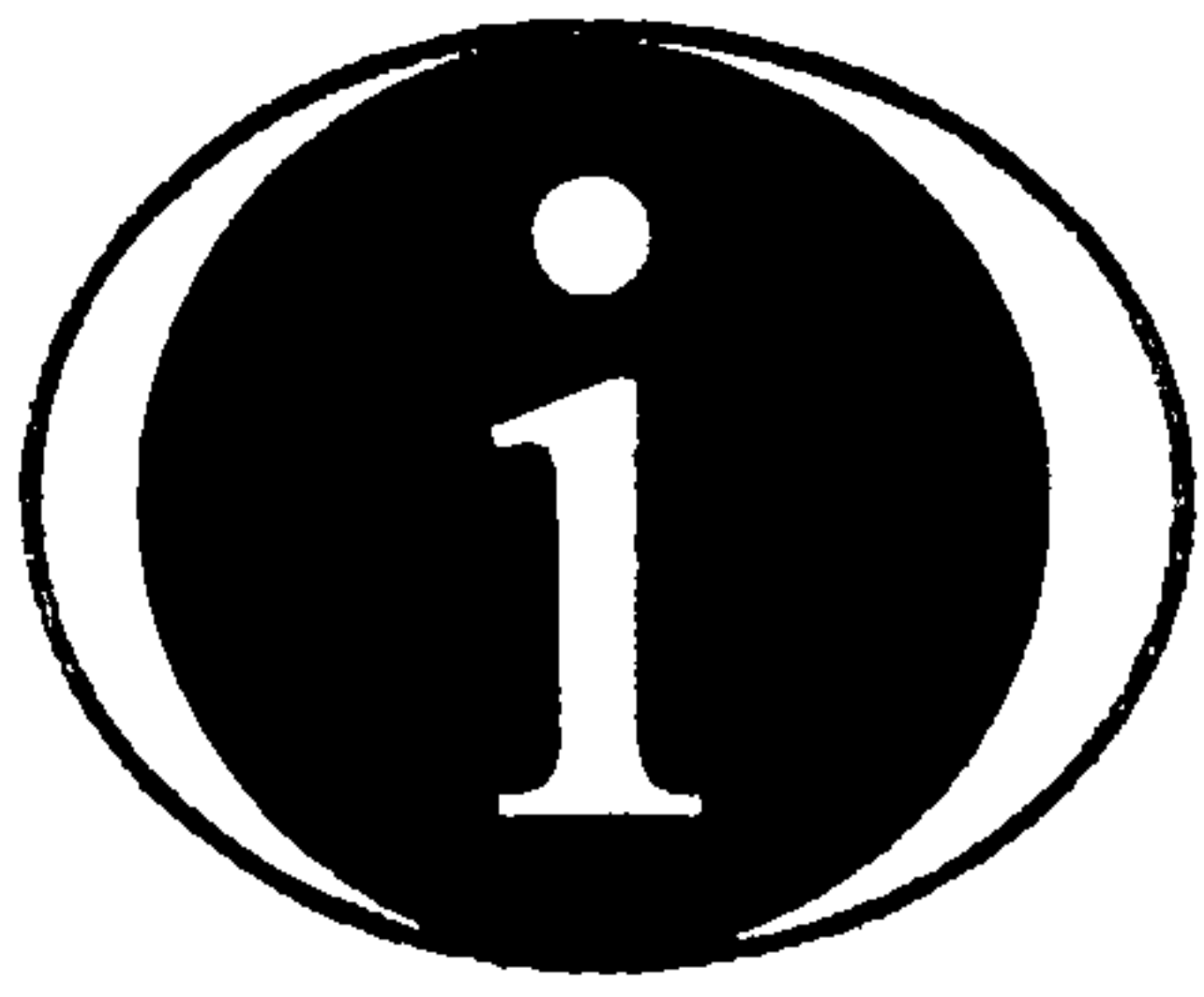
#### project aims

- Re-evaluate current MWO product thinking.
- Develop an informed understanding of how MWO products are actually used.
- Ascertain user preferences on existing product range interface devices and functions.
- Spotlight and promote appropriate usability issues and functions for adaptation to future products.

Establish a usability culture for microwave product development to:

- Improve product usability.
- Improve product development process quality.
- Improve user performance.
- Improve customer satisfaction.
- Create a marketing edge for Electrolux MWO products.





research methods





In order to attain the kind of material required to gain a clearer understanding of the 'actual' needs of everyday users, a system of exploratory exercises was needed to attempt to unearth the facts concerning usability problems, and the extent to which existing functions are used and understood.

To explore the possibilities we utilised design evaluation tools being developed by (HMI Lab) at Teesside University, this provided us with a mechanism from which to find the kind of information necessary in order to get an accurate day to day picture of the way our products work. Also to provide feedback to help us form a picture of how to improve the user interfaces of our products.

The interaction design tools which were used to form the basis of our research had not been applied to this particular product previously, but encouraging results had come from workshops focusing on other appliances, so the suitability of this kind of exercise was favourable.

With the intention being to run the workshops swiftly the first of the design evaluation tools was used in its basic form. This gives us an understanding of how best to use the tool to search for information, and also time to consider the option of deciding whether just to let the exercise run and see what kind of directions the users take us; or to decide whether to manipulate the process and channel the directions from which users can supply feedback.





## **Description of the Tools:**

### **Card Sorting (utilised for Workshop 1, 2 sessions)**

This design tool is a collaborative activity between anticipated users. The participants sort and place cards on a table with interface designers, the main purpose of the tool is to find out what needs and requirements potential users of a conceptually or loosely defined interface maybe.

Depending on the objectives of the exercises, participants arrange the cards, adding new ones if necessary, which best fit their jointly agreed representation of the exercise objectives.

The cards allow users to think differently about the role and significance of each function permitting a less constrained, more creative approach to their needs for a proposed product interface.

### **The benefits of using this tool:**

- Users find it difficult to communicate ideas or concepts beyond their own experiences.
- Users are often not able to anticipate scenarios of product usage that they are not familiar with, or able to reliably describe or interpret their own usage behaviour with existing products.
- The cards provide a discussion mechanism or act as 'transitional objects' allowing more critical contextual thinking to occur about product interaction.
- Prospective functions can be divorced from defined or existing technology therefore product functionality which is currently not possible can be discussed.
- Users don't know what they need; can't articulate their needs, or if they can, they don't know what is possible or impossible.



# Card Sorting (As used for microwave interface research)

A workshop exercise where participants, for example: produce a meal without the need for actually cooking, by arranging cards with predetermined descriptors in a line of sequence. The aim of the exercise being to find and explore fundamental usability problems with our own products, and to discover new and latent user needs, and functionality preferences.

## Step 1

### Task Planning

Highlight and agree specific functionality issues to research.  
Decide on appropriate exercise to satisfy research criteria.

### Participation

Consider type of participant suitability:  
Participants can be randomly selected, or specifically chosen for suitability.  
  
Workshop coordinators:  
1 to drive, prompt, and direct the exercise.  
1 to monitor take notes, and possibly video workshop for analysis.

### Getting Started

Clearly explain how you want the workshop to work.  
  
Monitor and direct progress, keeping participants on track but maintaining good flow of ideas, and encourage open thinking .

## Step 2

### Functional Inserts

For a cookery testing exercise:  
  
Produce an appropriate menu.  
  
Collect required utensils, cookware etc.,  
or: Produce utensil description cards.  
  
Produce Ingredient cards to be arranged.  
  
Produce Task cards for insertion at critical points.  
  
Produce Function cards (showing current and speculative functions) for insertion at critical points.  
  
Produce Event cards for random insertion.  
  
Prepare a time line as a means of measurement for the menu. Can be made up simply using a line of tape on a flat area.

## Step 3

### Matrix Filter

A grid for positioning functionality preferences in for e.g.:  
Can be made up simply using tape on a flat area.  
  
Participants select function cards and place them into categories.  
  
Typical categories could be:  
  
Useful not useful.  
Liked disliked.  
Preferred not preferred.  
Worthwhile not worthwhile.  
Difficult to learn/Easy to learn.

## Step 4

### Evaluation

Record Key moments and points of selection for analysis.  
For this you could use photographs or video for catching dialogue.  
  
Retain outcome of matrix filter for quick reference.  
  
Evaluate research and prepare findings.





selecting a recipe

For the workshops to produce constructive material it is essential that the menu selected challenges a broad range of functionality. Also to have the potential to require the participants to select additional or completely new functions; which perform tasks deemed unachievable by the use of existing functions.

For the purpose of the workshops outlined in this report a menu was selected which required the participants to rearrange the menu into a suitable cooking order. For instance when the menu requires an accompaniment to a dish a sequence of events has to be established to ensure that everything is completed and hot at serving time.

Microwave cooking differs in this way to conventional cooking methods in that you must rebuild a chosen menu to work with the functionality of your product. A planned approach is necessary as only one cooking cavity is at your disposal to satisfy all requirements.

To ensure that existing functions were tested for continued suitability, and new function opportunities explored thoroughly; a fish curry with rice was selected as the cooking task.



## TASK Overview

**YOUR TASK IS TO PREPARE A MIXED FISH CURRY WITH A SERVING OF BOILED RICE.  
SERVING 4 PEOPLE.**

### INGREDIENTS

5ml (1 tsp) Cumin powder.  
5ml (1 tsp) Chilli powder.  
2.5ml (half tsp) ground Tumeric.  
1 clove Garlic, crushed.  
30ml (2tbsp) Cornflour.

25g (1oz) Butter.  
1 Onion, sliced.

Pinch of Salt.  
2 Tomatoes, skinned & chopped.  
10ml (2tsp) Coconut, softened in a little milk.  
250ml (half pint) Water.

Pinch of Sugar.  
Juice of half a Lemon.

3pt frozen Prawns (about 250g (10oz) after shelling).  
Any cooked white Fish to make up to 400g (1lb) with Prawns.

200g (8oz) Patna Rice.  
Pinch of Salt.  
Large knob of Butter or 15ml (1tbsp) oil.

### Mixed Fish Curry (Method)

**Mix the Chilli, Cumin, Tumeric and Cornflour to a paste with a little Garlic.**

**Melt the butter in a large bowl for 30-45 seconds.**

**Add the Onion and cook on 50% power for 3/4 minutes.**

**Add all the other ingrediants except the fish.**

**Cook on full power for 3-4 (5-6) minutes, stirring every minute until thickened.**

**Add the mixed spices gradually.**

### Boiled Rice (Method)

**Place rice in a deep covered dish, with salt and a large knob of butter or 15ml (1tbsp) oil.**

**Add 500ml (1pt) boiling water. Stir after adding water.**

**Cook for 10-12 (12-14) minutes on full power.**

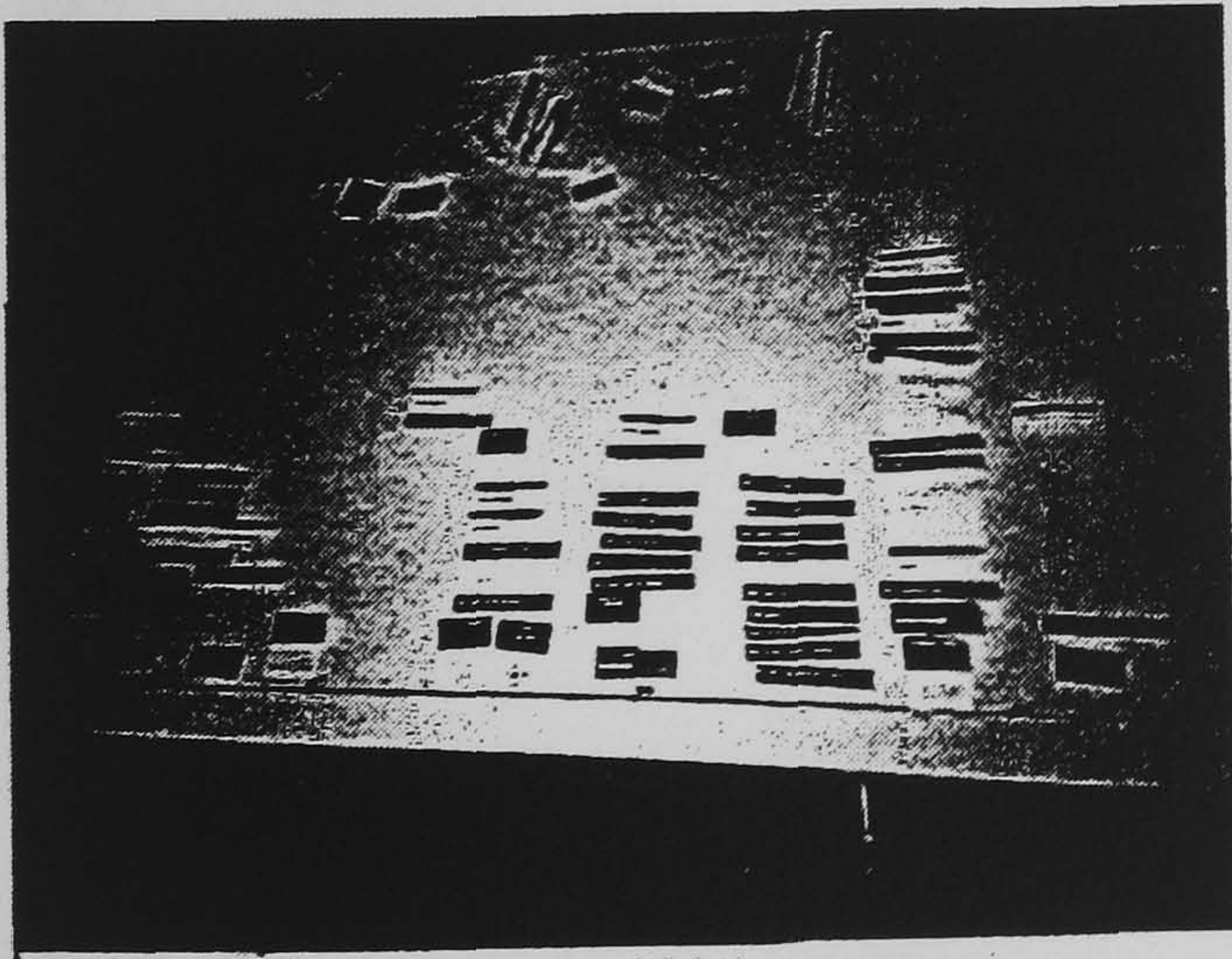


## Card Sorting (Workshop) exercise 1

### 'Quick Reference'



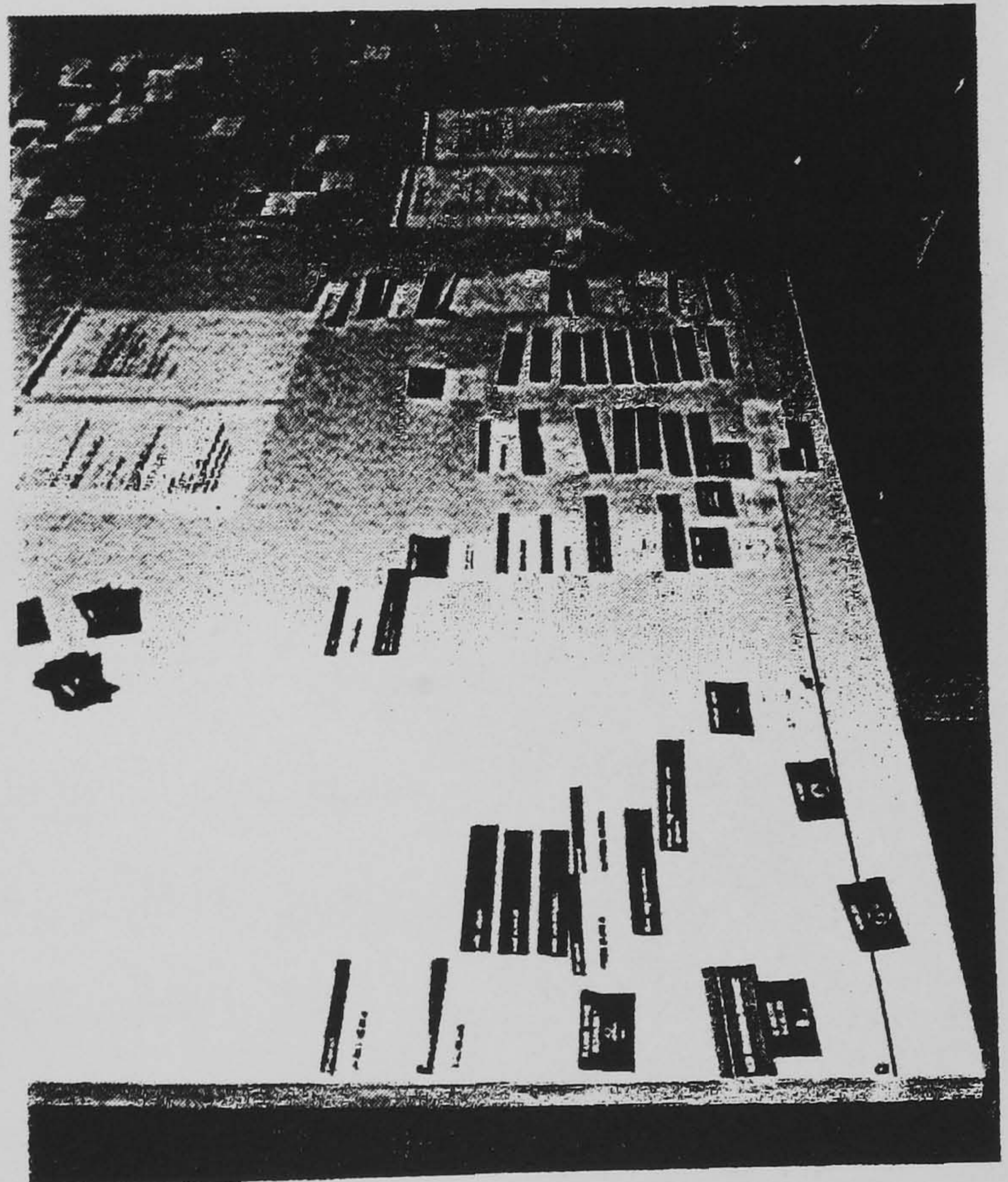
1. Planning the cooking stages.



3. Adding utensil, ingredient and function cards.



2. Starting out, arranging the cards



4. Selecting function and event cards.



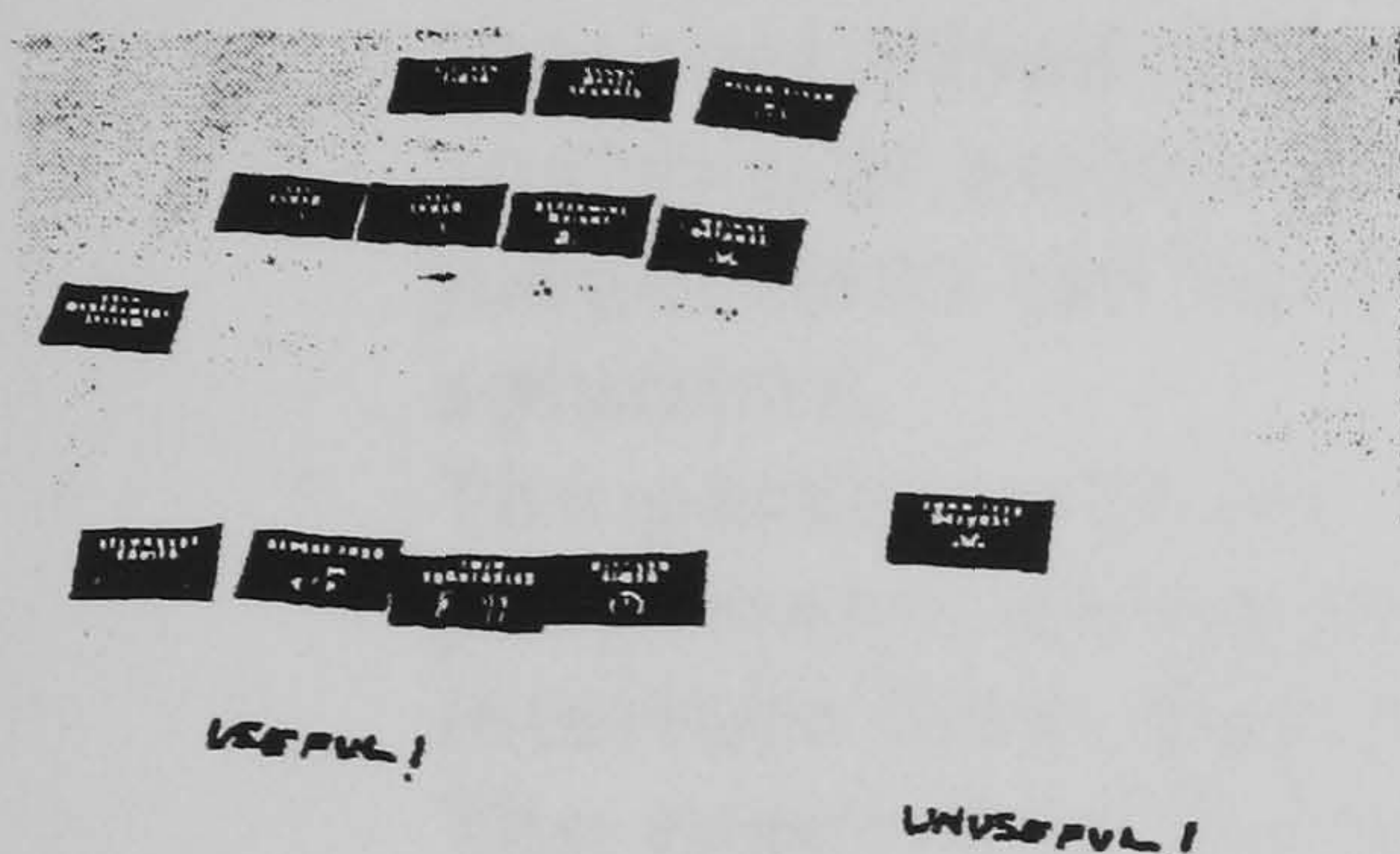
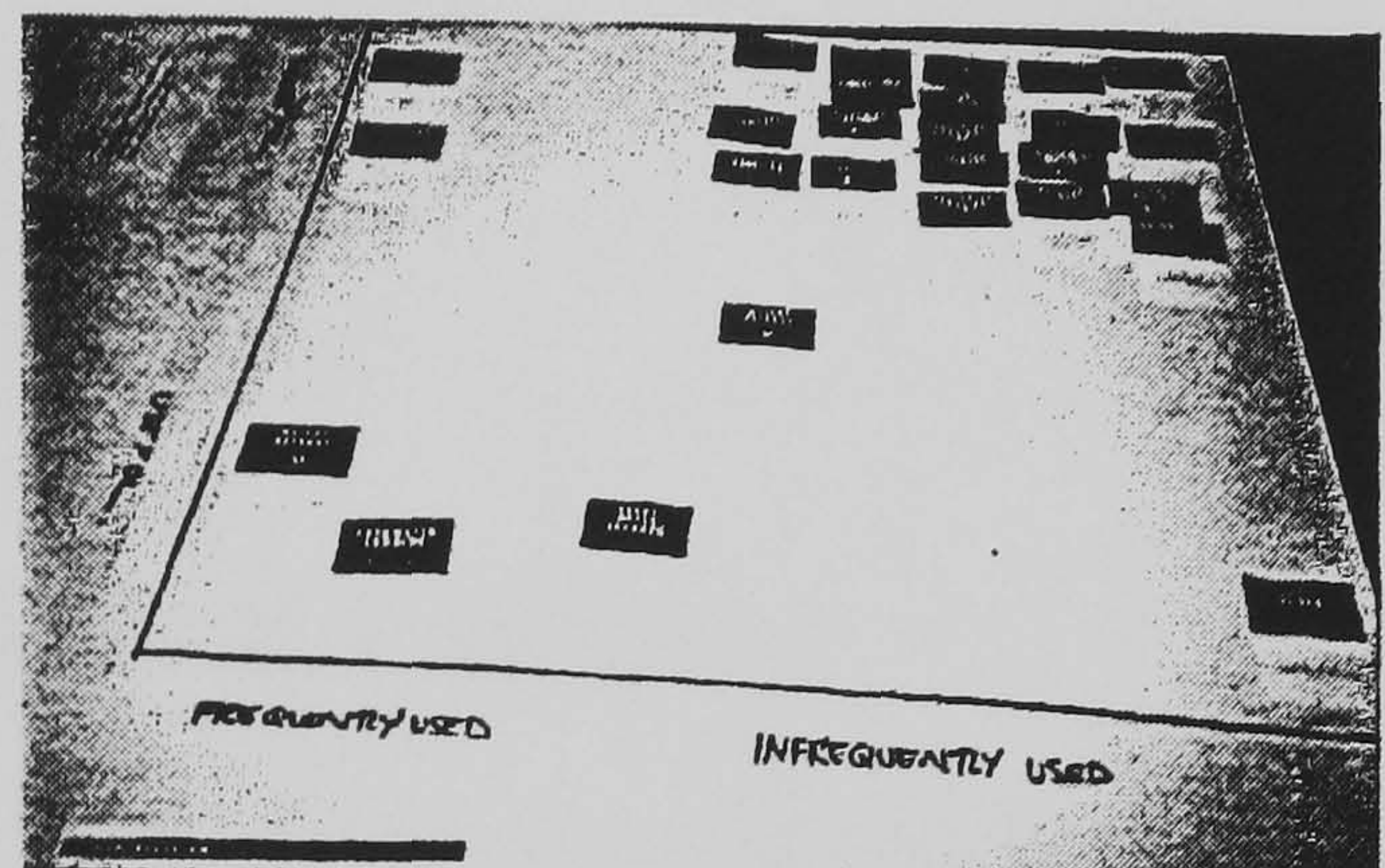
## Card Sorting (Workshop) exercise 1

## 'Quick Reference'

## 6. Function, Event options.



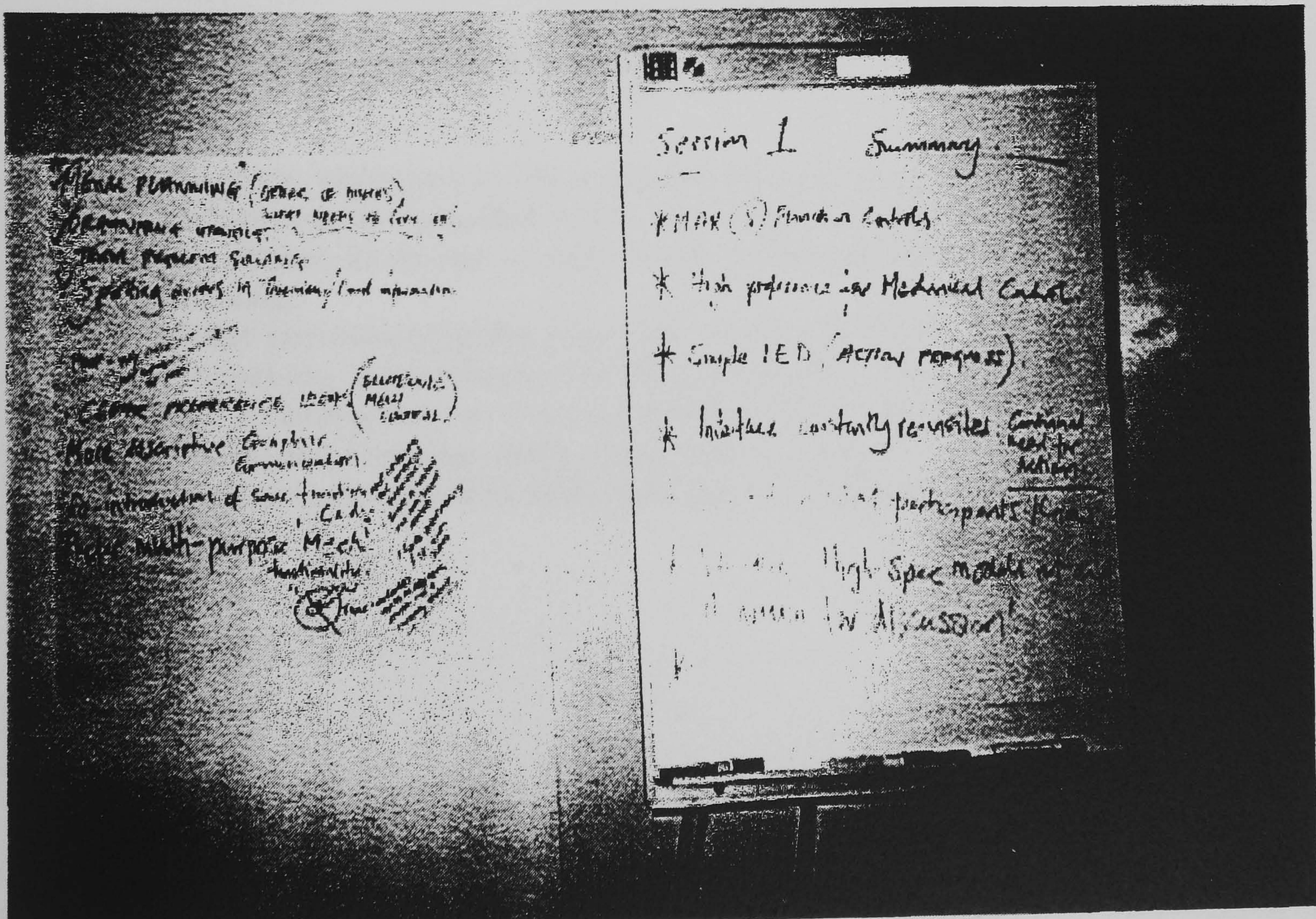
## 7. Adding preferences to a simple matrix



## 8. Collecting Preferences



**9. Paste-up preferences for quick reference.**



9. Review notes/observations at the end of each workshop session.





## **Description of the Tools:**

### **Scenario Design (utilised for Workshop 2, 2 sessions)**

The scenario in this case is the cooking of the recipe utilised in the card sorting workshop.

This tool allows the participants to be immersed within a particular contextual environment. From this, more informed and realistic judgements can be made with more insightful and creative solutions.

The participants are expected to make more critical design judgements about proposed interfaces and also help design the interface from their perspective.

The essence of the tool is to allow participants to explore the proposed concepts while acting or role playing within the scenario. It is within the context of the scenario that participants can make more informed judgements about the match between the interface design and its suitability to the tasks.

## **The Benefits of Using this Tool:**

The main objective of the exercise being to test the functionality preferences as specified in the card sorting workshop. This reality test allows us to see at what point the chosen functions fail or succeed.

Whilst constructing the interface we gain valuable information concerning the performance of our existing functionality.

This information can then be added to the pool of knowledge concerning the way users operate our products, understand our product functionalities and necessary function sequences.



# Scenario Design (As used for microwave interface research)

A workshop exercise with two participants and two coordinators.

For example:

Participants follow and prepare recipe ingredients to make a meal which covers the predetermined objectives of the exercise. The workshop coordinators operate the product on the instructions of the participants. Using a basic keyline model the coordinators add the functions, (written or sketched on post-it notes for example) the participants deem necessary to perform each step of the recipe, this tests the suitability of functions chosen in the card sorting matrix, and also creates a variety of functions for post exercise analysis.

Participants actually cooking, highlights real problems with the product and prompts suggestions and discussions for replacement functions, and improved usability.

## Step 1

### Task Planning

Decide on appropriate exercise to cover research criteria.

### Participation

Consider suitability of participants.  
One participant from each of the Card Sorting exercises is best.

Workshop coordinators:  
1 to drive, prompt, direct the exercise, and possibly video events.  
1 to operate the appliance on the instructions of the participants, monitor and take notes.

### Getting Started

Clearly explain how you want the workshop to work.

Monitor and direct progress, keeping participants on track but maintaining good flow of ideas, and encourage open thinking .

## Step 2

### Preparation

For a cookery testing exercise:

Use the same menu as used in the Card Sorting workshops.

Collect required utensils, cookery and ingredients, prepare any ingredients which need pre-cooking.

Produce a simple blank line drawing of a relevant product, without any controls or function information.

Produce function description cards (can be on post-it notes in written or illustrated form).  
Pin to a selection board.

Setup a product to be used in the exercise.

## Step 3

### Running the Exercise

Participants prepare each stage of the recipe.

Coordinators operate product on the instruction of participants.

Coordinators request an alternative function choice if the function the participants have requested does not achieve the result required in the recipe.

A speculative function can be added if the participants feel it would work better than an existing function.

Progress the exercise until the meal is completed.

### Recording

Record Key moments and selection points for analysis.  
For this you could use photographs or video for catching dialogue.

## Step 4

### Evaluation

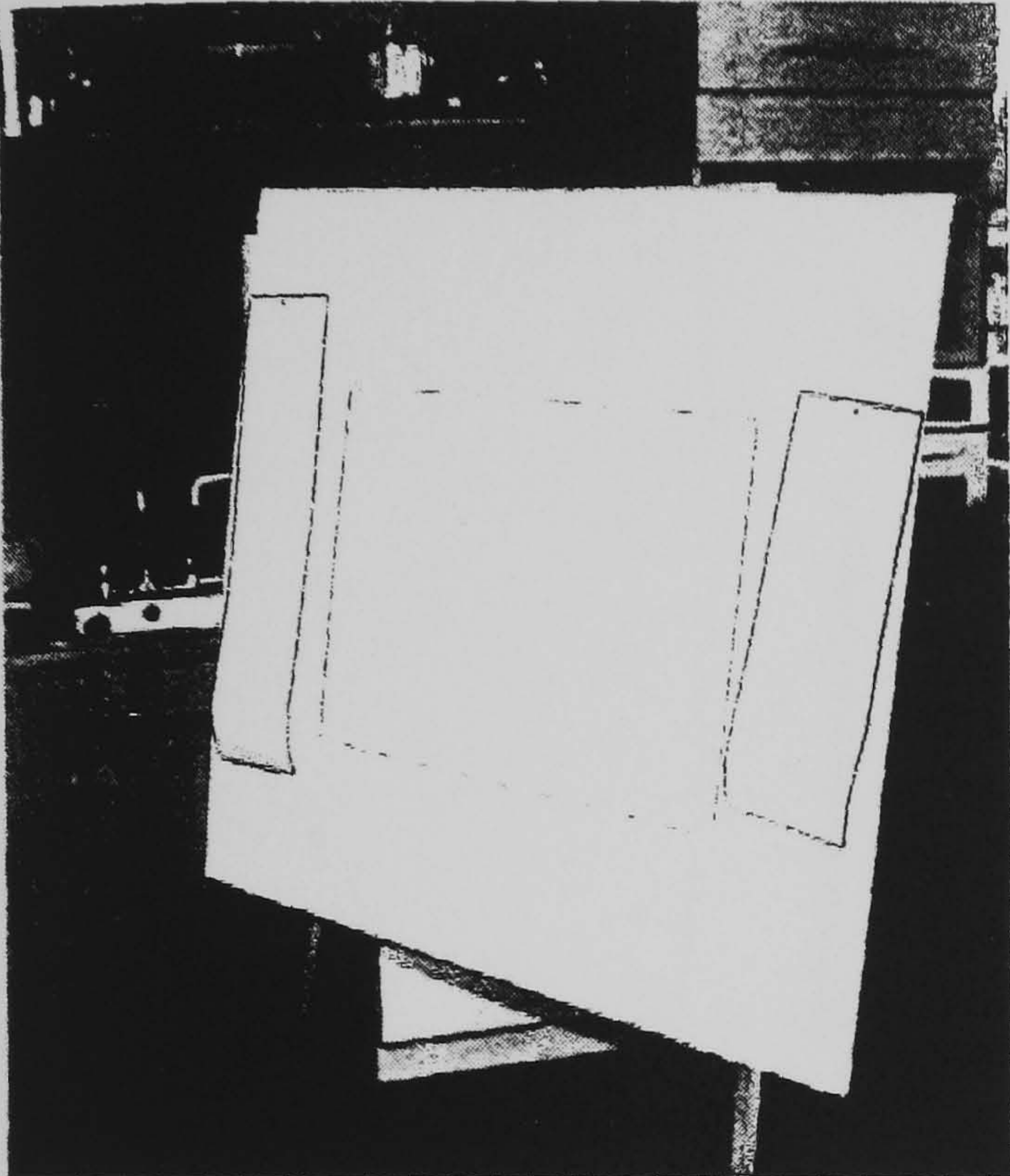
Retain keyline model/models for quick reference.

Evaluate research and prepare findings.



## Scenario Design (Workshop) exercise 2

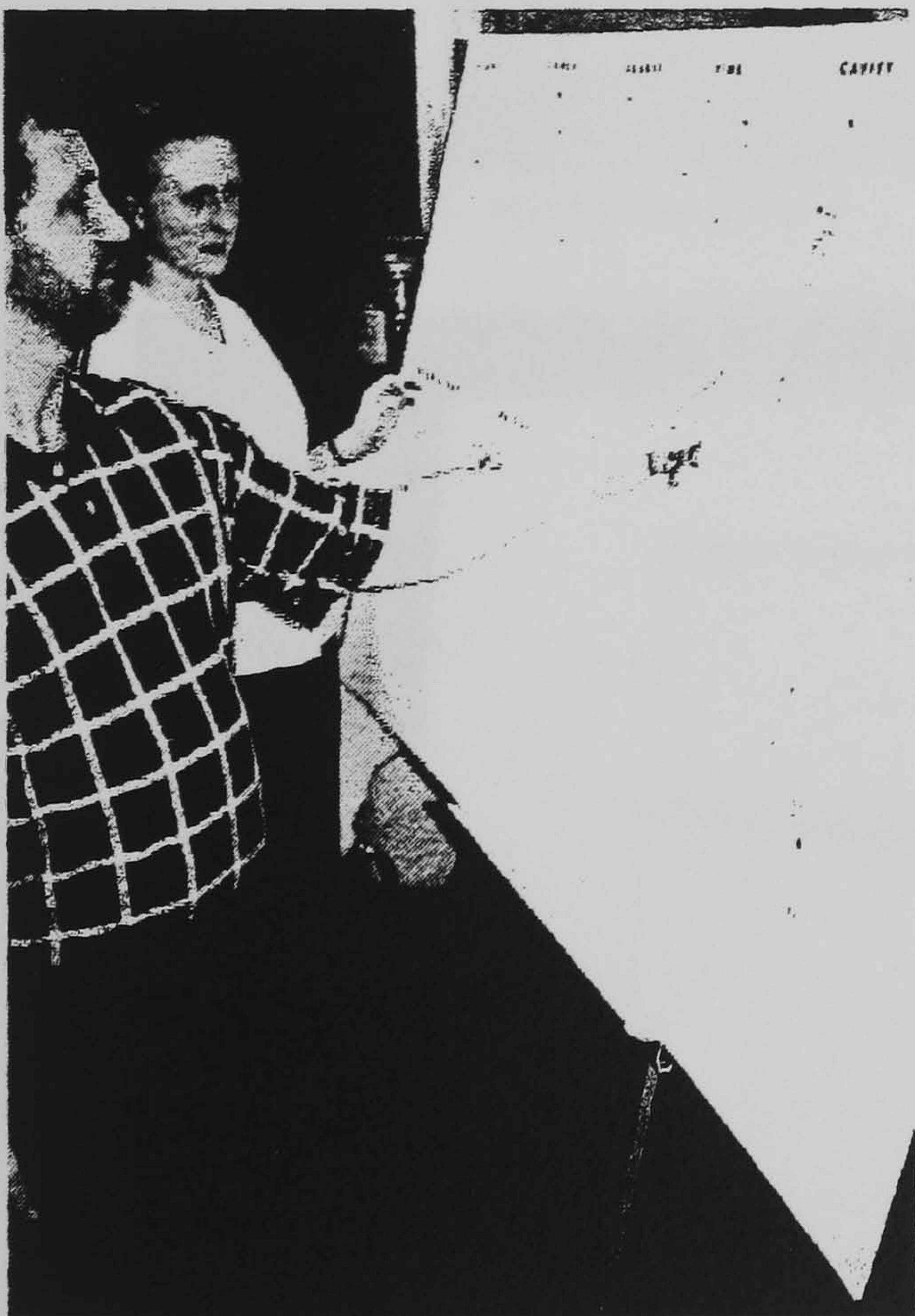
### 'Quick Reference'



1. Prepare basic keyline model.



2. Preparing the ingredients.



3. Selecting alternative functions.

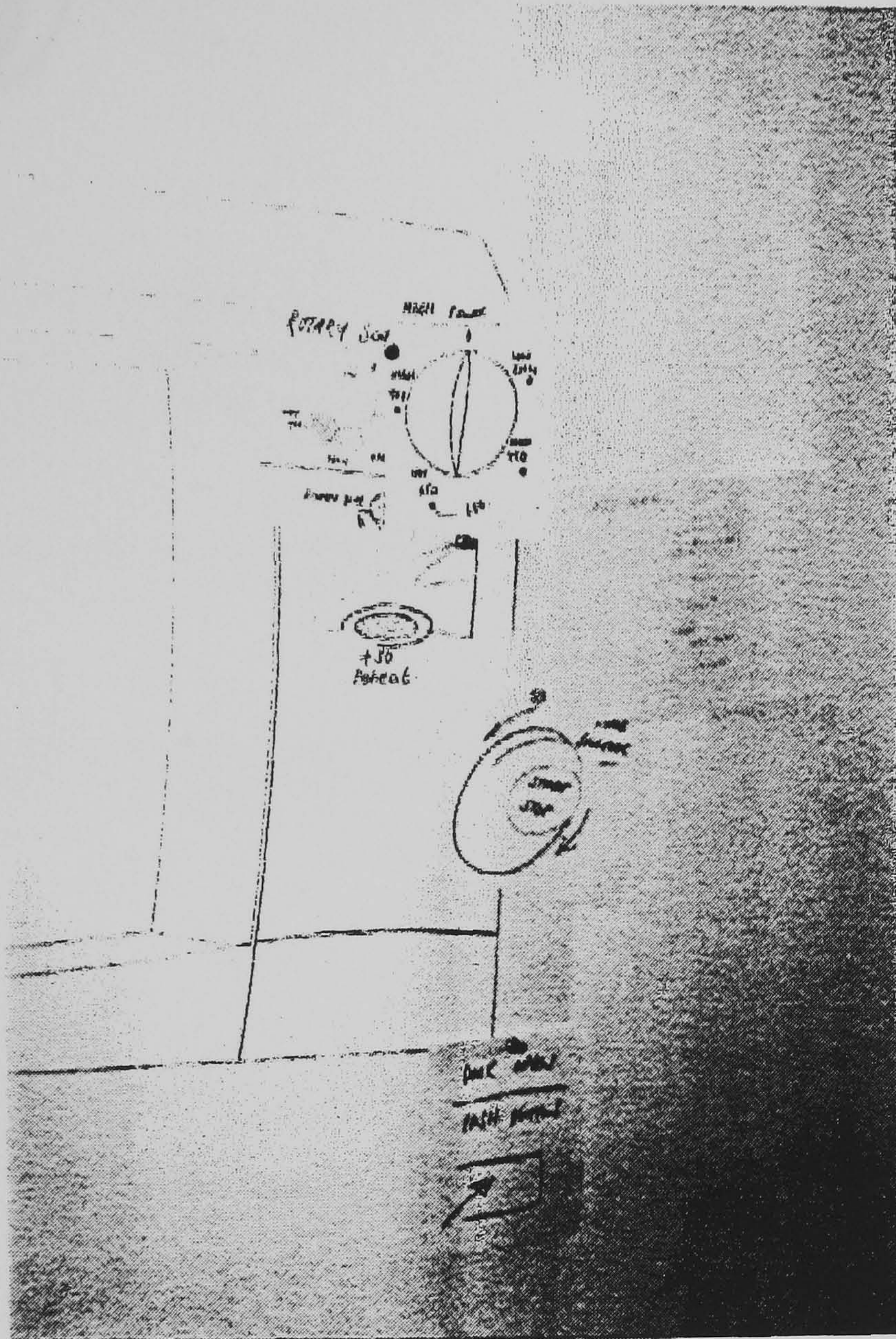


4. Building the model.

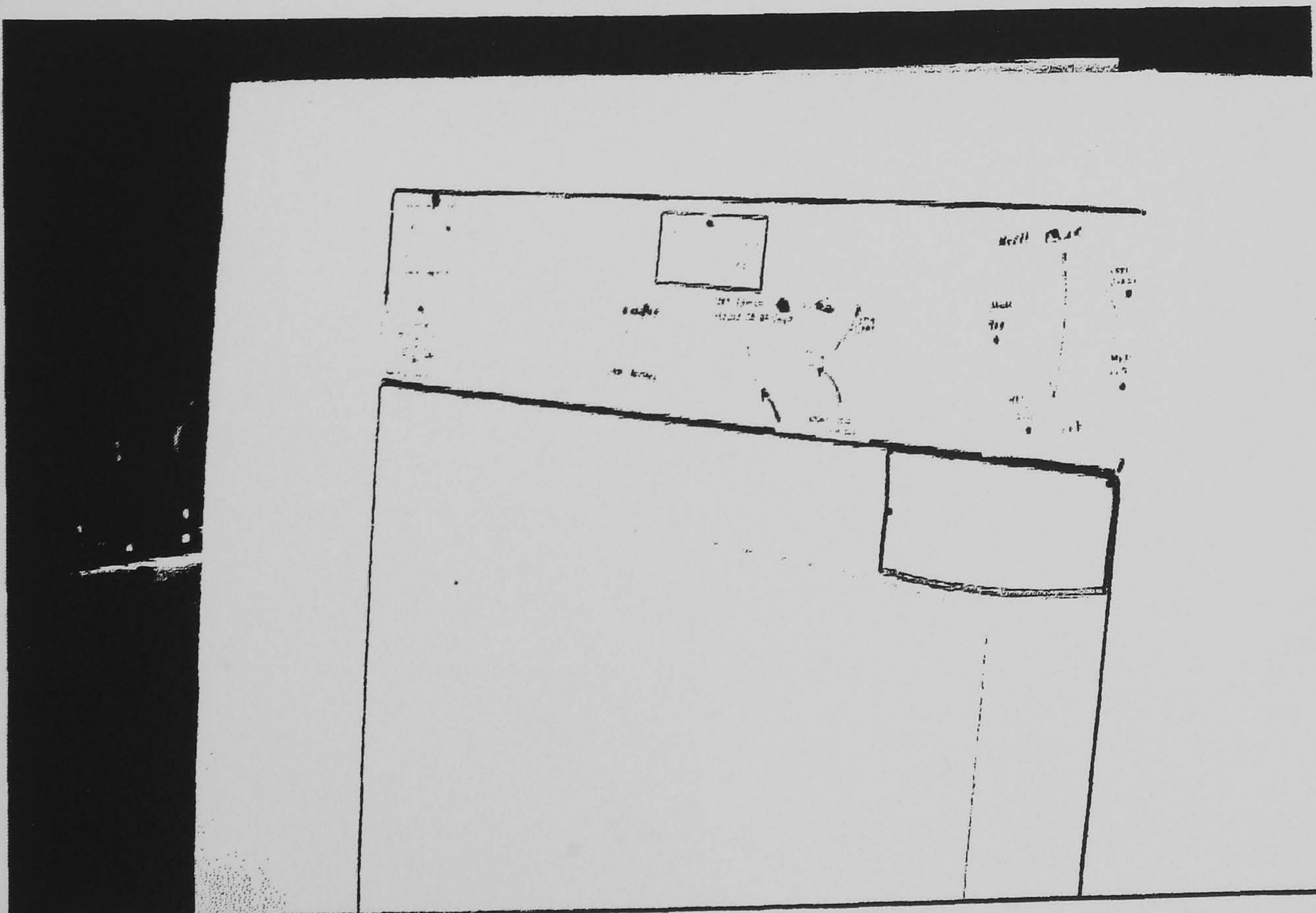


## Scenario Design (Workshop) exercise 2

## 'Quick Reference'



### 5. Model example 1.



## 6. Model example 2.





information gathering





The user requirement brief describes the functions offered to the designers for insertion in the card sorting exercise and also as choices for selection in the scenario design workshop.

Feedback is broken down into three categories:-

**Importance:**

Feedback which helps us to place a level of importance relevant to the scope of each offered function.

**Frequency of Use:**




Information which helps us to design interfaces with the most commonly used functions incorporated, and to design interfaces which offer more logical operational and setting sequences.

**Significance to Different Users and Tasks:**

This information provides us with valuable information which helps us to form a clearer picture about the perception and value users attach to functional options.







# User Requirement Brief

Function	Attributes		
	Importance	Frequency of Use	Significance to Different Users & Tasks
<b>TWIN TURNTABLES</b>  Allows two turntables to be used in microwave cavity.	Good optional feature for use when cooking multiple fast food meals or large meals consisting of different food types with similar cooking times.  This feature was utilised in the scenario design workshop.	Not used.	Applicable to users who use their microwaves as a total cooking product.  Due to cost implications most suited to a combi microwave model.
<b>SECONDARY CAVITY</b>  Add on secondary dumb cavity, toggle interface to secondary cavity & use microwave functions as normal.	Useful.	Not used.	Considered to be a good option available on any microwave product.  With the extra cavity available as a rental accessory.
<b>AUTOMATED COOKING</b> <b>AutoCook</b> Select Food Type. 	A preferred option considered useful as a rough guide to cooking times for listed foods.	Not used.	This function caused a polarity of opinion in the user groups.  Several members commented that they had tried this function before and that it did not work.  There was a suspicion of technology when used to control cooking cycles.  It was seen as a disempowerment for the traditional cooks within the user group.
<b>READY MEALS SCANNER</b> <b>AutoCook</b> Uses scanner pen to down load cooking time & weight for pre-packed products.	A preferred option especially when the context of the microwaves use is for ready-meals.  Definately one for the fast food junkie!	Not used.	Seen by the user group as another form of 'video recorder syndrome' technology for technologies sake!  And as a result treated as a function which would not work, this however is a usability issue not a problem of the functions intent.






# User Requirement Brief

Function	Attributes		
	Importance	Frequency of Use	Significance to Different Users & Tasks
<b>CLEAR</b> 	Important.	Low.	<p>Used to clear the display when incremental cooking tasks were being performed i.e. when a set cooking time was not known.</p> <p>eg. melting a knob of butter.</p>
<b>STOP</b> 	<p>Important, but not readily used in the card sorting scenario, however this function was utilised heavily in the scenario design exercise to check the progress of food prior to opening the cavity door for stirring of ingredients etc.</p>	Low.	<p>Criticism was leveled at the intuitiveness of the stop graphic.</p> <p>Finding the function on the interface panel would be made easier if it echoed the form of the stop symbol or was simply colour coded, this would greatly improve usability on existing Orbit models.</p>
<b>START</b> 	<p>Seen as the keypoint in a microwave interface as it initiates the cooking process.</p> <p>Very Important.</p>	High.	<p>Criticism was leveled at the intuitiveness of the start graphic and also the technical language employed.</p> <p>Should the start button be labelled <b>COOK</b>?</p> <p>Finding the function on the interface panel would be made easier if it echoed the form of the start symbol.</p>
<b>SET CLOCK</b>  <p>Automatic resetting atomic clock.</p>	<p>An excellent function automating a generally poor usability interface operation.</p> <p>It was questioned whether microwaves actually needed a clock as most cookers include one.</p>	Infrequent	<p>Used at the beginning of the cooking task when the microwave oven was first turned on.</p> <p>Considered to be a significant asset/function to a microwave oven.</p> <p>The most common criticism in all the user groups was the difficulty and lack of clarity communicated by the microwave product when the user wants to set the clock.</p>







User Requirement Brief

Function	Attributes		
	Importance	Frequency of Use	Significance to Different Users & Tasks
<div>SET CLOCK</div> <div></div> <div>Enter time on physical analogue clock.</div>	<p>Seen as an improvement to existing methods of setting microwave clocks due to its familiarity.</p> <p>Considered to be useful.</p>	<p>Not used in set cooking task.</p>	<p>Microwave seen as a technological product, analogue was not seen as giving accurate enough time increments for cooking etc..</p>
<div>REHEAT FOOD</div> <div></div> <div>One button instant reheat. Provides full power cooking in 30 second increments.</div>	<p>Useful.</p>	<p>Low.</p>	
<div>REHEAT FOOD</div> <div>Auto Sensing</div> <div>If food has been left to stand for a period of time, automatically reheats back up to temp.</div>	<p>Essential.</p> <p>A feature favoured by both user groups very strongly.</p>	<p>High - used throughout the cooking process.</p>	<p>Technology in this context, as an aid or fail safe was seen as a positive benefit.</p> <p>Technology dis-empowering the user in the cooking process was seen as a big negative.</p> <p>* 'People put their trust in technology.'</p> <p>* 'You would not trust a computer to drive your car, but you do trust it to operate your air bag on impact!'</p>
<div>WEIGHT DEFROST</div> <div></div>	<p>Useful.</p> <p>The rotary action of the encoder was seen as a signifier of a natural incremental scale &amp; would give the user real feedback as to the magnitude of the input weight.</p>	<p>Not used.</p>	<p>Both user groups had a cognitive difficulty with values relating to weights.</p> <p>It was recognised that it was not the physical interface which caused these problems, but the relation between the physical mass of the ingredients and their assigned numerical value.</p>



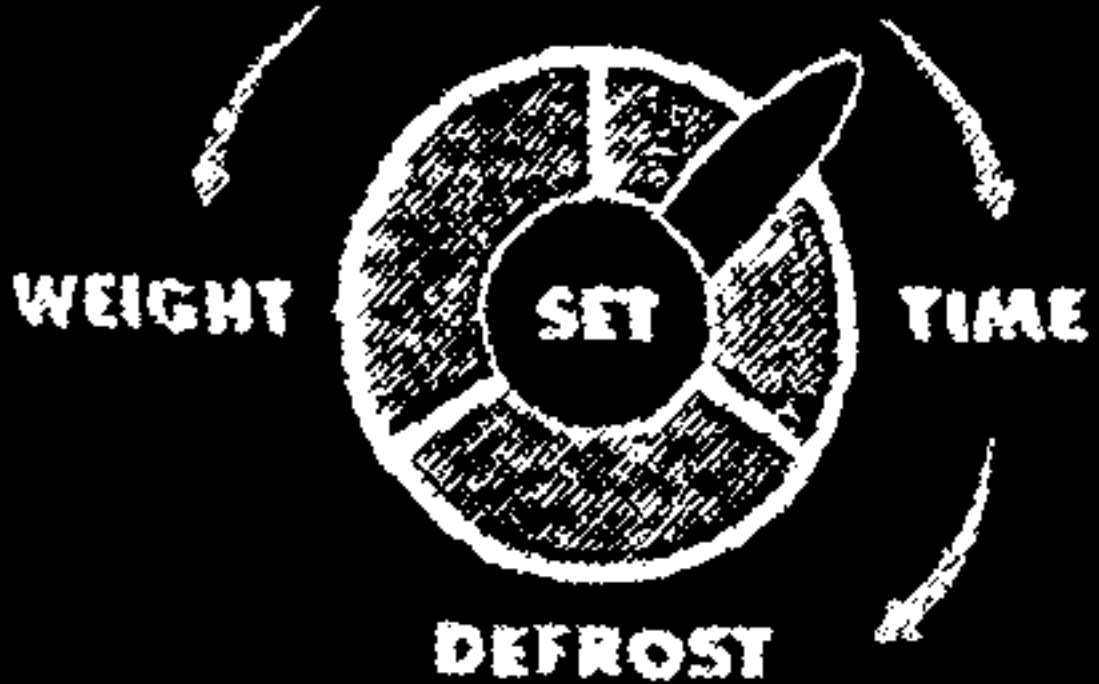



User Requirement Brief

Function	Attributes		
	Importance	Frequency of Use	Significance to Different Users & Tasks
<div><div>WEIGHT DEFROST</div><div></div><div>Drop physical weight icons into interface panel to represent preset food weights.</div></div>	User Group 1-Useful. User Group 2-Unuseful.	Not used.	<p>Preferred by user group 1 as a frequently used option, it enabled physical interaction with weights which the user preferred rather than dealing with the on screen/virtual approach.</p> <p>User group 2 saw the drop in weights as items which could be easily lost &amp; as a complicating factor.</p>
<div><div>WEIGHT DEFROST</div><div></div><div>Input preset food weights using a single dedicated button.</div></div>	Useful.	Not used.	Preferred as an option as it would simplify the interface panel.
<div><div>WEIGHT DEFROST</div><div></div><div>Place food type on microwave cavity scales &amp; press start.</div></div>	Essential.	Not used.	<p>The preferred solution to determining weight.</p> <p>Users see the microwave as a technology driven product &amp; the ability to determine weight electronically was seen as a logical progression for the microwave.</p>
<div><div>OVEN MANAGEMENT SYSTEM</div><div></div><div>A control system which controls via sensors:  Weight Humidity Density Turntable Functions Oven Rack Cooking</div></div>	Never used.	Not used.	



# User Requirement Brief

Function	Attributes		
	Importance	Frequency of Use	Significance to Different Users & Tasks
<b>DETERMINE COOKING TIME</b>  Enter time using analogue clock face.	Never used.	Not Used.	Microwave seen as a technological product, analogue was not seen as giving accurate enough time increments for cooking etc..
<b>DETERMINE COOKING TIME</b>  Enter time using rotary encoder & time display.	Essential.	Very High.	<p>Considered by the user group to be the best approach providing tactile input &amp; visual feedback.</p> <p>The Orbit models were well received for this reason alone.</p>
<b>UNIVERSAL INPUT CONTROL</b> Allows time & weight to be selected mechanically through one input device. 	<p>Preferred.</p> <p>This form of mechanical input was favoured over touch controls &amp; could be applied to a new range of mechanical microwave oven models.</p>	Not used.	<p>Seen as a way forward for simplifying existing complicated microwave interfaces limiting contact to one single input device on a primary level.</p> <p>However it is a concept which would need significant development &amp; user trials to be proven.</p>
<b>DELAY STAND</b>  Press delay stand selector button & enter time.	Useful.	Not used.	Not used in the card sorting workshop, but was heavily relied upon in the scenario design workshop.



User Requirement Brief

Function

Attributes

Importance

Frequency  
of  
Use

Significance  
to Different  
Users & Tasks

SET  
CLOCK



Press clock button, enter hour & minutes with rotary encoder.  
  
Press clock button to set.

Useful.

Not Used.

Considered to be the best option following the self setting atomic clock, as it is a primary level interface feature.

CAVITY  
SCALES



Place food item on turntable scale & press read-out button.

Essential.

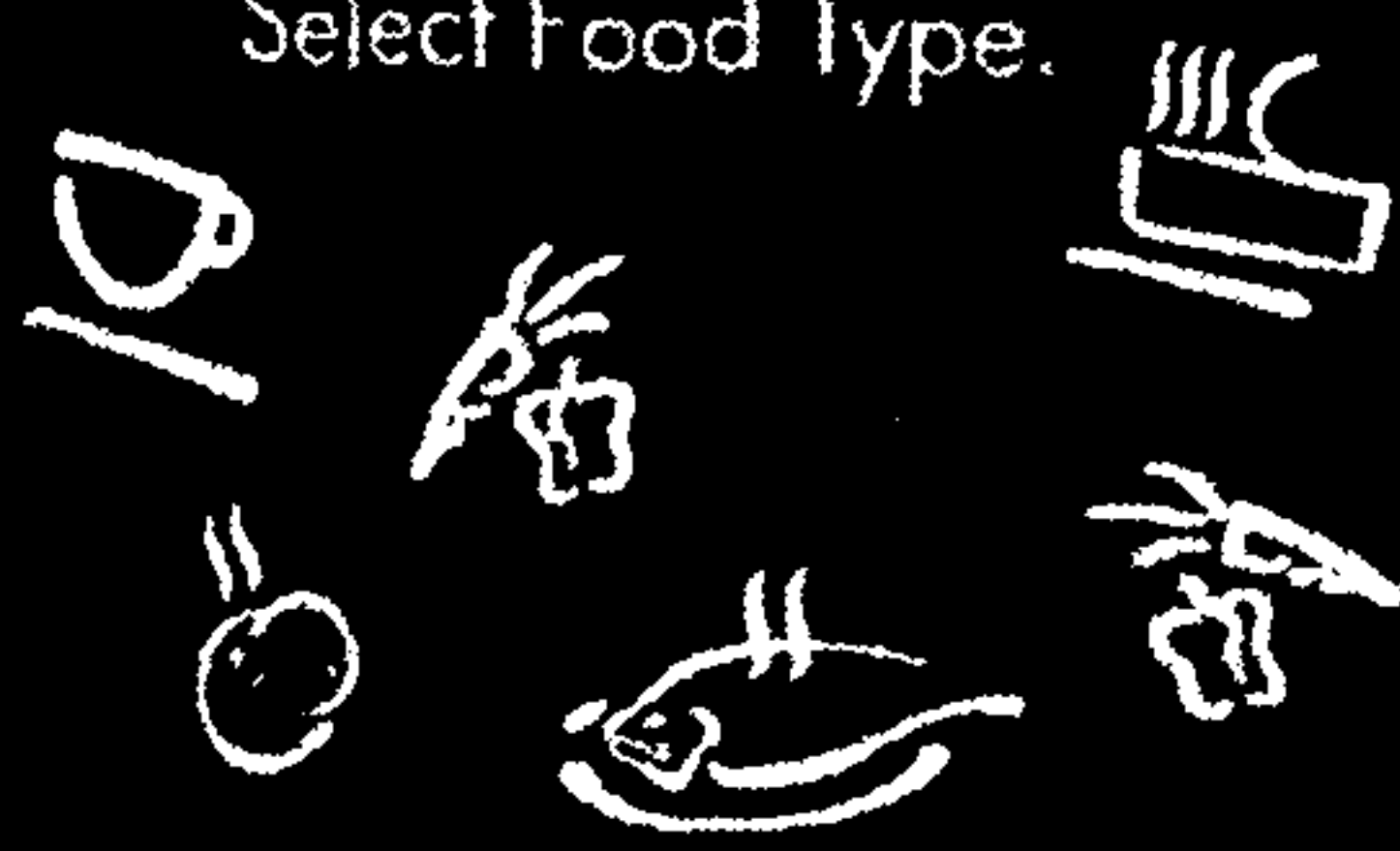
Not Used.

Seen by the user group as an essential feature.  
  
However it was viewed as a high end function by the user group - the cost of such a feature was questioned, but deemed very desirable.

FOOD TYPE  
DEFROST



Select Food Type.



Enter weight.

A preferred option considered useful as a rough guide to cooking times for frozen foods.

Not used.

FOOD TYPE  
DEFROST



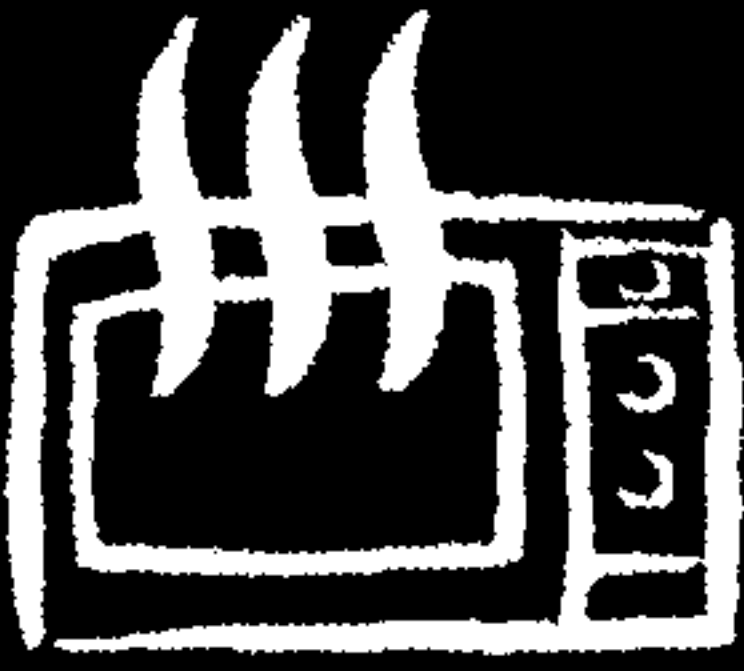



Use food specific cards to down load weight defrost values.  
  
Enter weight.

Never used.

Not used.







# User Requirement Brief

Function	Attributes		
	Importance	Frequency of Use	Significance to Different Users & Tasks
<div>HUMIDITY SENSOR</div> <div>  </div> <div>Alarm sounds to warn that the food being cooked is too dry.</div>	<div>Prefered.</div>	<div>High.</div> <div>Activated throughout the cooking process.</div>	<div>A common fault identified by the user group related to microwave cookery was that it tends to dry food.</div> <div>This function was seen as a positive measure to prevent this from happening.</div>
<div>MOISTURE INDUCTION</div> <div>  </div> <div>Uses automatic cooking cycle time to rehydrate food.</div> <div>Fill moisture tray with water to rehydrate.</div>	<div>Prefered.</div>	<div>Not used.</div>	
<div>KITCHEN TIMER</div> <div>  </div> <div>Removable from interface for carrying around, away from the cooking environment.</div>	<div>Useful.</div>	<div>Not used.</div>	
<div>KITCHEN TIMER</div> <div>  </div> <div>Set power to zero &amp; enter time via encoder on screen display.</div>	<div>Useful.</div>	<div>Not used.</div>	



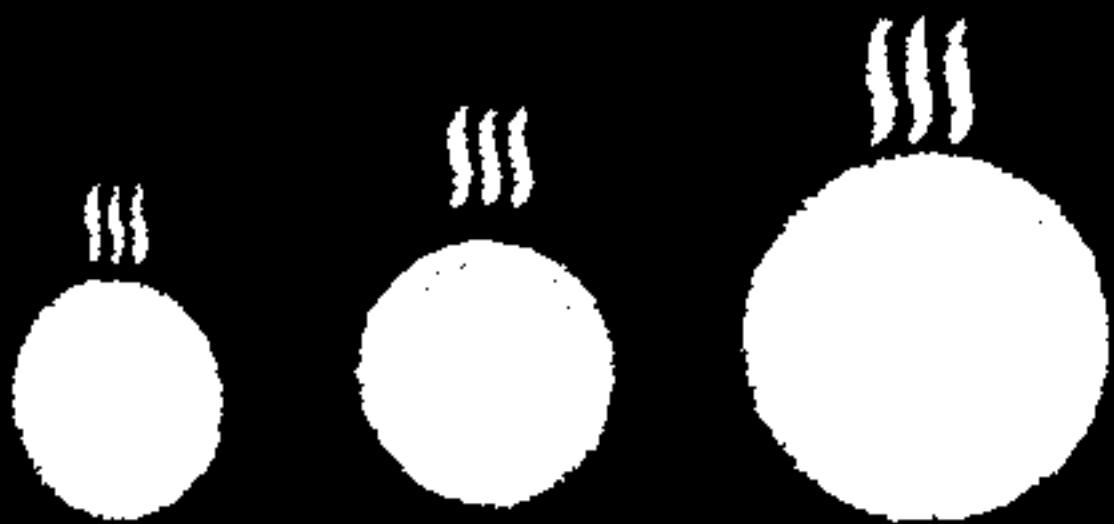

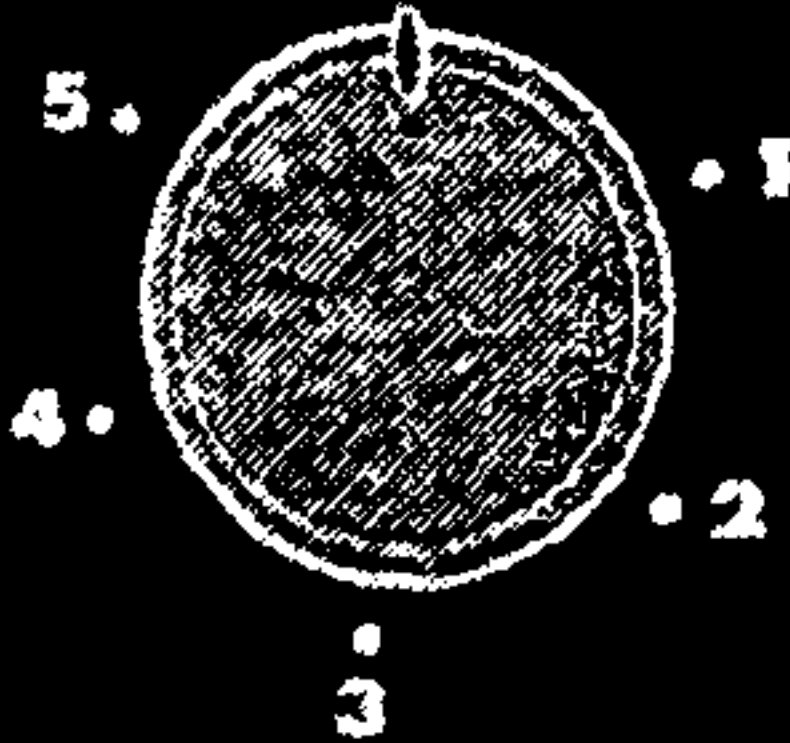
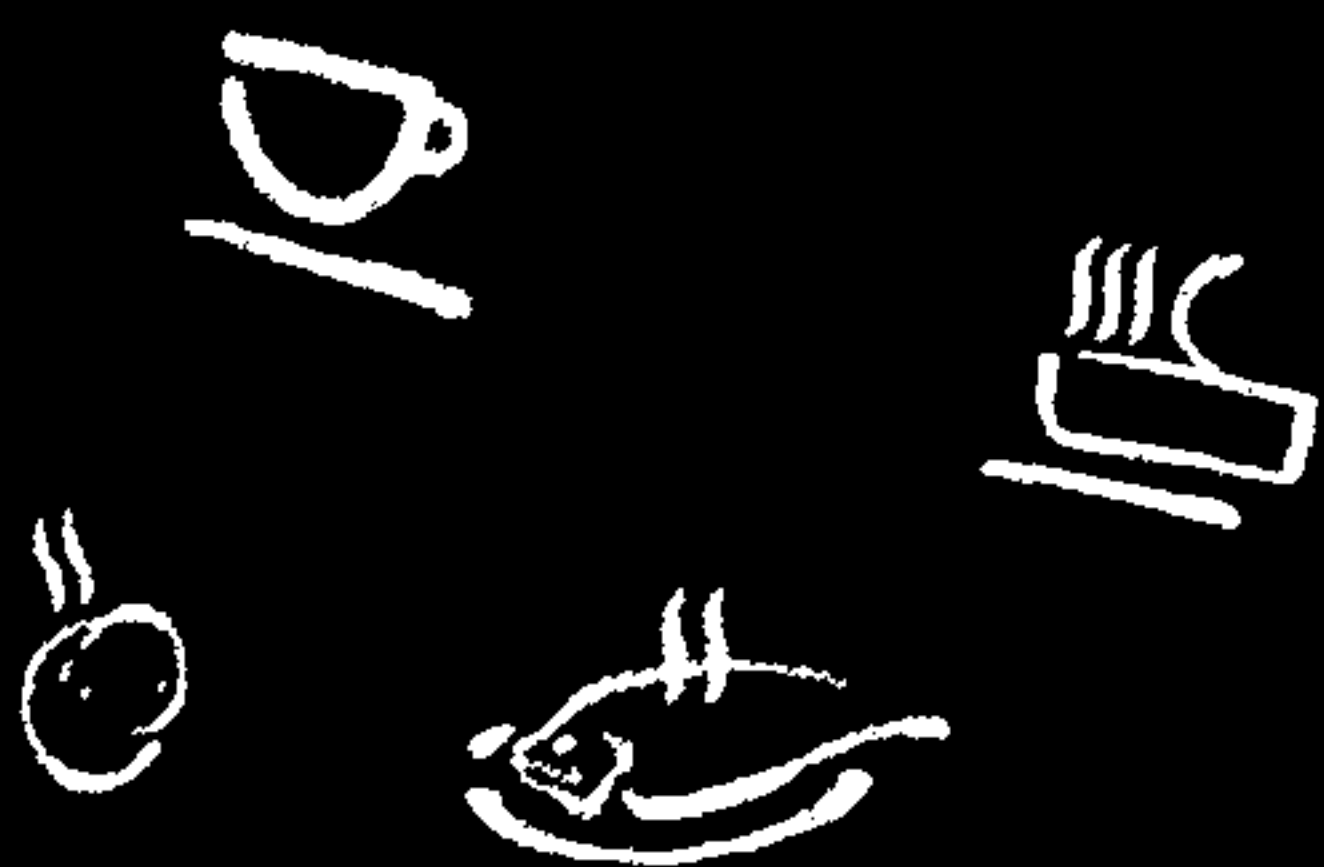


User Requirement Brief

Function	Attributes		
	Importance	Frequency of Use	Significance to Different Users & Tasks
<div>POWER LEVEL</div> <div></div> <div>Single button scrolls through on screen wattage options.</div>	Low.	High.	<p>Users found it hard to relate wattage options to power.</p> <p>People normally define power as low, medium or high ( a linguistic scale).</p>
<div>POWER LEVEL</div> <div></div> <div>Rotary encoder scrolls through on screen wattage options.</div>	Essential.	High.	<p>Rotary encoders were generally preferred on all aspects of interface, due to their intuitive mechanical action.</p>
<div>POWER LEVEL</div> <div></div> <div>Touch screen graphical scale.</div> <div></div>	Essential.	High.	<p>Touch screen interfaces were not liked by the users. Although the use of an on screen scale coupled with wattage values was seen as a true benefit.</p> <p>Pre-packaged foods give instructions in watts, however users think in terms of power (high, medium &amp; low).</p> <p>An on screen scale coupled with a rotary encoder was seen as the best option.</p>







User Requirement Brief

Function	Attributes		
	Importance	Frequency of Use	Significance to Different Users & Tasks
<div>GRILL FOOD</div> <div></div> <div>Single button screen scroll select.</div>	<p>Essential.</p> <p>User group two preferred the single dedicated grill button option as it provided less visual clutter on the interface panel.</p>	<p>Low.</p>	<p>There was concern that existing grill models do not communicate the actual grill temperature effectively on displays.</p> <p>Wattage values did not give an indication to actual temperature, it was suggested a scale should be used on screen in conjunction with wattage values.</p>
<div>GRILL FOOD</div> <div></div> <div>Select from 3 button heat levels.</div> <div></div>	<p>Never Used.</p>	<p>Low.</p>	<p>The size of the individual grill buttons did not significantly communicate the difference in grill temperature.</p> <p>The user group also felt it was over complicating an interface panel with 3 buttons when the same function could be designated to one.</p>
<div>GRILL FOOD</div> <div></div> <div>Select grill heat level using rotary control.</div> <div></div>	<p>Essential.</p> <p>Well received by user group one due to its similarity with existing cooker grill controls.</p> <p>Rotary encoders were generally preferred on all aspects of interface, due to their intuitive mechanical action.</p>	<p>Low.</p>	<p>The rotary action of the encoder was seen as a signifier of a natural incremental scale &amp; would give the user a tactile response to the grill setting increments.</p>
<div>MENU CARDS</div> <div></div> <div>Food specific slot-in cards which down load preset weights into the microwave for automated cooking.</div>	<p>Never Used.</p>	<p>Never Used.</p>	



User Requirement Brief

Function	Attributes		
	Importance	Frequency of Use	Significance to Different Users & Tasks
<div>DETERMINE WEIGHT</div> <div> kg</div> <div>Input food weight using rotary encoder.</div>	<p>Useful.</p> <p>The rotary action of the encoder was seen as a signifier of a natural incremental scale &amp; would give the user real feedback as to the magnitude of the inputted weight.</p>	<p>Not used.</p>	<p>Both user groups had a cognitive difficulty with values relating to weights.</p> <p>It was recognised that it was not the physical interface which caused these problems, but the relationship between the physical mass of the ingredients and their assigned numerical value.</p>
<div>DETERMINE WEIGHT</div> <div> kg</div> <div>Drop physical weight icons into interface panel to represent preset food weights.</div>	<p>User Group 1-Useful.</p> <p>User Group 2-Unuseful.</p>	<p>Not used.</p>	<p>Preferred by user group 1 as a frequently used option, it enabled physical interaction with weights which the user preferred rather than dealing with the on screen/virtual approach.</p> <p>User group 2 saw the drop in weights as items which could be easily lost and as a complicating factor.</p>
<div>DETERMINE WEIGHT</div> <div> kg</div> <div>Input preset food weights using a single dedicated button.</div>	<p>Useful.</p>	<p>Not used.</p>	<p>Preferred as an option as it would simplify the interface panel.</p>
<div>DETERMINE WEIGHT</div> <div> kg</div> <div>Place food type on microwave cavity scales.</div>	<p>Essential.</p>	<p>Not Used.</p>	<p>Seen by the user group as an essential feature.</p> <p>However it was viewed as a high end function by the user group - the cost of such a feature was questioned, but deemed very desirable.</p>



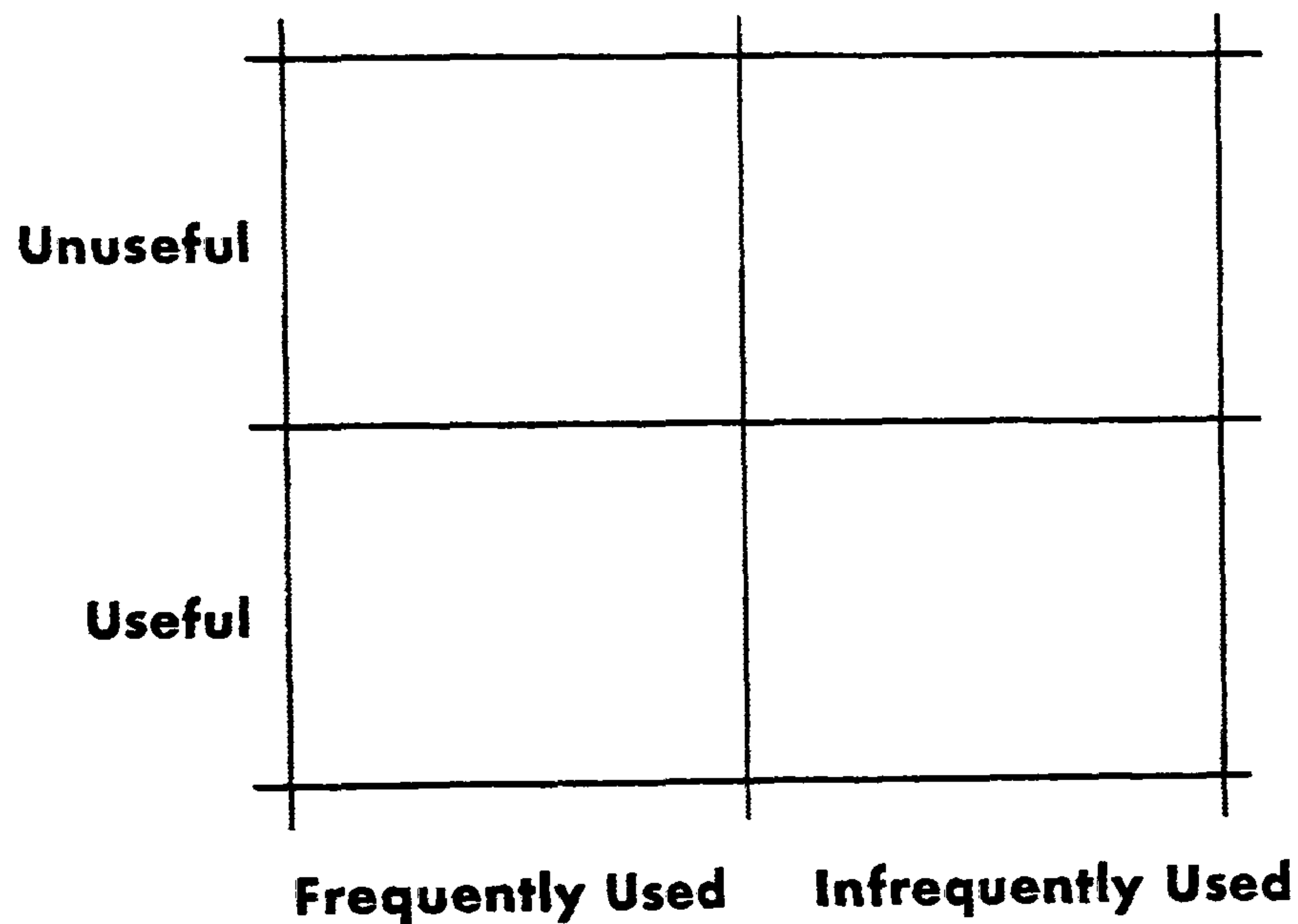


## matrix filter

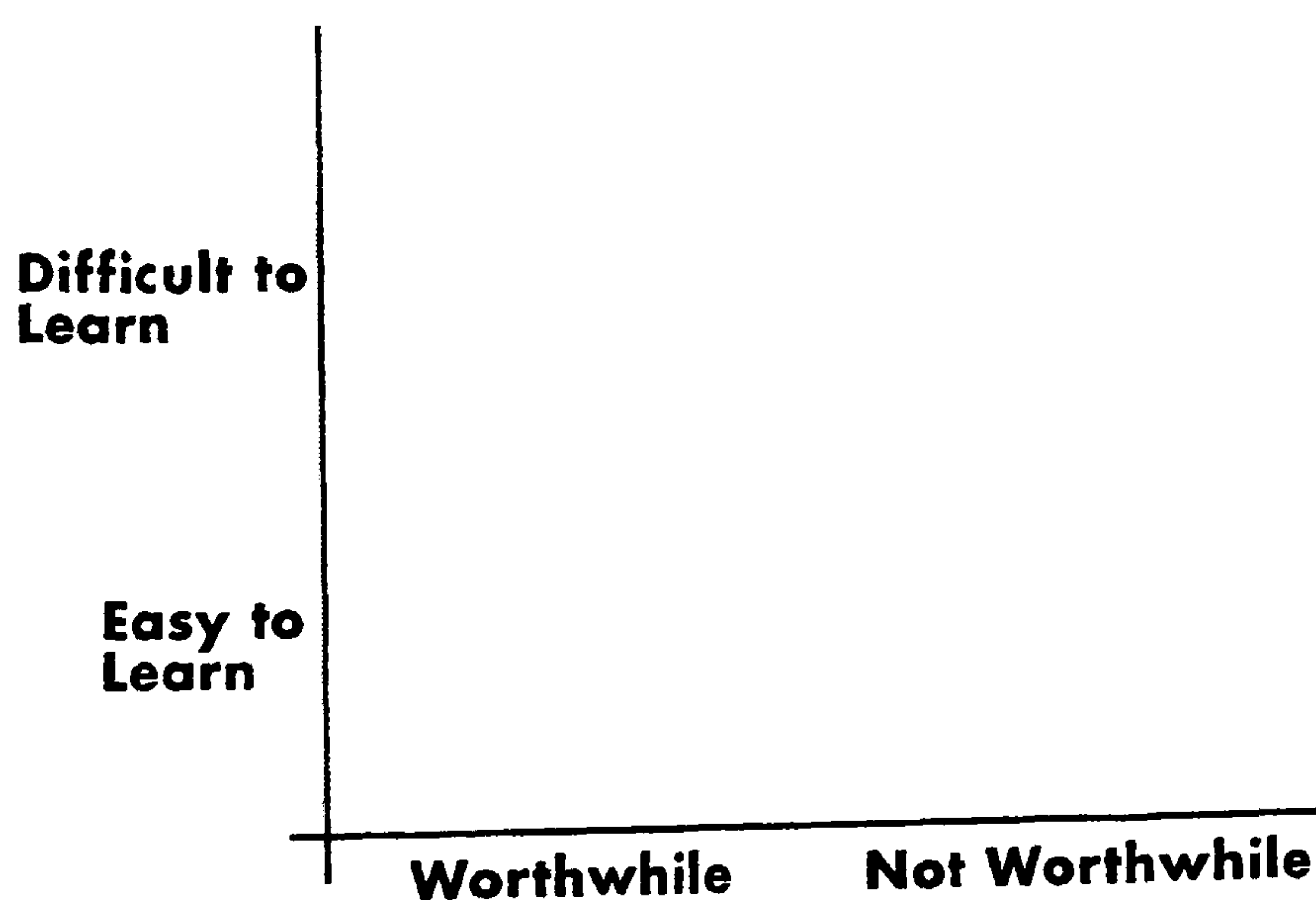
The creation of a matrix filter device allows participants to place value judgements on control and display function cards. Each function card is considered by the group and judged against two rating scales placed on a 'x' and 'y' axes.

The rating scales are arbitrary and can be defined by the design team.

Typical layouts as used in the workshops-




These exercises place a value on each card and provide the designers with information about each function.






MATRIX FILTER (Workshop 1, Card Sorting)

GRILL FOOD




Single layer, lower shelf only

REHEAT FOOD



One layer, lower shelf, heat from below

GRILL FOOD




Two layer, 2 shelves, lower shelf

WEIGHT DEFROST




Display panel weight scale, no time limit, no power, no defrost

READY MEALS SCANNER




One layer, lower shelf, heat from below

AUTOMATED COOKING



One layer, lower shelf, heat from below

TWIN TURNABLES




Two layer, lower shelf, heat from below

FOOD TYPE DEFROST




One layer, lower shelf, heat from below

CAVITY SCALES




One layer, lower shelf, heat from below

HUMIDITY SENSOR



One layer, lower shelf, heat from below

GRILL FOOD




Single layer, lower shelf only

POWER LEVEL



Power level, 1-9

POWER LEVEL



Power level, 1-9


STOP



CLEAR



SET CLOCK



Frequently Used

Infrequently Used



## MATRIX FILTER (Workshop 1, Card Sorting)

(30)

## MATRIX FILTER (Workshop 1, Card Sorting)

<b>WEIGHT DEFROST</b> CUU	Place food type on scale to determine weight. (see manual for more info)
<b>CAVITY SCALES</b> kg	Place food type on scale to determine weight. (see manual for more info)
<b>DETERMINE COOKING TIME</b> ⌚	
<b>START</b> ⏮	
<b>REHEAT FOOD</b> AutoCook	Reheat food type on scale to determine weight. (see manual for more info)
<b>GRILL FOOD</b> ⏮	Grill food type on scale to determine weight. (see manual for more info)
<b>POWER LEVEL</b> △	Power level on scale to determine weight. (see manual for more info)
<b>STOP</b> ⏮	
<b>CLEAR</b> ⏮	

<b>MOISTURE INDUCTION</b> ⏮	Use moisture induction to cook food type on scale to determine weight. (see manual for more info)
<b>OVEN MANAGEMENT SYSTEM</b> ⏮	Use oven management system to cook food type on scale to determine weight. (see manual for more info)
<b>WEIGHT DEFROST</b> CUU	Place food type on scale to determine weight. (see manual for more info)
<b>DETERMINE WEIGHT</b> kg	Place food type on scale to determine weight. (see manual for more info)
<b>HUMIDITY SENSOR</b> ⏮	Humidity sensor on scale to determine weight. (see manual for more info)
<b>GRILL FOOD</b> ⏮	Grill food type on scale to determine weight. (see manual for more info)
<b>UNIVERSAL INPUT CONTROL</b> ⏮	Universal input control on scale to determine weight. (see manual for more info)

<b>SET CLOCK</b> ⌚	Set clock on scale to determine weight. (see manual for more info)
<b>GRILL FOOD</b> ⏮	Grill food type on scale to determine weight. (see manual for more info)

<b>SECONDARY CAVITY</b> ⏮	Secondary cavity on scale to determine weight. (see manual for more info)
<b>TWIN TURNTABLES</b> ⏮	Twin turntables on scale to determine weight. (see manual for more info)
<b>KITCHEN TIMER</b> ⌚	Kitchen timer on scale to determine weight. (see manual for more info)

<b>FOOD TYPE DEFROST</b> CUU	Food type on scale to determine weight. (see manual for more info)
<b>DETERMINE COOKING TIME</b> ⌚	

<b>SET CLOCK</b> ⌚	Set clock on scale to determine weight. (see manual for more info)
<b>GRILL FOOD</b> ⏮	Grill food type on scale to determine weight. (see manual for more info)

<b>WEIGHT DEFROST</b> CUU	Place food type on scale to determine weight. (see manual for more info)
<b>CAVITY SCALES</b> kg	Place food type on scale to determine weight. (see manual for more info)
<b>DETERMINE COOKING TIME</b> ⌚	
<b>START</b> ⏮	
<b>REHEAT FOOD</b> AutoCook	Reheat food type on scale to determine weight. (see manual for more info)
<b>GRILL FOOD</b> ⏮	Grill food type on scale to determine weight. (see manual for more info)
<b>POWER LEVEL</b> △	Power level on scale to determine weight. (see manual for more info)
<b>STOP</b> ⏮	
<b>CLEAR</b> ⏮	

<b>WEIGHT DEFROST</b> CUU	Place food type on scale to determine weight. (see manual for more info)
<b>CAVITY SCALES</b> kg	Place food type on scale to determine weight. (see manual for more info)
<b>DETERMINE COOKING TIME</b> ⌚	
<b>START</b> ⏮	
<b>REHEAT FOOD</b> AutoCook	Reheat food type on scale to determine weight. (see manual for more info)
<b>GRILL FOOD</b> ⏮	Grill food type on scale to determine weight. (see manual for more info)
<b>POWER LEVEL</b> △	Power level on scale to determine weight. (see manual for more info)
<b>STOP</b> ⏮	
<b>CLEAR</b> ⏮	

<b>WEIGHT DEFROST</b> CUU	Place food type on scale to determine weight. (see manual for more info)
<b>CAVITY SCALES</b> kg	Place food type on scale to determine weight. (see manual for more info)
<b>DETERMINE COOKING TIME</b> ⌚	
<b>START</b> ⏮	
<b>REHEAT FOOD</b> AutoCook	Reheat food type on scale to determine weight. (see manual for more info)
<b>GRILL FOOD</b> ⏮	Grill food type on scale to determine weight. (see manual for more info)
<b>POWER LEVEL</b> △	Power level on scale to determine weight. (see manual for more info)
<b>STOP</b> ⏮	
<b>CLEAR</b> ⏮	

<b>WEIGHT DEFROST</b> CUU	Place food type on scale to determine weight. (see manual for more info)
<b>CAVITY SCALES</b> kg	Place food type on scale to determine weight. (see manual for more info)
<b>DETERMINE COOKING TIME</b> ⌚	
<b>START</b> ⏮	
<b>REHEAT FOOD</b> AutoCook	Reheat food type on scale to determine weight. (see manual for more info)
<b>GRILL FOOD</b> ⏮	Grill food type on scale to determine weight. (see manual for more info)
<b>POWER LEVEL</b> △	Power level on scale to determine weight. (see manual for more info)
<b>STOP</b> ⏮	
<b>CLEAR</b> ⏮	

<b>WEIGHT DEFROST</b> CUU	Place food type on scale to determine weight. (see manual for more info)
<b>CAVITY SCALES</b> kg	Place food type on scale to determine weight. (see manual for more info)
<b>DETERMINE COOKING TIME</b> ⌚	
<b>START</b> ⏮	
<b>REHEAT FOOD</b> AutoCook	Reheat food type on scale to determine weight. (see manual for more info)
<b>GRILL FOOD</b> ⏮	Grill food type on scale to determine weight. (see manual for more info)
<b>POWER LEVEL</b> △	Power level on scale to determine weight. (see manual for more info)
<b>STOP</b> ⏮	
<b>CLEAR</b> ⏮	

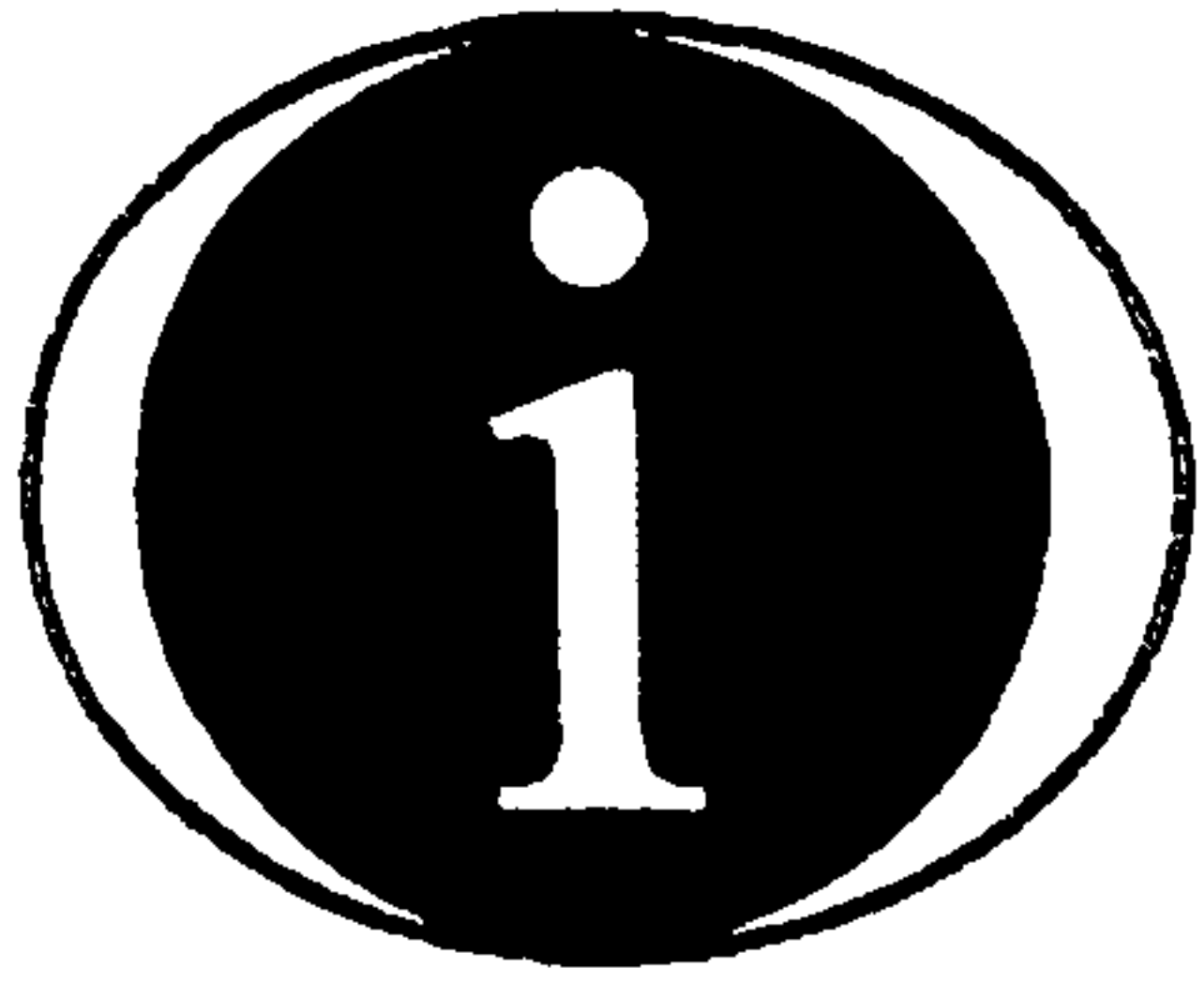
<b>WEIGHT DEFROST</b> CUU	Place food type on scale to determine weight. (see manual for more info)
<b>CAVITY SCALES</b> kg	Place food type on scale to determine weight. (see manual for more info)
<b>DETERMINE COOKING TIME</b> ⌚	
<b>START</b> ⏮	
<b>REHEAT FOOD</b> AutoCook	Reheat food type on scale to determine weight. (see manual for more info)
<b>GRILL FOOD</b> ⏮	Grill food type on scale to determine weight. (see manual for more info)
<b>POWER LEVEL</b> △	Power level on scale to determine weight. (see manual for more info)
<b>STOP</b> ⏮	
<b>CLEAR</b> ⏮	

<b>WEIGHT DEFROST</b> CUU	Place food type on scale to determine weight. (see manual for more info)
<b>CAVITY SCALES</b> kg	Place food type on scale to determine weight. (see manual for more info)
<b>DETERMINE COOKING TIME</b> ⌚	
<b>START</b> ⏮	
<b>REHEAT FOOD</b> AutoCook	Reheat food type on scale to determine weight. (see manual for more info)
<b>GRILL FOOD</b> ⏮	Grill food type on scale to determine weight. (see manual for more info)
<b>POWER LEVEL</b> △	Power level on scale to determine weight. (see manual for more info)
<b>STOP</b> ⏮	
<b>CLEAR</b> ⏮	

<b>WEIGHT DEFROST</b> CUU	Place food type on scale to determine weight. (see manual for more info)
<b>CAVITY SCALES</b> kg	Place food type on scale to determine weight. (see manual for more info)
<b>DETERMINE COOKING TIME</b> ⌚	
<b>START</b> ⏮	
<b>REHEAT FOOD</b> AutoCook	Reheat food

**Never Used**





interface building



TRADITIONAL 'WATERFALL' MODEL OF PRODUCT INTERFACE DEVELOPMENT

The main difference between the “waterfall” and user-centred development models is that the user-centred approach puts evaluation (involving users) at the heart of the development process and accepts evolutionary prototyping as being an inevitable and healthy consequence.

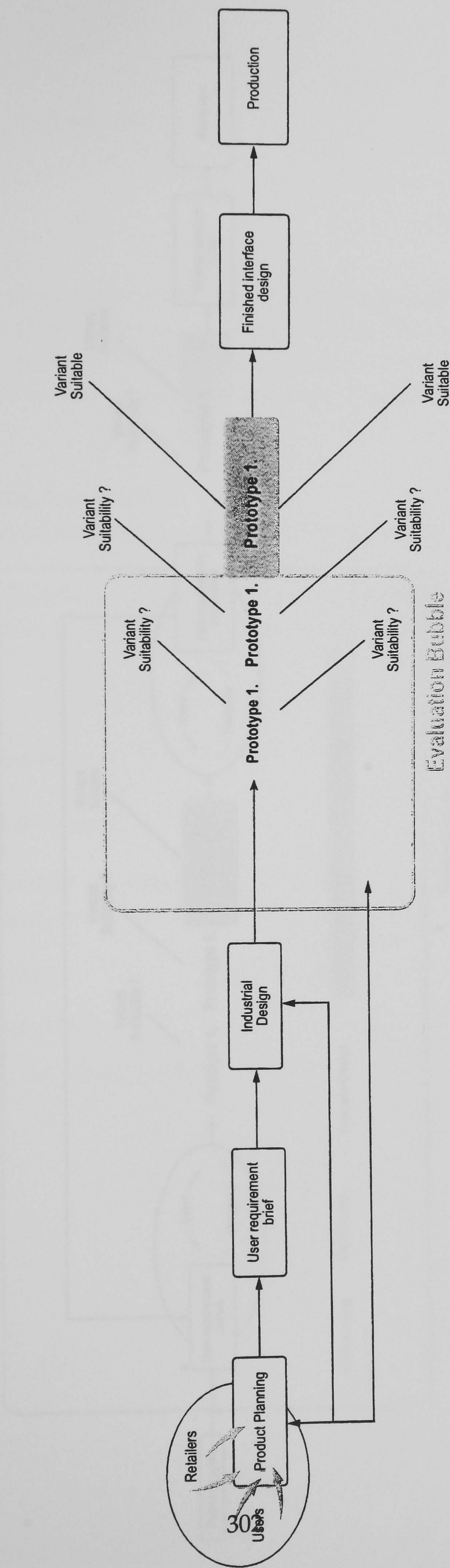
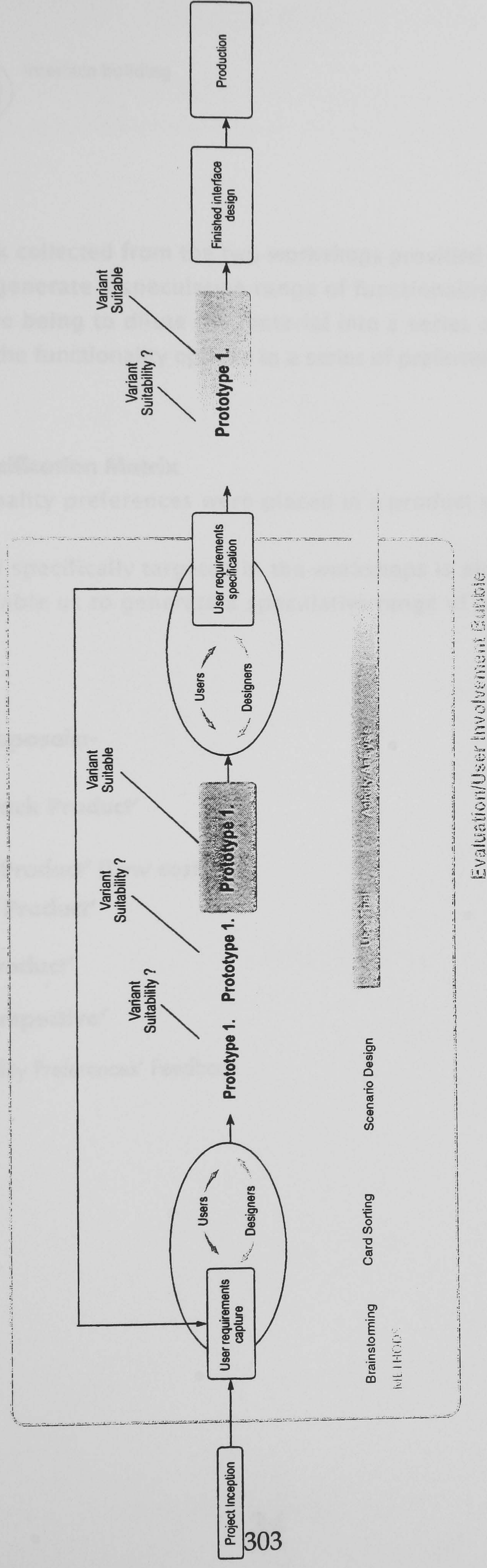


Figure 1.





**Figure.2.**





The feedback collected from the two workshops provided us with enough material to generate a speculative range of functionality levels.

The objective being to dilute the material into a series of proposals which show the functionality options in a series of preferred arrangements.

### **Product Specification Matrix**

The functionality preferences were placed in a product specification matrix.

The material specifically targeted in the workshops is plotted using this device to enable us to generate a speculative range of user interfaces.

### **Interface Proposals:-**

**'Lifestyle Snack Product'**

**'Mid-Range Product' (Low cost)**

**'Mid-Range Product'**

**'Top-Spec Product'**

**'Another Perspective'**

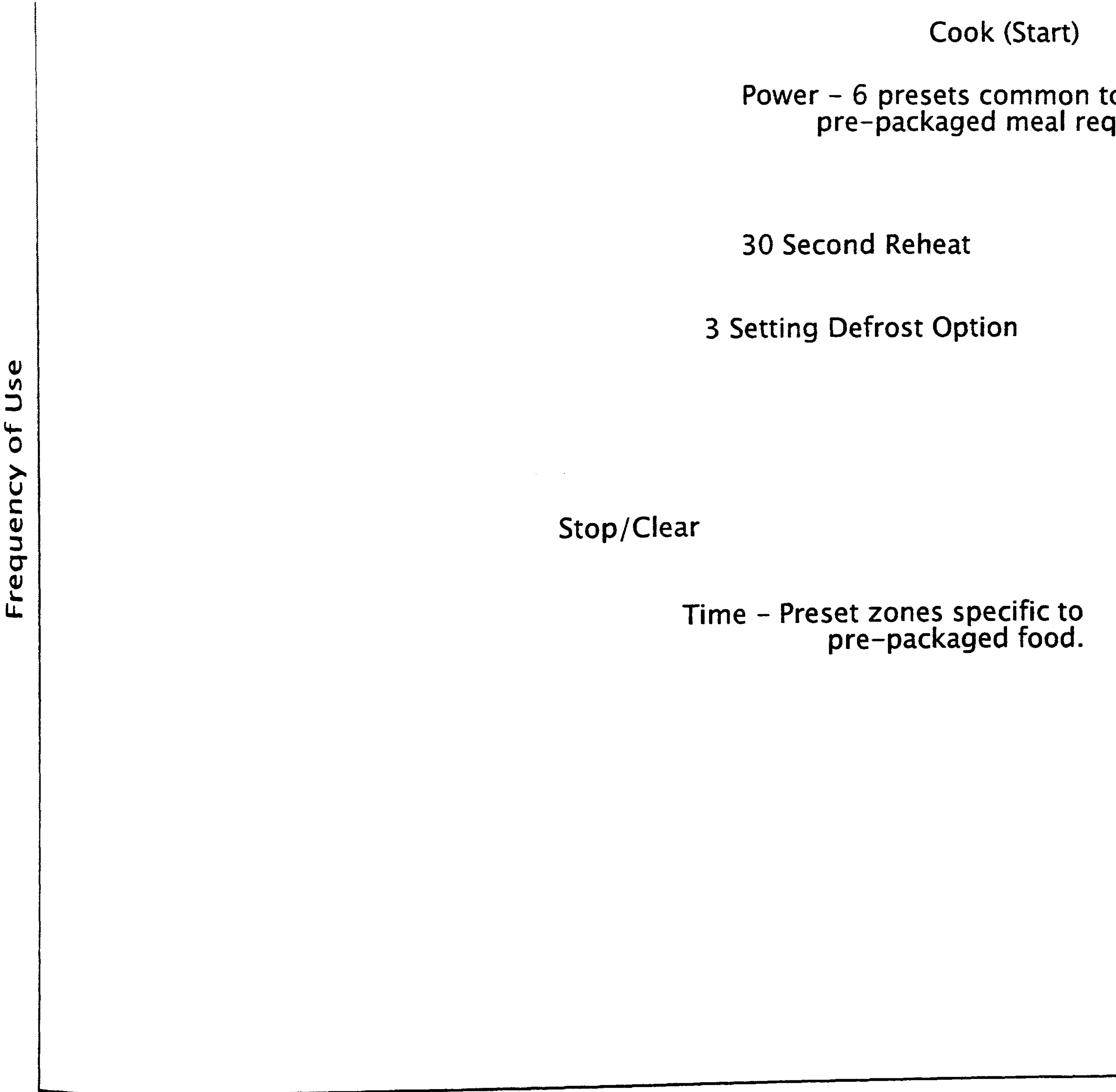
**'Overall Usability Preferences' Feedback**



# The Usability Range - Product Specification Matrix

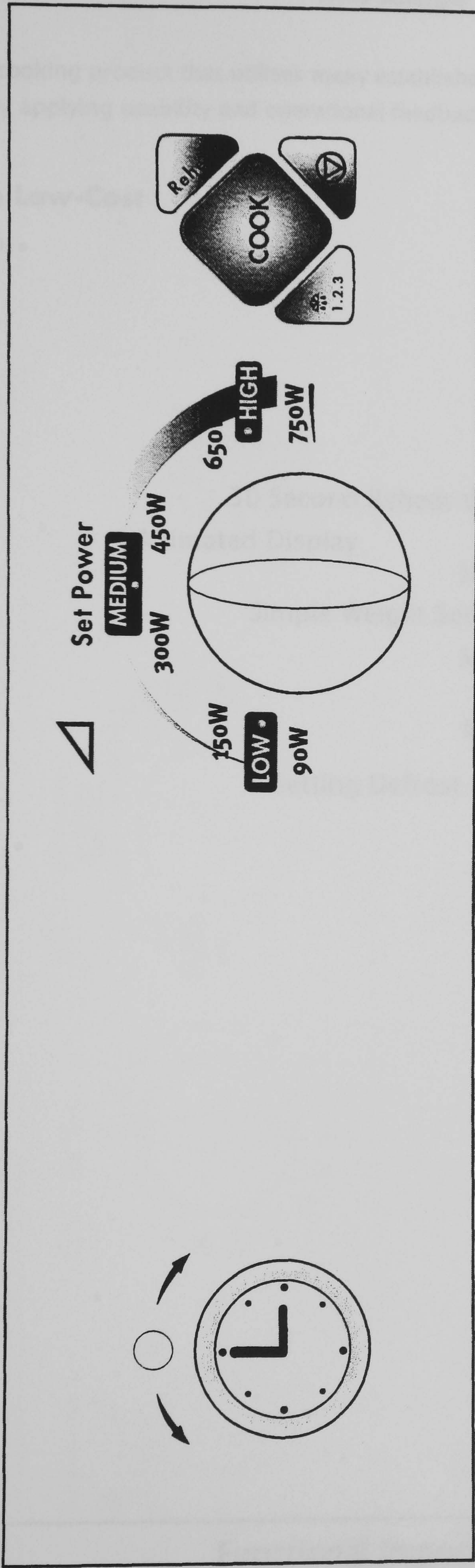
## 'Lifestyle Snack' Product

A microwave cooking product interface that is dedicated to the preparation & cooking of convenience foods for people who are extremely time pressured and wish only to operate microwave products on a basic level.





# 'Lifestyle Snack' Product



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## Interface/Features

Mechanical knob selects power level (six options in accordance with most common pre-packed meal requirements).

LED Illuminates following selection.

Clustered microwave operation buttons:  
(Cook (Start) / Defrost--(three options) / Reheat / Stop/Clear.

Analogue clock.

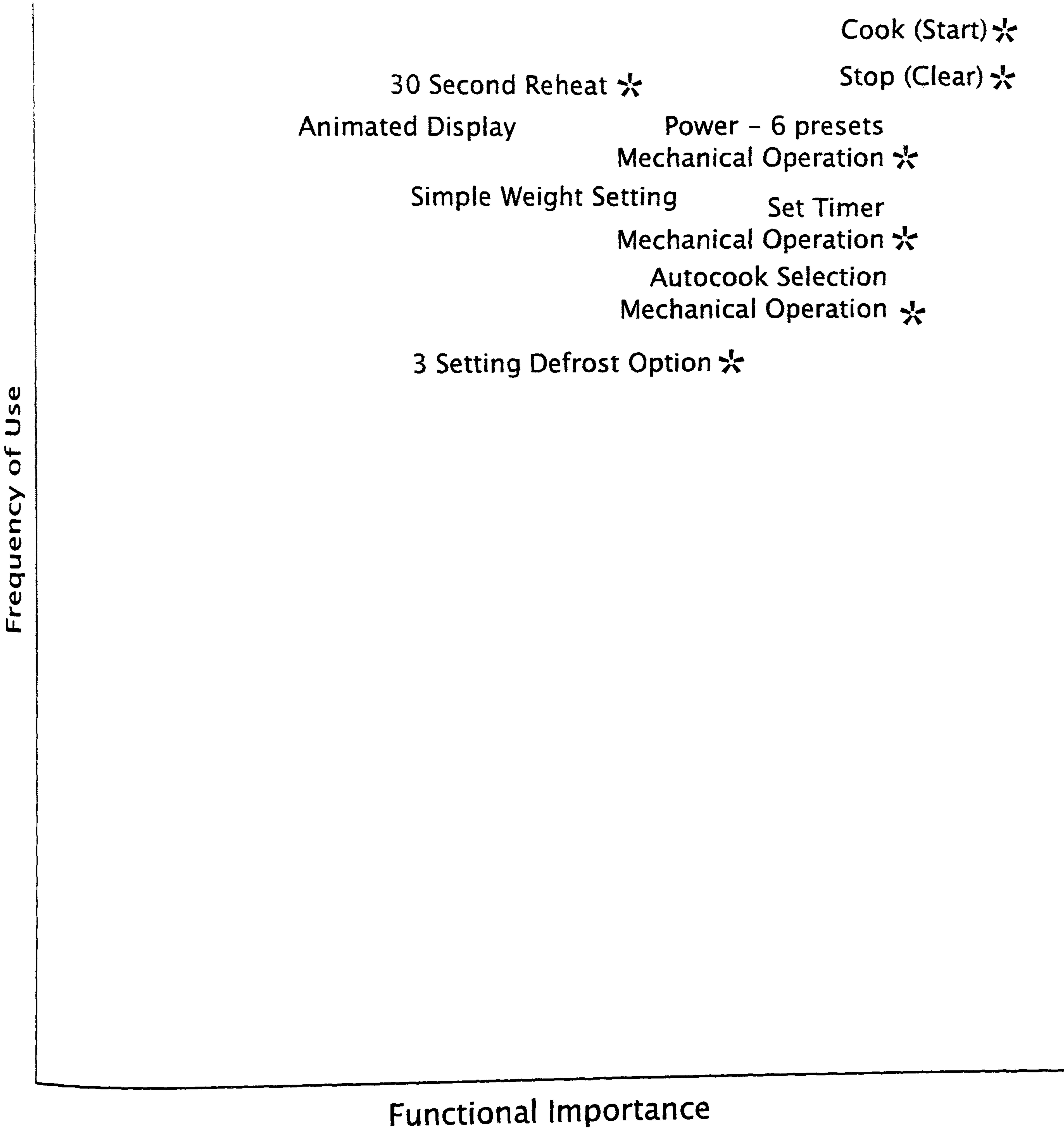


# The Usability Range - Product Specification Matrix

## 'Mid Range' Product

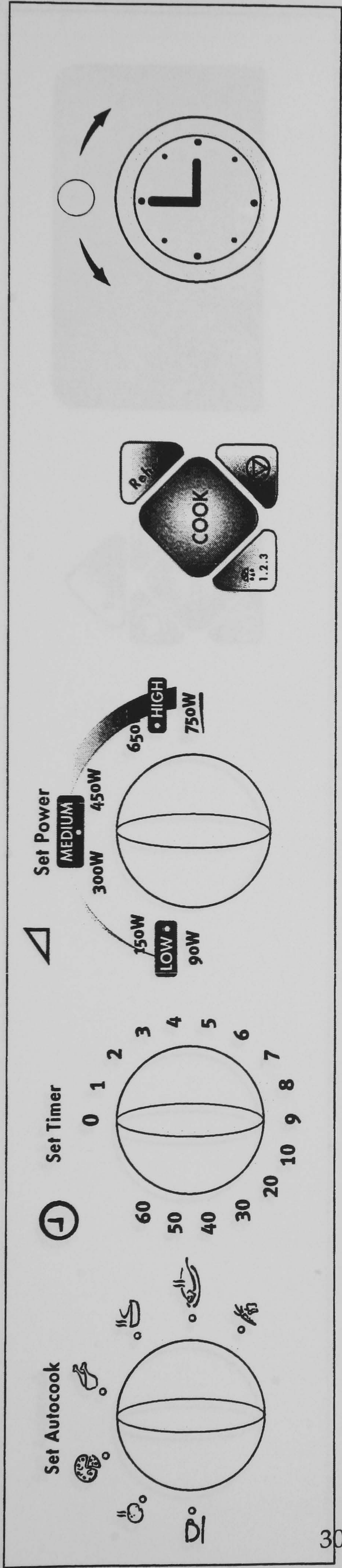
A microwave cooking product that utilises many established functions, the operation of these functions is redefined by applying usability and operational feedback.

Mid Range Low-Cost  
Mid Range





# 'Mid-Range Option' (Low-cost).



## Interface/Features

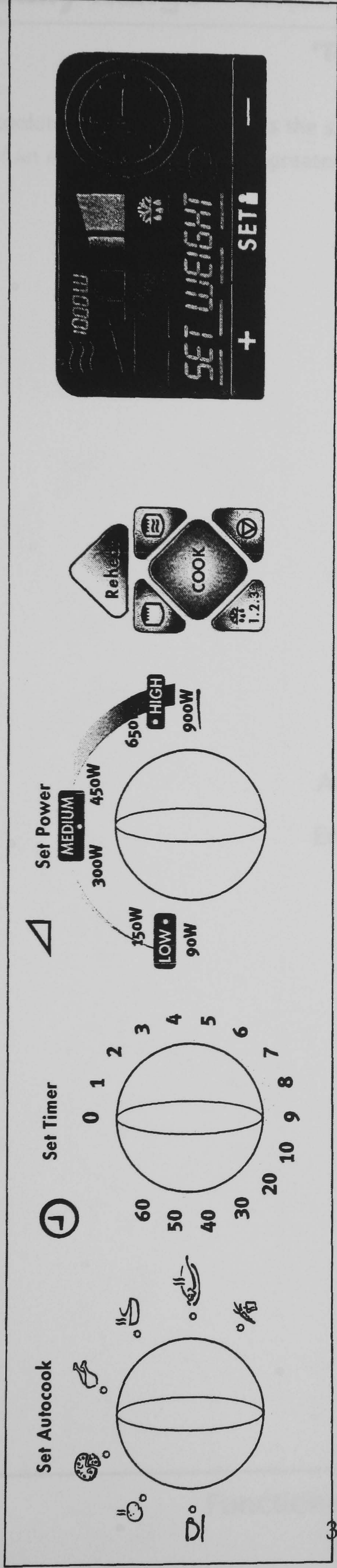
Mechanical knob selects power level (six options). LED illuminates following selection.  
Mechanical knob selects Autocook programmes (seven options). LED illuminates following selection.  
Mechanical knob sets timer.

Clustered microwave operation buttons:  
(Cook (Start) / Defrost –(three options) / Reheat  
Stop/Clear.

Analogue clock.



# 'Mid-Range Option'



## Interface/Features

Mechanical knob selects power level (six options). LED illuminates following selection.  
Mechanical knob selects Autocook programmes (seven options). LED illuminates following selection.  
Mechanical knob sets timer.

Clustered microwave operation buttons:  
(Cook (Start) / Defrost – (three options) Reheat / Grill / Grill and microwave.  
Stop / Clear.

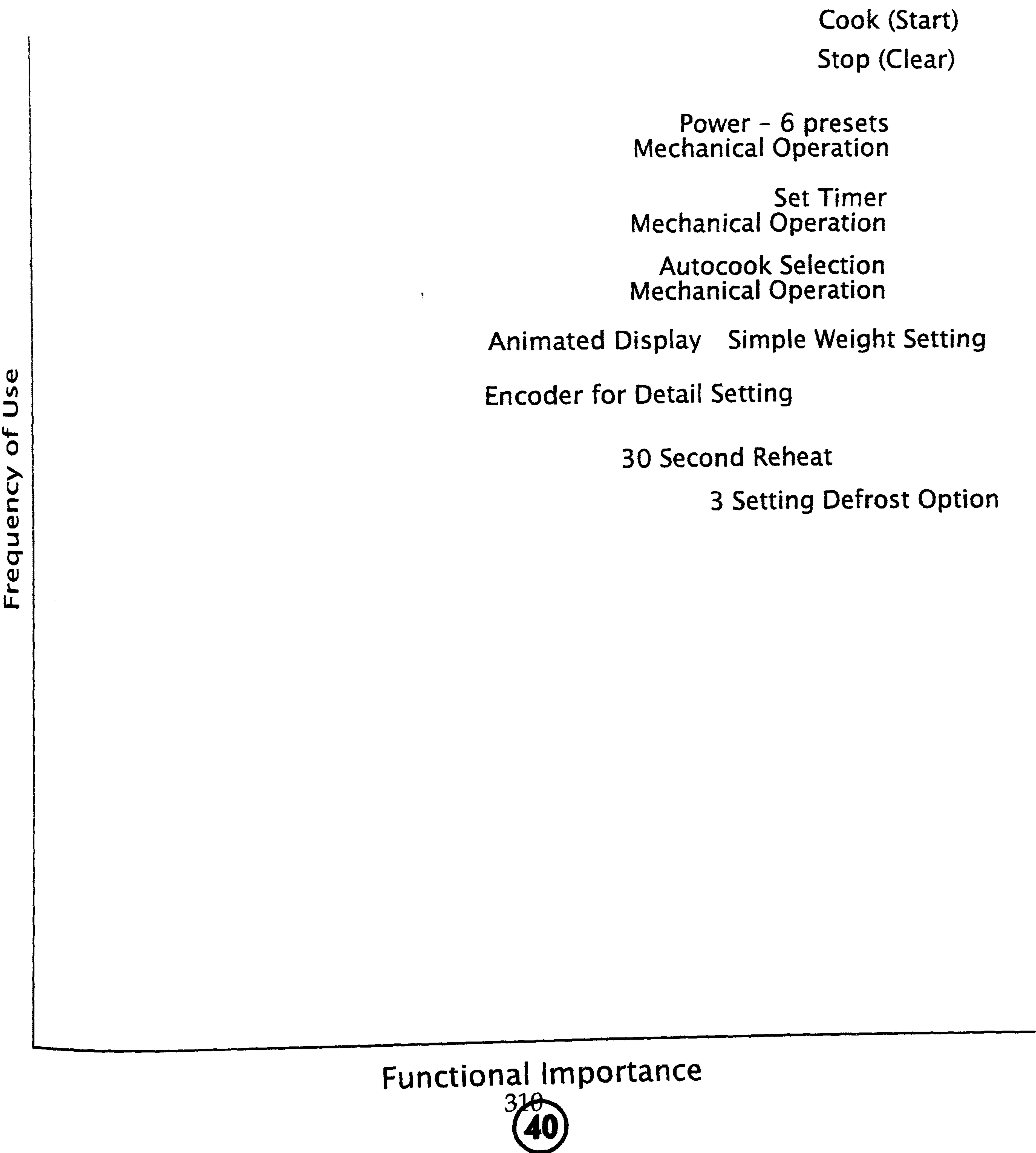
Electronic display shows animated count down clock reverting to analogue, weight setting preference, set by + / – buttons.



# The Usability Range - Product Specification Matrix

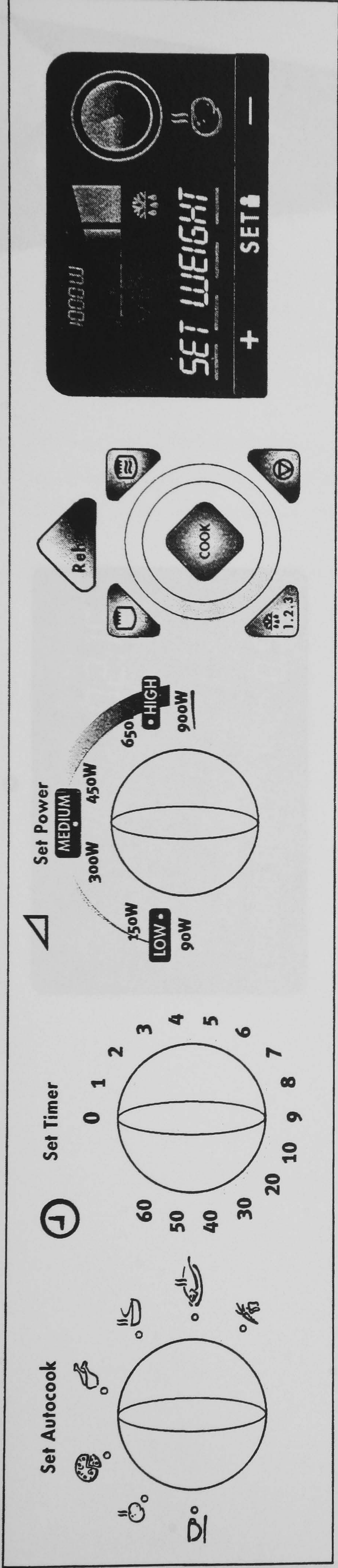
## 'Top Spec' Product

A microwave cooking product that utilises the same functional layout as the mid-range product but with the addition of an encoder for inputting greater accuracy on clustered microwave functions.





# 'Top-Spec Option'



## Interface/Features

Mechanical knob selects power level (six options). LED illuminates following selection.  
Mechanical knob selects Autocook programmes (seven options). LED illuminates following selection.  
Mechanical knob sets timer.

Clustered microwave operation buttons:

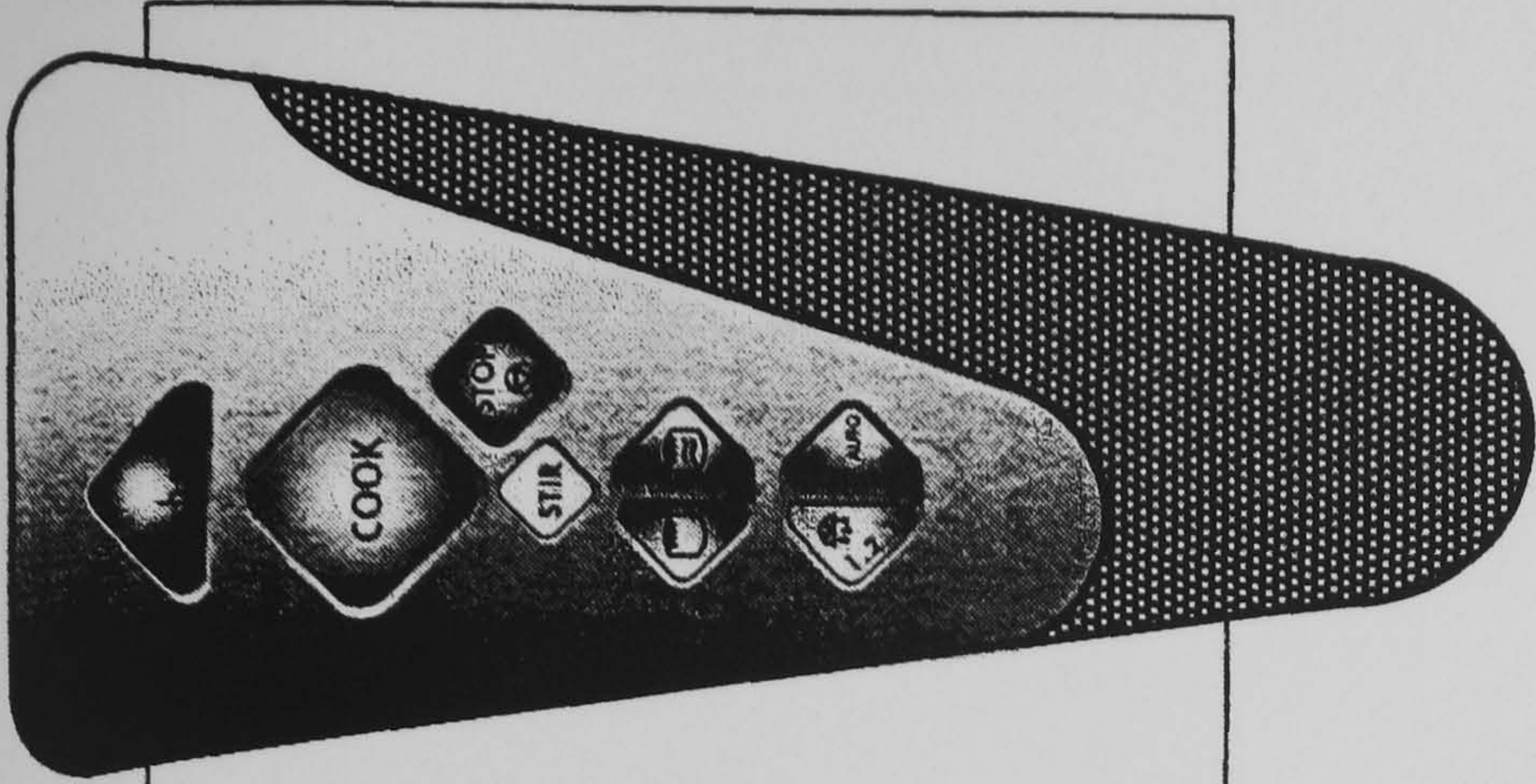
(Cook (Start) / Defrost-three options) Reheat / Grill / Grill and microwave / Stop/Clear.  
Encoder for detail setting.

Electronic display shows animated count down clock reverting to analogue, weight setting preference, power feedback chart, grilling feedback, defrosting feedback, autocook selection.  
Weight set by + / - buttons.

## Other

Twin turntables.





## Interface/Features

Remote control operation Selects:

Cook/Start, Grill, Grill/Microwave, Autocook 1-6, Defrost 1-3, Reheat, Pause, Stop/Clear.

Cavity Management System.

Weight sensors weigh object in cavity, deducting weight of cookware for more accurate setting.

Temperature sensors calculate defrost setting.

Humidity sensors monitor, inject moisture during cooking.

Centrally mounted Stirrer.

Grill option (Remote operation).

## Additional

3 different sizes of cookware dishes + 1 multi-compartmental dish.





overall usability preferences

Further to collating information necessary to improving the operation and usability of our interfaces, workshop participants were encouraged to offer suggestions as to how we might improve the general operations essential to use a microwave product.

As well as finding a strong preference for the horizontal control panel we found that users preferred the drop down door; a step further toward bridging the gap and breeding familiarity between all cooking products.

Aesthetically this suggestion can be taken a stage further by taking away the push button door open operation and replacing it with a door mounted handle. Therefore in keeping with door open operations as on large scale cooking products and brand/family styling.

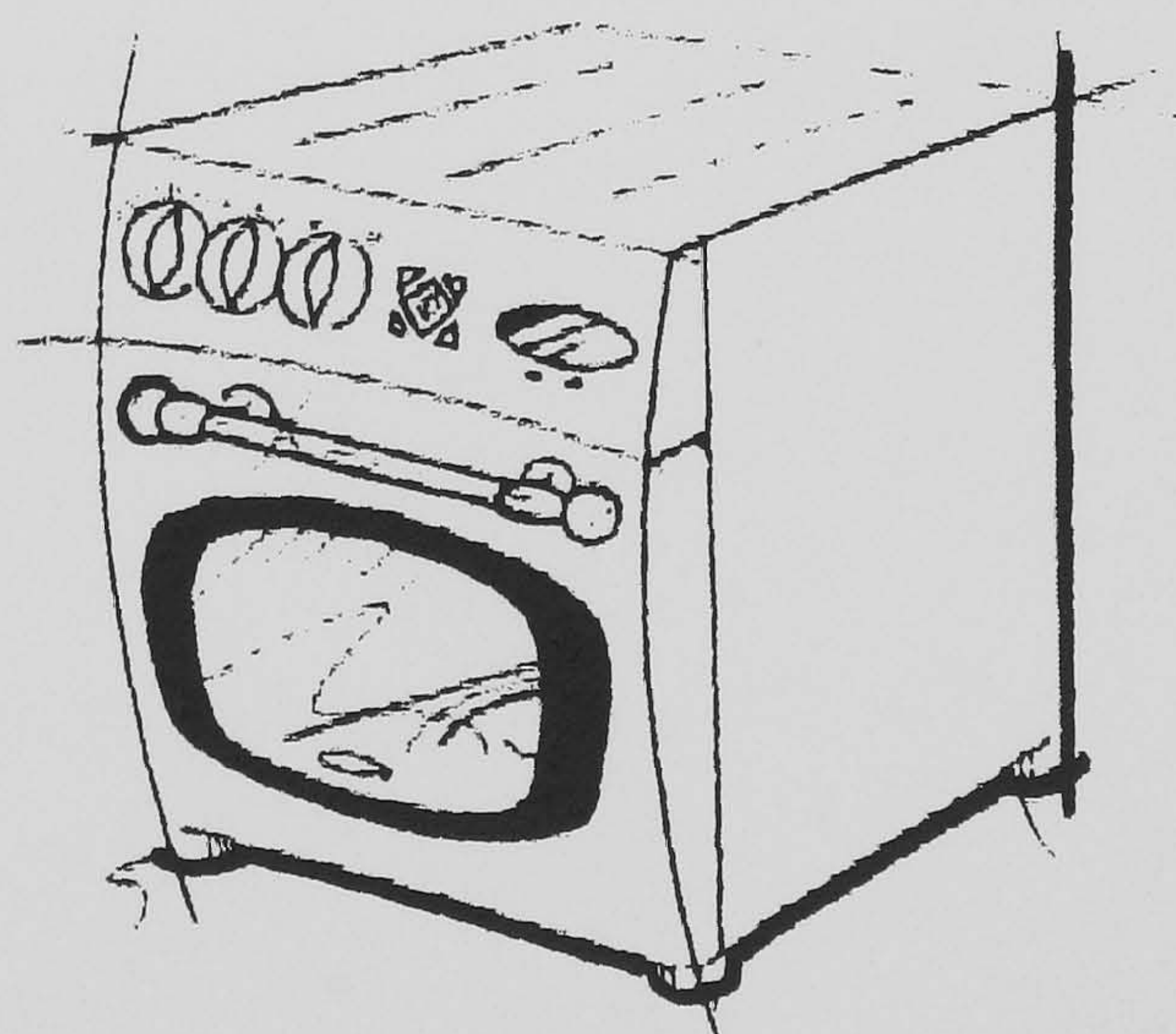
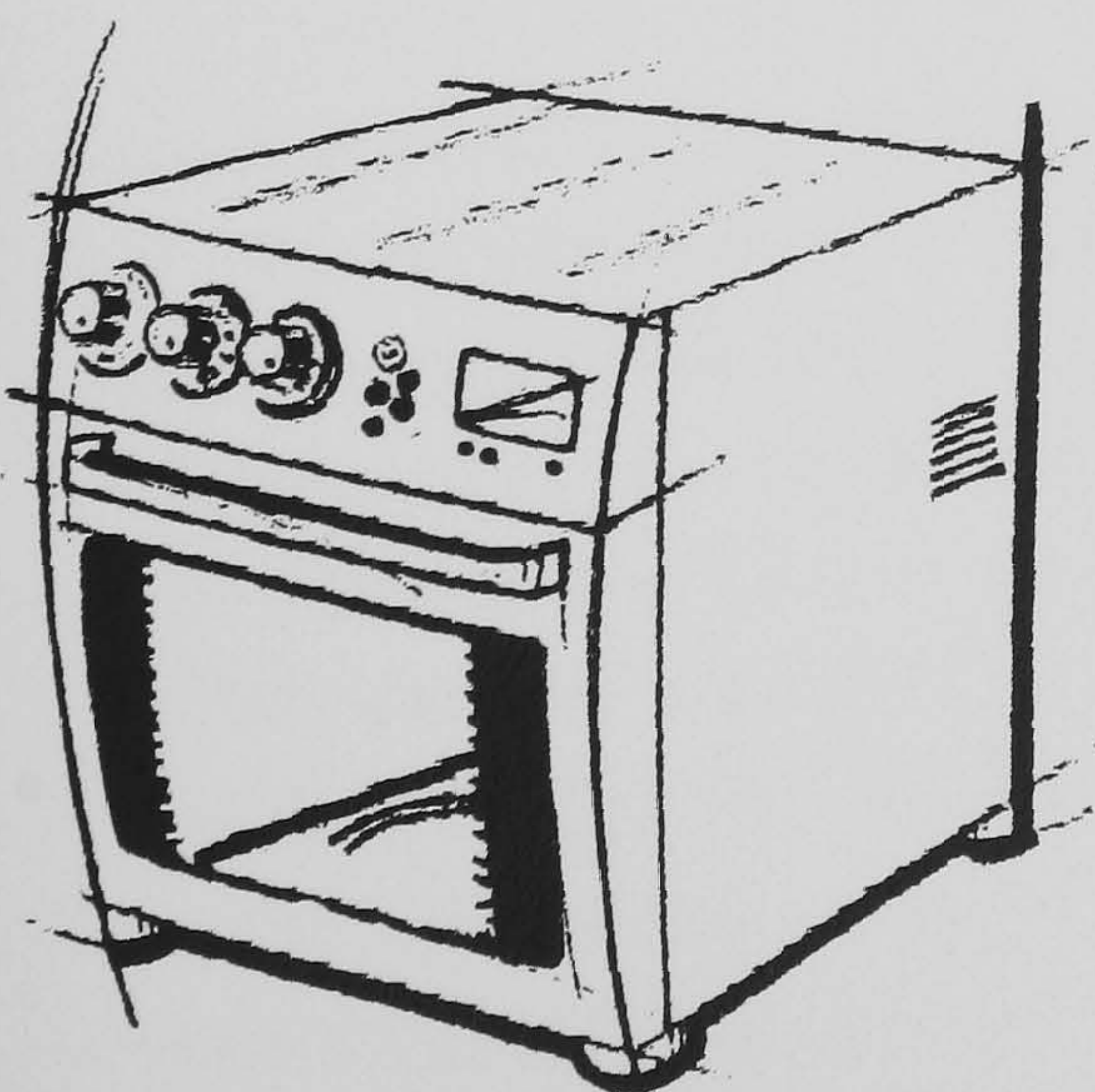
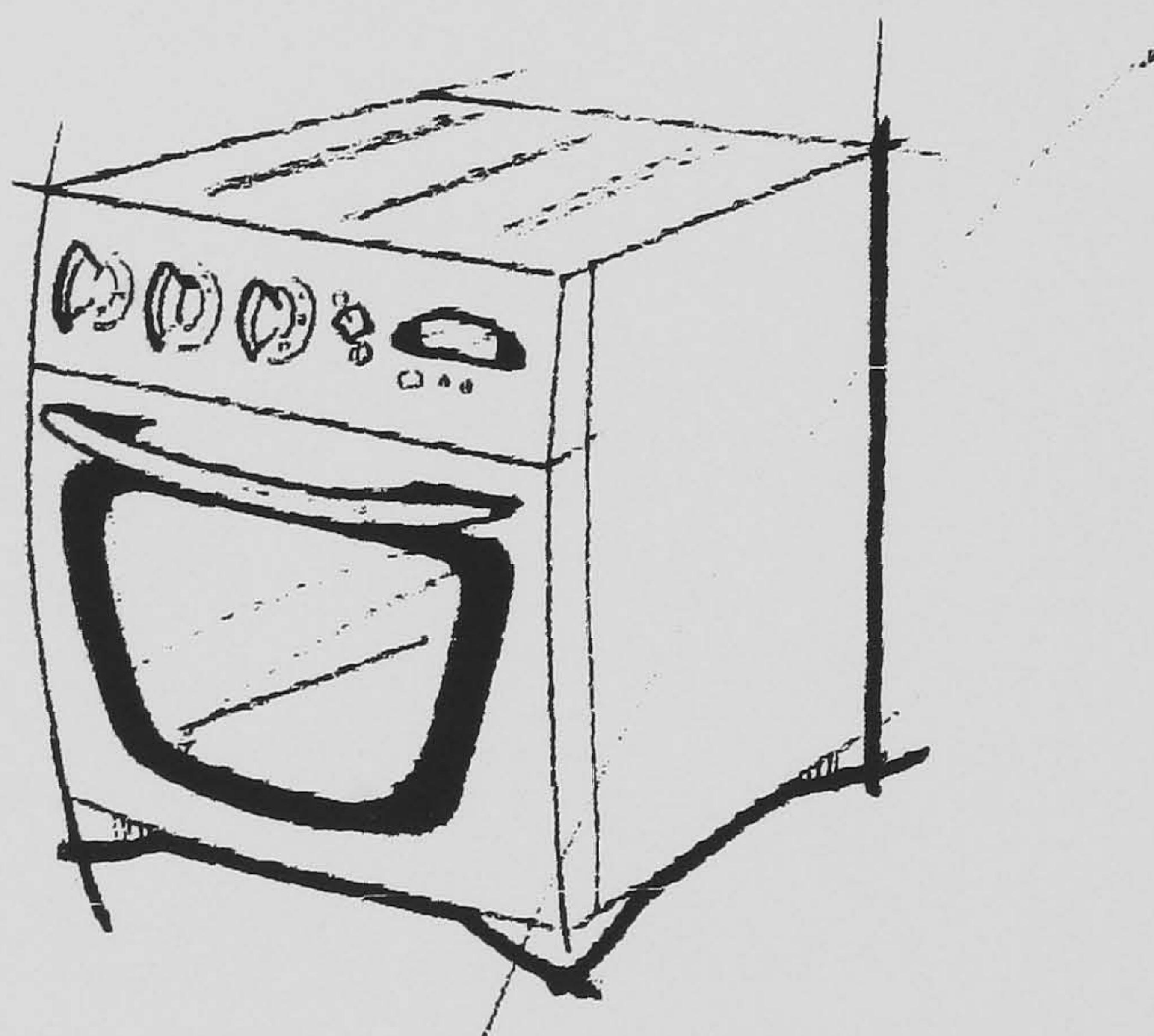
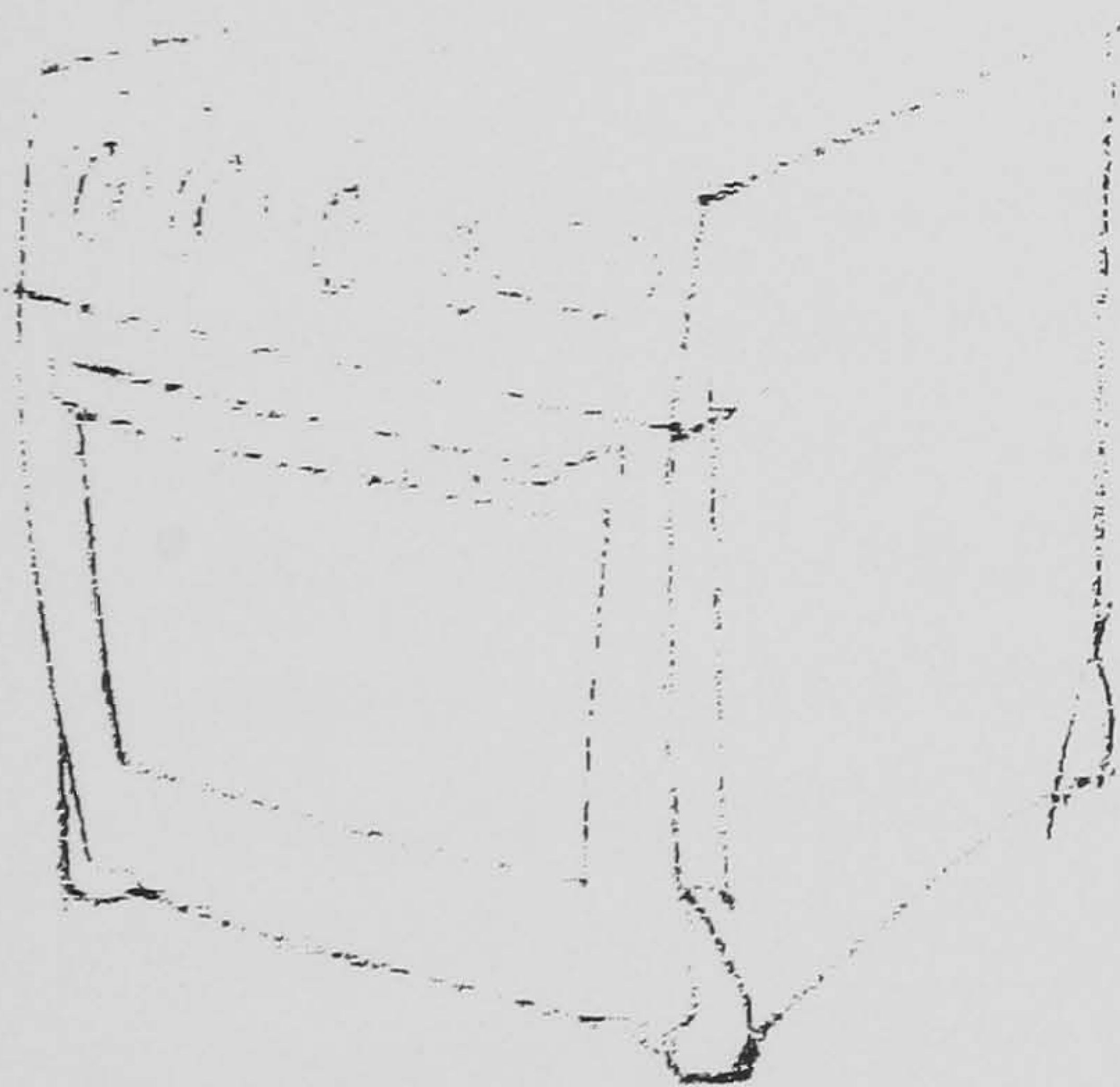
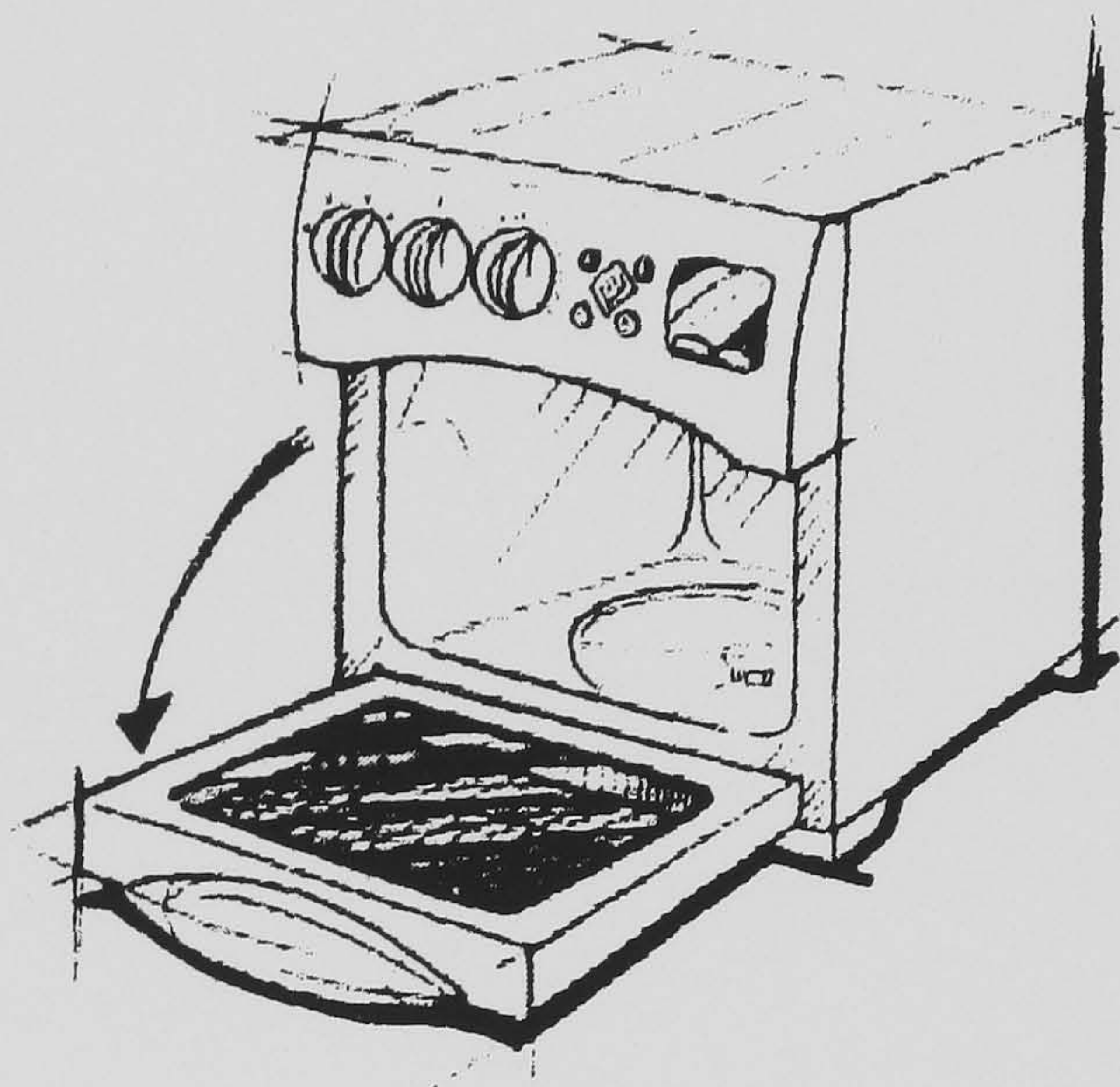
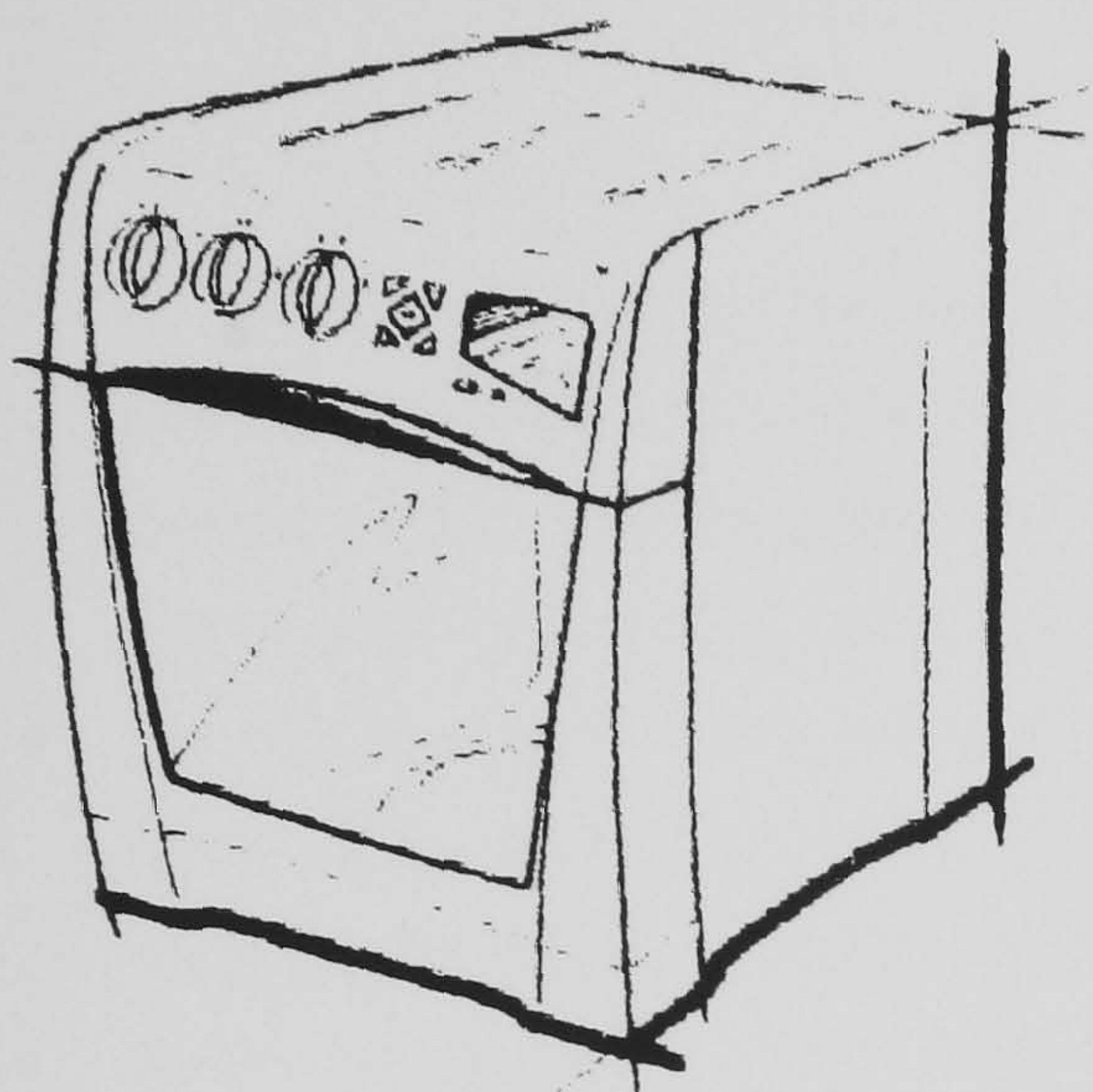
For Built-In products the handle could simply be side mounted in keeping with brand Built-In styling, to combat the height factor with the drop down door suggestion.

Quick keyline sketches are included to help visualise the suggestions.



## Overall Usability Preferences

'Quick Reference'







comments / recommendations





It became apparent in the early stages of the workshops that interface simplicity was a recurring request. A number of the workshop participants owned full touch electronic products but only ever used 20% of the products functional capability. The remaining participants owned mechanical operation products which they felt comfortable with, but all felt intimidated by the level of involvement required to operate further than reheat and simple cooking settings. Many users feel that the product generally does too much, and what it does offer it does inappropriately.

It is a common opinion that attempts to achieve a simple to operate product can result in the creation of a product which is actually harder to use! It is felt that future interface development would be better served by using a 'ground up' common sense approach, concentrating on trialing and building logical sequences.

Although there is an intimidation factor surrounding high technology, there was a suggestion that LED feedback, applied in a different way, could provide a helpful source of information. Currently, in most cases our displays do not hold the visual information following input. To address this new top-spec models could show throughout the cooking cycle, visual scales providing technological automation feedback: Power level, time remaining, grilling/defrosting, weight of item and animated countdown clock. These aids could breed familiarity, and reduce the isolation and uncertainty factors present in the setting process. Relevant feedback with appropriate symbology (animation perhaps), acting in an information aid capacity, as apposed to an input only display, could be a way forward and a move away from the confusing abbreviated selection choices on some of our products.

We know that LED displays can create confusion in the kitchen, but at point of sale attractive pricing combined with large impressive functionality specifications look impressive and act as a good persuader when competing against many 'similar looking' products. It is probably the case that the electronic to mechanical models ownership ratio is heavily waited in favour of full electronic models, but with a large majority of users utilising only low spec functions. To address this the four concepts explored in this report highlight the need to include the most used or useful features to reduce clutter, increase usability and omit misunderstood and unused technology.





On occasion graphic communication has had to work harder to beautify as well as describe interface controls, especially on sourced products. Now that we have our own exclusive ranges in production through a couple of manufacturers, we have the opportunity to address the extent to which we apply graphics and experiment. A less cluttered appearance could aid interface usability. Less description and perhaps a move to colour coded, printed or embossed button graphics; control panels could still be printed to communicate basic mechanical operation settings; in an attempt to breed more familiarity with large cooking products.

Often the job of the operator is made harder by the undeveloped areas of the product. We can design a considered improved interface, but the cavity lets us down as an area where labour intensive activities take place. For example a 'Cavity Management' system could be considered to take care of many of the settings currently activated through the interface.

Such as: Temperature setting for frozen or chilled items, in-cavity stirring, humidity setting with moisture injection, temperature check probe for reassurance feedback; item weight setting could also be an option as weight setting is often an area where operators suffer from the intimidation factor.

To help set weight accurately the product could be purchased with a set of specific cookware items, if this consisted of say four items the user could input the container size by pushing a single button, from this the software will recognise the chosen cookware and deduct its weight from the overall weight of the item. Therefore performing the required task more accurately. Part of a cookware set could be a multi-compartmental item to reduce overall cooking time, for more basic food types.

It is hoped the information in this document will help us to start to gain a core knowledge of 'actual' user approaches to interface development. From which to trigger discussion, prompt new thinking, brave action and hopefully operate as a fresh platform to germinate ideas which grow, realign design direction, and cultivate a right first time culture applicable to new and revisited projects. The emphasis remaining solidly with usability and interaction processes true to the needs of the user.





terms of reference





## **Usability**

Usability as a concept places emphasis on tasks and on user characteristics, the context of use (or environment) are a vitally important design consideration.

Usability engineering is about making systems easy to learn, efficient, effective, safe, functional and enjoyable. It is task orientated done by people, rather than functions supported by machines. Focus is placed on the quality of experience that the users have (if only for commercial advantage!). Instead of whether the system fulfills its functional specification.

## **Functionality**

Functionality is concerned with satisfying what the system should do, for example a functional requirement might be:

The microwave oven will permit the following operations on rotary encoder time, start/stop.

Interface and functionality are semi-independent, while there is a necessary relationship between the two, there will be a large number of possible interface designs for any functional specification.

Interface is the method by which functions are made into a useable context for the user.

## **User Centered Design**

User Centred Design is a process which entails immersion in the intended working environment of the product and a detailed understanding of the day to day realities of that product environment. The User Centred Design approach is a foundation for allowing the user to offer input, feedback and prototype evaluation as the design progresses.





terms of reference

## **Design Tools**

Methods for collecting quality information which provides interface designers with a pool of knowledge, greater insight and a 'real' view from a users perspective.

Examples of design tools:

Card Sorting / Scenario design:

Exercises conducted in a workshop format with a series of non expert users.

## **Scenario**

A scenario, can be defined as a 'constructed, stereotypical story based on a set of scenes'.





Research conducted January 1999, with the help of J. Bonner,  
(HMI Lab) Teesside University.

Report compiled April 1999 by J. Dalton, & D. West,  
Electrolux Industrial Design Centre UK.