Human-Computer Interaction Standards

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1. DIFFERENT APPROACHES TO STANDARDS FOR HCI

It is often assumed that a standard means a precise specification. Such standards have brought benefits in many fields, eg: bolts which screw into nuts, ATMs which can read credit cards, and compilers which can read programming languages. Some HCI standards are also of this type: many design guides provide a detailed specification of the nature of the user interface. Although standard user interfaces provide the benefit of consistency, they become out of date as technology changes, and are usually only appropriate for limited types of users and tasks (Bevan and Holdaway, 1993). Thus most work on international standards for HCI has not been about precise specification, but instead has concentrated on the principles which need to be applied in order to produce an interface which meets user and task needs.

These standards broadly fall into two categories. One is a "top-down" approach which is concerned with usability as a broad quality objective: the ability to use a product for its intended purpose. The other is a product-oriented "bottom-up" view which is concerned with aspects of the interface which make a system easier to use. The broad quality view originates from human factors, and standards of this type are applicable in the broad context of design and quality objectives. The product-oriented view concentrates on the design of specific attributes, and relates more closely to the needs of the interface designer and the role of usability in software engineering (see Bevan, 1995).

Section 4 explains how standards can be used to provide a means of meeting the requirements for the operator-computer interface in the European Directive on Display Screen Equipment.

1.1 Usability as a quality objective

These standards relate to usability as a high level quality objective, and usability is defined in this way in ISO 9241-11:

> *Usability:* 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.

Standards of this type can be used to support the following activities:
- specification of overall quality and usability requirements and evaluation against these requirements (ISO 9241-11 and ISO/IEC 14598-1)
- incorporation of usability into a quality system (ISO 9241-11)
- incorporation of usability into the design process (ISO/IEC 13407)

Section 2 describes these standards.

1.2 Product-oriented standards

In the product-oriented view, usability is seen as one relatively independent contribution to software quality, and is defined in this way in ISO/IEC 9126:

> *Usability:* 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.

Section 3 describes standards which deal with usability in terms of attributes which must be designed into a software product to make it easy to use:

ISO 9241: Ergonomics requirements for office work with visual display terminals:
    Part 10, 12-17: dialogue design
ISO/IEC 10741-1 Dialogue interaction - Cursor control for text editing
ISO/IEC 11581 Icon symbols and functions
ISO/IEC 9126 Software product evaluation - Quality characteristics and guidelines for
their use
These standards can be used in the following ways:
- To specify details of the appearance and behaviour of the user interface
- To provide detailed guidance on the design of user interfaces
- To provide criteria for the evaluation of user interfaces

However the attributes which a product requires for usability depend on the nature of the user, task and environment. A product has no intrinsic usability, only a capability to be used in a particular context. ISO 9241-11 can be used to help understand the context in which particular attributes may be required.

2. USABILITY AS A HIGH LEVEL QUALITY OBJECTIVE

2.1 ISO 9241-11 Guidance on Usability

The objective of designing and evaluating for usability is to enable users to achieve goals and meet needs in a particular context of use. ISO 9241-11 explains how usability can be specified and evaluated in terms of user performance and satisfaction. User performance is measured by the extent to which the intended goals of use are achieved (effectiveness) and the resources such as time, money or mental effort that have to be expended to achieve the intended goals (efficiency). Satisfaction is measured by the extent to which the user finds the use of the product acceptable.

ISO 9241-11 also emphasises that usability is dependent on the context of use and that the level of usability achieved will depend on the specific circumstances in which a product is used. The context of use consists of the users, tasks, equipment (hardware, software and materials), and the physical and organisational environments which may all influence the usability of a product (see Figure 1).
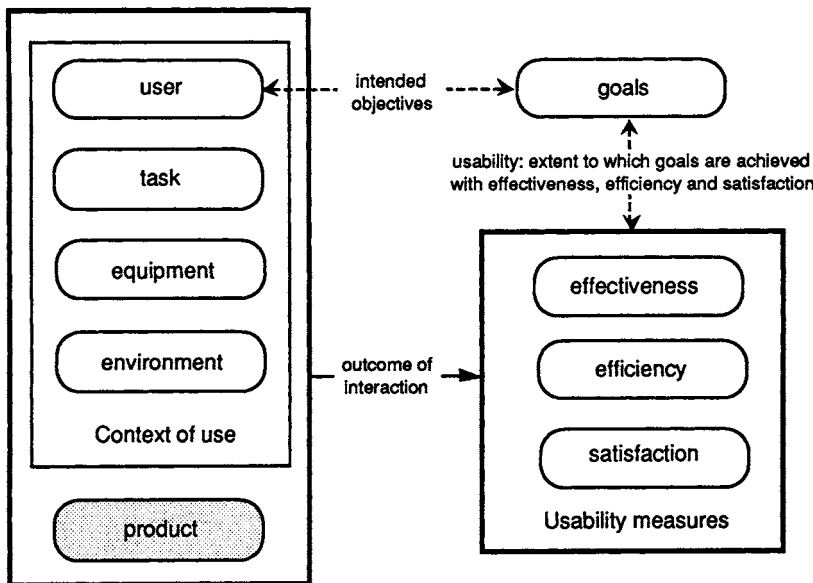

Figure 1 Usability framework

ISO 9241-11 was developed in close conjunction with the MUSiC project. The user-based MUSiC methods and tools provide a practical implementation of the principles of the standard. The Usability Context Analysis Guide (Macleod 1994) provides a procedure for documenting the context of use and context of evaluation. The Performance Measurement Method (Bevan and Macleod, 1994) provides a reliable and repeatable method for measuring effectiveness and efficiency and diagnosing usability problems. SUMI (Kirakowski, 1995) enables different aspects of user-perceived usability to be measured and areas of difficulty to be pin-pointed. Cognitive workload can be measured (Wiethoff et al 1993) as a means of predicting over- or under-loading of the user.

2.2 Quality Systems and ISO 9001

Dealing with usability as part of a quality system for design and development of products, as specified in ISO 9001, involves the systematic identification of requirements for usability, including usability measures and verifiable descriptions of the context of use. These provide design targets which can be the basis for verification of the resulting design.

ISO 9001 specifies what is required for a quality system. A quality system is a documented set of procedures intended to ensure that a product will meet initially stated requirements. A quality system is a desirable (though not sufficient) condition for achieving quality of the end product.

ISO 9241-11 describes how the usability of a product can be defined, documented and verified as part of a quality system which conforms to ISO 9001 (Figure 2). The overall context of use should be identified, usability requirements should be specified, usability issues should be monitored during development, and the usability achieved should be evaluated.
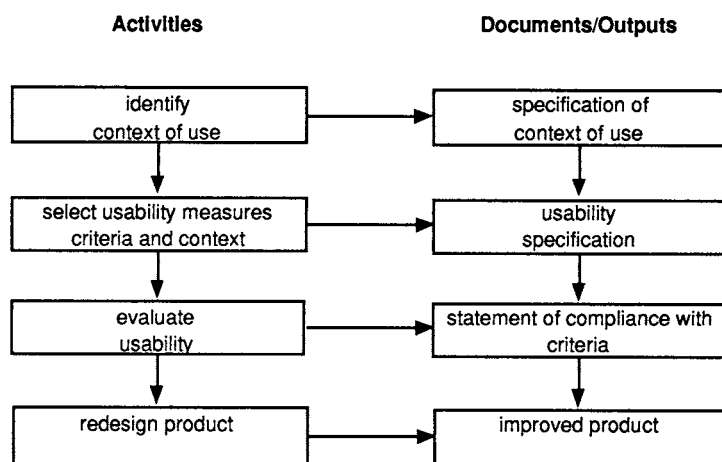
Activities   **Documents/Outputs**

identify context of use	→	specification of context of use
select usability measures criteria and context	→	usability specification
evaluate usability	→	statement of compliance with criteria
redesign product	→	improved product

Figure 2 Quality Plan

Overall context of use: Information about the characteristics of users, their goals and tasks and the environments in which the tasks are carried out provides important information for use in the specification of overall product requirements, prior to development of specific usability requirements.

Usability requirements: Prior to development of a custom system, the purchasing organisation should specify the usability requirements which the system must meet and against which acceptance testing may be carried out. Specific contexts in which usability is to be measured should be identified, measures of effectiveness, efficiency and satisfaction selected, and acceptance criteria based on these measures established.

Monitor usability: At various stages during the development process the developer should measure the usability achieved against these targets. This information enables objective decisions to be taken about the need for design changes to enhance usability, and about trade-offs which may be appropriate between usability and other requirements.

Usability evaluation: The characteristics of the context in which a product is likely to be used need to be identified. To ensure the validity of test results the users, tasks and environments used for the evaluation should match the real context of use as closely as possible.

2.3 Quality of use

ISO 9241-11 introduces the concept of a work system, consisting of users, equipment, tasks and a physical and social environment, for the purpose of achieving particular goals. Measures of user performance and satisfaction assess the quality of the work system in use, and, when a product is the focus of concern, these measures provide information about the usability of that product in the particular context of use provided by the rest of the work system.

ISO 9241-11 defines the quality of a work system in use as:

> *Quality of a work system in use*: the extent to which specified goals can be achieved with effectiveness, efficiency and satisfaction in a specified work system.

The difference between usability and the quality of a work system in use is a matter of focus. When usability is evaluated, the focus is on improving a product while the other components of the work system (user, task, equipment, and environment) are treated as given.

If the aim is to improve the quality of the overall work system in use, any part of the work system may be the subject of design or evaluation. For example it may be appropriate to consider the amount of user training to be provided, changes in lighting, or re-organisation of the task. In this case the element which is the object of design or evaluation is considered to be subject to potential variation, while the other elements of the work system are treated as fixed.

2.4 Software quality evaluation

ISO 8402 (Quality Vocabulary) defines quality as:

> *Quality:* the totality of characteristics of an entity that bear on its ability to satisfy stated and implied needs.

This defines quality in terms of the characteristics of a product. To the extent that user needs are well-defined and common to the intended users it implies that quality is an inherent attribute of the product. However, if different groups of users have different needs, then they may require different characteristics for a product to have quality.

ISO/IEC 14598-1 (Information Technology - Evaluation of Software Products - General guide) distinguishes between the concept of quality as an inherent characteristic of the product, and quality of use:

> *Quality of use:* the extent to which an entity satisfies stated and implied needs when used under stated conditions

The ultimate objective of software quality evaluation is to ensure that the product provides quality of use - that it meets the needs of the users. (Users may include operators, recipients of the results of the software, or maintainers of software.) This definition of quality of use is very similar to the definitions of usability and the quality of a work system in use in ISO 9241-11. The only difference is that ISO 9241-11 specifically defines the needs in terms of user performance and satisfaction, and the stated conditions in terms of users, goals and environments.

Internal software quality attributes (such as the functionality, usability and efficiency attributes defined in ISO/IEC 9126) can be used as indicators to estimate final software quality. The specific internal attributes which are relevant to final quality of use will depend on the intended conditions of use - for an interactive product this will depend on the needs of the eventual end users and the tasks.

2.5 Human-centred design

To achieve the overall objective of usability and quality of use requires a human-centred approach to design. This is the subject of a standard under development: ISO 13407 (Human-centred design process for interactive systems). This standard is expected to cover topics including: planning the usability process, incorporating human-centred design activities in interactive system development processes, and assessing the benefits of human-centred design.

3. DESIGNING FOR USABILITY: PRODUCT-ORIENTED STANDARDS

Usable products may be designed by incorporating product features and attributes known to benefit users in particular contexts of use. ISO 9241 provides requirements and recommendations relating to the attributes of the hardware, software and environment which contribute to usability, and the ergonomic principles underlying them. The following parts of ISO 9241 and other standards deal with attributes of the software:

• *ISO 9241-10: Dialogue principles.* This part of ISO 9241 deals with general ergonomic principles which apply to the design of dialogues between humans and information systems: suitability for the task, suitability for learning, suitability for individualisation, conformity with user expectations, self descriptiveness, controllability, and error tolerance

• *ISO 9241-12: Presentation of information.* This part of ISO 9241 contains specific recommendations for presenting and representing information on visual displays. It includes guidance on ways of representing complex information using alphanumeric and graphical/symbolic codes, screen layout, and design as well as the use of windows.

• *ISO 9241-13: User guidance:* This part provides recommendations for the design and evaluation of user guidance attributes of software user interfaces including Prompts, Feedback, Status, On-line Help and Error Management.

• *ISO 9241-14: Menu dialogues.* This part provides recommendations for the ergonomic design of menus used in user-computer dialogues. The recommendations cover menu structure, navigation, option selection and execution, and menu presentation (by various techniques including windowing, panels, buttons, fields, etc.). Part 14 is intended to be used by both designers and evaluators of menus (however, its focus is primarily towards the designer).

• *ISO 9241-15: Command language dialogue.* This part provides recommendations for the ergonomic design of command languages used in user-computer dialogues. The recommendations cover command language structure and syntax, command representations, input and output considerations, and feedback and help. Part 15 is intended to be used by both designers and evaluators of command dialogues, but the focus is primarily towards the designer.

• *ISO 9241-16: Direct manipulation dialogues.* This part provides recommendations for the ergonomic design of direct manipulation dialogues, and includes the manipulation of objects, and the design of metaphors, objects and attributes. It covers those aspects of "Graphical User Interfaces" which are directly manipulated, and not covered by other parts of ISO 9241. Part 16 is intended to be used by both designers and evaluators of command dialogues, but the focus is primarily towards the designer.

• *ISO 9241-17: Form-filling dialogues.* This part provides recommendations for the ergonomic design of form filling dialogues. The recommendations cover form structure and output considerations, input considerations, and form navigation. Part 17 is intended to be used by both designers and evaluators of command dialogues, but the focus is primarily towards the designer.

• *ISO/IEC 10741-1 Dialogue interaction - Cursor control for text editing.* The standard specifies how the cursor should move on the screen in response to the use of cursor control keys.

• *ISO/IEC 11581 Icon symbols and functions - Part 1: General.* This part contains a framework for the development and design of icons, including general requirements and recommendations applicable to all icons.

• *ISO/IEC 11581 Icon symbols and functions - Part 2: Object icons.* This part contains requirements and recommendations for icons that represent functions by association with an object, and that can be moved and opened. It also contains specifications for the function and appearance of 20 icons.

Before designing appropriate usability attributes into the software following the guidance and requirements of the standards listed above, a software designer needs to identify the anticipated users, tasks and environments using ISO 9241-11. However, using attributes which conform to these standards cannot guarantee that a product reaches a required level of usability, as these standards do not provide an exhaustive specification of how to apply the general principles that make a product usable.

4. EUROPEAN DISPLAY SCREENS DIRECTIVE

The European Directive on Display Screen Equipment (EEC 1990, Bevan 1991) is primarily concerned with the physical working environment and working conditions, but also includes requirements that:
• Software must be suitable for the task.
• Software must be easy to use and where appropriate adaptable to the user's level of knowledge or experience.
• Systems must display information in a format and at a pace which are adapted to users
• The principles of software ergonomics must be applied.
This applies to software used as part of new workstations immediately, and all workstations from 1997. Conformance with usability standards provides one means to ensure compliance with the Directive.

The minimum requirements of the Directive are similar, but not identical to, the requirements of the relevant parts of ISO 9241 which are in much greater detail. In particular, ISO 9241-10 contains the main principles of software ergonomics. In general, the standards contain broader requirements than the Directive, as the Directive is concerned only with health and safety, while the standards are also concerned with the effectiveness and efficiency of users.

It would have been simpler if the Directive had made direct reference to standards rather than containing its own requirements. However, not all the standards are complete, and the contents of standards are agreed by experts in national standards bodies, while the contents of the Directive are approved at a political level in the European Commission.

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