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Context of Use within usability activities

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Designing for usability involves establishing user requirements for a new system or product, developing design solutions, prototyping the system and the user interface, and testing it with representative users. However, before any usability design or evaluation activity can begin, it is necessary to understand the *Context of Use* for the product, i.e. the goals of the user community, and the main user, task and environmental characteristics of the situation in which it will be operated. This paper describes the background to, and importance of, understanding Context of Use, and presents a process for performing a context analysis. The method described is particularly aimed at non-experts in the area of user-centred design and evaluation.

KEYWORDS: context of use; user; task; environment; usability.

1. Introduction

Context is an important concept in everyday life. People often provide context when writing postcards referring to the weather or holiday atmosphere. A knowledge of context can also help to explain why an art object such as Donatello's bronze statue of David was produced. As stated by Clark (1992), "such monumental figures were symbolic of a new-found confidence, and represented the freedom of Renaissance man from the medieval past". Context can also explain the background to an historical event, such as the assassination of the Archduke Ferdinand in Sarajevo, which triggered war in Europe in 1914 ... and, of course, words taken out of context often distort the speaker's intended meaning!

When a product (or system) is developed, it will be used within a particular context. It will be used by a user population with certain characteristics. The user will have certain goals and wish to perform various tasks. The product will also be used within a certain range of technical, physical and social or organizational environments that may affect its use.

When assessing a product from Human Factors (HF) point of view, there is a tendency to forget about the Context of Use. Information Technology (IT) products are often simply divided into those which are usable and have "ergonomic features" and those which are not. In fact, it is incorrect to describe a product as ergonomic or usable, without also describing the *context* in which the product will be used—in other words, whom the product was designed for, what it will be used for and where it will be used.

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A manufacturer might, for instance, claim to have a very usable wristwatch. In fact, it may only be usable in a certain range of contexts. The visual nature of the display might exclude people who are visually impaired. If the watch face lacks numbers and minute markings, this would make it unsuitable for tasks that require precise timings at a sports meeting. Without luminous or illuminated dial markings, the watch would not be suitable for use in the dark, whereas the use of reflective glass could impede viewing in bright light. Unless it is a watertight watch, it may be affected by rain and would certainly not work under water. This example shows the pitfalls of classifying a watch or any other product, as usable without referring to the context for which it is intended.

2. The development of context of use ideas

2.1. EARLY RECOGNITION OF CONTEXT

In the field of natural science, the procedure of specifying, controlling and reporting the context in which measurement takes place has been routine for centuries. This procedure ensures that measurements are both meaningful and reproducible. Much of the early Human Factors work was performed in the military sector to test equipment components in unstable, harsh and extreme environments to represent battlefield conditions. In the field of human computer interaction (HCI), it has been recognized for many years that the users and the tasks they carry out are likely to have a strong effect on the results of any system evaluation (Miller, 1971).

2.2. REALISTIC USERS AND REPRESENTATIVE TASKS

Many authors have emphasized the importance of selecting representative users and realistic tasks when carrying out user testing or evaluation of IT products (Neal & Simon, 1984; Bury, 1984; Rosenbaum, 1989). Yet, if the literature is explored, it is often found that evaluation studies have either used unrepresentative subjects to carry out unrealistic tasks, or more commonly have failed even to report the nature of the subjects and the tasks they carried out. Often it is only after the study has been completed that the effects of badly chosen subjects and tasks will be used to explain the "odd" nature of the results.

2.3. TASK TOOL ANALYSIS

By the early 1980s the differences in characteristics of particular user groups were well established. At the HUSAT Research Institute, several papers were produced characterizing users of different kinds such as managers, clerical staff and specialists and discussing their needs. Eason (1981) presented the concept of the user–task–tool analysis, highlighting the fact that the user and task characteristics have to be supported by characteristics of the tool, i.e. the computer system or product.

2.4. THE WORK OF WHITESIDE AND COLLEAGUES

In the mid-1980s there was an increase in awareness of context issues promoted by the work of Whiteside and his colleagues (Whiteside, Bennett & Holtzblatt, 1988; Wolf,

1989). They found that although many products performed well in their laboratory experiments, they did not work when transferred to the real world. They put this down to the fact that the research often overlooked something crucial to the context in which the product would be used. The classical research methodology which they applied told them a lot about how to control variables, but little about how to select the most important variables in the first place. As a result of this they developed contextual research, where they would work with people carrying out real work in real situations rather than "artificially contrived" ones. In adopting this approach, Whiteside and his colleagues not only stimulated the discussion on the relative merits of laboratory vs. field studies, but also highlighted the importance of context issues.

2.5. LABORATORY VS. FIELD STUDIES

Laboratory tests and field observations are both valuable methods for product evaluation which complement each other in the design process. The high degree of control and enhanced observation and video-recording facilities associated with laboratory studies are particularly suited to summative evaluation, where the aim is to test whether a product meets certain predefined usability criteria. Field studies may then be used to "identify special problems associated with the integration of the product into the actual working environment" (Neal & Simon, 1984). Furthermore, field studies can tell you about the acceptability of a product (i.e. whether the product will actually be used in real life), whereas, in laboratory tests where the subjects generally have no option but to use the product, this is often not possible. Karat (1989) demonstrated the complementary nature of the two approaches by applying both laboratory and field studies in order to help iteratively design a security application. Interestingly, participants completed the tasks in 25% less time in the field than when subjects completed similar tasks in laboratory conditions. Karat comments that "there are possible problems in comparing the results of the different tests; however the benefits of having both types of test data outweigh the negative factors".

2.6. THE USABILITY CONCEPT

Usability became a well-established concept in the IT world to represent the user-friendliness of a system. However, there was a need to establish the concept more clearly and to determine how to measure it. Shackel has done much work in this area, starting by his paper on The Concept of Usability in 1984, and through to his approach to defining usability in an operational manner (Shackel, 1986, 1991).

2.7. THE HUFIT TOOLSET

In 1985, a large-scale European project was started within the EU ESPRIT I programme, called HUFIT (HUman Factors and Information Technology). This brought together a number of university institutions and major IT companies for the first time to try to integrate Human Factors methods into the IT design cycle. Within this project, the

HUSAT Research Institute developed the planning, analysis and specification toolset (PAS), reported by Taylor (1990). This provided a process for identifying stakeholders and analysing their characteristics in order to develop a system to match them.

2.8. THE MUSiC APPROACH TO CONTEXT

The ESPRIT II MUSiC project built on the work of HUFIT. It aimed to develop standard measurement tools and methods for usability evaluation. An important concept that the project developed was "Measurement of Usability in Context" (hence the name MUSiC). In an attempt to ensure that proper attention was paid to context issues, the MUSiC project advocated the following principles.

- The usability of a product depends on its Context of Use.
- Products should be designed for specific contexts.
- Measurement of usability must always be carried out in an appropriate context.
- Usability measurements should always be accompanied by a detailed description of the context of measurement.

Recording the context of measurement information allows other people to assess the validity or fairness of the measurement, and gives them the opportunity to generalize the results of the measurement to their own context if they see fit. It was recognized in the MUSiC project that the guidelines and principles presented above can only be put into practice if suitable tools and methods are available. This led to the development of a Context of Use Questionnaire (Maissel, Dillon, Maguire, Rengger & Sweeney, 1991; Thomas & Bevan, 1995) to describe a product's Context of Use and to specify an appropriate context of measurement (Bevan & Macleod, 1994).

2.9. USER REQUIREMENTS SPECIFICATION

Establishing user requirements has tended to be an unstructured approach, unlike the formal process of system requirements engineering. The EU Telematics Applications Programme RESPECT (Requirements Engineering And Specification In Telematics) project (http://www.lboro.ac.uk/research/husat/respect) developed a structured process for user requirements specification, and the translation of those requirements into specifications. An important component of this process was to specify the future Context of Use for the system and thence to identify potential user requirements. Templates to support this activity are contained within the RESPECT Handbook (Maguire, 1998).

2.10. MOBILE ENVIRONMENTS

The development of mobile and in-vehicle devices such as navigation systems has created new areas for Human Factors research and design. Usability evaluation of such products needs to be carried out in realistic environments such as in a driving simulator or on the road. First, of course, the Context of Use for such systems must be reviewed and defined. Ross and Burnett (2001) provide an example of this type of study, and discuss the influence of different contextual factors on driver performance.

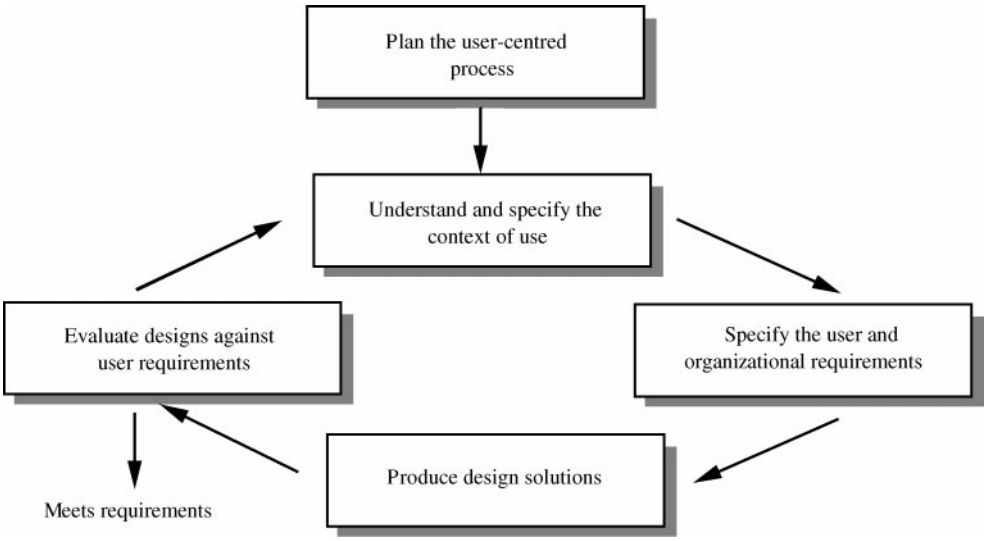

FIGURE 1. The human-centred design cycle (from ISO13407).

2.11. CONTEXT OF USE IN STANDARDS

The international standards community has also recognized the role of Context of Use within usability. The ISO 9241 standard *Part 11—Guidance on Usability* (ISO, 1997) refers to it in its definition of usability:

> "Usability is the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use."

This definition emphasizes that the usability of a product is affected not only by the features of the product itself, but also by the specific circumstances in which a product is used. As defined by the standard:

> "The Context of Use consists of the users, tasks and equipment (hardware, software and materials), and the physical and social environments in which a product is used."†

Context of Use is also incorporated into the ISO 13407 standard on human-centred design (ISO, 1999). This defines the process of understanding and specifying the Context of Use as one of the main stages within the human-centred design process (see Figure 1):

†Note: The term "usability" is sometimes used to refer specifically to the usability attributes of a product, e.g. the ISO/IEC 9126 standard (ISO, 1991) defines it as a software quality and describes it as "A set of attributes of software which bear on the effort needed for use and on the individual assessment of such use by a stated or implied set of users". In contrast, usability in ISO 9241—Part 11 (ISO, 1997) refers to the outcome of interaction in a context: i.e. the extent to which the intended goals of use of the overall system are achieved (effectiveness); the resources such as time, money or mental effort that have to be expended to achieve the intended goals (efficiency); and the extent to which the user finds the overall system acceptable (satisfaction). To distinguish the two concepts, the latter concept of usability has become known as: "Quality in Use".

TABLE 1
Producing a description of the Context of Use at different stages in the design process

Describing the Context of Use		
Who	When	Why
Procurer and usability analyst	Specification stage	To aid specification of user requirements. To set usability goals and acceptance criteria.
Designer	Concept stage	To ensure high-quality design by tailoring the product to the context and introducing early assessment of usability.
Usability analyst	Testing stage	To match the Context of Measurement to the Context of Use.
Project manager or system developer	Throughout the process	To help them be aware of usability issues throughout the design process and to track the achievement of usability goals.

3. Context of Use in product design

3.1. BENEFITS

The analysis of the Context of Use helps to specify, in a systematic way, the characteristics of the users, the tasks they will carry out and the circumstances of use. The benefits of adopting this approach are as follows.

- Provides an understanding of the circumstances in which a product will be used.
- Helps to identify user requirements for a product.
- Helps address issues associated with product usability.
- Provides contextual validity of evaluation findings.

It also provides a system focused approach which leads to a shared view among the design team.

3.2. WHEN AND WHO MAY WISH TO PERFORM CONTEXT OF USE ANALYSIS?

An understanding of the Context of Use of a product plays a role at different stages in the design process. Table 1 summarizes who should be involved in describing and re-describing Context, at what stages in the lifecycle and the benefits that this will bring.

4. Summary of contextual factors

This section provides a description of the main aspects of context. It is followed by a table listing the different contextual factors (Table 2).

TABLE 2
Components of Context of Use analysis

System report and stakeholder analysis	**User**	**Task**
System or product report • System or product name and version • System or product description and purpose • Main application areas • Major functions • Target market **Stakeholder report** *User and stakeholder list* **User/stakeholder type 1, 2, etc.** *Descriptions* • User/stakeholder type • User/stakeholder role or goals • Potential benefits from system or product • Costs of using system/product • Further analysis to be carried out? (i.e. *Context of Use analysis*)	**User name** • User type • User role **Experience, knowledge and skills** • Product experience • Related experience • Task knowledge • Organizational knowledge • Training • Input device skills • Qualifications • Language skills **Personal attributes** • Age, gender • Physical capabilities and limitations • Cognitive capabilities and limitations • Attitude and motivation	**Task list** • Task 1 • Task 2, etc. • Task characteristics (per task) • Task name • Task goal/output • Task steps • Task frequency • Task duration • Task flexibility • Task dependencies • Physical and mental demands • Task output • Risks resulting from error • Safety critical demands
Environment		
Technical environment • Hardware • Software • Network • Reference materials • Other equipment	**Physical environment** **Workplace conditions** • Atmospheric conditions • Auditory environment • Thermal environment • Visual environment • Environmental instability **Workplace design** • Space and furniture • User posture • Location **Workplace safety** • Health hazards • Protective clothing and equipment	**Organizational environment** **Structure** • Group working • Work practices • Assistance • Interruptions • Management structure • Communications structure • Salary or payment **Attitudes and culture** • Policy on computer use • Organizational aims • Industrial relations **Job design** • Job functions • Hours of work • Job flexibility • Performance monitoring • Performance feedback • Pacing, autonomy, discretion

4.1. USER GOALS AND CHARACTERISTICS

The central part of the Context of Use analysis of a system focuses upon the users of the product. A stakeholder analysis should be performed to identify all the different users of the system, and also those who are affected by it, i.e. have a stake in its success. If the user population is composed of more than one user type, then an analysis should be completed for each type. Relevant characteristics of users also need to be described. These can include knowledge, skill, experience, education, training, physical attributes and motor and sensory capabilities.

4.2. TASKS

Tasks are the activities undertaken to achieve a goal. Characteristics of tasks which may influence usability should be described, e.g. the frequency and duration of the task. Tasks should not be described solely in terms of the functions or features provided by a product or system. Descriptions of the activities and steps involved in performing the task should be related to the goals that are to be achieved. For the purpose of specifying user requirements or evaluating usability, a key subset of contextual tasks will typically be selected to represent the significant aspects of the total set of tasks.

4.3. TECHNICAL ENVIRONMENT

The technical environment is the software and hardware which is used in conjunction with the product. The characteristics of the technical environment (such as the speed of the processor or the layout of keys on the keyboard), may have an affect on the usability of the product.

4.4. PHYSICAL ENVIRONMENT

The physical environment can have a profound effect on the usability of a product. Bad lighting or loud noise in the workplace may actually prevent the users from receiving vital feedback from the product. Likewise, even the location of the product in relation to the user's workplace can magnify the effect of minor usability problems, such as having to reinsert cassettes frequently when the tape backup machine is located down the corridor (Brooke, 1986).

4.5. SOCIAL OR ORGANIZATIONAL ENVIRONMENT

The organizational environment will also affect the usability of a product. At a higher level, the attitudes of the organization and its employees towards the introduction of an IT system, and the way work is monitored, can affect whether a system is accepted and used to carry out the work. At a lower level the structure of the organization, the way people work (individually and in groups), the availability of assistance and the frequency of interruptions, are also likely to affect the usability of a product.

A list of contextual factors is presented in Table 2. This draws from the work of Maissel *et al.* (1991), Thomas and Bevan (1995) and from ISO 9241 part 11 (ISO, 1997).

Context of Use information needs to be collected under each of the headings for the context in which the equipment is actually used (or is intended to be used).

5. Stages in performing a usability context analysis

Before the context study is begun, a small "usability team" should be set up consisting of at least one usability analyst, and one person with a good knowledge of the product, its intended users and any constraints that may occur during the evaluation. It is also important to include someone of sufficient seniority to ensure that results of the study can be used to influence decision-making.

> The results from a usability context analysis are typically captured in a set of Context Tables. The tables shown in section 6 of this paper (Tables 4 to 11) may be used to guide the process of collecting the context information. These tables give examples of typical output from analysing the Context of Use of a bank "cashpoint machine" to illustrate the process.

One method of collecting information required in the Context Questionnaire is by holding a meeting of the usability team (a "Context Meeting") with people who can supply the required information—the stakeholders. This is a cost-effective way to elicit the information, but care must be taken to ensure that everyone has an opportunity to express their views and that they are accurately recorded. If it is possible that views cannot be expressed freely, for example because of power relationships which may exist between the participants, then separate meetings must be arranged with groups of people at similar levels in the organization.

Collecting information about the Context of Use of a product will also encourage other participants in the design process to consider context-related issues, and to make explicit their views of the assumed Context of Use. Information is required for all the contextual components—users, tasks and environments—and views may be requested from different departments. A list of personnel from whom information may be collected, or who may be invited to the Context Meeting are shown in Table 3.

The following steps are involved in specifying the Context of Use for a product.

Step 1: Describe the product or system (or concept) within a Project Report.
Step 2: Identify users and other stakeholders for the product or system and select main user groups for further analysis
Step 3: Describe the Context of Use
Step 4: Identify important usability factors
Step 5: Document potential requirements or test conditions

The five steps are described briefly below.

Step 1: Describe the product or system. The development of a new or existing product will normally take place as a "project". It is important for the user requirements analyst to gain a high level of understanding of the product and the reason for its development. It then becomes possible to understand how this will affect the user population. The information may be drawn from the initial statement of requirements. It may require reading and understanding the basic system proposal and asking for clarification where needed. The information is placed in a Project Table or Report.

TABLE 3
People who can provide information for a Context Study

Job title	**Role in product (or system) development**
Customer	Commissions the product and sets requirements.
Project manager	Responsible for the current product development activities.
Systems analyst	Identifies requirements and makes specifications.
Designer/programmer	Programmes the system.
Marketing specialist	Plans the promotion strategy and advertising.
Technical author	Produces user documentation.
Technical/user support	Provides support to end-users when required.
Users	Help develop requirements, provide input and feedback on prototype, require training and support.
Quality manager	Responsible for the implementation of quality systems.
Training manager	Defines user training requirements.
Human Factors specialist	Responsible for usability aspects of the system.

The Project Report should be completed with the input from people with appropriate knowledge of the product. During development this would include product development managers, technical developers, sales and marketing staff and documentation and training material authors. When the product is being evaluated by a user organization, the individuals involved could be product installation managers and technical support staff (cf. Table 4 for an example of a Project Report).

Step 2: Identify users and other stakeholders. This section identifies the main users and stakeholders for the product in order to get a broad perspective on who is involved and affected by it. This will help to ensure that the needs of all involved are taken account of and, if required, the product is tested by them. Stakeholder analysis will identify the following.

- Primary user groups—those who use the system directly ("hands on"). They may or may not be the purchaser of the system. They include: end-users, installers, maintainers.
- Secondary user groups—those who influence or are affected by the system, but may not be the actual users. They include: recipients of output from the system, marketing staff, purchasers (who are not also the main users) and support staff.
- For each groups of users and stakeholders, it is important to identify their *main roles or task goals* in order to find out how useful and appropriate the product can be to them. (cf. Table 5 for an example of a Stakeholder Analysis Report).

Step 3: Describe the Context of Use. The next step is to document the Context of Use factors related to the product. A set of tables has been produced to help elicit contextual information. A completion of the tables will help to create a comprehensive description of the Context of Use of a product. It guides the usability analyst through a structured breakdown of the relevant characteristics of the intended users, tasks and environments for which the product is being developed.

Knowledge of the Context of Use in itself will improve the design of a product. It encourages designers to tailor the design to the specified real-world usage, and also to specify usability criteria so the product's usability can be assessed by evaluation throughout the design process (See the *left-hand column* within Tables 6–11, for example components of a Context of Use Description Report.)

Step 4: Identify important usability factors. The usability analyst then uses the Context Report Table to consider each of the components of the Context of Use, and decide whether or not they could affect the usability of the product. There are three possible responses to this question—"yes", "maybe" or "no". If the answer to this question is "yes" then it is considered a critical component of the context. If the analyst is unsure whether a component will affect the usability of the product, he or she can reply "maybe" to the question, and re-evaluate the response when it comes to step 3 of the procedure. If the answer is "no" or if the component is not relevant to the product, then the analyst will not have to consider this component any further. Each decision has to be made based on the usability analyst's knowledge of HCI and ergonomics, and their experience of similar product evaluations (See the *middle column* within Tables 6–11 to show the identification of usability factors within the Context of Use Description.)

Critical components must be identified regardless of whether they can be represented in the Context of Evaluation. Other parties, such as consumer organizations, can then assess the validity and generalizability of the usability evaluation results. If it is not feasible to simulate any of the critical components, e.g. the availability of a Help Desk, then they will be omitted from the Context of Evaluation. The implementation of any of the critical components of the Context of Use in the Context of Evaluation depends upon the scope of the usability evaluation and any financial and technical constraints.

Step 5: Document potential requirements or test conditions. Having documented the Context of Use, and identified the important components, the next step is to document (a) potential user requirements which follow on from the context information and (b) features of the usability evaluation study that should be included when the product is ready for testing.

For establishing *user requirements*, it is helpful to go through each usability component as part of a brainstorm and propose ideas that could address potential problems related to the context or that would match specific user needs or task characteristics. (See the *right-hand column* within Tables 6–11 to show potential user requirements labelled 'Req' or test conditions, labelled 'Test'.)

For establishing the *characteristics of a usability test*, each usability component (marked as "yes" or "maybe") may be classified as follows.

Ignore: No consideration given to setting the context item in the evaluation (e.g. do not care whether subjects have glasses or not).

Monitor: Context item not specified in the evaluation, but values will be monitored to avoid extreme conditions (e.g. no restriction on the proportion of male to female subjects but avoiding all men or all women).

Control: Set value for the context item either *fixing it* e.g. lighting level, or *varying it* e.g. to meet a certain characteristic e.g. having subjects in three different age categories.

Evaluate: Decide how to test, for example use two or more evaluation conditions for comparison, e.g. equal numbers of subjects with and without previous experience of using touch screens.

5.1. OPERATIONALIZING THE DECISIONS

When the analyst has decided whether a component should be controlled, monitored or developed experimentally, etc., he or she must then specify exactly how this is to be carried out. For example, if the analyst has decided to provide assistance, then a decision must be made on how that can be provided in a standard format.

The next step is to develop an evaluation plan, which contains all relevant information from the Context Report giving specific details of how the evaluation will be performed. The plan should include the following.

- The number of users who will take part in the evaluation, what characteristics they should have (those which are to be Controlled), and what are to be determined as part of the evaluation (those which are to be Monitored).
- The tasks that the users will carry out as part of the evaluation and how the users will be introduced to it.
- The organizational conditions under which the users will work. For example, the number of and nature of any interruptions identified in the Context of Use as affecting usability.
- Details of the hardware, software and any network environment that will be provided during the evaluation.
- Description of the physical location and characteristics of the workplace.

Finally, the evaluator should define the usability measures to be recorded and success criteria associated with them. This can take place early in design to form part of the product requirements. During detailed design, the main objective may be to obtain design feedback from informal evaluation of mock-ups and partial prototypes, in which case measures may not be required.

6. An example Context of Use for an ATM (bank machine)

The following fictitious example, designed to illustrate the procedure, has been used during several training courses. It documents the Context of Use for an Automated Telling Machine (ATM) which can provide simple banking services automatically to bank customers. These devices are also often called "cashpoint machines" or "bank machines".

6.1. DESCRIPTION OF PRODUCT

The aim of this project is to produce a usable new generation of bank machine. The aim is to broaden the facilities available to existing ATM users and to encourage the 24% of

TABLE 4
Project summary

Project summary	
Product or system name	**ATM 2000—a new generation of indoor bank machine.**
Aim or characteristics of the system	• *To provide an increased range of services to bank customers via bank machines.* • *To offer a reliable service with the machines out of operation for less time.* • *To offer a more secure and safe service.*
Reason for system	• *To promote the wider use of bank machines in a competitive market.* • *To encourage new users such as people who are elderly and disabled.*
Target marketplace	• *Banks and building societies.*
Scope of system/system functions planned	• *Traditional services of cash withdrawal, statement, balance, ordering chequebook, etc.* • *Short on-line introductions for new users and spoken instruction.* • *Possible new services include getting change, requesting a loan, transferring money between accounts, etc.*

bank customers who are non-users to consider using them. Reasons for non-use are: distrust of computers, anxiety about becoming targets for muggers and forgetting PINs or secret access numbers (Derbyshire, 1999). Another reason may be limited English language skills. In this example, the product constitutes the software and hardware that a customer sees when using an ATM. (See Table 4)

6.2. STAKEHOLDER ANALYSIS

An analysis of stakeholders has identified bank customers as the primary users with bank staff and machine maintenance staff as secondary users. Another group with a stake in the system are bank marketing staff. (See Table 5)

6.3. RECORDING CONTEXT OF USE

Tables 6 to 11 describe the Context of Use for the system or product for the bank customer. There are separate tables for the users themselves, their tasks and the technical, physical and organizational environments. In each table:

Column 1 is used to record the characteristics of the context in which the ATM will be used.

Column 2 is used to record whether each of the context items affects usability of the product (i.e. "yes", "no" or "maybe").

TABLE 5
Result of stakeholder analysis

Stakeholders and task goals	
System name: ATM 2000—A new generation of bank machine	
Primary users	**Main task goals**
Bank customer	*To obtain money* *To request information* (*statement or balance*) *To order a cheque book or statement* *To perform account transactions and pay bills* *To open and close an account.* *To obtain an alternative bank service e.g. order foreign currency, set up a loan, set up savings, insurance or pension scheme.*
Secondary users	**Main task goals**
Bank staff	*Will be responsible for day-to-day maintenance, e.g. filling machine with paper* (*for receipts and statements*), *correcting minor faults and reporting major faults.*
Machine maintenance staff	*Will perform routine maintenance every 6 months and will come out to deal with major faults.*
Security staff	*Load ATMs with prefilled cassettes of notes.*
Other stakeholders	**Main task goals**
Bank marketing staff	*Will be concerned with deciding what services to offer on the machine and what advertising to display when the machine is not in use.*

Column 3 is used to record potential user requirements or evaluation conditions for components marked "yes" and "maybe".

Task scenarios are listed in Table 7 as typical examples of ATM usage.

The task characteristics table (Table 8) should be completed for each task to be analysed.

Please note: Although the example concerns bank machines located indoors, contextual factors, user requirements and test conditions for machines located out of doors are also listed for illustrative purposes.

From the above tables, possible *user requirements* can be identified such as a recess for wheelchair access, speech output for visually impaired users, customization features for rapid access, finger print for identification, visor appearing during sunny weather, buttons lighting during darkness, register button when faults occur, alarm button for security alert. The basic structure of a *usability evaluation* and different evaluation conditions can also be specified such as users operating the ATM without pre-training or instructions, with and without gloves, using auditory and manual input, and in different lighting conditions.

TABLE 6
User context description

Context of Use	Affects usability?	User requirements or test conditions
1. USERS **1.1. User type**		
1.1.1. Name of type *Bank customers.*	*Maybe, control*	*Test: Use members of the general public.*
1.1.2. User role (or aim) *To carry out bank transactions and obtain new services.*	*Yes* *Control*	*Req: Provide basic transactions and new services in consistent and similar way.* *Test: Specify typical tasks to reflect normal user aims and also financial aspirations.*
1.2. Experience/knowledge		
1.2.1. Experience/knowledge with system or product *Varies from none to regular daily use.*	—	
1.2.2. Experience/knowledge with similar systems or products *70% of users will have used bank machines elsewhere.* *Others will have limited or no experience.*	*Yes* *Monitor*	*Req: Try to make the system conform with any accepted ad hoc standards for bank machines.* *Develop ways to introduce new users to machine banking e.g. video introductions in post, bank staff support, speech instructions, etc.* *Test: Check with user length of time card held and frequency of use.*
1.2.3. Task knowledge *Nearly all experienced in withdrawing cash over counter. Goal is essentially the same but task process different (one is self-service, the other is not).*	*Yes*	*Req: Study bank counter exchanges for new forms of transaction proposed and reflect in self-service kiosk.* *Test: Include some users who have accounts but rarely visit banks.*

1.2.4. Organizational knowledge *Many customers will have little knowledge of bank organization.*	—	
1.2.5. Level of training *Mainly none. Some users may have received introduction from bank staff.*	*Yes* *Ignore*	*Req: Provide short interactive guide on screen for new users, "help" facility to support user, spoken instructions and video to play at home. Ensure job flexibility to allow bank staff to provide support.* *Test: Concentrate on testing without providing equivalent human introduction.*
1.2.6. Input device skills *Full range. Some motor impaired users will have very limited skills.*	*Yes*	*Req: Develop speech recognition interface for those with limited keyboard skills.*
1.2.7. Qualifications *Any level.*	*Yes* *Control*	*Req: Design to be usable by people who may have limited reading skills (e.g. spoken instructions).* *Test: Include some non-readers.*
1.2.8. Language skills *English will be main language.* *Some areas of country will include up to 30% of population where English is second language.* *Used by tourists, especially from EU.*	*Yes*	*Req: Use English language and up to eight other language options, depending on local area. Use simple terminology, diagrams and pictures.* *Test: Include some users for whom English is second language.*
1.3. Personal attributes		
1.3.1. Age *16 upwards for main bank customers. Accounts for 12–15-year-olds may allow some use of bank machine.*	*Yes* *Control*	*Req: Given particular consideration to older user groups who may be more reserved about new technology.* *Test: Recruit 25% of users in each of the following age categories: 16–25*, 26–40, *41–70, 70+ .*

TABLE 6
Continued

1.3.2. Gender *Roughly 50% male, 50% female.*	*Maybe, control*	*Test: Try to get an even balance between males and females.*
1.3.3. Physical capabilities and limitations *Significant minority with visual, hearing, speech, motor or mental impairments.*	*Yes* *Control*	*Req: Ensure that system keyboard and screen are placed at a standard height. Use larger keys and short-cut option. Provide recess for wheelchair.* *Test: Consider inclusion of wheelchair users, users with motor control problems and users with visual impairment.*
1.3.4. Cognitive capabilities and limitations *Significant minority with memory and other cognitive problems.*	*Yes* *Control*	*Req: Colour code or number certain key groups to reinforce sequence. Provide voice prompts on request. Allow user to cancel easily if unsure.* *Test: Consider inclusion of users with cognitive problems.*
1.3.5. Attitude and motivation *Highly motivated to complete task.*	*No*	

TABLE 7
Selection of task scenarios

Context of Use	**Analyse further**
2. TASKS **2.1. Range of typical tasks**	
1. To withdraw a sum of money quickly.	Task T1
2. To check balance, decide how much to withdraw and make withdrawal.	Task T2
3. To order a statement and/or cheque book.	Task T3
4. To deposit notes or cheque into account.	Task T4
5. To transfer funds from one account to another.	Task T5
6. To pay a bill e.g. electricity, gas, telephone, TV licence.	Task T6
7. To obtain change for a high-value note.	Task T7
8. Change PIN or password.	Task T8
9. To set up a loan.	Task T9
10. To deposit or order foreign currency.	Task T10

6.4. EXAMPLE EVALUATION PLAN

An example evaluation plan, based on the product, primary users and test conditions specified in Tables 4–11, is presented below. References to specific parts of the Context of Use tables are shown in parentheses.

Users

- The evaluation will be based on members of the general public ($n = 120$), the sample being obtained via local newspaper advertising and contact with local disability and community groups (1.1.1). They will be asked to assume the normal role of a bank user (1.1.2).
- The advertisement will state that people of all ages and physical abilities would be welcome to take part in the evaluation.
- During the recruitment process (over the telephone), check whether prospective recruit uses a bank machine and how frequently they do so (1.2.2).
- Recruit the following sample. When recruiting, monitor the sample to achieve roughly the following balance.
  - — 40 frequent users (at least once a month)—group 1
  - — 40 infrequent users (at least once per year)—group 2
  - — 40 novice users (once or twice only or never at all)—group 3.
  - — For each group, recruit 10 within each of the following four age categories: 16–25, 26–40, 41–70, 70+ .

- Provide half of the users in each group with an introduction to use the new machine to compare trained and untrained user performance (1.2.5).
- If possible recruit 4 of group 3 to be non-readers (1.2.7).
- If possible recruit 4 of group 3 to be persons for whom English is their second language (1.2.8).
- Recruit even balance of male and female users across the groups (1.3.2).
- Recruit 3 users (one per group) who are wheelchair users (1.3.3).
- Recruit 3 users (one per group) who have limited upper limb movement (1.3.3).
- Recruit 3 users (one per group) who have visual impairment—to be defined more precisely later (1.3.3).
- Consult disability expert on suitability for users with cognitive impairments (1.3.4).

Tasks

- Each user will perform the following tasks based on Table 7.
  1. Withdraw a sum of money leaving £500 in the account (T2).
  2. Deposit foreign currency—5000 Belgian Francs (T10).
  3. Obtain foreign currency—100 United States Dollars (T10 – 2.2.6).
  4. Transfer £200 to savings account (T5).
  5. Change password to mother's maiden name (T8).
  6. Set up loan of £1000 over 12 months (T9) using video link and speech interaction to bank staff member (3.1).
- Conditions 2.2.5 (long task duration) and 2.2.7 (insufficient funds to meet request) to be omitted from tests at this stage.

Technical environment

- New multimedia bank terminal (3.1) and software (3.2).
- Two users in each group to use system after reading instruction card (3.4).

Physical environment

- Two bank machines will be set up, one for standing use (1 m above ground—4.2.1) and one for wheelchair use (4.2.2). During the evaluation any posture or reach difficulties, particularly for the wheelchair users, will be noted. However, if time permits, informal testing of the initial height and mounting could be carried out before the main study.
- Two users in each experience group to use bank machine wearing gloves (4.3.2).
- Test within normal indoor conditions with comfortable temperature (4.1.3) and good lighting (4.1.4)

Organizational environment

- The evaluation will be based on users working alone (5.1.1)
- No assistance will be given unless the user becomes completely stuck and cannot proceed (5.1.3)
- Money and receipt will always be given (5.3.5)
- No queue will be simulated (5.3.6 and 5.3.7) although this may be simulated in later testing.

TABLE 8
Task characteristics description

Context of Use	Affects usability?	User requirements or test conditions
2. TASK T10 **2.2. Task characteristics**		
2.2.1. Task name *Order foreign currency.*	—	
2.2.2. Task goal or output *Obtain currency at an acceptable rate of exchange.*	*Yes, Control*	*Test: Use as basis for test task.*
2.2.3. Task breakdown *Step 1: Enter card.* *Step 2: Enter PIN.* *Step 3: Select "Order currency".* *Step 4: Select currency type.* *Step 5: Show currency exchange rate and change over period.* *Step 6: Enter amount.* *Step 7: Take money and collect card.*	*Yes*	*Reqs:* — *Notch/picture to show way to insert.* — *Allow user to specify password as a series of alphanumeric characters (to be more memorable).* — *Allow speech interaction option.* — *Do not time out too quickly.* — *Having selected currency, show current rate and rate change over period of time (e.g. last few days).* — *Provide range of standard currency amounts to withdraw.* — *Allow user to specify amount in UK or foreign currency.* — *Allow time lapse to allow user to put money in pocket*, purse or wallet.
2.2.4. Task frequency *Variable. Average perhaps once every few months.*	*No*	

2.2.5. Task duration *2–3 min (varies with system response times).*	*Yes, control*	*Test: System could be tested with long and standard system response times.*
2.2.6. Task flexibility *User may wish to simply obtain currency without checking exchange rates. Allow user to specify amount in UK currency or in foreign currency.*	*Yes*	*Req: Allow short-cut option.* *Test: Both variations where user selects currency and amount with and without checking rate changes.*
2.2.7. Task dependencies *Bank account containing sufficient cash. Bank Card. Knowledge of PIN and withdrawal limit.*	*Yes, evaluation condition*	*Test: System could be tested when account does not hold enough money to provide currency amount user requires.*
2.2.8. Physical/mental demands *Low physical demand.* *Low mental demand after initial use.*	*No*	
2.2.9. Risk resulting from error (e.g. forgetting PIN) *Loss of card.* *Not receiving money required.*	*Yes*	*Req: Provide means for user to register problem at the time with the machine, and to get "receipt" to allow checking by bank staff.*
2.2.10. Safety critical demands *Generally not hazardous. Possible robbery of people withdrawing. Growing problem of fraud.*	*No*	*Req: Provide alert button for user to press if they feel unsafe. This alerts bank staff and suspends transaction. Iris or finger print recognition for user identification.*

TABLE 9
Technical environment description

Context of Use	Affects usability?	User requirements or test conditions
3. TECHNICAL ENVIRONMENT		
3.1. Hardware *ATM linked via network to bank's computer.*	*Yes, control*	*Req and test: New multimedia bank terminal with video link and speech handset also adapted to needs of disabled users.*
3.2. Software *Bespoke transaction software.*	*Yes, control*	*Req: Use flexible development software to allow for changes.* *Include colour/graphic display to increase attractiveness to customers.*
3.3. Network *Established bank communications network.*	—	
3.4. Reference materials *Through post when card received.*	*Yes, control*	*Req: Develop instruction card to send to new customers in post.* *Test: System to be tested, in the main, without instructional materials but allow small number of users to read card beforehand.*
3.5. Other equipment *Telephone handset for speech interaction.*	*Yes, evaluation condition*	*Test: Set up additional evaluation task to test system using speech interaction and video link.*

7. Case studies

Two examples are described here of Context of Use analysis being used to help develop plans for usability evaluations. Both examples relate to EC projects being coordinated by the Central Library in Dublin. For both projects, there was a requirement to plan usability evaluations of prototype systems. HUSAT were asked to guide the evaluation process.

The first example is based on the EC TAP MUMLIB project within the Framework 4 Telematics Applications Programme. Here Dublin City Library, working with partner organizations Lisbon University and the Dansk Biblioteks Center, had developed a CD-ROM of modern literature and poetry representing work in Ireland, Portugal and Denmark. The product had been developed as an educational resource for use in libraries in the three countries. This was done in both cases by holding a context meeting with librarians involved both in the project and in supporting the general public visiting

the Reference Library. A context meeting was held by the author (representing HUSAT) working through the various stages of Context of Use analysis. The main stakeholders were members of the general public. The meeting identified a range of typical questions that the user may wish to answer using the CD-ROM e.g. "Which novels has Roddy Doyle produced?", "What were the influences on the writing career of Sheamus Heaney?" and "Which women have made a strong impact in modern Irish literature?" The environmental context was also analysed, the main factors being: use without support in the Reference Library initially (although librarian support could be given if required), and use in relatively undisturbed environment at a desk. It was found to be very convenient to replicate this in the context of measurement.

It was decided to develop an evaluation plan control for different levels of user experience and drawing from different study groups including students, working adults and librarians. The evaluations were carried out in all three partner countries so the Context of Use study helped produce a plan where the factors to be kept consistent in the trials within each country were identified. Thus, for example, the user tasks for Irish users had to be replicated with similar tasks for users in Portugal and Denmark. The test ran successfully with both performance and attitude measurements being taken. Recommendations for change were also identified from the results which formed part of the study report by the author, completed in October 1996.

A second study was part of the EC TAP PDWEB project. Here partners in Ireland (Dublin City Library), the UK (Calderdale Council) and Sweden (the town of Bastad) had set up local kiosks in towns and cities providing information for the public. Again a Context of Use analysis was performed at a meeting involving partners from different countries and chaired by the author. The main stakeholders identified for study were local members of the community and tourists. Both groups were included in a usability evaluation with relevant sets of tasks being developed for each. Thus for local members of the public, the questions were oriented towards local council information, employment opportunities, and business start-up information. Questions for tourists emphasized local attractions, restaurants and hotels, and how to locate places. The Context of Use analysis was particularly helpful in identifying environmental factors such as use in a public place (indoors and outdoors), possibly with people queuing behind them, limited assistance, and variable lighting and weather conditions. The tests were held on kiosks located in a variety of places to gather data of real use. In one Swedish fishing town the kiosk was set in a small boat, placed vertically to create a housing. Tests were run in three countries and again user performance results and attitude feedback were obtained. The data were passed to the author to analyse and a report was produced with recommendations to improve kiosk usability. The work was completed in September 1997.

In both case studies, the author found it helpful to work through the forms identifying stakeholders, and Context of Use characteristics, i.e. user, task and environmental characteristics, with the project teams. These were listed on a whiteboard. After deciding to focus on the end-users for the evaluation work, there was further discussion about the design of the evaluation plan and which contextual factors should be represented in it (the Context of Measurement). The author then took this information and developed the evaluation plan, specifying preparations to be made, how to run each user session, what measures to take, etc. This approach of discussing the factors at a context/evaluation planning meeting and producing the outline of a practical evaluation plan helped to cut

TABLE 10
Physical environment description

Context of Use	Affects usability?	User requirements or test conditions
4. PHYSICAL ENVIRONMENT **4.1. Workplace conditions**		
4.1.1. Atmospheric or weather conditions *Indoor: Comfortable conditions.* *Outdoor: UK weather conditions—may be uncomfortable e.g. rain, snow wind.*	*No* *Yes*	*Outdoor req: Some type of shelter for outdoor kiosk.*
4.1.2. Auditory environment *Indoor: Low noise level.* *Outdoor: UK urban street. Noise will vary from quiet street at night to busy shopping street heavy traffic.*	*No* *Yes, control*	*Outdoor test speech interaction outside under normal street conditions.*
4.1.3. Thermal environment *Indoor: Generally comfortable temperatures.* *Outdoor: UK outdoor temperatures varying from −5°C to 30°C.*	*No* *Yes, ignore*	*Outdoor test: Will simulate with winter clothing—see below.*
4.1.4. Visual environment *Indoor: Public building lighting.* *Outdoor: UK urban street. From night time with street lighting to full sun.*	*Yes, control* *Yes, evaluation condition*	*Indoor and outdoor req: Provide installation guidance to avoid placement where lighting or glare from the sun may affect machine usage.* *Outdoor test: In normal light, darkened and bright sunlight conditions.* *Outdoor req: Self-lit keys for night-time use. Shaded display to avoid glare.*
4.1.5. Environmental instability *None.*	—	
4.2. Workplace design		

4.2.1. Space and furniture *Indoor and outdoor: ATM mounted 1m. above ground, inset in wall sometimes with small ledge below.*	*Yes, control*	*Indoor and outdoor test: 1 m above ground level.*
4.2.2 User posture *Indoor and outdoor: Standing. Wheelchair users sitting.*	*Yes, control*	*Indoor and outdoor req: To have two machines, one for standing and one for wheelchair use.* *Indoor and outdoor test: Include standing and wheelchair users.*
4.2.3. Location *Indoor: Inside bank building.* *Outdoor: Street, public thoroughfares.*	*No* *Yes, real or control*	*Outdoor test: Test outside if possible. Otherwise set up lab simulating environmental conditions.*
4.3. Health and safety		
4.3.1. Health hazards *None*	—	
4.3.2. Protective clothing and equipment *Indoor and outdoor: Winter clothing would include gloves, mittens etc.*	*Yes, evaluation condition*	*Indoor and outdoor test: Include a test with users wearing gloves.*

TABLE 11
Organizational environment description

Context of Use	Affects usability?	User requirements or test conditions
5. ORGANIZATIONAL ENVIRONMENT **5.1. Structure**		
5.1.1. Group working *Single user or small group. May be parent with children.*	*Yes, control*	*Test: Evaluation based on single users.*
5.1.2. Work practice *Not relevant.*		
5.1.3. Assistance *Possibly available from bank staff or member of public in queue.*	*Yes, control*	*Test: No assistance.*
5.1.4. Interruptions *Usually none.*	*No*	
5.1.5. Management structure *Not relevant.*		
5.1.6. Communications structure *Not relevant.*		
5.1.7. Salary or payment *Not relevant.*		
5.2. Attitudes and culture		
5.2.1. IT Policy *All bank branches to have own ATM and to encourage usage to reduce staff time on routine transactions.*	*No*	

5.2.2. Organizational aims *Not relevant.*	—	
5.2.3. Industrial relations *Not relevant.*	—	
5.3. Job design/user control		
5.3.1. Job functions *Not relevant.*	—	
5.3.2. Hours of work *Not relevant.*	—	
5.3.3. Job flexibility *Not relevant.*	—	
5.3.4. Performance monitoring *PINS monitored, for security, together with response speeds and number of transactions per day.*	*No*	
5.3.5. Performance feedback *Receipt of money and receipt.*	*Yes, control*	*Test: Money and receipt will always be given (i.e. no simulation of money or paper running out).*
5.3.6. Pacing *Queue pressure during busy periods.*	*Yes, control or ignore*	*Test: Possibly simulate queue or limited time to complete tasks. However, bank may implement machines in cubicles where effect of queue is reduced.*
5.3.7. Autonomy or discretion *May decide to go into branch if user feels unsafe or queue is too long.*	*Yes, control or ignore*	*Test: May be sufficient to test with no queue.*

down on the amount of time and effort needed to perform the full Context of Use analysis. The issue of the effort required to perform the method is discussed further in the following section.

8. Discussion

The Context of Use analysis presented in this paper is a structured method that provides a number of benefits.

- It ensures that all relevant usability variables are considered when specifying or evaluating a product.
- It provides a basis for developing an evaluation plan that can be replicated.
- It provides a focused approach, and a shared view that fosters group working between members of the design team involved (including both managers, users, developers and usability personnel).
- It helps ensure contextual validity of evaluation findings.

Although the Context of Use work on the MUSiC project focused on helping to specify the evaluation of a user system, a Context of Use analysis can also be used to help generate user requirements as demonstrated within Tables 6–11 above. However, Context of Use is only part of the user requirements analysis process; other aspects such as improving current processes, user cost–benefit analysis and the development of an acceptable design concept may also be part of the process of establishing user requirements, as described for example by the RESPECT framework (Maguire, 1998).

The issue of reconciling technical and business requirements with user requirements remains. For example, in the ATM machine illustration, putting an interactive tutorial on the machine might increase individual transaction time and lead to longer queuing times, something the banks are anxious to avoid. The requirements process will also need to include a list of technical or business constraints or requirements that impact on the user, such as the need to maintain a certain level of customer throughput for bank machines. This may lead to the development of a new user requirement, i.e. to provide special bank terminals for training purposes or for more complex transactions that can be used for longer periods.

The advantage of applying Context of Use analysis throughout the design lifecycle is that it forms a complementary method for both user requirements specification early on and user-based testing at later stages. If, for example, a contextual factor at the requirements stage is "user has impaired motor control", this may lead to the proposed requirement for a speech-based user interface. Prototyping with potential users (also specified by the Context of Use) will show whether the use of speech with the chosen recognition system is feasible. The same Context of Use description can later be used for more formal user testing to see whether the system can be used successfully for real tasks in the intended operational environment.

Are there any disadvantages? The reader may feel that the method is too heavyweight and will require the generation of lots of paperwork by several people. This is fair comment. In fact, those who are most likely to find the Context of Use analysis approach useful, in this documented form, are those who have never performed this type of analysis

before. For experienced usability personnel, they may prefer not to complete the Context of Use forms in the detail shown previously but may wish to use them as a checklist to identify the main stakeholders and the contextual factors. However, they should, of course, still document the context of measurement so that others may run similar tests in future if required.

Another possible criticism is that the headings for user characteristics and environmental characteristics reflect fixed and more complex contexts such as a process plant, a large office or command and control centre. Again, there is some truth in this and arguably there is a greater range of contextual factors that will affect these situations which therefore must be considered. However, for smaller or simpler systems it is still important to consider the context of use when analysing user requirements and specifying the usability evaluation plan. But the analyst may find it helpful to simplify the list of Context of Use components shown in Table 2 at the start to meet their specific situation. They may also wish to add components that represent the environment they are working in. For telematic systems in a car (e.g. for vehicle navigation, traffic information or driving assistance), it may be important to have context headings for: other passengers, type of road, traffic conditions, etc.

Another question is how the Context of Use should be addressed in a more dynamic development environment through a series of prototypes, where the requirements, expectations and perceived opportunities are evolving all the time. It is recommended that a lightweight Context of Use description document is maintained throughout this process to show the background against which the prototype is being developed. This will be helpful to ensure that the evolving prototype does not become isolated from the real situation in which the finished system will be employed.

In summary, the Context of Use analysis method presented in this paper should be seen as a means of supporting the user-centred design process and not inhibiting it. It may be followed in a step-by-step fashion as described or it may be used as an aide memoir for experienced usability professionals to help them make sure they avoid forgetting about major contextual factors in the design process.

9. Conclusion

This paper has argued that the usability of a system or product depends on its Context of Use, so context analysis is an essential pre-requisite for any work on usability. An understanding of the Context of Use forms a useful input to the process of specifying usability requirements, constructing a design prototype which can be evaluated and evaluating the prototype with typical end-users.

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