TECHNICAL REPORT

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Ergonomics of human-system interaction — Usability methods supporting human-centred design

Ergonomie de l'interaction homme-système — Méthodes d'utilisabilité pour la conception centrée sur l'opérateur humain

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Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

Attention is drawn to the possibility that some of the elements of this Technical Report may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TR 16982 was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 4, *Ergonomics of human-system interaction*.

Introduction

There is a growing emphasis on “human-centred design” as an essential part of the development of computer based systems. ISO 9241-11 and ISO 13407 provide “guidance on usability” and “on human-centred design processes for interactive systems”. ISO 13407 provides general guidance and four main conditions to make a product (hardware and software) “human-centred” but does not address specific methods.

The purpose of this Technical Report is to help project managers make informed decisions about the choice of usability methods to support human-centred design as described in ISO 13407 (with support from human-factors specialists, as appropriate). It is not its aim to turn the project manager into a human-factors specialist.

This technical Report provides an overview of existing usability methods which can be used on their own or in combination to support design and evaluation. Each method is described with its advantages, disadvantages and other factors relevant to its selection and use. These include the implications of the project's stage in the life cycle for the choice of method.

Since the appropriateness of individual methods is dependent upon the design activities being undertaken, it is necessary to relate them to the design process. ISO/IEC 12207 is used to provide the basic framework against which the suitability of the methods is assessed.

Annex A provides a template for practitioners, annex B gives real life examples when filling in this template and annex C provides detailed additional methods and techniques.

Ergonomics of human-system interaction — Usability methods supporting human-centred design

1 Scope

This Technical Report provides information on human-centred usability methods which can be used for design and evaluation. It details the advantages, disadvantages and other factors relevant to using each usability method.

It explains the implications of the stage of the life cycle and the individual project characteristics for the selection of usability methods and provides examples of usability methods in context.

The main users of this Technical Report will be project managers. This Technical Report therefore addresses technical human-factors and ergonomics issues only to the extent necessary to allow managers to understand their relevance and importance in the design process as a whole.

Such issues are dealt with more fully in ISO 9241 which is complementary to this Technical Report and is aimed at system developers, specifiers and purchasers of systems. Nonetheless, all parties involved in human-centred system development, including the end users of systems, should find the guidance in this Technical Report relevant.

The guidance in this Technical Report can be tailored for specific design situations by using the lists of issues characterizing the context of use of the product to be delivered. Selection of appropriate usability methods should also take account of the relevant life-cycle process.

This Technical Report is restricted to methods that are widely used by usability specialists and project managers.

It does not specify the details of how to implement or carry out the usability methods described.

NOTE Most methods require the involvement of human-factors specialists. It may be inappropriate for them to be used by individuals without adequate skills and knowledge.

2 References

ISO 9241 (all parts), *Ergonomic requirements for office work with visual display terminals (VDTs)*

ISO/IEC 12207, *Information technology — Software life cycle processes*

ISO 13407:1999, *Human-centred design processes for interactive systems*

ISO/IEC 14598 (all parts), *Software engineering — Product evaluation*

3 Terms and definitions

For the purposes of this Technical Report, the following terms and definitions apply.

3.1
prototype
representation of all or part of a product or system that, although limited in some way, can be used for evaluation

[ISO 13407:1999]

3.2
user
individual interacting with the system

[ISO 9241-10:1996]

3.3
usability
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

[ISO 9241-11: 1998]

3.4
usability method
method supporting human-centred design used for the purpose of increasing the usability of a product or a system

4 Adequate deployment of usability methods

4.1 General

Usability methods help to ensure that systems can be developed to meet the usability goals of a human-centred design process, described in more detail in ISO 13407.

The benefits of a human-centred approach include increased satisfaction and productivity, enhanced quality of work, reductions in support and training costs and improved user health and well-being. The usability methods described in this Technical Report support these goals.

Basic knowledge about the usability methods, including an understanding of their key differences and the basic principles of their application, is needed to be able to make an appropriate choice of usability methods.

Usability methods provide a means to increase the chances that systems deployed or to be deployed will achieve these objectives.

4.2 Basic principles issued from ISO 13407

ISO 13407 identifies four basic principles:

a) appropriate allocation of function between user and system, based on an appreciation of human capabilities and demands of the task;

b) active involvement of users in order to enhance the new system and its acceptance;

c) iteration of design systems to entail the feedback of users following their use of early design systems;

d) multi-disciplinary design teams to allow a collaborative process which benefits from the active involvement of various parties, each of whom have insights and expertise to share.

The application of these principles leads to the identification of four key human-centred design activities which should be undertaken to incorporate usability requirements into the development process and which are carried out in an iterative fashion and repeated until the particular usability objectives have been attained. The user-centred design activities are as follows.

1) Understand and specify the context of use. This information can be gathered via a variety of methods, this Technical Report intends to help make an adequate choice from these methods.

2) Specify the user and organizational requirements.

3) Produce designs and prototypes.

4) Carry out user-based assessment.

4.3 Methods and their use

4.3.1 Methods and methodologies

The usability methods which are described in this Technical Report stand-alone i.e. they can be selected and used for a variety of purposes (e.g., for user needs analysis, for establishing requirements, for design and specification, for evaluation) and many of them can be used concurrently or sequentially within a larger framework of human-centred design methodologies. Such methodologies are not covered in this Technical Report. Methodologies can result from the ad hoc selection of several methods within the same design process or from methodologies commonly used or described in the human-factors literature. Examples of such methodologies are: activity and task analyses methodologies that can group interviews, user observation, questionnaires, and even experiments; walkthrough and parallel-design methodologies that can group various evaluation methods, various expert and non-expert assessments, as well as creativity aspects together. References to published methodologies are provided in the bibliography.

4.3.2 Design and evaluation perspectives

The usability methods described in this clause apply in general to both design and evaluation. Specific choice (or selection) of these methods, depending on their design stages, is described in clause 6.

The main difference between design and evaluation in terms of their use of usability methods is a difference in focus. The difference is as follows.

— The focus of design is to determine users' knowledge, capabilities and limitations relative to the tasks for which the product or system is being designed. Of particular interest are the ways in which system and product designers can understand better users' tasks and task vocabulary, users' physical capabilities, etc. This information is used to guide the design of the system or product to maximize its usability. Often, this focus leads to the discovery of unanticipated ways in which users view the operation or use of a product or system. This focus may involve the comparison of competing designs to determine which is more usable.

— The focus of evaluation is to assess a design on a particular dimension (e.g., interface features, recommendations, standards) or against a model (e.g. user model, expected task completion time, expected use pattern), with some kind of measurement and data-gathering tools (e.g. questionnaires, errors-logging, time-stamp), according to users' performance or preferences.

With this difference in focus in mind, various usability methods are presented that can be used either to diagnose problems or to facilitate design and redesign.

— In the first case, the methods, often labelled data-gathering techniques, are usually described within the phase of the project which involves the description and modelling of job, tasks and users at various degrees of precision, though they may also be used for evaluation.

— In the second case, the methods are often labelled evaluation methods, though they are also used for design.

The focus of these methods may be the actual system being evaluated, or a prototype, or even an existing situation that does not incorporate a computer system yet (for example, when a completely new application is being designed).

To sum up, all of the usability methods described in this clause are human-centred ways of gaining a better understanding of the situation and context. That will allow for either assessment of whether the human-centred goals are met (evaluation) or will provide requirements, limitations or suggestions for designing systems (models, scenarios, prototypes or full systems) that will eventually be evaluated in an iterative process.

4.3.3 Use of several methods

Individual usability methods are described in clause 5. However, in practice, several usability methods may be used together, e.g. interviews and observations. Also, different methods may be used to address different issues during the life of a project.

It is useful for these reasons to avoid limiting oneself to one preselected method. The more methods used to achieve the usability objectives, the better the results will be.

Several methods can be used jointly (e.g. inspection and user testing, creativity methods and formal methods, critical incidents and expert evaluation, questionnaire and interviews). Using several methods may, in this way, increase the coverage of the results.

Examples of situations using a mix of usability methods are presented in annex B.

4.4 Direct involvement of users as a key factor

The active involvement of users is one of the key principles underlying the human-centred design process. Many of the usability methods described here provide a means of gaining that active involvement. In addition, there are also many usability methods that do not require users to be directly involved since they rely on other sources of information about user issues. They should be used to complement the active involvement of users.

4.5 Available methods

The methods that are presented in this Technical Report are those that are most frequently used. Table 1 lists each method. Variants of these methods are used under other names. A list of known variants (in books or on web sites) is provided in the bibliography.

Methods are divided into two broad categories (see Table 1, Column 2):

— methods that imply the direct involvement of users (Y = yes);

— methods that imply the indirect involvement of users (N = no) which are used either when it is not possible to gather usage data due to non-availability of the users or where they provide complementary data and information.

Table 1 — Brief description of the referenced methods

Name of the method	Direct involvement of users	Short description of methods
Observation of users	Y	Collection in a precise and systematic way of information about the behaviour and the performance of users, in the context of specific tasks during user activity.
Performance-related measurements	Y	Collection of quantifiable performance measurements in order to understand the impacts of usability issues
Critical incidents analysis	Y	Systematic collection of specific events (positive or negative).
Questionnaires	Y	Indirect evaluation methods which gather users' opinions about the user interface in predefined questionnaires.
Interviews	Y	Similar to questionnaires with greater flexibility and involving face-to-face interaction with the interviewee
Thinking aloud	Y	Involves having users continuously verbalize their ideas, beliefs, expectations, doubts, discoveries, etc. during their use of the system under test.
Collaborative design and evaluation	Y	Methods which allow different types of participants (users, product developers and human-factors specialists, etc) to collaborate in the evaluation or design of systems.
Creativity methods	Y/N	Methods which involve the elicitation of new products and systems features, usually extracted from group interactions. In the context of human-centred approaches, members of such groups are often users.
Document-based methods	N	Examination of existing documents by the usability specialist to form a professional judgement of the system
Model-based approaches	N	Use of models which are abstract representations of the evaluated product to allow the prediction of the users' performance.
Expert evaluation	N	Evaluation based upon the knowledge, expertise and practical experience in ergonomics of the usability specialist.
Automated evaluation	N	Algorithms focused on usability criteria or using ergonomic knowledge-based systems which diagnose the deficiencies of product compared to predefined rules.

4.6 Choice of usability method(s) (UM)

4.6.1 Factors affecting the choice of methods

The factors affecting the choice of methods are

a) the life-cycle steps,

b) the characteristics of the users,

c) the characteristics of the task to be performed,

d) the product or system itself,

e) the constraints which affect the project, and

f) the degree of expertise in ergonomics available in the development or evaluation team.

4.6.2 Suitability of methods

The issues identified are evaluated on a scale of five levels as follows:

— recommended (++);

— appropriate (+);

— neutral (when the cell is empty);

— not recommended (−);

— not applicable (NA).

There may be a number of candidate usability methods which could be used to gather the information required. Some of the methods may be eliminated because they cannot be used in a particular context. For example, if there are no current users, it will not be possible to interview them and this would lead to a rating of (NA), i.e. the method is not applicable. On the other hand, if there are current users but they are not fully representative of the characteristics of future users, interviews may be appropriate (+) but an analytical method may also receive a recommendation. The decision about whether or not to use a combination of methods, and the level of detail needed should be taken, bearing in mind the risk that poor design will lead to errors or a lack of satisfaction.

These ratings are based on typical situations and should be reviewed in the context of a specific project.

5 Usability methods

5.1 Methods that imply the direct involvement of users

5.1.1 General

These methods can be used when it is possible to gather data directly from users, or when there is access to users.

5.1.2 Observation of users

This method consists of the precise and systematic collection of information about the behaviour and the performance of users, in the context of specific tasks during the user's activity which may be carried out either in real-life situations or laboratories. Such observation is structured and based on predefined classifications of users' behaviour.

Much observation is based on taking detailed notes on what the users do and then analysing the data later.

The advantages and disadvantages of this method are as follows.

Advantages

— Method can be performed in “real world” settings;

— real activity is reported.

Disadvantages/constraints

— It is time consuming to analyse the data;

— needs expertise to accurately interpret data;

— no direct insight into mental processes.

The following are examples of the types of quantitative and qualitative information which can be logged:

— different actions involved in achieving task goals: interaction with the computer, including physical behaviour, interaction with other tools or other persons;

— numbers of attempts to complete a task;

— reasons for success or failure.

5.1.3 Performance-related measurements

Performance-related measurements are also called task-related measurements.

The commonly used quantifiable performance measurements related to effectiveness and efficiency include the following:

— time spent to complete a task;

— number of tasks which can be completed within a predefined duration;

— number of errors;

— time spent recovering from errors;

— time spent locating and interpreting information in the user's guide;

— number of commands utilized;

— number of systems features which can be recalled;

— frequency of use of support materials (documentation, help system, etc.);

— number of times that the user task was abandoned;

— number of digressions;

— amount of idle time (it is important to distinguish between system-induced delays, thinking time and delays caused by external factors);

— number of total key strokes.

Performance-related measurements can often be performed on the whole system or a part of it.

The advantages and disadvantages of this method are as follows.

Advantages

— Collects quantifiable data;

— results are easy to compare.

Disadvantages/constraints

— Does not necessarily uncover the cause of problems;

— requires some kind of working version of system or product.

For additional methods, see Annex C.

5.1.4 Critical-incident analysis

Critical-incident analysis consists of the systematic collection of events which stand out against the background of user performance. The incidents are described in the form of short reports which provide an account of the facts surrounding the incident. The data can be collected from interviews with the user and from objective observations of the interaction. The incidents are then grouped and categorized.

Whereas performance-related measurements have current tasks and existing situations as the focus of interest, critical-incident techniques enable the examination of significant events, positive or negative, which may have occurred in the past or over a period of time.

The advantages and disadvantages of this method are as follows.

Advantages

— Collects causes of problems;

— focuses on events where demands on users are high;

— real activity is reported.

Disadvantage/constraints

— May require a long elapsed time to complete;

— insufficient events to report can effect the validity of the analysis.

5.1.5 Questionnaires

There may be several occasions during development when it will be useful to gather information from users using questionnaire items. The questionnaire items can be either open-ended statements or checklist/closed questionnaire items and scales: the advantage of the former is that they allow people to give elaborate answers but there is always a danger of collecting only cryptic statements which are difficult to interpret. For this reason, the closed questionnaire item format is often preferred.

Standardized questionnaires can also be used for systematic comparisons, for example between design features or between competing designs.

The type of data being collected can include users' quantifications, suggestions, opinions and ratings of the systems, features, user help, preferences, ease-of-use, etc. Qualitative methods are generally indirect in that they do not study the user interaction but only users' opinions about the user interface.

There is also a need for including consistency checks in questionnaires, for example using different question formats referring to the same item. For this reason, closed questions are often preferred.

The advantages and disadvantages of this method are as follows.

Advantages

— Uncovers subjective preferences;

— easy to manage;

— quick to conduct.

Disadvantages/constraints

— Self-evaluation can be unreliable as a measure of performance;

— questionnaire items open to bias both in the questions and the answers.

5.1.6 Interviews

Interviews are similar to questionnaires but with greater flexibility since there is face-to-face interaction with the interviewee.

There are many different forms of interview from highly structured to very open-ended. Interviewing an user on an individual basis requires much more staff time than administering a questionnaire.

Interviews have the advantage, however, of being more flexible since the interviewer can explain difficult questions more deeply or reformulate a question if it is unclear to the user. Interviewers can also follow up answers that require further elaboration or that lead to new insights which had not been anticipated in the design of the interview.

The advantages and disadvantages of this method are as follows.

Advantages

— Collects quick overview of users' opinion;

— flexible, allows probing per users' responses.

Disadvantages/constraints

— Detailed analysis is time consuming ;

— it is open to biases (both in the questions and the answers);

— needs expertise to accurately interpret data.

5.1.7 Thinking aloud

Thinking aloud involves having users continuously verbalize their ideas, beliefs, expectations, doubts, discoveries, etc. during their activity when using the system. Thinking-aloud protocols provide valuable data with regard to why users are performing certain actions. This data is an important supplement to the objective data capture of the performed actions through observation, performance measurement, data logging or video.

The instructions for getting users to think aloud have to be given before starting and repeated during the session.

The verbalizations can be concurrent (i.e. spoken while the user works with the system) or retrospective (user voices her/his comments after the task has been completed, with or without the option of viewing a video recording of the actions carried out). Concurrent verbalizations are usually preferred by experimenters because they eliminate the possibility of the users being selective in their recall or introducing after-the-event rationalizations.

The advantages and disadvantages of this method are as follows.

Advantages

— Quick to conduct;

— collects insights into users' mental process;

— flexible, allows probing per users' responses.

Disadvantages/constraints

— May be uncomfortable for some users;

— detailed analysis is time consuming;

— cannot collect task performance data during use of method.

For more details, see annex C.

5.1.8 Collaborative design and evaluation

Collaborative methods involve having different types of participants (users, product developers and human-factors specialists, etc.) collaborate in the evaluation or design of systems.

Collaborative methods stress the importance of the user playing an active role in design and evaluation. The reason for this is that the context of use and/or the tasks of the users might be difficult for the designer and those responsible for the development to understand, or the fact that users may have a difficulty expressing their actual needs or requirements in the development process.

In a collaborative approach, users and developers can participate on equal terms. Collaborative approaches focus on organizational issues and the users' work routines. They use development tools familiar to the user, e.g. prototypes rather than formal models. They focus just as much on quality as on productivity. Future work situations can be visualized through simulations in real environments, for example using role-play.

The advantages and disadvantages of this method are as follows.

Advantages

— Quick to conduct;

— can be used from the early stages of a project;

— enhances communication and learning among the users, usability experts, designers and those responsible for the development.

Disadvantages/constraints

— May reveal conflict between the parties;

— cannot collect task-performance data during the use of the method.

5.1.9 Creativity methods

The aim of such methods is the elicitation of new products and systems features, usually extracted from group interactions. In the context of human-centred approaches, members of such groups are often users.

Creativity methods are used in many fields to generate a list of ideas to create new products and/or to solve a problem by changing perspectives and considering alternative options.

They are not uniquely ergonomic methods, but they can be used in the context of the human-centred/user-centred design approach.

These methods work more effectively with users' involvement but can also be run without users. They fit the conception stage of the design process particularly well and can be used in the early stages of a project.

They help to create and define new products, their functionality and their interfaces.

The advantages and disadvantages of this method are as follows.

Advantages

— Skills required, but skills more widely available than for other more specific ergonomics methods;

— well adapted to the early stages of a project.

Disadvantages/constraints

— Detailed analysis is time consuming;

— open to bias.

5.2 Methods that imply the indirect involvement of users

5.2.1 General

These methods can be used when there is an established body of knowledge which can be applied, when it is not possible to gather data directly due to lack of access to users, or when carrying out evaluations in the very early stages of design.

The specification of the new product or system can be based on, or compared to, the features or qualities required in an “ergonomic interface”.

5.2.2 Document-based methods

In the document-based methods (also called document-based analysis), the usability specialist uses existing checklists or other documents in addition to his own judgement. The expert has to have enough experience to be in a position to use these documents in a way that is appropriate to the context of use and to carry out the design or evaluation in an efficient way.

These documents, based on commonly agreed rules or experimentally proven demonstrations, are available from different sources (e.g. scientific literature, standards, style guides).

The advantages and disadvantages of this method are as follows.

Advantages

— Expertise not always required, but would enhance results;

— enhances communication among the users, developers, usability experts and improves consistency;

— can be based on state-of-the-art knowledge.

Disadvantages/constraints

— Does not cover every aspect of user interaction with the system;

— can be time consuming if done exhaustively.

Typical documents include the following.

— Style guides, which can come from the provider of the software or be defined/customized in the company in which they will be used, possibly with the help of a human-factors specialist.

— Handbooks, recommendations guides, which are usually wider in scope than style guides and which are generally based on state-of-the-art ergonomic knowledge.

— Standards, which can be proprietary, national or international and contain recommendations which are likely to become increasingly important with the growing acceptance of the standards. Examples of such standards are ISO 9241-13 to 17.

— Evaluation grids which provide a list (as complete as possible) of properties of appropriate ergonomic interfaces. Each property is evaluated by providing a notation on a range of values. The properties may come from agreed rules of ergonomics (often organized into dimensions, principles, criteria, etc) or other sources of best practice.

— Cognitive walkthroughs. The process involves “walking through” the tasks the user has to perform with the system taking account of the user goals, knowledge and context of use. The aim is to avoid the risk of bias due to the personal view of the person conducting the design or evaluation.

Document-based methods may be supported by computer or other tools at various levels of sophistication (e.g. simple or dynamic access to documentation, knowledge-based systems, reporting tools). These tools make available information contained in documents (style guides, guidelines, handbooks), production rules extracted from the literature (for interactive object selection), in data bases, hypertexts, expert systems, and design environments for the purpose of good human-system interface design.

5.2.3 Model-based methods

5.2.3.1 General

Two types of model-based approach are described here:

a) user interface specification and design methods which allow the modelling of user behaviour and data;

b) formal methods which are based on models of users and tasks. Such methods allow the prediction of user performance.

The advantages and disadvantages of these methods are as follows.

Advantages

— Widely available;

— standardizes comparisons and predicts performance;

— earlier integration with engineering approaches.

Disadvantages/constraints

— Time consuming;

— open to bias;

— needs expertise to build and interpret models.

5.2.3.2 Usability specification and design methods

These specification and design methods may expand software engineering methods, adapting UML notification language, or are dedicated methods to user interface, covering both the specification and the design stages (for example, MUSE, Method for Usability Engineering).

These methods use flow charts, UML's class diagram for users' conceptual model, interaction diagrams and state diagrams for task description.

It is also possible to use other more general methods, like Petri's nets, to define the procedure.

5.2.3.3 Formal methods

Formal methods allow the abstraction of user behaviour or interface behaviour. These methods can be used either to specify and design the user interface, at the early stages of the process, or to evaluate existing paper or software prototypes, at later stages of design. When selecting methods, a number of issues and factors should be considered.

Their use of formality leads to high internal validity if their results can be reproduced. On the other hand, their ecological validity is very low, since they don't take into account the real context of use. Most of these methods come from cognitive sciences and have no link with software engineering formal methods.

Examples of these methods are

— Keystroke Level Model (KLM),

— Goals, Operators, Methods, Selection rules (GOMS), and

— analytical method of description (Méthode Analytique de Description – MAD*);

5.2.4 Expert evaluation

Expert evaluation is based on the background and knowledge of the expert. In this kind of evaluation, the expert identifies the most frequently observed problems by reference to an optimum man-machine interface model he/she has in mind.

Expert evaluation can lead to the rapid identification of potential problems and may also be used to eliminate the causes of the problems.

These expert evaluation methods provide means to identify known types of usability problems and can be applied early in the life cycle. However, they are limited by the skill of the usability specialists and cannot be used to identify unpredictable problems which only arise with real users.

There can be large differences between experts when diagnosing usability problems. These differences can be reduced by the use of the appropriate document-based methods and by having more than one evaluator.

The advantages and disadvantages of this method are as follows.

Advantages

— Quick to conduct;

— well adapted to early stage of a project;

— can identify specific problems and recommend solutions.

Disadvantages/constraints

— High skills in ergonomics required;

— may miss important problems.

5.2.5 Automated evaluation

Based on algorithms focused on usability criteria or using ergonomic knowledge-based systems, automated evaluations can diagnose the deficiencies of the system compared to predefined rules. The fact that the context of use is not addressed in these approaches implies the complementary use of other methods.

The advantages and disadvantages of this method are as follows.

Advantage

— Consistency on evaluation across projects.

Disadvantages/constraints

— May miss important problems;

— requires a working version of prototype.

The following are examples of automated evaluation methods:

a) Knowledge-based

A knowledge-based system (KBS) helps to evaluate and automatically improve graphical views. It proposes guidance based on ergonomic rules stored in the databases.

b) Automatic analysis of perceptive screen complexity

The screens are analysed by programs which use agreed criteria (global density, local density, number of sets of characters, medium size of the groups, number of items, complexity of presentation, etc.).

c) Automatic analysis of presentation quality

The purpose is to evaluate the ability of the representation to make clear the logical structure of a given set of information. The proposed model establishes a relationship between the abstract representation of the structure and the abstract methods of presentation.

The structural relationships between the entities of a set of information are formalized in a semantic network independently of their technical implementation.

6 Choice of usability methods based on generic issues

6.1 General

The flexibility of many of the methods discussed in this Technical Report means that they can be used across a range of systems and development stages. Nevertheless it is possible to provide a general indication of their scope and so identify more precisely situations in which specific methods would be more or less suitable choices.

It is generally more cost-effective to implement human-centred design activities as early as possible in the life cycle, before there is a significant investment in implementing design solutions. The costs and benefits of a given usability method are not static properties: early deployment of usability methods will yield correspondingly greater benefits with lower cost implications for later development, as it is always more expensive to resolve problems later in the development schedule.

Plans for carrying out human-centred design activities and the accompanying usability methods should be made as part of the overall planning for the development.

During the early stages of development, usability methods provide information about the context of use. For example, a plan might include the use of observation and interviews to gather context-of-use information, collaborative design activities to support the specification process, creativity methods when producing design solutions, and expert evaluation and user testing when evaluating designs against requirements. The specific activities planned will depend on the life cycle, constraints, user and task characteristics, the nature of the product and the skills available.

During design, methods relating to guidance and standards, expert evaluation and early prototyping are generally appropriate.

In the later stages of the life cycle, when implementation and testing are the major concerns, user-based testing, performance measurement and evaluation methods involving the users are generally relevant.

Evaluations carried out by experts and user-based methods may be equally cost-effective in detecting usability problems, and the balance of benefits and costs and the resulting choices will depend on the stage of the life cycle and the availability of users and experts. The combination of expert and user-based methods in an iterative fashion provides the best chances of predicting, detecting and resolving problems

6.2 Choice of usability methods based on life-cycle process

6.2.1 General

A common framework for the software life-cycle process has been described in ISO/IEC 12207.

ISO/IEC 12207 will be used as a reference to explain when the usability methods can be used with benefit with regard to:

— the stage of the life cycle called primary life-cycle processes in ISO/IEC 12207;

— the support activities (like quality assurance) called supporting life-cycle processes in ISO/IEC 12207;

— the management activities called organizational life-cycle processes in ISO/IEC 12207.

The fact that ISO/IEC 12207 is restricted to software does not imply any restriction on the scope of this Technical Report.

The correspondence between the four key human-centred design activities of ISO 13407 and the primary life cycle of ISO/IEC 12207 can be established as follows:

Table 2 — Cross-reference between ISO 13407 and ISO/IEC 12207

		ISO/IEC 12207 primary life cycle				
		Acquisition and supply	Development			Operation and maintenance
			Requirements analysis	Architectural design	Qualification testing	
ISO 13407	Understand and specify the context of use			NA	NA	NA
	Specify the user and organizational requirements			NA	NA	NA
	Produce design solutions				NA	NA
	Evaluate designs against requirements					
NA Not applicable.						

6.2.2 Choice of usability methods within the primary life-cycle processes

Position in the design life cycle is a very important determinant of the appropriateness of individual usability methods. For example, task related measurement of performance carried out on an existing system may be very cost efficient in identifying usability problems that can be addressed in the requirements stage of the design of the next version. The same method of task related measurement applied to a full-scale prototype of the next release may be equally effective in identifying problems but require much greater expenditure of resource to correct.

6.2.2.1 Acquisition and supply processes

When a product or system is being acquired it is possible to apply usability methods from an evaluation perspective. This implies that usability methods supporting the identification of the user requirements have also been used to identify the criteria that will be used as the basis for choice, together with the means of judging whether the criteria have been met.

When the choice is being made between existing products, the full range of usability methods can be used based both on the involvement of the users and methods which do not imply the direct involvement of users.

Most methods are possible at this stage. The nature of the usability methods to be used varies according to the context of the product to supply, which can be “off the shelf”, or produced in accordance with provided specifications, or a combination of both. However, methods such as observation of users and document-based methods are particularly recommended.

The acquirer will carry out the acceptance testing of what is delivered, including tests based on usability methods and will accept delivery from the supplier when all acceptance conditions have been satisfied.

On his side, the supplier can be in a position to agree to a contract in which human-factors are defined as critical issues. It will be necessary to ensure that the product to be delivered will satisfy these requirements.

Depending upon the terms of the contract, these proofs can relate to development, operation and/or maintenance. They can be provided by the supplier or by a third party.

6.2.2.2 Development process

a) Requirements analysis (system and software)

During requirements analysis, both at the high level (system) and at the software level, “human-factors engineering (ergonomics)”, “environmental conditions under which the software item is to perform” and “man-machine specifications” (reference ISO/IEC 12207) need to be taken into account.

It is very important to establish task and user requirements early.

In the initial stages of requirements analysis, observation of users and interviews permit involvement of users in a relatively cost-effective way.

b) Architectural design (system and software)

During the design phases (again covering both system and software depending upon the level of refinement), usability methods will be implemented to confirm, modify or refine the previous findings.

At this stage, there are demonstrable prototypes or systems that can be evaluated with several methods. Methods which involve users can be used productively.

c) Qualification testing (system and software)

Qualification testing is the activity where usability methods are applied in order to test the match with the requirements. Usability methods will be used to certify the delivered “products” according to ergonomic issues.

All methods are appropriate for the final products, but the user-based ones provide the best answers.

6.2.2.3 Operation and maintenance processes

Maintenance is linked with operation (since they are performed on an existing product or system) but they are, by nature, developmental (modifications need the same kind of project management methods as new developments). In reality most development work involves enhancements. Human-factors involvement in that phase should not be neglected as it is a useful way of gathering actual data on use.

Similar usability methods can be used for maintenance as for development. The differences will be that

— there will always be an existing group of users,

— the size of the investment available may restrict the scope of ergonomic investigations, and

— the pre-existence of an application with existing features will create additional constraints on the options for change.

During the maintenance process, evaluation can involve observation of users, performance-related measurements or critical incidents methods. The objective is to obtain information on the dysfunction of the existing software to correct it or to improve it.

Anything that is helpful to monitor usage is a good method.

Table 3 gives methods related to primary life-cycle processes.

Table 3 — Methods related to primary life-cycle processes

Life cycle process	Methods											
	Observation of users	Performance-related measurements	Critical incidents analysis	Questionnaires	Interviews	Thinking aloud	Collaborative design and evaluation	Creativity methods	Document-based methods	Model-based methods	Expert evaluation	Automated evaluation
Acquisition - Supply	++	+	+	+	+		+		++		+	
Development - Requirements analysis	++	+	+	++	++	++	+	+	+	+	+	
Development - Architectural design	+	++		+	+	++	+	++	++	+	+	+
Development - Qualification testing	+	++	+	++	++	+	+		+	+	+	+
Maintenance - Operation	+	+	++	+	+		+				+	

Legend

++	Recommended;
+	Appropriate;
When the cell is empty	Neutral;
–	Not recommended;
NA	Not applicable (NA).

6.2.3 Usability methods in conjunction with supporting life cycle processes

Usability methods are in the scope of the following supporting processes identified in ISO/IEC 12207 as they can

— be used to ensure the quality of the product from the user perspective (quality assurance process);

— help determining whether the requirements and the final as-built system or software product fulfils its specific intended use with regards to human-factors consideration (validation process);

— be run using joint review process.

6.2.4 Usability methods in relation to the organisational life cycle processes

Usability methods are in the scope of the four organisational processes identified in ISO/IEC 12207 as they

— have to be managed (management process);

— may need equipment, tools, techniques (infrastructure process);

— contribute to assess and improve the Software Life-Cycle Processes (improvement process);

— use the training materials as inputs or lead to develop them more adequately (training process).

6.3 Constraints of project environment

6.3.1 Very tight time-scale

When time is constrained, examples of methods that are relatively not time consuming are: expert evaluation, document-based evaluation methods or available automated evaluations. Most other methods require more time (but sometimes better results can be obtained) although interviews and creativity methods can also be run in a short timescale. However, even if time is tight, not addressing usability correctly runs a significant risk of product failure.

6.3.2 Cost/price control (costly method or not)

The cost of a method is obviously related to a certain extent to the time required. Nevertheless, the two notions should not be equated. For instance, involving several experts to run methods which imply the involvement of users can be costly but can be carried out without major impacts on delays. Buying the expertise of an automated evaluation can speed up the assessment but can be expensive. On the other hand, document-based methods are probably the less costly (a restriction is that they may not be necessarily appropriate to detect complex usability issues). In any case, a low involvement of usability methods can lead to sub-optimal outcomes.

One way to by-pass this constraint is to consider cost/benefit ratio. Informed choice (specific to the project) can then be supported by the expectation that the costs (for example, costs for the direct involvement of users) can be overtaken by the benefits accrued (for example in terms of greater user acceptance and performance levels).

6.3.3 High quality level of the product to be delivered as the dominant requirement

When the goal is to reach a very high quality level, the more methods the better, especially when methods can involve users directly.

6.3.4 Need for early information/feed-back/diagnosis

When the diagnosis has to be obtained early in the development process, all methods that allow direct user feed-back are recommended, particularly interviews.

6.3.5 Highly evolving specifications

If the specifications for a project are highly evolving , prototypes will be especially useful. They will be used in conjunction with methods which imply the involvement of users to stabilise the content of functions to be delivered according to the needs of the users.

Table 4 gives methods related to primary life-cycle processes.

Table 4 — The constraints of the environment on the project

Project characteristics	Methods											
	Observation of users	Performance-related measurements	Critical incidents analysis	Questionnaires	Interviews	Thinking aloud	Collaborative design and evaluation	Creativity methods	Document-based methods	Model-based methods	Expert evaluation	Automated evaluation
Very tight time-scale		–	–	–		–	–		+	–	++	+
Cost/price control		–	–		–	–		–	++	–	+	
High quality level of the product to be delivered as the dominant requirement	++	++	+	++	++	+	+	+	+	+	+	+
Need for an early information/feed-back/diagnosis	+			+	++		+	+			+	
highly evolving specifications	+	+	+	+	+	+	++	+				

Legend

++	Recommended;
+	Appropriate;
When the cell is empty	Neutral;
–	Not recommended;
NA	Not applicable (NA).

6.4 User characteristics

6.4.1 Cannot be involved/accessed

If it is impossible for users to be involved there will be heavy reliance on methods based on indirect user involvement, such as document-based, model-based, expert evaluation, and automatic methods. However, every effort should be made to validate the results derived from these indirect sources by gathering information via some form of user involvement when the design had been implemented.

6.4.2 Can be involved/accessed

Involving users is best; however this involves knowing the characteristics of the groups to which the product is dedicated, in order to gain access to the users (including the agreement of their management if necessary) and to obtain their consent to participate.

If the user population varies widely in skills, knowledge, experience, cultural and linguistic background, age, etc., methods which involve users can still be used but their validity will depend upon the sample size and the extent to which they are representative of the whole set of users. Heterogeneity of the targeted population precludes none of the methods. If there is no restriction about the users of the product or system, the constraints on sampling due to the costs of large surveys may be prohibitive. However, expert evaluation and the use of models can still be useful, based on a sub-set of the population.

6.4.3 Have a significant disability

When the users have severe disabilities, knowledge about exact capability can be difficult to obtain and inter-individual variations for a given handicap can be considerable, excluding the use of "universal" guidance. Consequently methods that imply a close relationship between the user and the analyst are particularly recommended (e.g. observations, interviews, collaborative design).

Table 5 gives methods related to the user characteristics.

Table 5 — Methods related to the user characteristics

User characteristics	Methods											
	Observation of users	Performance-related measurements	Critical incidents analysis	Questionnaires	Interviews	Thinking aloud	Collaborative design and evaluation	Creativity methods	Document-based methods	Model-based methods	Expert evaluation	Automated evaluation
Cannot be involved/accessed	NA	NA	NA	NA	NA	NA	NA	NA	+	+	+	+
Can be involved/accessed	++	++	+	++	++	+	++	+	+	+	+	+
Have a significant disability	++	+	+	+	++	+	++	+	+	–	+	–

Legend

++	Recommended;
+	Appropriate;
When the cell is empty	Neutral;
–	Not recommended;
NA	Not applicable (NA).

6.5 Characteristics of the task to be performed

6.5.1 The task is highly complex

When the level of complexity is high, it is particularly important to have a complete and reliable task model. Therefore all methods converging towards that goal (especially critical incidents analysis, interviews and thinking aloud) are recommended.

The complexity requires both ergonomic skills and the use of several approaches.

6.5.2 Errors can lead to severe consequences

When the errors can lead to severe consequences (e.g. safety critical systems), it is important to gather detailed data on the situation, for instance using observation and performance-related measurements as well as model-based methods. However when safety is essential, the more methods the better.

6.5.3 The task is completely new to the users

When the task is a completely new one, there is a need to collaborate with the user in order to identify appropriate specifications. Collaborative design and evaluation as well as creativity methods are recommended.

In addition, the observation of users (when a prototype is available) as well as methods based on existing ergonomics knowledge can be useful.

6.5.4 There is a wide task spectrum

When the range of tasks is wide, that is when there are large variations in functionality, all methods can be used. However, facing such a wide spectrum may be facilitated by using “standardised” methods, themselves with broad scope such as questionnaires, document-based methods and automated evaluation.

6.5.5 There are major changes in organisation/jobs/technical

In this situation, most methods involving users are useful, especially those that can also concern higher level aspects (social and organisational changes) such as creativity methods and collaborative design. Model-based and automated evaluation do not focus on such changes.

Also it may be useful to perform evaluations on a small scale using a pilot site.

6.5.6 There are high levels of time and accuracy constraints for interaction

In this situation, that is when there is time pressure, tight schedules, heavy workload and strong constraints on accuracy, it is recommended to use methods that allow evaluation of user output performances such as performance related measurements or estimations through model based evaluation, or tracking of past deviations through critical incident analysis.

Table 6 gives methods related to the task to be performed.

Table 6 — Characteristics of the task to be performed

Task characteristics	Methods											
	Observation of users	Performance-related measurements	Critical incidents analysis	Questionnaires	Interviews	Thinking aloud	Collaborative design and evaluation	Creativity methods	Document-based methods	Model-based methods	Expert evaluation	Automated evaluation
The task is highly complex	+	+	++	+	++	++	+	+		+		
Errors can lead to severe consequences	++	++	++	+	+	+	+		+	++	+	
The task is completely new to the users	+		NA				++	++	+	+	+	
There is a wide task spectrum	+	+	+	++	+	+	+	+	++	+	+	++
There are major changes in organisation/jobs/ technical	+	+	+	+	+	+	++	++	+	–	+	–
There are high levels of time and accuracy constraints for interaction	+	++	++			–	–	–	–	+	–	–

Legend

++	Recommended;
+	Appropriate;
When the cell is empty	Neutral;
–	Not recommended;
NA	Not applicable (NA).

6.6 The product used

6.6.1 Adaptation of an already existing system/product

Most methods are appropriate: methods with direct user involvement, but also methods that are based on existing ergonomics knowledge or expertise in cases where the previous system has been widely assessed from an ergonomic point of view.

6.6.2 Limited and simple well-understood product

In such situations, that is when the product is simple, when its characteristics are not particularly novel, “standardised” ergonomic knowledge can be applied (e.g. document-based and expert evaluation) as well as limited investigations of users opinions and perceptions through structured questionnaires.

6.6.3 High degree of adaptability of the product (customisable product)

The product can be described as having a “high degree of adaptability” when it can be customised according to the specific environment within which it will be used. That is especially the case when the product is parameterized and when user-tailoring allows it to be adapted.

In such cases, the methods which imply the involvement of users are preferred, in order to fine tune the tailoring.

Table 7 gives methods related to the product used.

Table 7 — Product used

Product characteristics	Methods											
	Observation of users	Performance-related measurements	Critical incidents analysis	Questionnaires	Interviews	Thinking aloud	Collaborative design and evaluation	Creativity methods	Document-based methods	Model-based methods	Expert evaluation	Automated evaluation
Adaptation of an already existing system/product	+	++	++	++	+	+	+		++	++	+	+
Limited and simple well-understood product	+	+		++	+		+		++		++	
High degree of adaptability of the product (customisable product)	+	+	+	+	++	+	++	+				

Legend

++	Recommended;
+	Appropriate;
When the cell is empty	Neutral;
–	Not recommended;
NA	Not applicable (NA).

6.7 The abilities required for the designer or appraiser/evaluator

6.7.1 The designer/appraiser has access to extensive ergonomic/human-factors skills/expertise

Whenever human-factors expertise is available in-house or outside, all methods can be used including the ones that require high skill levels. Of course such expertise has to be relevant to the application domain and this may imply the involvement of experts in the task domain.

6.7.2 The designer/appraiser has no access to extensive ergonomic/human-factors skills/expertise

In this situation, there is a limited access to state-of-the-art methods. However certain methods can be used without extensive expertise such as collaborative design and creativity methods (but possibly with non-optimal results). Also ergonomic knowledge can be accessed through document-based methods and standardised questionnaires when automated evaluations can only be run carefully with existing well-documented protocols. In addition observation is always useful.

Table 8 gives methods related to expertise.

Table 8 — The abilities required for the designer or appraiser/evaluator

Skills issues	Methods											
	Observation of users	Performance-related measurements	Critical incidents analysis	Questionnaires	Interviews	Thinking aloud	Collaborative design and evaluation	Creativity methods	Document-based methods	Model-based methods	Expert evaluation	Automated evaluation
The designer/appraiser has access to extensive ergonomic/human-factors skills/expertise	++	++	++	++	++	++	++	++	++	++	++	++
The designer/appraiser has limited access to ergonomic/human-factors skills/expertise	+	–	–	+	–	–	+	+	+	–	NA	+

Legend

++	Recommended;
+	Appropriate;
When the cell is empty	Neutral;
–	Not recommended;
NA	Not applicable (NA).

Annex A

Proposed template to identify the adequate usability methods for a specific project

A.1 How to start ?

First step: first review based on project characteristics (stage in life-cycle process and environment constraints)

As the choice of possible usability methods is highly dependent upon the stage of the project, the first step (see Table A.1) will be dedicated to identify appropriate methods with regards to the position of the project in the life cycle.

Another orientation of choices can be made by taking into account the environment constraints of the project.

The way to proceed is to answer each one of the questions in the list, and then to focus the choice on those which are recommended (++) or appropriate (+), rather than methods which are not recommended (–) or not applicable (NA).

A.2 How to refine the choice ?

Second step: complementary selection based on project specifics

There are then four main issues that can influence the choice (see clause 6 for more details):

a) the user characteristics;

b) the task characteristics;

c) the product characteristics ;

d) skills issues.

These issues lead to detailed questions (see Table A.2) which allow refinement of the choice.

The sequence in which they have to be considered depends a lot on the context.

The absence of ergonomic expertise inside the project is not considered as a constraint and has to be considered at the end as this expertise can be imported (bought from outside).

If, after filling in the grid, elementary choices lead to incompatibilities, then the number of items checked and the priorities given have to be taken into account to reach a final choice. Notations can also be fine tuned depending on the context of the specific project.

If more methods are used, the higher the probabilities of obtaining a human-centred result.

Table A.1 — First step: first review based on project characteristics (stage in life-cycle process and environment constraints)

Project characteristics	Categories of methods											
	Observation of users	Performance-related measurements	Critical incidents analysis	Questionnaires	Interviews	Thinking aloud	Collaborative design and evaluation	Creativity methods	Document-based methods	Model-based methods	Expert evaluation	Automated evaluation
Life-cycle process												
Acquisition – Supply	++	+	+	+	+		+		++		+	
Development – Requirements analysis	++	+	+	++	++	++	+	+	+	+	+	
Development – Architectural design	+	++		+	+	++	+	++	++	+	+	+
Development – Qualification testing	+	++	+	++	++	+	+		+	+	+	+
Maintenance – Operation	+	+	+	+	+		+				+	
Project environment constraints												
Very tight time-scale		–	–	–		–	–		+	–	++	+
Cost/price control		–	–		–	–		–	++	–	+	
High quality level of the product to be delivered as the dominant requirement	++	++	+	++	++	+	+	+	+	+	+	+
Need for an early information/feed-back/diagnosis	+			+	++		+	+			+	
Highly evolving specifications	+	+	+	+	+	+	++	+				

Legend

++	Recommended;
+	Appropriate;
When the cell is empty	Neutral;
–	Not recommended;
NA	Not applicable (NA).

Table A.2 — Second step: complementary selection based on project specifics

Characteristics	Methods											
	Observation of users	Performance-related measurements	Critical incidents analysis	Questionnaires	Interviews	Thinking aloud	Collaborative design and evaluation	Creativity methods	Document-based methods	Model-based methods	Expert evaluation	Automated evaluation
User characteristics												
Cannot be involved/accessed	NA	NA	NA	NA	NA	NA	NA	NA	+	+	+	+
Can be involved/accessed	++	++	+	++	++	+	++	+	+	+	+	+
Have a significant disability	++	+	+	+	++	+	++	+	+	–	+	–
Task characteristics												
The task is highly complex	+	+	++	+	++	++	+	+		+		
Errors can lead to severe consequences	++	++	++	+	+	+	+		+	++	+	
The task is completely new for the users	+		NA				++	++	+	+	+	
There is a wide task spectrum	+	+	+	++	+	+	+	+	++	+	+	++
There are major changes in organization/jobs/technical	+	+	+	+	+	+	++	++	+	–	+	–
There are high levels of time and accuracy constraints for interaction	+	++	++			–	–	–	–	+	–	–
Product characteristics												
Adaptation of an already existing system/product	+	++	++	++	+	+	+		++	++	+	+
Limited and simple well-understood product	+	+		++	+		+		++		++	
High degree of adaptability of the product (customizable product)	+	+	+	+	++	+	++	+				
Skills issues												
The designer/appraiser has access to extensive ergonomic/human-factors skills/expertise	++	++	++	++	++	++	++	++	++	++	++	++
The designer/appraiser has limited access to ergonomic/human-factors skills/expertise	+	–	–	+	–	–	+	+	+	–	NA	+

Legend

++	Recommended;
+	Appropriate;
When the cell is empty	Neutral;
–	Not recommended;
NA	Not applicable (NA).

Annex B

Examples of *in situ* applications

B.1 Example 1: diagnosis of car breakdowns

The customer was a car manufacturing company.

That company (its after-sales service management) took a software core and library to a software editor and consulting society, asking for customization to their specific needs.

The purpose of the target system in this company is to help the maintenance technicians to diagnose car breakdowns, depending on the characteristics of the car.

When the beta system was shown to the technicians, during training, all technicians rejected the new system. The system was difficult to use, because of the use of very bad labelling.

The goal of the intervention was to correct the interface as soon as possible due to the emergency of the situation, but without impacting the data model.

The intervention occurred later in the process (Development – Qualification testing step). The software being completed, few modifications were possible.

Taking place just before the summer holidays, the constraint was for the prestation to be completed before the holidays. The consulting lasted one week (Very tight time scale).

The users were the technicians of the company's worldwide network. One of the main jobs of these users was the maintenance of cars, both diagnoses and repairs.

The software-supported diagnosis tool, which was added as a new function of the existing tool (Adaptation of an already existing system/product), modified the task of the users (There are major changes in organization/jobs/technical). The worldwide distributed system had a very large audience. Moreover, in the workshop, the technicians could not use paper-help support, putting high constraints on the “hands-on” direct usability of the human-computer interface (There are high levels of accuracy constraints for interaction).

The service provided was the evaluation of the target human-computer interface and the design of a prototype for a new interface by a human-factors expert (The appraiser has access to extensive ergonomic expertise). Its associated workload was five man-days.

The expert (a human-factors engineer) was able to interview the trainer, a highly skilled technician, who explained

— the end user's work, including the fact that the new features of the dashboard were not mastered by the end user, and

— the constraints upon the task (the software was on a workstation outside the car, while the breakdown was on the dashboard).

The trainer showed photographs and documents. Then, the expert was able to design a prototype. After validation of this prototype by the client, it was implemented in the software.

The selected methods were the following.

— Expert evaluation of the target system.

— Interview with a maintenance expert, member of the after-sales service management. Analysis of documents which are used for communication between the customers and this company.

— Analysis of cars' control panel, using photographs.

— Collaborative design of a mock-up, using a GUI tool, implementing the proposals.

The following methods were not selected for the reasons stated:

— observation of users: the problems were quite obvious and straightforward, it was not necessary to observe the users performing their tasks;

— performance-related measurement: the software was not used, it was not possible to get performance measurement; moreover, the time constraints didn't allow this measurement to be made;

— critical incidents analysis: no critical incidents were recorded before;

— questionnaires: there were not enough people to allow questionnaire or survey methods;

— thinking aloud: the problems were clear and simple, it was not necessary to use this method;

— creativity methods: the solution, being trivial, did not need creativity methods;

— model-based methods: the model-based methods could not be done in a very short delay;

— automated evaluation: it was not possible to make an automated evaluation with this software (no capture).

Match with ISO/TR 16982 (see Table B.1)

In order to simplify the presentation, only the applicable questions with regard to the given case have been kept.

The chosen methods are identified in the table with a grey background.

Table B.1 — Grid of ISO/TR 16982: diagnosis of car's breakdown

Characteristics	Categories of methods											
	Observation of users	Performance-related measurements	Critical incidents analysis	Questionnaires	Interviews	Thinking aloud	Collaborative design and evaluation	Creativity methods	Document-based methods	Model-based methods	Expert evaluation	Automated evaluation
Development-qualification testing	+	++	+	++	++	+	+		+	+	+	+
Very tight time-scale		–	–	–		–	–		+	–	++	+
Can be involved/accessed	++	++	+	++	++	+	++	+	+	+	+	+
There are major changes in organization/jobs/technical	+	+	+	+	+	+	++	++	+	–	+	–
There are high levels of time and accuracy for interaction	+	++	++			–	–	–	–	+	–	–
Adaptation of an already existing system/product	+	++	++	++	+	+	+		++	++	+	+
The designer/appraiser has access to extensive ergonomic/human-factors skills/expertise	++	++	++	++	++	++	++	++	++	++	++	++

Legend

++	Recommended;
+	Appropriate;
When the cell is empty	Neutral;
–	Not recommended;
NA	Not applicable (NA).

B.2 Example 2: accounting software

The customer was a service company in management and accountancy, dedicated to specific professionals (such as doctors, notaries, etc.).

This company mainly proposed accountancy processing services. Until now, the customers either wrote the accounts or used software for this purpose. One of those tools was an internal software package, developed by the computer department of the company.

The company wanted to develop a new accounting package (Development – Requirements analysis) keeping benefit from internet media for entry, transfer and processing of the data.

The backer was the computer department of the company. The intervention, which was 30 man-days during three months, occurred before and during specifications.

The users were members of the accountancy profession and customers of the company.

They were not familiar with computers and were likely to be reticent with the use of data processing and internet for the acquisition and transfer of data accounts. So, it was very important to make sure that tools fitted their users'

needs. (There are major changes in organization/jobs/technical but users can be accessed in conditions of real-life use.)

The consulting service consisted of running a preliminary analysis (Need for an early information/feed-back/diagnosis) in order to take part in the specification of the new product.

The methods used were the following:

— users' activity and task analysis in the context of accounting task (observations, interviews);

— analysis of documents (delivers accountancy, various documents of exchanges between the customers and the company, etc.);

— analysis of preliminary tools: paper-forms and software;

— analysis of critical incidents on these tools (hot-line, interviews of the accountants of the company);

— free observation of use of software already used.

Match with ISO/TR 16982 (see Table B.2)

In order to simplify the presentation, only the pertinent questions with regard to the given case have been kept. The chosen methods are identified in the table with a grey background.

In this case, the document-based analysis and expert methods have been used, although there were high constraints on the task interaction. In fact, when expertise is available, those methods are classically used at the early stage of the ergonomic work, in order to plan the whole ergonomic process. For example, it helps to build the protocol for the users' observations and interviews.

Performance-related measurements were not practised, because the duration of the intervention didn't allow it. Such performance-related measurements preparation takes time and has to be done after capturing some information about the task (through interview or observation). So, good interviews and observation were chosen as a focus.

Table B.2 — Grid of ISO/TR 16982: accounting software

Characteristics	Methods											
	Observation of users	Performance-related measurements	Critical incidents analysis	Questionnaires	Interviews	Thinking aloud	Collaborative design and evaluation	Creativity methods	Document-based methods	Model-based methods	Expert evaluation	Automated evaluation
Development – Requirements analysis	++	+	+	++	++	++	+	+	+	+	+	
Need for an early information/feed-back/diagnosis	+			+	++		+	+			+	
Users can be easily involved/accessed	++	++	+	++	++	+	++	+	+	+	+	+
There are major changes in organization/jobs/technical	+	+	+	+	+	+	++	++	+	–	+	–
There are high levels of time and accuracy constraints for interaction	+	++	++			–	–	–	–	+	–	–
Adaptation of an already existing system/product	+	++	++	++	+	+	+		++	++	+	+
Limited and simple well-understood product	+	+		++	+		+		++		++	
The designer/appraiser has access to extensive ergonomic/human-factors skills/expertise	++	++	++	++	++	++	++	++	++	++	++	++

Legend

++	Recommended;
+	Appropriate;
When the cell is empty	Neutral;
–	Not recommended;
NA	Not applicable (NA).

B.3 Example 3: software for industrial-scrap treatment

The customer was a small consulting company in industrial-scrap treatment. The backer was the company's manager. The company was developing software relating to its own competence (Development – Architectural design). The goal was to realize a tool which could be used even by people not used to a computer.

The company was aware of the complexity of some tasks and considered the usability of the software to be a challenge.

The intervention occurred during the prototyping phase. The constraint was that the company could not afford too big a budget for this consulting (Cost/price control).

The users were different persons in the company (director, director of production, etc.) who had to manage the industrial scrap treatment. Those people, not used to computers, could use the software only once a month.

The proposed service was a five man-day evaluation of some functionalities and of the human-computer interface.

As the users were not accessible (User cannot be involved/accessed) and because of the budget constraint, the choice for the methods used was restricted to

— document-based methods, and

— expert evaluation.

Match with ISO/TR 16982 (see Table B.3)

In order to simplify the presentation, only those pertinent questions regarding the given case have been kept. The chosen methods are identified in the table with a grey background.

Table B.3 — Grid of ISO/TR 16982: software for industrial-scrap treatment

Characteristics	Methods											
	Observation of users	Performance-related measurements	Critical incidents analysis	Questionnaires	Interviews	Thinking aloud	Collaborative design and evaluation	Creativity methods	Document-based methods	Model-based methods	Expert evaluation	Automated evaluation
Development – Architectural design	+	++		+	+	++	+	++	++	+	+	+
Cost/price control		–	–		–	–		–	++	–	+	
Highly evolving specifications	+	+	+	+	+	+	++	+				
User cannot be involved/accessed	NA	NA	NA	NA	NA	NA	NA	NA	+	+	+	+
There are major changes in organization/jobs/ technical	+	+	+	+	+	+	++	++	+	–	+	–
The designer/appraiser has access to extensive ergonomic/human-factors skills/expertise	++	++	++	++	++	++	++	++	++	++	++	++

Legend

++	Recommended;
+	Appropriate;
When the cell is empty	Neutral;
–	Not recommended;
NA	Not applicable (NA).

B.4 Example 4: telephone software

The customer was a telecom company which had developed a telephone software dedicated to small enterprises. The company wanted to evaluate the software before bringing it to the market (Development – qualification testing). The backer was the marketing service.

The intervention occurred during the last version of the product, a few months before its commercialization. Some evolution was allowed, but it was not possible to make too major a change impacting the architecture.

The product was designed for small companies, which could not afford to set up a phone standard, the users being different members of these small enterprises managing their communications on their own.

The users were supposed to use a computer and to be able to control all their communication (telephone, fax, e-mail, small electronic message, etc.) through this software (offering different functionalities to control and archive communications).

The consulting consisted of 70 man-days dedicated to evaluation of the software and of its on-line help through the following methods:

— user tests;

— expert evaluation.

Match with ISO/TR 16982 (see Table B.4)

In order to simplify the presentation, only the pertinent questions with regard to the given case have been kept. The chosen methods are identified in the table with a grey background.

In this case, the performance-related measurements were the major method. But, to prepare the user tests, it was necessary to do a previous analysis, through expert evaluation, using documents.

Table B.4 — Grid of the ISO/TR 16982: Telephone software

Characteristics	Methods											
	Observation of users	Performance-related measurements	Critical incidents analysis	Questionnaires	Interviews	Thinking aloud	Collaborative design and evaluation	Creativity methods	Document-based methods	Model-based methods	Expert evaluation	Automated evaluation
Development – Qualification testing	+	++	+	++	++	+	+		+	+	+	+
Users can be easily involved/accessed	++	++	+	++	++	+	++	+	+	+	+	+
The task is highly complex	+	+	++	+	++	++	+	+		+		
Errors can lead to severe consequences	++	++	++	+	+	+	+		+	++	+	
The task is completely new for the users	+		NA				++	++	+	+	+	
There are major changes in organization/jobs/technical	+	+	+	+	+	+	++	++	+	–	+	–
The designer/appraiser has access to extensive ergonomic/human-factors skills/expertise	++	++	++	++	++	++	++	++	++	++	++	++

Legend

++	Recommended;
+	Appropriate;
When the cell is empty	Neutral;
–	Not recommended;
NA	Not applicable (NA).

B.5 Example 5: web site of documentation centres and libraries

The customer was an institution whose goal was to animate the site of a group of documentation centres and libraries, offering information about those centres and the opportunity to examine their catalogues.

The backer was the group in charge of the site (web technicians, documentation professionals).

The consulting objective was to evaluate the site in order to improve it (Maintenance – Operation), especially to make it easier to use and closer to the users' needs (Users can be easily involved).

This site was dedicated to two different kinds of population: documentation professionals and users of the centres and libraries. So, the challenge was to have a site which could satisfy these two kinds of population. Catalogue queries, in particular, had to be accessible to a non-specialist public.

This service (evaluation and improvements proposal) was performed in 60 man-days.

The chosen methods were

— expert evaluation,

— observation, interviews, questionnaires, and

— user tests.

Match with ISO/TR 16982 (see Table B.5)

In order to simplify the presentation, only the pertinent questions with regard to the given case have been kept. The chosen methods are identified in the table with a grey background.

In this case, there was a span of several possible methods. The choice was to consult the users, after a first expert evaluation (documented) through different methods: observation, performance-related measurements, interviews and questionnaires, etc.

The document-based analysis and expert evaluation methods were used, although it was a maintenance activity. In fact, when the ergonomic task is run by a specialist, those methods are classically used at the early stage of the ergonomic work in order to prepare the whole ergonomic process, as it helps to build the protocol of the users' observations and interviews.

Table B.5 — Grid of ISO/TR 16982: Web site of documentation centres and libraries

Characteristics	Methods											
	Observation of users	Performance-related measurements	Critical incidents analysis	Questionnaires	Interviews	Thinking aloud	Collaborative design and evaluation	Creativity methods	Document-based methods	Model-based methods	Expert evaluation	Automated evaluation
Maintenance – Operation	+	+	++	+	+		+				+	
Highly evolving specifications	+	+	+	+	+	+	++	+				
Users can be easily involved	++	++	+	++	++	+	++	+	+	+	+	+
The task is highly complex	+	+	++	+	++	++	+	+		+		
There is a wide task spectrum	+	+	+	++	+	+	+	+	++	+	+	++
The designer/appraiser has access to extensive ergonomic/human-factors skills/expertise	++	++	++	++	++	++	++	++	++	++	++	++

Legend	
++	Recommended;
+	Appropriate;
When the cell is empty	Neutral;
–	Not recommended;
NA	Not applicable (NA).

Annex C

Additional methods and techniques

The detailed methods presented in this annex are linked with methods in Table 1. They are described, if they exist and if they are sub-methods of those already quoted.

Table C.1 — Additional methods and techniques versus referenced methods

Name of the method	Additional methods and techniques
Observation of users	Log files, video captures and scan converter
Questionnaires	Electronic surveys
Collaborative design and evaluation	Parallel design
Creativity methods	Focus group and brainstorming

C.1 Log files

Log files are linked to the observation of users, performance-related measurement and critical incident. It is more a technique than a sub-method.

It is often desirable to have the computer automatically collect a detailed, time-stamped history of the users' entire session. It is sometimes possible to modify the logging software so that only those events which are of immediate interest are recorded, for example, in order to avoid collecting low-level interactions.

In situations where it is important to get some understanding of the reasoning process behind some user action, it is necessary to combine the logs with methods, such as thinking aloud or retrospective interviews.

Advantages

- Unobtrusive data capture for the user;
- highly accurate data;
- entire history of users interaction is recorded.

Disadvantages/constraints

- Large volume of data to be analysed;
- raw data is of little use in evaluating the users' performance;
- events recorded are low-level (only transactions are recorded).

C.2 Video capture

Video capture is linked to observation of users and thinking aloud. It is more a technique than a sub-method.

Video-taping users as they interact with the system is essential for many purposes. Expert analysis of the data will be necessary before useful recommendations can be made. In other words, simply capturing the user interaction on film will not give us the answers to what features may need to be modified and how to modify them.

Advantages

— Entire history of users' interaction is recorded;

— can be shown to developers to illustrate problems encountered by users;

— useful back-up for real-time observations.

Disadvantages/constraints

— Potentially, can create huge mass of data to be analysed;

— raw data is of little use in evaluating the users' performance;

— video-taping can feel intrusive to some users.

C.3 Scan converter

The scan converter is linked to the observation of users and performance-related measurement. It is more a technique than a sub-method.

When it is important to get the clearest image possible of the screen, as opposed to the user interacting with the computer, it may be preferable to use a scan converter as opposed to a video camera. The converter records the data directly from the computer screen onto the film. Using a converter also puts some users at ease, who might otherwise be uncomfortable being filmed.

C.4 Electronic surveys

Linked to questionnaires, electronic surveys are like paper surveys. In comparing answers to the same questionnaire administered on paper and electronically on-line, not much difference is found in the respondents' answers. However, the timing of the questionnaires' administration may be critical in that those who complete it shortly after having used the system may give more informative answers than those who complete it a few days later.

C.5 Parallel design

Linked to collaborative design and evaluation, parallel design is a method for developing and evaluating different system ideas before settling on a single approach as a basis for the system. In the case of human-centred approach, parallel design can involve different groups of designers and users, in order to test and compare various solutions and/or human-centred methods.

C.6 Focus group

Linked to the creativity method, a focus group usually consists of a discussion involving small groups, led by a moderator. The aim is to gain information about user opinions and perceptions, attitudes and preferences. Successful focus groups depend on having well-structured questions to ask and having a skilled discussion leader who understands the goals of the session. The moderator has to encourage the free flow of users' ideas but keep them on track with regard to the theme being discussed.

Focus groups cannot deliver information about how users will interact with the product or system.

In addition to supplying ideas for design, focus groups can be used in the evaluation perspective.

C.7 Brainstorming

Linked to the creativity method, brainstorming is a team activity which can involve the designer and/or users.

The principle is to collect ideas from the members of the team. They have to call out ideas (no matter how impractical). Those ideas are then recorded and noted by one member of the team. One team member acts as a “moderator”. The moderator's role is to prompt the team and to ensure that the discussion is not going off at a tangent.

This technique is often used in deciding on the interface metaphor or style used in multimedia applications.

The detailed methods presented in this annex are linked with the methods given in Table 1. Detailed methods are described, if they exist and if they are sub-methods of those already quoted.

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