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Human-centred design processes for interactive systems

Processus de conception centrée sur l'opérateur humain pour les systèmes interactifs

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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.

International Standard ISO 13407 was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 4, *Ergonomics of human-system interaction*.

Annexes A, B and C of this International Standard are for information only.

Introduction

Human-centred design is an approach to interactive system development that focuses specifically on making systems usable. It is a multi-disciplinary activity which incorporates human factors and ergonomics knowledge and techniques. The application of human factors and ergonomics to interactive systems design enhances effectiveness and efficiency, improves human working conditions, and counteracts possible adverse effects of use on human health, safety and performance. Applying ergonomics to the design of systems involves taking account of human capabilities, skills, limitations and needs.

Human-centred systems support users and motivate them to learn. The benefits can include increased productivity, enhanced quality of work, reductions in support and training costs, and improved user satisfaction. Although there is a substantial body of human factors and ergonomics knowledge about how such design processes can be organized and used effectively, much of this information is only well-known by specialists in these fields. This International Standard aims to help those responsible for managing hardware and software design processes to identify and plan effective and timely human-centred design activities. It complements existing design approaches and methods.

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Human-centred design processes for interactive systems

1 Scope

This International Standard provides guidance on human-centred design activities throughout the life cycle of computer-based interactive systems. It is aimed at those managing design processes and provides guidance on sources of information and standards relevant to the human-centred approach.

This International Standard is concerned with both hardware and software components of interactive systems.

NOTE Computer-based interactive systems vary in scale and complexity. Examples include off-the-shelf (shrink wrap) software products, custom office systems, plant monitoring systems, automated banking systems and consumer products.

This International Standard addresses the planning and management of human-centred design. It does not address all aspects of project management.

This International Standard provides an overview of human-centred design activities. It does not provide detailed coverage of the methods and techniques required for human-centred design, nor does it address health and safety aspects in detail.

The main users of this International Standard will be project managers. This International Standard 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 (see bibliography) which is complementary to this International Standard 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 International Standard relevant.

2 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

2.1
interactive system
combination of hardware and software components that receive input from, and communicate output to, a human user in order to support his or her performance of a task

NOTE The term “system” is often used rather than “interactive system”.

2.2
prototype
representation of all or part of a product or system that, although limited in some way, can be used for evaluation

2.3
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, definition 3.1]

2.4
effectiveness
accuracy and completeness with which users achieve specified goals

[ISO 9241-11:1998, definition 3.2]

2.5
efficiency
resources expended in relation to the accuracy and completeness with which users achieve goals

[ISO 9241-11:1998, definition 3.3]

2.6
satisfaction
freedom from discomfort, and positive attitudes to the use of the product

[ISO 9241-11:1998, definition 3.4]

2.7
context of use
users, tasks, equipment (hardware, software and materials), and the physical and social environments in which a product is used

[ISO 9241-11:1998, definition 3.5]

2.8
user
individual interacting with the system

[ISO 9241-10:1996, definition 2.2]

3 Structure of this International Standard

Clause 4 outlines the reasons for adopting a human-centred design process. These can be used to provide a rationale for the use of human-centred methods, or to determine priorities for resource allocation during a project.

Clause 5 gives guidance on the principles of human-centred design. Clause 6 lists the issues to be considered when planning human-centred design activities and discusses how these should relate to system design goals.

Clause 7 is the core of this International Standard. It describes each of the four essential human-centred activities which should take place during the design process. Clause 8 gives further guidance on reporting human-centred activities.

4 Rationale for adopting a human-centred design process

All work systems should follow the ergonomic principles described in ISO 6385:1981. Making interactive systems more human-centred has substantial economic and social benefits. In most countries, employers and system providers have legal obligations to protect users from risks to their health and safety. Making systems more usable means systems can contribute to these aims, meeting user and organizational needs better. They

a) are easier to understand and use, thus reducing training and support costs,

b) improve user satisfaction and reduce discomfort and stress,

c) improve the productivity of users and the operational efficiency of organizations, and

d) improve product quality, appeal to the users and can provide a competitive advantage.

The complete benefits of human-centred design can be determined by taking into account the total life-cycle costs of the system including conception, design, implementation, support, use and maintenance.

5 Principles of human-centred design

5.1 General

There are many industry and proprietary standard methods for the design of computer-based interactive systems. This International Standard does not assume any one standard design process, nor does it cover all the different activities necessary to ensure effective system design. It is complementary to existing design methods and provides a human-centred perspective that can be integrated into different forms of design process in a way that is appropriate to the particular context. All the human-centred design activities identified in clause 7 are applicable, to a greater or lesser extent, at any stage in the development of a system.

Whatever the design process and allocation of responsibilities and roles adopted, the incorporation of a human-centred approach is characterized by the following:

a) the active involvement of users and a clear understanding of user and task requirements;

b) an appropriate allocation of function between users and technology;

c) the iteration of design solutions;

d) multi-disciplinary design.

5.2 The active involvement of users and a clear understanding of user and task requirements

The involvement of users in the development process provides a valuable source of knowledge about the context of use, the tasks, and how users are likely to work with the future product or system. The effectiveness of user involvement increases as the interaction between the developers and the users increases. The nature of user involvement varies depending on the design activities which are being undertaken.

When custom-made products are being developed, the proposed users and the tasks performed can be directly linked to the development process. The organization procuring the system has the opportunity to have a direct influence on the design as it emerges, and solutions can be evaluated by those who are actually going to be working with them. Such involvement and participation also increase user acceptance and commitment.

When generic or consumer products are being developed, the user population is dispersed and is perhaps not easily accessible. It is still essential that users or appropriate representatives are involved in development, in order that the relevant user and task requirements can be identified for inclusion in the system specification, and in order to provide feedback through testing of the proposed design solutions.

5.3 An appropriate allocation of function between users and technology

One of the most important human-centred design principles concerns the appropriate allocation of function – the specification of which functions should be carried out by the users and which by the technology. These design decisions determine the extent to which a given job, task, function or responsibility is to be automated or assigned to human performance.

The decisions should be based on many factors, such as relative capabilities and limitations of humans versus technology in terms of reliability, speed, accuracy, strength, flexibility of response, financial cost, the importance of successful or timely accomplishment of tasks and user well-being. They should not simply be based on determining which functions the technology is capable of performing and then simply allocating the remaining functions to users, relying on their flexibility to make the system work. The resulting human functions should form a meaningful set of tasks. Representative users should generally be involved in these decisions. For further guidance, see ISO 9241-2 and ISO 10075.

5.4 Iteration of design solutions

In iterative design approaches, feedback from users becomes a critical source of information. Iteration, when combined with active user involvement, provides an effective means of minimizing the risk that a system does not meet user and organizational requirements (including those requirements that are hidden or difficult to specify

explicitly). Iteration allows preliminary design solutions to be tested against “real world” scenarios, with the results being fed back into progressively refined solutions.

Iteration can be incorporated in other design approaches. Even in the “waterfall” model, where there is a systematic top-down hierarchy of design decisions and the relationship between the stages generally precludes iteration between them, there can be extensive iteration within a stage.

5.5 Multi-disciplinary design

Human-centred design needs a variety of skills. A range of personnel is necessary to address the human aspects of the design. This means that multi-disciplinary teams should be involved in a user-centred design process. These can be small, dynamic and need only last the life of the project. The composition of the teams should reflect the relationship between the organization responsible for technical development and the customer. The roles can include the following

a) end-user;

b) purchaser, manager of user;

c) application domain specialist, business analyst;

d) systems analyst, systems engineer, programmer;

e) marketer, salesperson;

f) user interface designer, visual designer;

g) human factors and ergonomics expert, human-computer interaction specialist;

h) technical author, trainer and support personnel.

Individual team members can cover a number of different skill areas and viewpoints. Multi-disciplinary teams do not have to be large but the team should be sufficiently diverse to make appropriate design trade-off decisions.

6 Planning the human-centred design process

A plan should be developed to specify how the human-centred activities fit into the overall system development process.

The plan should identify:

a) the human-centred design process activities described in clause 7, i.e. understanding and identifying context of use, specifying user and organizational requirements, producing prototypes and evaluating designs according to user criteria;

b) procedures for integrating these activities with other system development activities, e.g. analysis, design, testing;

c) the individuals and the organization(s) responsible for the human-centred design activities and the range of skills and viewpoints they provide;

d) effective procedures for establishing feedback and communication on human-centred design activities as they affect other design activities, and methods for documenting these activities;

e) appropriate milestones for human-centred activities integrated into the overall design and development process;

f) suitable timescales to allow feedback, and possible design changes, to be incorporated into the project schedule.

This human-centred design process plan should form part of the overall system development project plan and should also be subject to the same project disciplines (e.g. responsibilities, change control) as other key activities to ensure that it is followed through and implemented effectively. The plan should be revised as requirements change and updated to reflect the status of activities.

Project planning should allow for iteration and for incorporating user feedback. Some time is also required for effective communication among design team participants and for reconciling potential conflicts and trade-offs. Projects benefit from additional creativity and ideas from the interaction of team members who, collectively have an extensive skill base. Extra communication and discussion to identify and resolve problems early on in the project can result in significant savings at later stages when changes are generally more costly.

Design organizations should incorporate human-centred design into their existing internal procedures and development standards. This can include organization procedures for prototyping, for testing, for establishing appropriate user involvement, for ensuring the right mix of skills and competence in the development team.

If the developing organization has a quality system and associated quality plans for system development, then a specific plan should be included for the human-centred design process covering both the type of development process adopted and the quality control measures.

7 Human-centred design activities

7.1 General

There are four human-centred design activities that should take place during a system development project.

These activities are

a) to understand and specify the context of use,

b) to specify the user and organizational requirements,

c) to produce design solutions,

d) to evaluate designs against requirements.

The human-centred design process should start at the earliest stage of the project (e.g. when the initial concept for the product or system is being formulated), and should be repeated iteratively until the system meets the requirements, as illustrated in Figure 1.

The need for a human-centred design approach will be identified from the operational objectives of the system, for example, to satisfy customer requirements for usability.

When planning a system development project, the description of each activity and its sub-tasks should be studied and used as guidance in designing or selecting the human-centred design methods and techniques for carrying out the activity and reporting progress and findings. Whereas all of the human design activities described in this clause are generally relevant, the relative focus and overall investment in them will depend on the size and type of the product; for example, a large project, new product or new system could have a full multi-disciplinary team with a member for each relevant role and implement all the human-centred design activities recommended in this clause. In contrast, small projects, existing legacy products or systems or products targeted at niche or small markets could have a smaller design team with individual members representing multiple roles and use a more limited range of methods and techniques to support the activities.

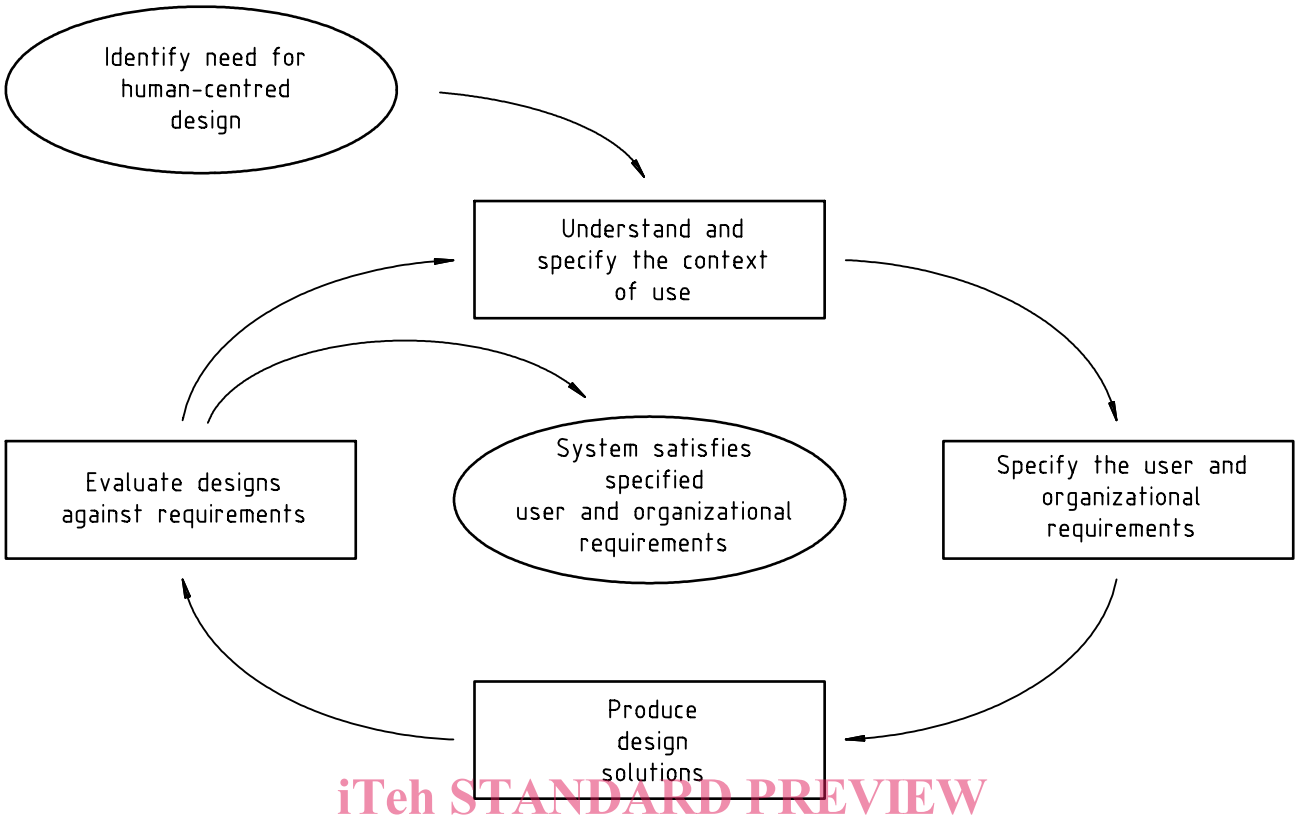

Figure 1 — The interdependence of human-centred design activities

7.2 Understand and specify the context of use

7.2.1 The characteristics of the users, tasks and the organizational and physical environment define the context in which the system is used. It is important to understand and identify the details of this context in order to guide early design decisions, and to provide a basis for evaluation.

Information should be gathered about the context of use of new products and systems. If an existing system is to be upgraded or enhanced, this information may already be available but should be checked. If there are extensive results from user feedback, help desk reports and other data, these provide a basis for prioritizing user requirements for system modifications and changes.

The context in which the system is to be used should be identified in terms of the following.

a) The characteristics of the intended users: relevant characteristics of the users can include knowledge, skill, experience, education, training, physical attributes, habits, preferences and capabilities. If necessary, define the characteristics of different types of users, for example, with different levels of experience or performing different roles (maintainers, installers, etc.).

b) The tasks the users are to perform: the description should include the overall goals of use of the system. The characteristics of tasks that can influence usability should be described, e.g. the frequency and the duration of performance. If there are implications for health and safety, e.g. controlling the behaviour of a computer-controlled production machine, these should also be described. The description should include the allocation of activities and operational steps between the human and technological resources. Tasks should not be described solely in terms of the functions or features provided by a product or system.

c) The environment in which the users are to use the system: the environment includes the hardware, software and materials to be used. Their description can be in terms of a set of products, one or more of which can be the focus of human-centred specification or evaluation, or it can be in terms of a set of attributes or performance characteristics of the hardware, software and other materials.

Relevant characteristics of the physical and social environment should also be described. These can include relevant standards, attributes of the wider technical environment (e.g., a local area network), the physical environment (e.g., workplace, furniture), the ambient environment (e.g., temperature, humidity), the legislative environment (e.g., laws, ordinances and directives) and the social and cultural environment (e.g., work practices, organizational structure and attitudes).

7.2.2 The output from this activity should be a description of the relevant characteristics of the users, tasks and environment which identifies what aspects have an important impact on the system design. (See ISO 9241-11 for more information about the context of use and a sample report.)

NOTE This description is unlikely to be a single output that is issued once. It is more often a “working document” that is first produced in outline terms and is then reviewed, maintained, extended and updated during the design and development process.

The context of use description should

a) specify the range of intended users, tasks and environments in sufficient detail to support design activity;

b) be derived from suitable sources;

c) be confirmed by the users or if they are not available, by those representing their interests in the process;

d) be adequately documented;

e) be made available to the design team at appropriate times and in appropriate forms to support design activities.

7.3 Specify the user and organizational requirements

7.3.1 In most design processes, there is a major activity specifying the functional and other requirements for the product or system. For human-centred design, this activity should be extended to create an explicit statement of user and organizational requirements in relation to the context of use description. The following aspects should be considered in order to identify relevant requirements:

a) required performance of the new system against operational and financial objectives;

b) relevant statutory or legislative requirements, including safety and health;

c) cooperation and communication between users and other relevant parties;

d) the users’ jobs (including the allocation of tasks, users’ well-being, and motivation);

e) task performance;

f) work design and organization;

g) management of change, including training and personnel to be involved;

h) feasibility of operation and maintenance;

i) the human-computer interface and workstation design.

7.3.2 User and organizational requirements should be derived and objectives set with appropriate trade-offs identified between the different requirements. This specification should define the “allocation of function” — the division of system tasks into those performed by humans and those performed by technology. These requirements should be stated in terms that permit subsequent testing and should be confirmed or updated during the life of the project.

NOTE Specific guidance on specifying software in a form that can be tested is contained in ISO/IEC 14598-1.

The specification of user and organizational requirements should

a) identify the range of relevant users and other personnel in the design,

b) provide a clear statement of the human-centred design goals,

c) set appropriate priorities for the different requirements,

d) provide measurable criteria against which the emerging design can be tested,

e) be confirmed by the users or those representing their interests in the process,

f) include any statutory or legislative requirements, and

g) be adequately documented.

7.4 Produce design solutions

7.4.1 General

Potential design solutions are produced by drawing on the established state of the art, the experience and knowledge of the participants and the results of the context of use analysis. The process therefore involves the following activities:

a) use existing knowledge to develop design proposals with multi-disciplinary input;

b) make the design solutions more concrete using simulations, models, mock-ups, etc.;

c) present the design solutions to users and allow them to perform tasks (or simulated tasks);

d) alter the design in response to the user feedback and iterate this process until the human-centred design goals are met;

e) manage the iteration of design solutions.

7.4.2 Use existing knowledge to develop design proposals with a multi-disciplinary input

There is a substantial body of scientific knowledge and theory from ergonomics, psychology, cognitive science, product design and other relevant disciplines that can indicate potential design solutions. Many organizations have internal user interface style guides, product knowledge and marketing information which can be useful in supporting the initial design, particularly when designing similar products. Generic human factors and ergonomics design guidance and standards are also available from national and international standards bodies. See annex A for relevant standards and bibliography for further sources of information.

7.4.3 Make the design solution more concrete using simulations, models, mock-ups, etc.

Using simulations, models and mock-ups or other forms of prototype allows designers to communicate more effectively with users and reduces the need and cost of reworking that can occur when products need to be revised later in the life cycle — in some cases after initial release to real customers.

The benefits are the following:

a) to make design decisions more explicit (this enables members of the design team to communicate with each other early in the process);

b) to allow designers to explore several design concepts before they settle on one;

c) to make it possible to incorporate user feedback into the design early in the development process;

d) to make it possible to evaluate several iterations of a design and alternative designs;

e) to improve the quality and completeness of the functional design specification.