# CHAPTER 6

# CONCEPTUAL MODEL OF USABILITY

## 6.1 Introduction

The objective of this chapter is to present a unified set of distinct variables that influence usability through a proposed, conceptual model of usability. In Chapter 2, a number of variables were identified that are known to affect usability, whilst in Chapter 5, additional variables were either accepted as valid or accepted for consideration into the model as a result of the evidence provided in the existing literature. All these variables are now synthesised into the proposed model of usability. Following the framework used in the literature to present various contexts of use [Bevan, 1994; Kirakowski and Cierlik, 1999; Maguire, 1998], we divide the model into three categories: (1) variables that relate to user characteristics, (2) variables that relate to task characteristics, and (3) variables that relate to the environment.

We begin this chapter by presenting an overview of the model in section 6.2, which comprises of the three contexts of user, task and environment. This is followed by a discussion of each of the contexts, including the comparisons that we performed in order to identify and remove the variables that were found to be duplicated between the different sets of variables that were identified and investigated, and to identify and categorise the correlated variables. The user context is discussed in section 6.3; the task context in section 6.4 and the environment context is discussed in section 6.5. We conclude the chapter with some suggestions for controlling for these variables (section 6.6).

## 6.2 Conceptual Model of Usability

An overview of the model is presented in Figure 6.1. Due to its size, we present here only the top levels for each context.

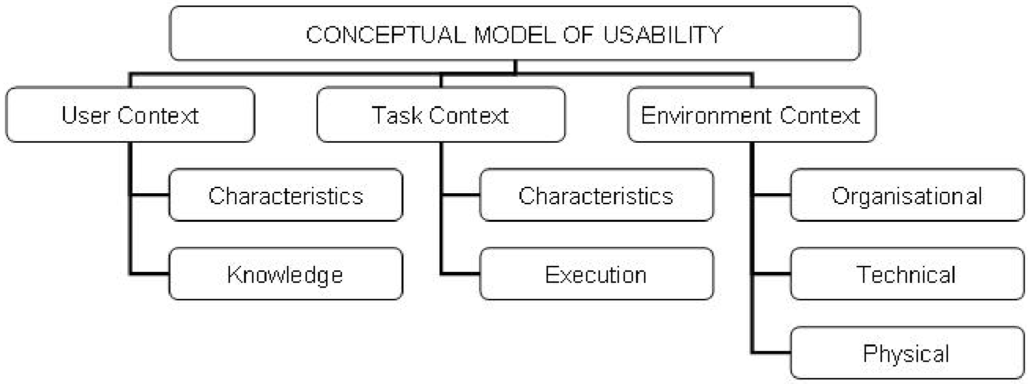


**Figure 6.1**: Overview of the Model of Usability

Each of these contexts is discussed in more detail in the sections that follow.

# 6.3 The User Context

The findings of the previous chapters, together with the comparisons performed between the various sets of variables suggest that the variables relating to the user context be grouped into the categories reflected in Figure 6.2.

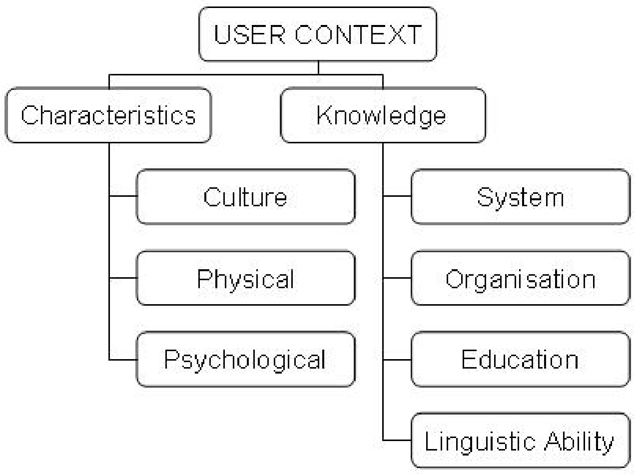


**Figure 6.2:** The User Context of the Usability Model

The user context is divided into the two categories of user characteristics and user knowledge. User characteristics are further broken down into the classes of culture, physical characteristics and psychological characteristics. User knowledge is defined as the user's general knowledge about the world [Mayhew, 1992], and is therefore divided into the classes of system knowledge, organization experience, education and linguistic ability. We now discuss the comparisons performed that led us to identify these classes and variables.

## 6.3.1 User Characteristics

Most of the variables included in this category were identified in the contexts of use put forward by Bevan [1994] and Kirakowski and Cierlik [1999], as well as the performance determinants proposed by Mayhew [1992]. Additional variables were identified in Chapter 5 in terms of the variables that influence user acceptance, objective cultural variables and subjective cultural variables. As illustrated in Figure 6.3 these variables have been grouped into the classes of culture, physical characteristics and psychological characteristics.

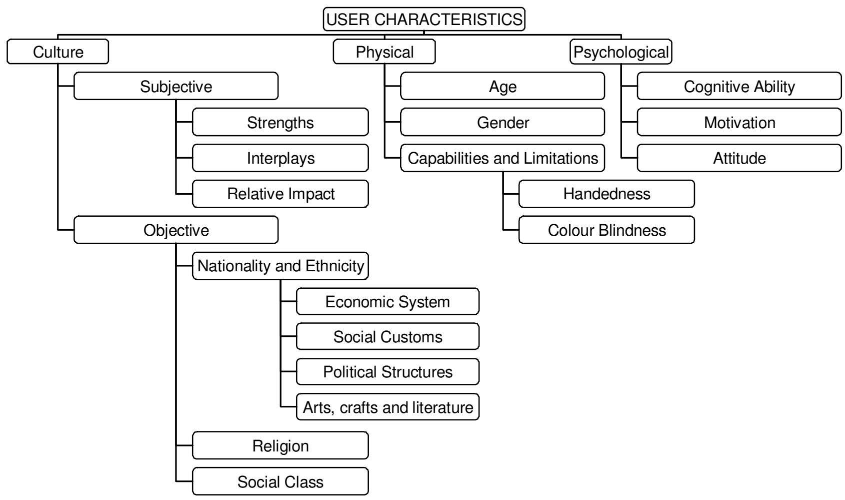


**Figure 6.3:** User Characteristic Variables

### 6.3.1.1 Physical characteristics

The variables that are included in this class of variables include physical capabilities and limitations, gender and age. Physical capabilities and limitations include such dimensions as handedness and colour-blindness. All of these variables were identified in both contexts of use discussed in section 2.4.2, as well as in the performance determinants discussed in section 2.3.4, therefore no further explanations of these variables are deemed necessary.

### 6.3.1.2 Psychological characteristics

Psychological characteristics included in the user context are cognitive ability, motivation and attitude. The variables associated with each of these sub-classes are depicted in Figure 6.3.1.

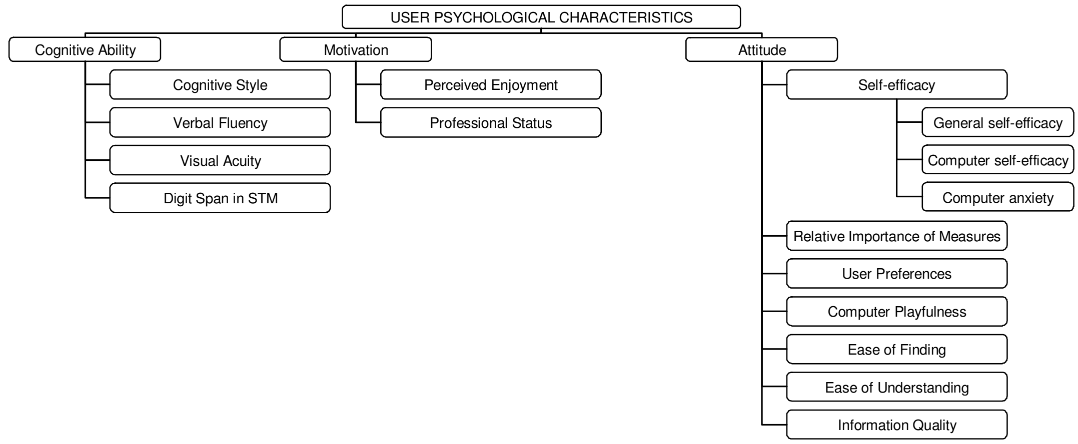


**Figure 6.3.1:** User Psychological Characteristic Variables

These variables were identified in the contexts of use put forward by Bevan [1994] and Kirakowski and Cierlik [1999], as well as the performance determinants proposed by Mayhew [1992]. As a result of our investigation into the variables proposed to influence usability (Chapter 5), we have expanded the cognitive ability, attitude and motivation variables to include additional variables. These are discussed below.

- Cognitive ability is defined as the ability of users to process information, make decisions and solve problems. As a result of our investigation into objective cultural variables (section 5.6.3), we identified that cognitive ability is partly dependent on the users' cognitive styles, verbal fluency, visual ability and digit span in STM [Choong and Salvendy, 1999].
    - Cognitive styles refer to the way in which people approach problem solving tasks. As discussed in section 5.7.2, users with different cognitive styles require different levels of detail of information. Therefore, users with a receptive cognitive style will consider interfaces that only provide summarized information to be less usable than those providing detailed information.
    - Verbal fluency relates to the users' ability to express and understand ideas using language (as opposed to drawing pictures). In contrast, visual abilities refer to the ability of the users to discriminate between visual patterns. Interfaces that predominantly make use of pictorial icons rather than text may be considered less usable by users who have low visual abilities.
    - Digit span in STM relates to the amount of data that can be held in the user's short-term memory. The amount of information that the interface requires the user to remember will therefore influence the usability of the interface, particularly if the users' digit span in STM is smaller than the average of the population.
- Attitude relates to the attitude of the users to their jobs and tasks, to a specific software product, to information technology in general, and to the organization that employs the users. Attitudes can be positive, negative or neutral [Mayhew, 1992]. In section 2.3.4.1, we

noted that self-efficacy influences attitude. We identified from our investigation into the user acceptance variables (section 5.4) that self-efficacy can consist of computer anxiety, computer self-efficacy and system self-efficacy; and further that computer playfulness, ease of finding, ease of understanding and information quality influence attitudes. We also noted that the relative importance of usability measures (section 5.6.1) is a valid variable, as are user preferences (section 5.6.2).

  - Computer anxiety, computer self-efficacy and system self-efficacy are similar in nature, as they all relate to the users' confidence in their ability to use and succeed with technology [Brown, 2002; Venkatesh, 2002; Agarwal et al., 2000]. High levels of anxiety and low levels of self-efficacy can lead to fear, which is a negative emotion, thus resulting in negative attitudes.
  - The relative importance of usability measures relates to the importance that users attach to the usability measures of speed, accuracy and satisfaction. This is seen as an attitudinal issue and is therefore included as a dimension of attitude.
  - User preferences relate to attitudes in terms of likes and dislikes, and are therefore included as a dimension of attitude.
  - Computer playfulness relates to the amount of fun during interaction [Venkatesh, 2000].
  - Ease of finding refers to how easy it is to navigate between screens of the interface and is seen as influencing the perceived ease of use of a system [Brown, 2002].
  - Ease of understanding refers to the comprehensibility of the content of the interface [Brown, 2002].
  - Information quality refers to the accuracy, timeliness, relevance and completeness of information [Lederer et al., 2000].

- Motivation can be internal, in that motivation stems from being able to perform well, or external to the actual performance of work. Internal motivation is related to work performance, in terms of the need for competence and self-determination. Consequently we are led to believe that the user acceptance variables of perceived enjoyment and professional status influence motivation.
  - Perceived enjoyment is defined as the extent to which using a computer is seen as enjoyable by the users [Venkatesh, 2000]. The greater the enjoyment, the more motivated some users will be to use the technology.
  - Professional status is defined as the extent to which using the system will enhance the user's professional status as perceived by the user's colleagues [Succi and Walters, 1999]. Peer recognition is seen to relate to external motivation.

#### 6.3.1.3 Culture

Although culture has not been included in the contexts of use proposed by Bevan [1994] and Kirakowski and Cierlik [1999], or the set of performance determinants proposed by Mayhew [1992], the discussions in the previous chapters have identified this to be a valid class of variables for inclusion into the model. The culture class is divided into the two sub-classes of objective culture and subjective culture.

- Subjective culture relates to the psychological features of a culture, including assumptions, values, feelings, beliefs and patterns of thinking [Hoft, 1996]. We identified in Chapter 5 (section 5.2.1) that subjective culture can be measured using various cultural dimension models, and that variables that should be considered when identifying the subjective culture of users include the strengths of the cultural dimensions and the interplays between dimensions. We also noted that different cultural dimensions may have different impacts on system usability.
- Objective culture, in contrast, relates to the institutions and artefacts of the culture, and includes variables such as economic and political structures, social customs, literature, arts and crafts (section 2.5.2.4). We identified in Chapter 5 (section 5.6) that objective culture also relates to the nationality and ethnicity of the users.

## 6.3.2 User Knowledge

All of the variables, except for two, included in this category were identified in the contexts of use and performance determinants. The two additional variables, of tool experience and IT role were identified from the set of user acceptance variables (section 5.6) Analysis of the performance determinants and the variables identified in the contexts of use suggests that user knowledge comprises of four classes of knowledge, namely system knowledge, organization knowledge, education and linguistic ability, as illustrated in Figure 6.4.

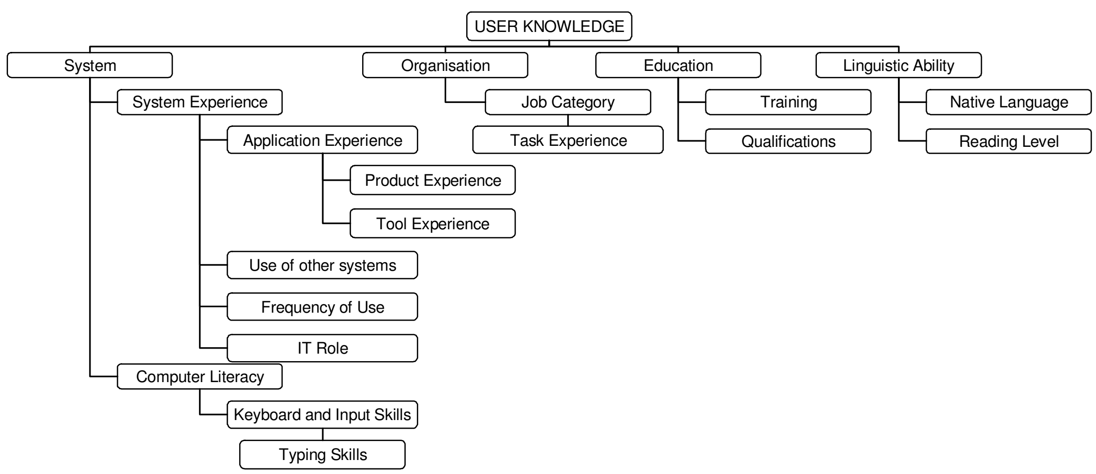


**Figure 6.4:** User Knowledge Variables

The classes that we use in the model are a little different to those used in the contexts of use and set of performance determinants. We discuss the rationale behind our classification below.

#### 6.3.2.1 System Knowledge

System knowledge is defined as knowledge and experience about computer-based systems in general [Kirakowski and Cierlik, 1999]. System knowledge is divided into the two sub-classes of system experience and computer literacy. System experience is seen to comprise of application experience, use of other systems, frequency of use and IT role, where application experience comprises of product experience and tool experience. Computer literacy includes keyboard and input skills, which also includes typing skills. The reasons for our categorizations are as follows:

- System experience refers to knowledge of the particular language or mode of interaction used in a specific system. Application experience refers to the experience that users have had with products of the same genre, for example accounting packages or word-processors. Use of other systems is similar to application experience, but refers to the use of systems in general, rather than the use of other systems of the same genre. IT role refers to the level of system expertise in terms of whether the user is a novice or expert user. System expertise is naturally dependent on system experience. Frequency of use refers to how many times and the duration of each time that the system is used; the more frequently that the user uses the system, the more experience the user will have with the system. Consequently, application experience, use of other systems, frequency of system use and IT role are seen as dimensions of system experience, which in turn is a dimension of system knowledge.
- Product experience is defined as hands-on experience with a particular software product such as Microsoft Word or Pastel accounting. As each specific product will have a particular language and mode of interaction, product experience is related to system experience. As a particular product may share a common mode of interaction or language with other applications of the same genre or other genres, product experience can be viewed as a dimension of application experience.
- Tool experience relates to the user's abilities to use tools appropriate to conducting tasks [Dishaw and Strong, 1999]. These can include computer-based tools such as spreadsheets or word-processors, or non-computer based tools such as calculators and telephones. Consequently, tool experience is seen as a dimension of application experience.
- Computer literacy refers to the user's ability to use the input and output devices common to computer based systems, as well as their general understanding of computers. This is viewed as a dimension of system knowledge, as a user may have basic computer literacy knowledge, but no experience with a particular product or genre. Keyboard and input skills relate to the ability to use input devices, and are therefore naturally a dimension of computer literacy. Typing skills relate specifically to, and is therefore a dimension of, the level of keyboard skills.

#### 6.3.2.2 Organisation Experience

Organisation experience relates to the user's prior work experience with specific organizations or organizations in general. The knowledge gained from work experience is part of the user's knowledge about the world. This knowledge can include knowledge and experience gained from performing tasks within one or more organizations, which in turn, is dependent on the job category in which the user is employed. Therefore task experience is seen as dimension of job category, which in turn is a dimension of organizational experience. Job category and task experience encompass many of the variables related to the task context, and are discussed in more detail in section 6.4.

#### 6.3.2.3 Education

Education refers to the level of education, for example, high school, technical or university degree. Training is defined as the type and manner in which users have learned to use computers and perform job functions. Qualifications are similar to training, but are seen as formal, whereas training is not necessarily formal and resulting in a qualification. For example, users can be trained by the information systems department staff on how to use a particular application, but do not receive a formal qualification for that system. Therefore, we view training and qualification as related, but separate dimensions of education.

#### 6.3.2.4 Linguistic Ability

Linguistic ability is defined as the user's ability to read, speak and understand a specific language [Kirakowski and Cierlik, 1999]. Linguistic ability therefore encompasses the two performance determinants of native language and reading level [Mayhew, 1992].

## 6.4 The Task Context

As illustrated in Figure 6.5, the task category is divided into the two classes of task characteristics and task execution. Task characteristics are further divided into the sub-classes of job category, risk, demands and linkages. Task execution comprises the classes of dependencies, flexibility and frequency. These categories and sub-categories are different to those used in the set of performance determinants and contexts of use.

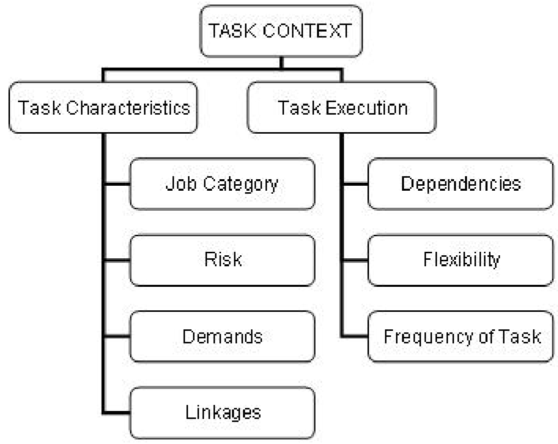


**Figure 6.5:** The Task Context of the Usability Model

We discuss the rationale behind our categorisations next.

## 6.4.1 Task Characteristics

Most of the variables included in this category were identified from the contexts of use [Bevan, 1994; Kirakowski and Cierlik, 1999] and performance determinants [Mayhew, 1992]. Three additional variables were identified as a result of our investigation into the variables that were proposed to influence usability: task-technology fit was identified from the user acceptance variables (section 5.6), and the number of navigational decisions and the number and length of bodies of text were identified as speed of performance variables (section 5.5). As illustrated in Figure 6.6 the variables relating to task characteristics have been grouped into the classes of job category, risk, demands and linkages.

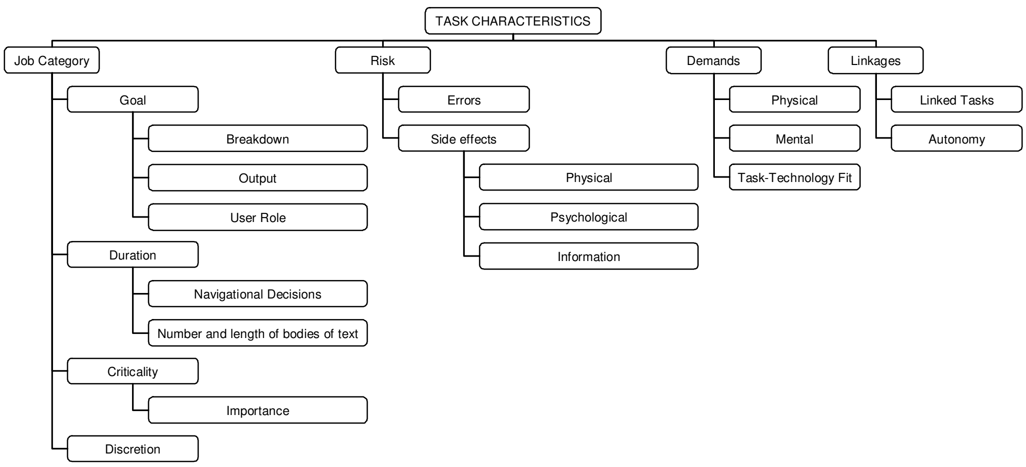


**Figure 6.6:** Task Characteristics Variables

#### 6.4.1.1 Job Category

Job category relates to the management or operational level that the task falls into within the organizational hierarchy. The organizational level at which the task is performed will often dictate the task goals, the duration of the task, the criticality of the task and the amount of discretion that the user is able to exercise when executing the task.

- Task goals are defined as the overall aim of the task, for example, preparing purchase orders or producing financial statements. The goals of the task, in turn, will dictate
  - the task breakdown, that is, the activities that need to be performed in order to complete the task;
  - the task output, which is defined as the information that the task produces; and
  - user role, which is defined as whether the user uses the system directly or indirectly.
- Task duration refers to how long the task will take to complete, and is naturally influenced by the task breakdown. In addition, if the task is performed using technology, then the number of navigational decisions and the number and length of bodies of text required to be read will also influence the duration of the task. Furthermore, the hardware platforms and the level of internet traffic (in the technical environment), will also influence the duration of the task, due to slower or faster download times of the relevant pages of the interfaces. These four variables were identified as speed of performance variables in section 5.5.
- Task criticality relates to how important it is that the task is carried out or completed. Task importance relates to how significant the task is to the user, and is seen as a dimension of task importance.
- Discretion relates to the ability of the user to make decisions about how the task is carried out, and is influenced by many of the other variables included in the task category.

#### 6.4.1.2 Risk

Risk is defined as the potential for monetary or other losses that may result from the completion or non-completion of the task. Consequently, this class of variables comprises of risk of errors and unwanted side effects when performing tasks. Side effects are seen to include those associated with risks and undesirable effects on the psychological and physical health of the employees performing the task, and unauthorised access to sensitive information used during the execution of the task.

#### 6.4.1.3 Demands

The variables included in this class are physical and mental demands, as well as task-technology fit. Physical and mental demands were identified in the contexts of use discussed in section 2.4.2. Task-technology fit was identified as a result of our investigation into the user acceptance variables, and is defined as the match between user task needs and available functionality of the IT [Dishaw and Strong, 1999]. Should the technology not support the task, the mental and the physical demands on the users will be increased.

#### 6.4.1.4 Linkages

This class of variables relates to the associations and linkages between a specific task and other tasks that are required to be performed in the organization, and therefore comprises the variables of linked tasks and autonomy.

- Linked tasks are those that are carried out concurrently with the task at hand.
- Autonomy refers to supervisory and quality check tasks that need to be performed on the task at hand. Autonomy is also seen to partly influence discretion, which is discussed as a separate variable in section 6.4.1.1.

### 6.4.2 Task Execution

Task execution relates to the variables that affect the way in which the task is carried out, and is therefore seen to comprise of the classes of dependencies, flexibility and frequency of the task. This is illustrated in Figure 6.7.

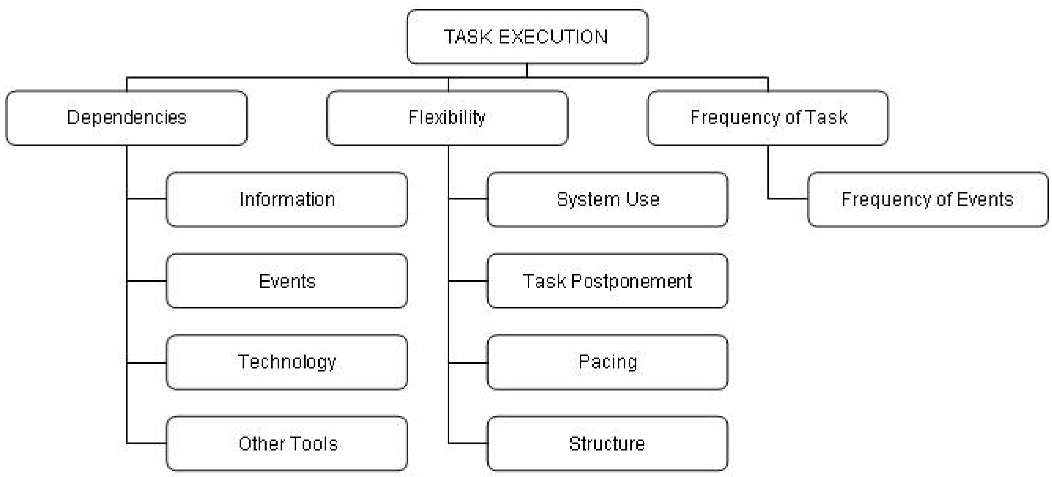


**Figure 6.7:** Task Execution Variables

Once again, all of the variables included in this category were also identified in the contexts of use and performance determinants. However, the classes that we have grouped the variables into are a little different, and are therefore discussed next.

#### 6.4.2.1 Dependencies

The variables that are included in this class relate to the resources that the execution of the task is dependent on. These include information, events, technology and other tools. All these variables were identified in the contexts of use and set of performance determinants, and therefore no further explanations are deemed necessary.

### 6.4.2.2 Flexibility

Flexibility relates to whether or not the task must be completed in a certain way. Flexibility therefore is seen to encompass the variables of system use, task postponement, pacing and structure.

- System use relates to whether the use of technology is mandatory or voluntary, and is therefore seen to relate to how the activities are to be performed.
- Task postponement refers to whether the user can postpone the completion of an activity at any stage, and is partly dependent on task pacing.
- Pacing refers to whether the activities need to be performed within a specific time constraint.
- Structure is defined as the repetitiveness and predictability of the operations relating to the task, which will therefore influence the flexibility of the task.

### 6.4.2.3 Frequency

The frequency of the task is defined as how often the task will be carried out. As the execution of a task can be dependent on the occurrence of events, the frequency of events is seen as a dimension of this variable.

## 6.5 The Environment Context

As illustrated in Figure 6.8, the environment context is divided into the sub-contexts of organizational, technical and physical environments.

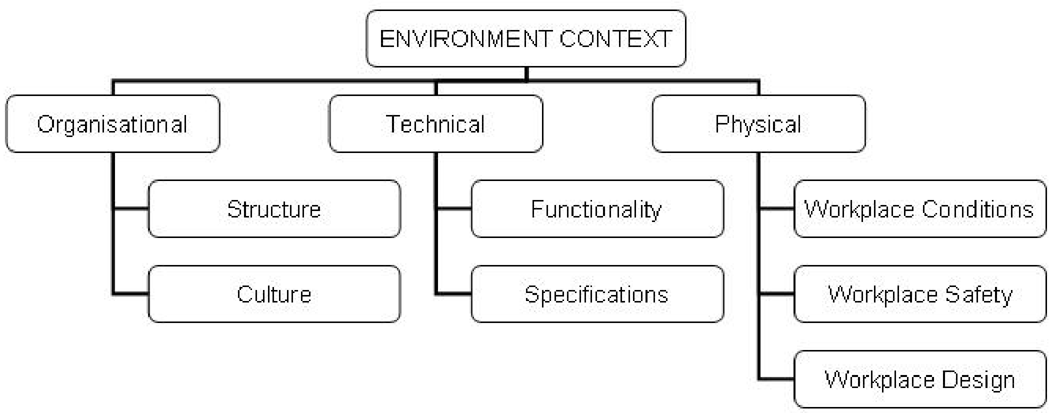


**Figure 6.8:** The Environment Category of the Usability Model

The environments identified in Figure 6.8 are in contrast to the four environments of organizational, technical, physical and social, proposed by Kirakowski and Cierlik [1999]. We have included two of the variables allocated to the social environment into the organizational environment, and the third variable into the technical environment.

## 6.5.1 The Organisational Environment

All of the variables, except for one, included in the organizational environment were identified in the contexts of use [Bevan, 1994; Kirakowski and Cierlik, 1999], and the performance determinants [Mayhew, 1992]. The additional variable, organizational support, was identified as a result of our investigations into the validity of the variables proposed to influence usability. As illustrated in Figure 6.9, the variables related to the organization environment have been grouped into the two categories of structure and culture.

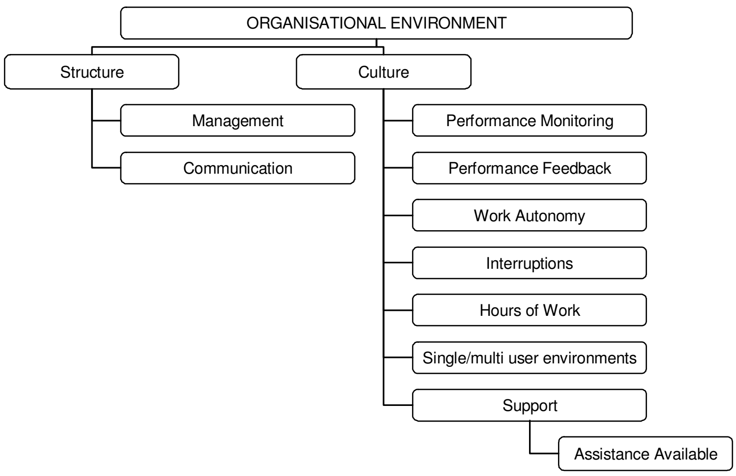


**Figure 6.9:** Organisational Environment Sub-categories and Classes

### 6.5.1.1 Organisational Structure

Organisational structure refers to the structures within the organization that affect the way in which the user works or uses information technology, and consists of the two classes of management structure and communication structure. No specific variables for these classes were identified.

### 6.5.1.2 Organisational Culture

Organisational culture relates to the policies and procedures that may influence the users' work practices, including the way in which the user interacts with information technology. The variables originally included into the organizational environment [Bevan, 1994; Kirakowski and Cierlik, 1999] of performance monitoring, performance feedback, hours of work, work autonomy and single or multi-user environments are therefore included in this class.

The interruptions and assistance available variables, originally included by the above-mentioned authors into the social environment, have also been included here. Organisational support was identified as a valid variable relating to user acceptance (section 5.6), and is defined as encouragement by top management and allocation of adequate resources. Assistance available (social environment) and facilitating conditions (user acceptance variables) were identified as a duplication of each other (section 5.6), and relate to the availability of assistance for users. Assistance available is therefore incorporated as a dimension of organizational support.

### 6.5.2 The Technical Environment

Most of the variables included in this environment were identified from the contexts of use [Bevan, 1994; Kirakowski and Cierlik, 1999]. Additional variables were identified in Chapter 5 in terms of the variables that influence the interface and speed of performance variables. As illustrated in Figure 6.10, these variables have been grouped into the two categories of functionality and specifications.

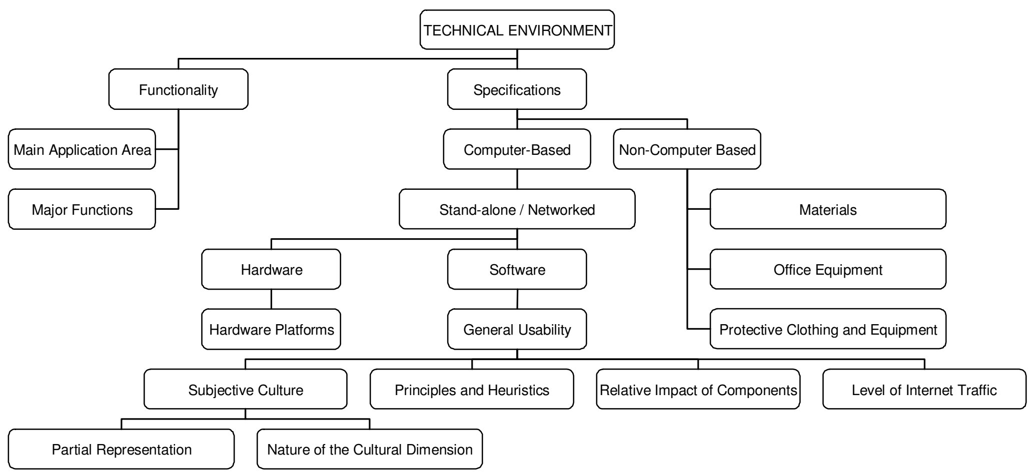


**Figure 6.10:** Technical Environment Sub-categories and Classes

#### 6.5.2.1 Functionality

The variables that are included in this category relate to the main application area and major functionality of the equipment. Both of these classes were identified in the contexts of use discussed in section 2.4.2.3. One additional variable was identified from the investigation into the user acceptance variables, namely tool functionality. However, as noted in section 5.6, tool functionality was seen as a duplication of major functions, and is therefore considered to be incorporated into this class.

### 6.5.2.2 Specifications

This category of variables is further grouped into the sub-categories of computer-based and non computer-based equipment and materials. Non computer-based equipment and materials incorporates materials such as user manuals and policy documents, office equipment such as telephones and calculators, and protective clothing and equipment. Computer-based equipment can be stand-alone or networked, and comprise of the two classes of variables of hardware and software. The hardware class includes hardware platforms which were identified in section 5.5 as a variable relating to speed of performance. We have included the additional variables related to the interface (section 5.3) and the level of internet traffic (section 5.5) as dimensions of the general usability of the software class. As all of these variables have already been defined in previous chapters, no further explanations are deemed necessary.

## 6.5.3 The Physical Environment

All of the variables included in this environment were identified from the contexts of use [Bevan, 1994; Kirakowski and Cierlik, 1999] and performance determinants [Mayhew, 1992]. Analysis of the variables identified in the previous chapters suggests that the variables be categorised into workplace conditions, workplace safety and workplace design, as illustrated in Figure 6.11.

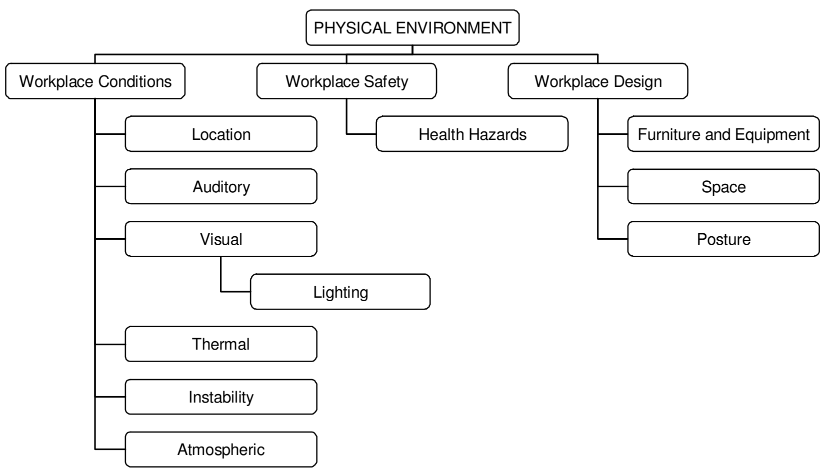


**Figure 6.11:** Physical Environment Sub-categories and Classes

The categories reflected in Figure 6.11 correspond to those used by Kirakowski and Cierlik [1999]. The classes and individual variables assigned to the categories are a little different to those used by these authors, and are therefore discussed next.

### 6.5.3.1 Workplace Conditions

Workplace conditions include the variables of atmospheric, thermal, auditory and visual conditions, as well as instability. As lighting refers to how well lit the working environment is, we have included this variable as a dimension of visual conditions. All the other variables included in this category are defined in section 2.4.2.3, and as no additional variables were identified, no further explanations are deemed necessary.

#### 6.5.3.2 Workplace Safety

Workplace safety consists of only one class of variables, namely health hazards, which is defined in section 2.4.2.3. As noted in Section 6.5.2, Kirakowski and Cierlik [1999] considered protective clothing and equipment as a dimension of health hazards. However, to avoid repetition, we have placed this variable under the technical environment.

#### 6.5.3.3 Workplace Design

Workplace design consists of the variables of space, posture and furniture and equipment, as identified by Kirakowski and Cierlik [1999], Bevan 1994] and Mayhew [1992].

- Space refers to the amount of space available that may constrict the user while executing a task (section 2.4.2.3).
- Posture relates to the extent to which the user will have to adopt an uncomfortable position while using the system or any other equipment while performing a task (section 2.4.2.3).
- Furniture and equipment refers to the accessibility of the furniture and equipment required to perform a particular task (section 2.4.2.3 and 2.3.4.5).

This concludes our discussion of the variables related to the user, task and environment contexts. In the rest of this chapter we turn our attention to using these variables in empirical research projects.

## 6.6 Strategies for controlling for variables

In this section, we propose strategies for controlling for the variables included in the usability model. Consequently, we discuss the variables in terms of their relevance to the components of an empirical research design, namely the

- selection of test subjects;
- identification of test interfaces;
- development of test tasks;
- identification of the test environment; and
- conducting the experiment.

The conditions for a test of usability must be representative of important aspects of the overall context of use [Honold, 2000; Bevan, 1994; Duncker, 2002; Rubin, 1994]. This means that the selection of the test subjects, the test interfaces and the test tasks must be done in terms of the context in which the interaction will take place in the real world [Bevan, 1994]. We noted in Chapter 5 that not all of the variables identified as valid are valid in all contexts of use. When designing an experiment in the form of a usability test, the variables that need to be controlled for are dependent on the context within which the product is expected to be used.

The usability model proposed in section 6.2 incorporates all the variables that have been identified from this research that influence usability in general. Consequently the model should not be seen as a static tool that is generically appropriate for all contexts. Rather, it should be used as a guideline that requires interpretation within specific contexts, in order to be able to extract the variables that are appropriate to the intended context within which the product is to be used.

## 6.6.1 Selection of Test Subjects

As illustrated by the number and complexity of the variables included in the user context of the usability model, humans are complex entities, comprising numerous character traits. It has also been shown that the relative importance of these variables is sometimes dependent on each other. Whilst it is not possible to identify and control for every possible trait that could influence performance, the basic strategy proposed for controlling for all these variables is to ensure that test subjects are homogenous in all of the variables, other than the variable being tested.

We expand on some of the more important proposed strategies for controlling for the variables below.

### 6.6.1.1 Subjective culture

Test subjects should differ only in the subjective cultural dimension that is being tested. For example, when testing the influence of power distance on usability, the cultural profile of the test subjects should differ only in terms of the power distance dichotomy. In addition, the strength of each dimension within the users' cultural profile should be similar.

A validated and reliable tool for determining the cultural profile and the strengths of each dimension of test subjects is Hofstede's [2001] Value Survey Model (VSM). However, it is important to note that the VSM was developed to determine the cultural profile of users within a work context. Should test users be students, or should the cultural profile of the users be required in a context other than work (for example in a gaming context), the VSM will need to be adapted and tested prior to use. As discussed in section 5.8.3, it is essential to ensure that the cultural profile questions are phrased to promote understanding, as well as to cater for high power distant users. Questions relating to power distance should be phrased in such a way so that a positive answer indicates high power distance, whilst a negative answer indicates low power distance.

If more than one cultural dimension is being tested at the same time, Taguchi orthogonal arrays provide a useful tool for reducing the number of experiments that need to be carried out. The use of this tool is discussed in detail in the studies conducted by Smith and Chang [2003]. In addition, the relative impact of the cultural dimensions can be established and controlled for by performing the point-biserial coefficient statistic on the results.

#### 6.6.1.2 Other User Characteristics

As illustrated in Figures 6.3 and 6.3.1, user characteristics other than subjective culture that need to be controlled for include objective culture, physical and psychological characteristics. Controlling for most of these variables will require the use of questionnaires, similar to the one used in our experiment, to identify test subjects that are homogenous in terms of these variables. As noted in Chapter 5, by controlling for the nationality and ethnicity variable, the following sub-classes of variables will also be controlled for:

- Cognitive abilities (cognitive style, verbal fluency, visual acuity and digit span in STM).
- Attitude, with regard to the relative importance of usability measures, user preferences, computer playfulness, and ease of finding and understanding.

All other variables related to the test subjects' psychological and physical characteristics, will need to be controlled for separately, as they are not related to nationality.

#### 6.6.1.3 User Knowledge

As with the variables associated with user characteristics, the variables relating to user knowledge are best controlled for through the use of a questionnaire to identify test subjects that are homogenous in terms of these variables. To better control for the knowledge variables, it will be necessary to identify the users' prior experiences with websites that belong to the same genre as the test interfaces, and to compare the mental models used and functionality available between these interfaces.

### 6.6.2 Identification of Test Interfaces

When conducting an experiment to establish the effects of subjective culture on usability, it is necessary to control for all user interface characteristics, other than subjective culture, that may influence usability. We have shown that the variables included in the user context can influence the usability of the interface in a number of ways. Therefore, the variables that need to be controlled for in the test interfaces include the user context variables (described in section 6.3) and the variables that influence the general usability of the interface (discussed in section 6.5.2.1). Strategies for controlling for these variables are discussed next.

#### 6.6.2.1 User Context Variables

User context variables are controlled for in the test interfaces by ensuring that the components of the test interfaces are homogenous in terms of objective and subjective culture, physical characteristics, and the psychological characteristics of the test subjects.

##### *a. Subjective Culture*

Test interfaces, like test subjects, should differ only in the subjective cultural dimension that is being tested. At the time of writing this dissertation, existing user interfaces that have been deliberately designed to accommodate a particular subjective cultural dimension could not be found. Therefore, it may be necessary to create a user interface for testing purposes. In this case, it will be necessary to develop an interface relevant to the cultural dimensions being tested.

Care should be taken to ensure that each interface component, on each screen, displays the same cultural dimension dichotomy, in the same strength. This will control for the user variables of cultural dimension strengths, cultural dimension interplays and the relative impact of cultural dimensions on usability, as well as the general usability variables of the relative impact of interface components on usability and partial representation of the cultural dimensions. If suitable interfaces cannot be found, and test interfaces cannot be developed for whatever reason, it will be necessary to develop test tasks that do not require access to the components that do not display the relevant sides of each dimension.

##### *b. Objective Culture*

Test interfaces should be consistent to the test subjects' objective cultural dimensions. This will require ensuring that the language and content used in the interface are appropriate to the test subjects' nationality and ethnicity, religion and social class.

##### *c. Physical Characteristics*

Age and gender can be controlled for by incorporating applicable content into the interface, whilst handedness would be controlled for by ensuring that the input and output devices used on all the test interfaces are of the same type. Colour-blindness should be controlled for by ensuring that the interfaces do not use colours or combinations of colours that are difficult for colour-blind users to see.

##### *d. Psychological Characteristics*

In terms of the psychological characteristics, only the cognitive ability variables and some of the attitude variables are relevant to the test interfaces. It is important to ensure that if more than one interface is used in the experiment, all interfaces are homogenous in terms of the cognitive styles, use of text and pictorial icons, and the amount of information that the test subjects are required to remember. This will control for the cognitive abilities of the test subjects, as well as some of the user preferences of the test subjects. Similarly, all test interfaces should be homogenous in terms of information quality, ease of finding and understanding, and the amount of computer playfulness incorporated into their design, to avoid unforeseen differences in user attitude.

In terms of user preferences, the number of and type of colours, type of menus and sounds used in all the interfaces need to be homogenous. Input and output devices are already controlled for by controlling for handedness.

#### 6.6.2.2 General Usability

To ensure that the test interfaces are homogenous in terms of general usability, the variables of partial representation, principles and heuristics, relative impact of components, hardware platforms and level of internet traffic needs to be controlled for.

The relative impact of interface components on usability and partial representation of the cultural dimensions have already been controlled for by controlling for the subjective cultural dimensions, as discussed in section 6.6.2.1.

The test interfaces should be homogenous in terms of the usability principles, heuristics and guidelines that have been accommodated into their design. As noted in section 5.3.2, not all of the principles, guidelines and heuristics are required to be controlled for – only those that are relevant to the test subjects' cultural profiles. Controlling for this category of variables will require that the test interfaces are evaluated prior to their use. In addition, the evaluators used to assess the interfaces should be homogenous in terms of their subjective and objective culture, which should also match the cultural profiles of the test subjects. As discussed in section 5.3.2, this will control for the possibility of the evaluators' cultural profile distorting the evaluation of the general usability of the test interfaces.

In addition, it will be necessary to ensure that all test interfaces are equivalent in terms of the hardware platforms used to run the interfaces, as well as the level of internet traffic experienced at the time of completing the task. The level of internet traffic is controlled for by ensuring that the test interfaces are used during the experiment at the same time, on the same day of the week. These issues will be revisited in our discussion of conducting the experiment in section 6.6.4.

### 6.6.3 Setting Test Tasks

The variables that should be taken into consideration when setting test tasks include those applicable to the user context, the technical environment and the task context. Specific controlling strategies for the relevant variables are proposed next.

#### 6.6.3.1 User Context Variables

Test tasks should be appropriate to the test subjects' subjective culture, physical and psychological characteristics and user knowledge.

##### *a. Subjective Culture*

It was noted in Chapter 3 that subjective culture influences the type of tasks that test subjects would want to perform. For example, high power distant users would not want to send an email to their superiors. Therefore, test tasks should be identified that are representative of the tasks that the test subjects would want to, or normally do, perform, while omitting redundant and offensive tasks.

##### *b. User Knowledge, Psychological and Physical Characteristics*

In terms of user knowledge, it is important to ensure that all the test tasks are homogenous in terms of the knowledge and experience required by the test subjects to perform the tasks. For example, setting test tasks that require domain knowledge of, say, library systems and airline bookings, would result in different performance levels between test subjects with and without such knowledge. The best way to control for variations within the test subjects would be to use the information obtained from the users to identify the task domains that all test subjects are either familiar or unfamiliar with.

In addition, it is important that the test tasks are appropriate to the test subjects' age and gender. For example, setting a task where test subjects are required to identify the 2004 Grand Prix winner may be inappropriate for female test subjects, increasing the possibility of reduced performance by female test users due to lack of interest, low motivation levels or lack of domain knowledge.

#### 6.6.3.2 Technical Environment Variables

Technical environment variables that are relevant to the test tasks include the functionality as well as some of the specification variables.

##### *a. Functionality*

Test tasks should be representative of the main application area and major functions that the test interfaces were developed for. For example, if an e-commerce website is being used as a test interface, then tasks relating to e-commerce functions should be identified. Similarly, if an accounting package or informational website is chosen to serve as the test interface, then the tasks should be appropriate to the functionality normally provided by such applications.

### b. Specification

Test tasks should control for any non-computer based equipment that is normally used to complete the tasks under real conditions. This can be done by selecting test tasks that require the test subjects to make use of any materials, office equipment or protective clothing and equipment in order to complete the tasks. In addition, the test tasks should require that the same components of the interfaces are used, to further control for the relative impact of the interface components on usability.

### 6.6.3.3 Task Context

When conducting an experiment, it is necessary to ensure that the time taken to complete the tasks can be attributable to the variables being tested, rather than inherent differences in the tasks. Therefore, variables that influence the duration of the test tasks need to be controlled for. As discussed in section 6.6.2.1, this will require that the test tasks should be homogenous in terms of the navigational decisions, and the number and length of bodies of text that are required in order to complete the tasks. For example, test subjects should be able to complete the test tasks by reading two bodies of text, of similar lengths, navigating through five pages and making four navigational decisions.

## 6.6.4 Conducting the Experiment

Four variables that influence the way in which the experiment should be conducted were identified in section 5.8. These are the relative importance of the usability measures, the adaptation of the cultural profile questionnaire (already discussed in section 6.6.1.1), the order effect and compulsory participation and time limits. In addition, some of the variables pertaining to the environment within which the experiment is conducted, need to be controlled for.

### 6.6.4.1 Relative Importance of Usability Measures

This variable has been partially controlled for by ensuring that the test subjects are homogenous in terms of nationality and ethnicity. However, this variable also needs to be controlled for in the way in which the usability measures are analysed. As discussed in section 5.8.1, should the test subjects consider one of the usability measures more important than the others, it will be necessary to assign weightings to the measures according to the relevant importance attached to the measures by the test subjects, rather than simply aggregating the usability levels for each measure

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### 6.6.4.2 The Order Effect

As discussed in Chapter 5, the order effect relates to the effect on user performance of the order in which the test subjects are exposed to each test task in the experiment. To control for this variable, it will be necessary to randomize the order in which the test subjects are required to complete each of the test tasks.

#### 6.6.4.3 Compulsory Participation and Time Limits

Users should participate voluntarily and no time limits should be imposed to avoid the possibility of decreased user performance due to lack of interest or stress.

#### 6.6.4.4 Environment Context Variables

From a technical environment perspective, the test tasks should be conducted using the same hardware and software specifications that will be used under real conditions. For example, if test subjects normally use the interfaces on networked systems, then the test interfaces should be run on networked systems. Specifically, if the test tasks require the use of web interfaces, and the test tasks are conducted over more than one day, the tasks should be completed during the same time and on the same day of the week to control for possible variances in the levels of internet traffic. The physical environment within which the experiment is conducted should also mirror the physical environment within which the product is intended to be used. For example, auditory, visual and atmospheric conditions should be commensurate to the test subjects' normal working environment. From an organization environment perspective, issues such as interruptions and the use of single or multi-user environments should also be considered when selecting the experiment environment.

## 6.7 Summary

In this section we have presented our proposed conceptual model of usability. The model comprises of the three contexts of the user, the task and the environment. We have also proposed strategies for controlling for these variables, in terms of the basic components of an empirical research design. These include strategies for controlling for variables relating to the identification of test subjects, test tasks and test interfaces, as well as variables relating to the way in which the experiment is conducted in general terms.