TECHNICAL REPORT

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Ergonomics — Ergonomics of human-system interaction — Human-centred lifecycle process descriptions

Ergonomie — Ergonomie de l'interaction homme/système — Descriptions des processus cycle de vie centrées sur l'opérateur humain

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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.

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is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.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 ISO/TR 18529 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TR 18529 was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 4, *Ergonomics of human-system interaction*, WG 6. It extends and formalises the human-centred processes defined in ISO 13407:1999, *Human-centred design processes for interactive systems*. It is presented in a similar form to the process definitions for software development defined in ISO/IEC TR 15504, *Information technology — Software process assessment*.

Introduction

This document is intended to assist those involved in the design, use and assessment of lifecycle processes for systems, hardware and software. It presents a definition of the processes which comprise a human-centred approach and lists their components, outcomes and the information used and produced. The intention is to inform the users of process models who want to take account of human-centred processes in system, hardware and software lifecycles.

ISO 13407 *Human-centred design processes for interactive systems* is the standard produced by ISO TC159/SC4/WG6 that explains the benefits achieved by making the interactive systems lifecycle more human centred, and the processes required to make a lifecycle human-centred. The human-centred lifecycle process model presented in this Technical Report is a structured and formalised definition of the human-centred processes described in ISO 13407. It is intended to make the contents of ISO 13407 accessible to process assessment and improvement specialists and to those familiar with or involved in process modelling.

The model presented in this document uses the format common to process assessment models. These models describe the processes which ought to be performed by an organisation to achieve defined technical goals. The processes in this model are described in the format defined in ISO/IEC TR 15504, *Information technology — Software process assessment*. Although the primary use of a process assessment model is for the measurement of how well an organisation carries out the processes covered by the model, such models can also be used as a description of what is required in order to design and develop effective organisational and project processes.

Human sciences experts (e.g. ergonomists, usability engineers etc.) may find the model useful as a means of presenting the activities required when projects or companies adopt a human-centred approach or need to develop products with an assured degree of quality in use. Process modelling and process definitions are means of discussing and planning the work required in order to take account of human sciences input in system development and operation. Process definitions are widely understood in the systems and software development communities. The ability to describe human sciences methods and techniques, and their inputs and outputs, in the language used by systems and software engineers and their managers simplifies the adoption and implementation of the human-centred approach.

Ergonomics — Ergonomics of human-system interaction — Human-centred lifecycle process descriptions

1 Scope

This Technical Report contains a formalised model based on the human-centred processes described in ISO 13407, *Human-centred design processes for interactive systems*. It should be used in the specification, assessment and improvement of the human-centred processes in system development and operation.

NOTE 1 The word formalised is used in the preceding paragraph to mean that the process descriptions in this document follow the format specified in ISO/IEC TR 15504, *Information technology — Software process assessment*. It should not be read as a claim that the model has any mathematical basis or rigour.

NOTE 2 The difference in coverage of the model and ISO 13407 is indicated in the relevant processes (HCD 1 clause 6.2 and HCD 7 Clause 6.8).

The scope of the model is based on that for ISO 13407 which has as its scope *'guidance on human-centred design activities throughout the life cycle of interactive computer-based systems.'* However, whilst the intended audience for ISO 13407 is given as '*those managing the design process*' this Technical Report is intended as guidance for those who are involved in the design, use and assessment of lifecycle processes for system, hardware and software.

Readers of this Technical Report are expected to be familiar with ISO 13407.

NOTE 3 Copyright release for the process descriptions: Users of this Technical Report may freely reproduce the process and work product descriptions contained in this document as part of any Assessment Model based on these descriptions, or as part of any demonstration of compatibility with the described processes, so that the descriptions can be used for their intended purpose.

2 Normative References

The following standards contain provisions which, through reference in this text (or the text of ISO 13407 which is normative on this standard) constitute provisions of this Technical Report. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Technical Report are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 6385:1981, *Ergonomic principles in the design of work systems*.

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

3 Definitions

For the purposes of this Technical Report, the terms and definitions given in ISO 6385:1981, *Ergonomic principles in the design of work systems*, ISO 9241-11:1998, *Ergonomic requirements for office work with visual display terminals (VDTS) — Part 11: Guidance on usability*, ISO 13407:1999, *Human-centred design processes for interactive systems,* ISO/IEC TR 15504-9:1998, *Information technology — Software process assessment — Part 9: Vocabulary*, ISO/IEC 9126-1, *Information technology — Software product quality — Part 1: Quality model* and

ISO/IEC 15288, *Information technology — System engineering — System life cycle processes* apply. The terms most relevant to this Report are given below.

(process) **Capability** The ability of a process to achieve a required goal (ISO/IEC TR 15504 part 9).

Context of use The users, tasks, equipment (hardware, software and materials), and the physical and social environments in which a system is used (ISO 9241 part 11).

Enterprise A business unit, company, corporation or other organisation engaged in trading a product or service. (ISO 15288)

Ergonomics Ergonomics produces and integrates knowledge from the human sciences to match jobs, systems, products and environments to the physical and mental abilities and limitations of people. In doing so it seeks to safeguard safety, health and well-being whilst optimising efficiency and performance (ISO/CD 6385).

Human/user-centred Approaches which have as their primary intention or focus the consideration of the interests or needs of the individuals and/or groups which will work with or use the output from a system. (developed from ISO 13407)

Lifecycle The stages and activities spanning the life of the system from the definition of its requirements to the termination of its use covering its conception, development, operation, maintenance support and disposal (derived from IEC 61508 and ISO 15288).

Organisational In making use of the definitions in these standards a potential conflict is created over the word 'organisational'. ISO/IEC TR 15504 uses the term 'organisational process category' to describe processes related to the maintenance of infrastructure and competence in the organisation which develops software. This document and ISO 13407 use the term 'organisational requirements' to refer to the needs of the client organisation. In this document 'organisational' should be taken to refer to the client, not the developer organisation. To avoid confusion the term 'enterprise' *q.v.* is used when referring to the organisation(s) which are developing a system for use by the client organisation. Apart from in this clause the term 'organisation' is used to refer to any other organisation, including the client organisation.

Practice A technical or management activity that contributes to the creation of the output (work products) of a process or enhances the capability of a process (ISO/IEC TR 15504 part 9).

Process A set of interrelated activities, which transform inputs into outputs (ISO 8402).

NOTE 1 In this model nearly the equivalent of a Capability Maturity Model key process area (KPA).

Process assessment A disciplined evaluation of an enterprise's software processes against a model (ISO/IEC TR 15504 part 9).

Process category A set of processes addressing the same general area of activity (ISO/IEC TR 15504 part 9).

Process improvement Action taken to change an enterprise's processes so that they meet the enerprise's business needs and achieve its business goals more effectively (ISO/IEC TR 15504 part 9).

Prototype Representation of all or part of a product or system that, although limited in some way, can be used for evaluation (ISO 13407).

Quality in use The capability of a (software product) to enable specified users to achieve specified goals with effectiveness, productivity, safety and satisfaction in specified environments (ISO 9126-1:1999) or contexts of use (ISO 9241 part 11).

Stakeholder Any individual who is affected by the output from, provides the input to, develops, maintains, uses or manages the use of a system (derived from ISO 15288).

NOTE 2 Stakeholders include all types of users and anyone else affected by the system. For example, the customer, regulatory bodies, maintenance staff, support desk, etc.

System A discrete, distinguishable entity with a physical existence and a defined purpose completely composed of integrated and interacting components, each of which does not individually comply with the overall purpose (ISO 15288).

NOTE 3 In this document the term system is used to describe a product *q.*v., implemented in any combination of physical equipment, computer software, documentation, human tasks and organisational or management procedures.

NOTE 4 The term 'system' is used in this document to mean large and small systems and also equipment and other products. A system can range from an entire outsourced information provision service, to a worksystem, to a consumer item such as a lawnmower.

Task Activities required to achieve a goal (ISO 9241 part 11).

User The individual interacting with the system (ISO 9241 part 10).

NOTE 5 A user is a stakeholder.

Usability The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in specified context of use (ISO 9241 part 11).

Worksystem The work system comprises a combination of people and working equipment, acting together in the work process, to perform the work task, at the work space, in the work environment, under the conditions imposed by the work task (ISO 6385).

(associated) **Work product** A document, piece of information, product or other item which acts as input to or output from a process (ISO/IEC TR 15504 part 9).

4 Abbreviations

HC Human-centred

HCD Human-centred design

UI User interface

5 Background to the human-centred process model

5.1 Use of the model

This document is intended to assist those who wish to make their system development process and its associated support processes more human-centred, and to include knowledge from the human sciences in system design. It presents a definition of the processes which comprise a human-centred approach. It lists their components, outcomes and the information used and produced.

This Technical Report should be used by those developing lifecycle process models. It provides a reference set of descriptions of human-centred processes for this purpose. This Technical Report does not place further requirements on those developing process models. However, ISO/IEC TR 15504, *Information technology — Software process assessment*, on which the format of the descriptions is based, gives further advice on the development of models for process assessment. Annex C of this Technical Report contains an informative interpretation of the relevant clauses of ISO/IEC TR 15504 which may be used in the qualification of process assessment models which claim compatibility with the processes described in this Technical Report.

5.2 Benefits of human-centredness in the lifecycle

ISO 13407, the standard for human-centred design processes for interactive systems, describes human-centred development as '*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.'

It goes on to say that '*Human-centred systems empower 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 health and safety. Although there is a substantial body of human factors and ergonomics knowledge about how such design processes can be organised and used effectively, much of this information is only well known by specialists in those 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.*'

As far as systems and software developers are concerned the use of a human-centred approach gives a more usable, trainable, and supportable product and greater client satisfaction. Human-centred design may reduce risk and can reduce health and safety risks associated with the operation of a system. In most sectors of industry predictable usability and training requirements are now expected attributes of an interactive system. Predictable support requirements allow the management of service costs. Human-centred processes require more investment in the early stages of the lifecycle, but have been found not only to reduce in-service costs but also to reduce development costs. In particular human-centred processes reduce the risk of unexpected changes in requirements and reduce re-work and installation costs. In the case of generic or off-the-shelf products usability and delight are now necessary requirements.

The goal of the human-centred approach is to ensure that the development, acquisition and operation of an interactive system take account of the needs of the user as well as the needs of the developer and owner. A human-centred approach takes account of the user's interaction with the components of the system and with other stakeholders. Human-centred processes allow developers and owners to analyse how the system will behave when it is in operation and to measure its quality in use. Human-centred processes take account of context of use, i.e. the complete environment in which the interactive system will be used. Human-centred processes address the total system within which software and hardware are components.

Human-centred approaches can also be used to design and improve processes within both the enterprise which is developing the system and the client organisation. A human-centred approach to process modelling and re-engineering addresses cultural issues and staff acceptance and engenders buy-in to new processes.

5.3 Rationale for the model

This model has been developed in response to a need to improve the performance of the human-centred part of system development and support projects. The model is intended to provide a basis for those planning the human-centred activities on a project and to assist those who wish to improve how well their enterprise performs human-centred activities. The model has been developed as a stand-alone model, not as part of one of the existing process models, such as ISO/IEC 12207, *Information technology — Software lifecycle processes*, the *Capability Maturity Model* (CMM) and the *System Engineering Capability Maturity Model* (SE-CMM) or ISO/IEC TR 15504, *Information technology — Software process assessment*. This is mainly because of the number and variety of process models, but also to make more clear the nature of human-centred activities and their implications for system lifecycles. The model conforms to and extends ISO 13407, *Human-centred design processes for interactive systems*. ISO 13407 explains the arguments for and purposes of a human-centred approach and describes the activities necessary to be human-centred in the design process.

5.4 Basis of the model

This model uses the format common to process assessment models. Such models describe what **processes** ought to be done by an enterprise to achieve defined technical goals. The processes in this model are described in the format defined in ISO/IEC TR 15504, *Information technology — Software process assessment*. The primary use of a process assessment model is for the measurement of how well an enterprise carries out the processes covered by the model. However, such models can also be used as a description of what is required in order to design and develop effective enterprise processes. For more information on this use of process models reference may be made to ISO/IEC TR 15504.

5.5 Structure of the model

The entity relationship diagram in Figure 1 describes the formal components of the model presented in this Technical Report.

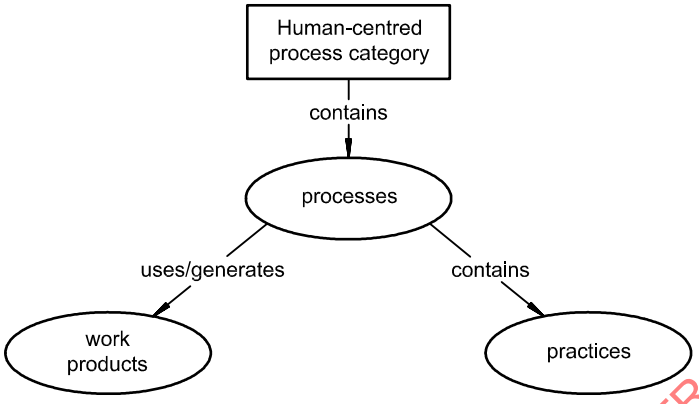

Figure 1 — Entity relationship diagram of the model

5.6 Elements of the model

The human-centred design process model consists of seven sets of practices. These practices describe what has to be done in order to represent and include the users of a system during the lifecycle as is emphasised in Figure 3. The contents of the model can be summarised as a process hierarchy as demonstrated in Figure 2.

Human-centred system development

HCD 1	HCD 2	HCD 3	HCD 4	HCD 5	HCD 6	HCD 7
Ensure HCD content in systems strategy	**Plan and manage the HCD process**	**Specify stakeholder and organisational requirements**	**Understand and specify the context of use**	**Produce design solutions**	**Evaluate designs against requirements**	**Introduce and operate the system**
represent stakeholders collect market intelligence define and plan system strategy collect market feedback analyse user trends	consult stakeholders plan user involvement select human-centred methods ensure a human-centred approach plan HCD activities manage HC activities champion HC approach support HCD	clarify system goals analyse stakeholders assess H&S risk define system generate requirements set quality in use objectives	identify user's tasks identify user attributes identify organisational environment identify technical environment identify physical environment	allocate functions produce task model explore system design develop design solutions specify system and use develop prototypes develop user training develop user support	specify context of evaluation evaluate for requirements evaluate to improve design evaluate against system requirements evaluate against required practice evaluate in use	manage change determine impact customisation and local design deliver user training support users conformance to ergonomic legislation

Figure 2 — Human-centred design processes and their practices

The processes in the model are linked and human-centred lifecycles are iterative.

Processes should not be confused with the stages of a lifecycle. Processes are enacted at more than one stage in the lifecycle. The need for, or emphasis between, the outcomes (i.e. the results of successful implementation and the work products) of a process will vary depending on the stage at which it is performed. This variation in emphasis will in turn affect the performance of the practices which comprise the process. The effect of stage and project context on the performance of processes and practices is one of the main differences between process models and methods/methodologies for system development.

NOTE 1 ISO 15288 describes the relationship between the processes which bring about required outcomes in the lifecycle and the stages in the lifecycle through which the system progresses.

Whilst it is possible to draw a number of simple diagrams which demonstrate the iterative nature of the human-centred lifecycle there are many different versions of lifecycles, depending on the type of system being developed and the market sector for which the system is intended. It is therefore difficult and may even be confusing to draw one simple diagram which demonstrates how processes are linked. Figure 3 attempts to convey the cyclical nature of the HCD processes and their linking. Human-centred processes are not performed in isolation. HCD processes use information from and create information for other system lifecycle processes.

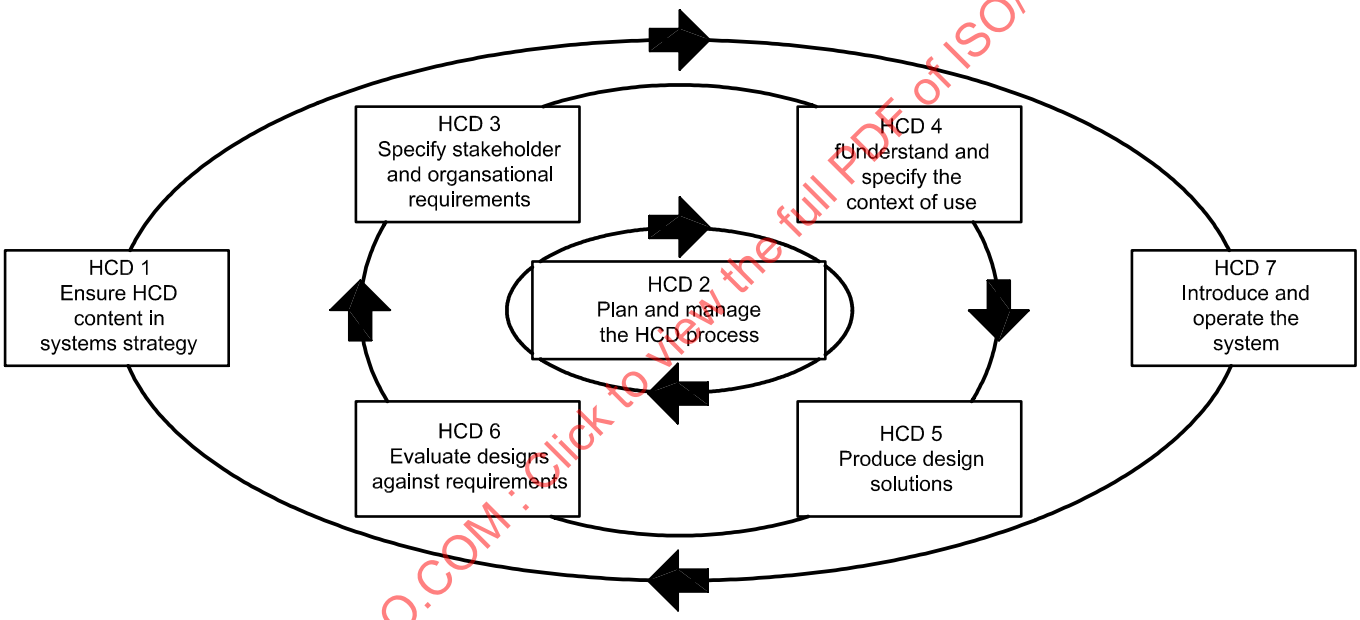

Figure 3 — Linking of Human-centred processes in the lifecycle

In general HCD 3-6 are more technical and form a tight loop at the core of the system development. This loop will be cycled several times during a typical development. HCD 2 covers management and control of human-centred activities. It uses information generated by the HCD 3-6 loop. HCD 2 connects the human-centred lifecycle to other processes in system development. HCD 1 connects the human-centred lifecycle to higher management processes and looks to the future of systems. HCD 1 sets boundaries and goals for projects which then cycle through HCD 3-6 and are implemented with HCD 7. HCD 7 is concerned with the use of the system. HCD 7 connects the HCD processes to the support phase of the system lifecycle. All processes may not be enacted with full rigour at all stages in the lifecycle. The character of process (how it is enacted) may change depending on the stage in the lifecycle.

NOTE 2 HCD 3 and 4 are closely related and there is a degree of overlap between the practices. See the note in clause 6.3.1 for more details.

5.7 Relationship between this model and ISO/IEC TR 15504

ISO/IEC TR 15504, *Information Technology — Software process assessment* presents a standard for software process capability determination. It defines a normative approach to the assessment of software process maturity. The processes presented in this document conform to ISO/IEC TR 15504 requirements for variant processes.

NOTE 1 Those familiar with process maturity models will observe that this model differs from generic models in that some practices (particularly evaluation activities) are enacted at particular times in a lifecycle and there is a requirement for the lifecycle to have certain attributes, such as the ability to iterate (particularly during the design of the system). These requirements arise from the technical necessities of a lifecycle which takes account of stakeholder and organisational requirements. Early in system development these requirements cannot be specified fully for a system throughout its entire life. This pragmatic consideration breaks one of the requirements of pure capability models in which all processes and practices can be enacted independently and continuously. However, users of this model will find that it supports a considerable degree of freedom in selection and implementation of lifecycles and practices, even within the limitations of this pragmatic consideration.

NOTE 2 ISO/IEC TR 15504 describes two types of practice, *base* and *management*. The majority of processes in this Technical Report are only base practices. However, this may not be the case for all HCD.2 practices or the case when HCD practices are used in other maturity models.

5.8 Relationship between this model and ISO 12207

ISO/IEC 12207:1995, *Information technology — Software life cycle processes* presents a standard for the processes required to develop software. ISO 13407 was developed as a set of processes which can be added to ISO/IEC 12207 to make a complete set of processes required to develop human-centred interactive systems which have the benefits described in clause 5.1 of this document. This Technical Report contains a more formal description of these human-centred processes and adds processes which may be used to extend the requirements activities for generic products and to support the implementation and operation of large management systems.

NOTE A new standard ISO 15288 *System lifecycle processes* is in preparation. This will extend the set of process definitions given in ISO/IEC 12207 to include all activities in the lifecycle of all systems created by humans.

6 Human-centred processes

6.1 Human-centred design

Human-centred design is achieved through the performance of **processes** which address the consideration of end-users and other stakeholders in the specification, development and operation of a system. These processes always relate to the worksystem under development, not just the details of the hardware and software. The processes account for human-centred activities throughout the life of a system.

NOTE The process descriptions describe two categories of roles for the people involved with interactive systems. Firstly the **end users** of the system. Secondly the **developers** and **maintainers** of the system. Most processes describe what the developers and maintainers should do to take account of the needs, context and capabilities of the end users. Some processes describe what the end users do when taking part in the development of the system. Readers should be aware of the role that is the focus of each process descriptions.

The human-centred design processes are presented in Figure 2 and are described in the following sections.

Processes are enacted through the implementation of a set of component **practices**. Practices are sub-processes of a process. They describe what needs to be done in order to achieve the process. Practices are enacted through the use of methods, techniques and tools. Particular human-centred methods, techniques and tools are not described in this model. However, some explanatory notes to the practices illustrate the requirements of methods, techniques and tools. Ergonomics standards and informative texts which describe how to carry out the practices are available in the general literature and some are listed in the annexes and bibliography to ISO 13407, *Human-centred design processes for interactive systems*.

Processes use and produce **associated work products**. Associated work products can be in many forms, including the following: pieces of information, documents, hardware, software, training courses, awareness in

individuals. Lists of typical associated work products from each of the processes described below are given in Annex A.

The uses of the human-centred processes are described in Annex B which outlines the definition of organisation or enterprise specific lifecycles, process improvement and the use of the model in process assessment.

6.2 Ensure HCD content in systems strategy (HCD.1)

6.2.1 Purpose

The purpose of the process *Ensure HCD content in systems strategy* is to establish and maintain a focus on stakeholder and user issues in each part of the organisation which deal with system markets, concept, development and support. As a result of successful implementation of this process:

— marketing will take account of usability, ergonomics and socio-technical issues

— systems will be targeted to meet users' needs and expectations

— planners will consider stakeholder and organisation requirements in setting out systems strategy

— systems will be more responsive to changes in users (their needs, tasks, context, etc.)

— the enterprise will be more responsive to changes in its users

— systems are less likely to be rejected by the market.

NOTE This process is not directly related to any clause in ISO 13407.

The purpose is typically achieved by the performance of the following practices.

6.2.2 Represent stakeholders (HCD.1.1)

Act as advocate for end users and other stakeholders in the system development enterprise and the development team.

NOTE 1 The stakeholder' advocate reminds the staff in the system development enterprise that the system is intended for use by real people and has to achieve quality in use. This role includes championing human-centred approaches, arranging for end-user involvement in conceptual studies, investigation and dissemination of context of use issues.

NOTE 2 This practice is related to HCD 2.7 and HCD 7.1.

6.2.3 Collect market intelligence (HCD.1.2)

Perform foresight research into potential user groups in order to identify forthcoming needs for systems and new users or user organisations. Identify expected context of use of future systems. Set up procedures to elicit user input regarding future systems in their expected context.

6.2.4 Define and plan system strategy (HCD.1.3)

Present market information as a vision (e.g. for senior management approval). Operationalise vision into implementation strategy. Use lifecycle cost accounting in order to assess the cost of an HCD approach.

6.2.5 Collect market feedback (HCD.1.4)

Perform optimising research to refine and consolidate system strategy, based on feedback from users and non-users in the system's marketplace.

6.2.6 Analyse trends in users (HCD.1.5)

Look for changes in: users (e.g. their skills and training for user organisations, as well as needs and desires for consumer products), tasks (e.g. changes in type of work or volumes of work), context (e.g. changes in working and living environments, new technologies, social and political mores and expectations). Analyse this information to estimate future needs.

6.3 Plan and manage the HCD process (HCD.2)

6.3.1 Purpose

The purpose of the process *Plan and manage the human-centred design process* is to specify how the human-centred activities fit into the whole system lifecycle process and the enterprise. As a result of successful implementation of this process:

— the project plan will allow for iteration and incorporation of user feedback

— resources will be allocated for effective communication between the design team participants

— potential conflicts and trade-offs between human-centred and other issues will be reconciled

— human-centred processes will be incorporated into quality systems, procedures and standards

— human-centred issues will be supported and promoted within the organisation.

NOTE 1 This process is directly related to ISO 13407, clauses: 7 *Planning the human-centred process*; 8.4.6 *Manage the Iteration of design solutions*; 8.5.2 *Evaluation plan*.

NOTE 2 Some practices in this process overlap with the management practices in the ISO/IEC TR 15504 capability scale. This overlap also occurs in ISO/IEC TR 15504 itself, see Part 5 of that standard.

The purpose is typically achieved by the performance of the following practices.

6.3.2 Consult stakeholders (HCD.2.1)

Establish structures, mechanisms and procedures to ensure that relevant stakeholders are effectively involved and consulted in each significant aspect of the system development and implementation.

NOTE Stakeholders include all types of users and anyone else affected by the system.

6.3.3 Identify and plan user involvement (HCD.2.2)

Decide on the most effective way to elicit user input at each stage of the project, taking best advantage of established good practice in team work and appropriate user involvement.

6.3.4 Select human-centred methods and techniques (HCD.2.3)

Decide which methods will be included and how they will link together in the development process. Define how this will interface to the particular lifecycle methodology being used in the development of the system.

6.3.5 Ensure a human-centred approach within the project team (HCD.2.4)

Establish a multi-disciplinary culture in the project team. Maintain staff focus on a human-centred approach. Identify the specialist skills required and plan how to provide them.

NOTE A multi-disciplinary team provides the wide range of skills and viewpoints required to produce an operable system. Examples of the range of skills which may be required include: end user, purchaser, business analyst, marketeer, visual designer, ergonomist, domain expert, technical author, human resources, health and safety, systems analyst, programmer.

6.3.6 Plan human-centred design activities (HCD.2.5)

Develop a plan specifying how the human-centred activities integrate into the overall system development process.

NOTE A human-centred design plan specifies how input from human-centred design processes (based, for example, on those given in this document) is used in the design and development process. A human-centred design plan allows for iteration where necessary. A human-centred design plan includes long term monitoring of the use of the system (see HCD.6.6).

6.3.7 Manage human-centred activities (HCD.2.6)

Take specific account of user issues in management of project and development departments. Ensure that the system development process takes account of user input. Take account of stakeholder and the user issues in support activities (e.g. contracts management and purchasing).

6.3.8 Champion human-centred approach (HCD.2.7)

Promote a human-centred approach within the enterprise. Establish and communicate a policy for human-centredness within the enterprise.

NOTE This practice is related to HCD 1.1

6.3.9 Provide support for human-centred design (HCD.2.8)

Include human-centred elements in support procedures (e.g. quality assurance, change control, process and method maintenance, resource management). Ensure that these are carried out as an integral part of the infrastructure management for the enterprise.

6.4 Specify the stakeholder and organisational requirements (HCD.3)

6.4.1 Purpose

The purpose of the process *Specify the stakeholder and organisational requirements* is to establish the requirements of the organisation and other interested parties for the system. This process takes full account of the needs, competencies and working environment of each relevant stakeholder in the system. As a result of successful implementation of the process, the following will be defined:

— required performance of new system against operational and functional objectives

— relevant statutory or legislative requirements

— co-operation and communication between users and other relevant parties

— the users' jobs (including the allocation of tasks, users' comfort, safety, health and motivation)

— task performance of the user when supported by the system

— work design, and organisational practices and structure

— feasibility of operation and maintenance

— objectives for the operation and/or use of the software and hardware components of the system.

NOTE 1 This process is directly related to ISO 13407 clause 8.3 *Specify user and organisational requirements*.

NOTE 2 HCD.3.1 to 3.3 determine high-level requirements for the system. HCD 3.4-3.6 define detailed requirements for the system. The definition of detailed requirements requires an understanding of the context of use. This is defined in HCD 4. The two processes therefore overlap in the lifecycle.

NOTE 3 Stakeholders include all types of users and anyone else affected by the system.

The purpose is typically achieved by the performance of the following practices.

6.4.2 Clarify and document system goals (HCD.3.1)

Describe the objectives which the user or user organisation wants to achieve through use of the system.

NOTE For a generic product the only user may be the end user of the system. For a larger or more complex system there will be more stakeholders and a user organisation, but there are still different types of user with different contexts of use.

6.4.3 Analyse stakeholders (HCD.3.2)

Identify and analyse the roles of each group of stakeholders likely to be affected by a system. Assess the significance and relevance of the system to each stakeholder group which will be end users of the system and/or will be affected by input to or output from the system.

6.4.4 Assess risk to stakeholders (HCD.3.3)

Review the safety, health and well-being risks to the stakeholders of the system. Relate this to the overall risk assessment for the system.

6.4.5 Define the use of the system (HCD.3.4)

Set and agree the required behaviour and performance of the system in terms of the total experience of the relevant stakeholders and/or the user organisation with the system. The total experience covers each aspect of a relevant stakeholder's relationship with the system and its context of use from its commissioning to its de-commissioning.

6.4.6 Generate the stakeholder and organisational requirements (HCD.3.5)

Develop an explicit statement of the stakeholder and organisational requirements for the system.

NOTE 1 The generation of requirements is an interactive and often iterative process.

NOTE 2 Requirements may be ranked in order of importance.

NOTE 3 Statutory requirements regarding working environment and workload are taken into account.

NOTE 4 Stakeholder and organisational requirements define a large part of the operational and performance requirements for the system.

6.4.7 Set quality in use objectives (HCD.3.6)

Generate and agree on measurable criteria for the required quality in use of the system.

NOTE The quality in use is stated as required levels of user effectiveness, productivity, safety and satisfaction for the system or its component parts in the context of particular tasks based on performance requirements (ISO/IEC 9126-1, *Information technology — Software product quality — Part 1: Quality model*).

6.5 Understand and specify the context of use (HCD.4)

6.5.1 Purpose

The purpose of the process *Understand and specify the context of use* is to identify, clarify and record the characteristics of the stakeholders, their tasks and the organisational and physical environment in which the system will operate. As a result of successful implementation of this process the following will be achieved:

— definition of the characteristics of the intended users

— definition of the tasks the users are to perform

— definition of the organisation and environment in which the system is used

— implications for design made explicit

— the context of use is available and used at all relevant points in the lifecycle.

NOTE This process is directly related to ISO 13407 clause 8.2 *Understand and specify the context of use*.

The purpose is typically achieved by the performance of the following practices.

6.5.2 Identify and document user's tasks (HCD.4.1)

Describe the activities which users perform to achieve system goals.

NOTE 1 Tasks are described in terms of user and organisational activities, not solely in terms of equipment functions or features.

NOTE 2 Tasks may change (or evolve) during the lifecycle of the system.

6.5.3 Identify and document significant user attributes (HCD.4.2)

Describe the relevant characteristics of the end-users of the system. This will include knowledge, language, physical capabilities, level of experience with job tasks and with relevant systems equipment, motivations in using the system, priorities, etc.

6.5.4 Identify and document organisational environment (HCD.4.3)

Describe the relevant social and organisational milieu, management structure, communications and organisational practices, etc.

6.5.5 Identify and document technical environment (HCD.4.4)

Describe the relevant characteristics of any equipment to be used in the system or the context of use. Particular attention should be paid to the equipment with which the users will directly interact.

NOTE For new systems the equipment characteristics are dependent on the system design solutions (see HCD 5.4 and 5.5) and will not be known until relatively late in the lifecycle.

6.5.6 Identify and document physical environment (HCD.4.5)

Describe the location, workplace equipment and ambient conditions and the implications for design. For example, lighting, noise levels, vibration, etc.

6.6 Produce design solutions (HCD.5)

6.6.1 Purpose

The purpose of the process *Produce design solutions* is to create potential design solutions by drawing on established state-of-the-art practice, the experience and knowledge of the participants and the results of the context of use analysis. As a result of successful implementation of the process:

— the whole socio-technical system in which any technical components operate will be considered in the design

— user characteristics and needs will be taken into account in the purchasing of system components

— user characteristics and needs will be taken into account in the design of the system

— existing knowledge of best practice from socio-technical systems engineering, ergonomics, psychology, cognitive science and other relevant disciplines will be integrated into the system

— communication between stakeholders in the system will be improved because the design decisions will be more explicit

— the development team will be able to explore several design concepts before they settle on one

— feedback from end users and other stakeholders will be incorporated in the design early in the development process

— it will be possible to evaluate several iterations of a design and alternative designs

— the interface between the user and the software, hardware and organisational components of the system will be designed

— user training and support will be developed.

NOTE This process is directly related to ISO 13407 clause 8.4 *Produce design solutions*.

The purpose is typically achieved by the performance of the following practices.

6.6.2 Allocate functions (HCD.5.1)

Analyse the context of use and the required functions and performance of the system, to distribute functions between the human, machine and organisational components of the system best able to fulfil each function.

NOTE 1 The allocation of functions may be dynamic. The aim is to optimise the performance of the overall system against the system goals.

NOTE 2 At high levels in the system hierarchy functions may not be allocated to particular human, organisational, software or hardware components but to sub-systems which may be made up from more than one of these components.

NOTE 3 For function allocation the task analysis (HCD 4.1) is the most important component of the context of use.

6.6.3 Produce composite task model (HCD.5.2)

Develop a feasible model of the user's new tasks from existing knowledge of best practice, the requirements, context of use, allocation of function and design constraints for the system.

NOTE HCD.5.1 to HCD.5.3 are enacted at each level in the system hierarchy. HCD.5.4 to 5.8 are enacted at the level where system components are being defined and developed.

6.6.4 Explore system design (HCD.5.3)

Generate and analyse a range of design options for each aspect of the system related to its use and its effect on stakeholders.

6.6.5 Use existing knowledge to develop design solutions (HCD.5.4)

Apply relevant human science information to the design of the system. Include the stakeholder and organisational requirements, context of use, international standards, legislative requirements, existing patents, good practice, style guides and project standards etc. in the design.

6.6.6 Specify system and use (HCD.5.5)

Produce a design for the user-related components of the system. Produce description(s) of how the system will be used. Change design in the light of feedback from evaluations.

NOTE Depending on the type of system, the specification can include, but is not limited to, one or all of the following: design of users jobs, users tasks, working environment, hardware, software, user documentation, packaging design, interface functionality etc.

6.6.7 Develop prototypes (HCD.5.6)

Make design solution(s) more concrete using simulations, models, mock-ups etc. Develop simulation or trial implementation of key aspects of the system for the purposes of testing with users or user representatives.

6.6.8 Develop user training (HCD.5.7)

Identify, specify and produce the training required to enable relevant users to perform tasks effectively using the new system. Cover or include any proposed changes in business processes, job design and tasks.

6.6.9 Develop user support (HCD.5.8)

Identify, specify and produce the user support services for the system. Take into account the proposed changes in business processes and job design.

6.7 Evaluate designs against requirements (HCD.6)

6.7.1 Purpose

The purpose of the process *Evaluate designs against requirements* is to collect feedback on the developing design. This feedback will be collected from end users and other representative sources. As a result of successful implementation of this process:

— feedback will be provided to improve the design

— there will be an assessment of whether stakeholder and organisational objectives have been achieved or not

— long-term use of the system will be monitored.

In the case of evaluation to identify improvements to the system (**formative evaluation**), successful implementation of the process will reflect:

— potential problems and scope for improvements in: the technology, supporting material, organisational or physical environment and the training

— which design option best fits the functional and stakeholder and organisational requirements

— feedback and further requirements from the users.

NOTE 1 Formative evaluation is generally carried out using fairly informal, open-ended, collaborative techniques (e.g. paper prototyping, discussion-based reviews etc.) early in the lifecycle in order to provide information for the requirements and design process. Summative evaluation is generally carried out as a validation activity using more formal, closed methods (e.g. assessment against product standards).

In the case of evaluation to assess whether objectives have been met (**summative evaluation**), successful implementation of the process will demonstrate:

— how well the system meets its organisational goals

— that a particular design meets the human-centred requirements

— conformity to international, national and/or statutory requirements.

NOTE 2 This process is directly related to ISO 13407 clause 8.4 *Evaluate designs against requirements*.

NOTE 3 Evaluation may be carried out in the short term (e.g. trials by potential users during design in order to compare features of prototypes) or in the long term (e.g. a post-installation study to validate the specification, monitoring of sickness records for health and safety problems or a survey to identify the requirements for the next version of a system).

NOTE 4 The opportunities for end user involvement are investigated for each evaluation. If end users are not involved the risks are assessed.

The purpose is typically achieved by the performance of the following practices.

6.7.2 Specify and validate context of evaluation (HCD.6.1)

Describe and check the conditions under which a system is tested or otherwise evaluated. Describe the relationship, and especially discrepancies, between the context of evaluation and the context of use.

NOTE This practice is performed prior to each of HCD 6.2 to 6.6.

6.7.3 Evaluate early prototypes in order to define the requirements for the system (HCD.6.2)

Benchmark appropriate systems using relevant criteria. Test the usability of component systems, competing/alternative systems and/or system concepts. Use prototypes to stimulate stakeholder input to system requirements. Test stability of requirements.

6.7.4 Evaluate prototypes in order to improve the design (HCD.6.3)

Collect user input on the quality in use of the developing system. Present the results to the design team(s) in the most appropriate format.

6.7.5 Evaluate the system in order to check that the stakeholder and organisational requirements have been met (HCD.6.4)

Test the developing or final system to ensure that it meets the requirements of the users, the tasks and the environment, as defined in its specification (see also HCD 3.5 and 3.6).

6.7.6 Evaluate the system in order to check that the required practice has been followed (HCD.6.5)

Check systems for adherence to applicable human science knowledge, style guides, standards, guidelines, and legislation.

6.7.7 Evaluate the system in use in order to ensure that it continues to meet organisational and user needs (HCD.6.6)

Check the system in use for changes in organisational, user, other stakeholder, and usability needs and to ensure that it continues to meet these needs (see also HCD 3.5 and 3.6).

NOTE 1 This includes routine contact with a representative number of users using a defined procedure to elicit information about human-centred aspects of the system by means of questionnaires, reports, logs, interviews etc. This also includes feedback to stakeholders.

NOTE 2 Evaluation of the system in use can also be used to assess whether the requirements and the resulting specification were correct.

6.8 Introduce and operate the system (HCD.7)

6.8.1 Purpose

The purpose of the process *Introduction and operate the system* is to establish the human-system aspects of the support and implementation of the system. As a result of successful implementation of this process:

— the needs of the stakeholders of the system will be communicated to the project

— the management of change, including the responsibilities of users and developers, will be specified

— the support requirements of end-users, maintainers and other stakeholders will be addressed

— there will be compliance to health and safety procedures

— local customisation of the system will be supported

— user reactions will be collected and the resulting changes to the system reported back to stakeholders.

NOTE 1 This process is not directly related to any clause in ISO 13407 and may not be applicable to generic product development.

NOTE 2 This process deals with the various HCD activities concerned with the operation of the system and may be enacted in part by the enterprise developing the system and in part by the organisation which operates the system.

NOTE 3 The activities in this process have less in common with each other than the activities in the other HCDs. However, it is convenient to group them into one separate process.

NOTE 4 HCD.6.6 describes an important aspect of monitoring of the system in operation. However, because it is also enacted at start-up and may be carried out to elicit re-design information it is described in HCD.6.

NOTE 5 The context of use may change during the life of a system. Periodic re-assessment may be required. This process comprises the following practices.

The purpose is typically achieved by the performance of the following practices.

6.8.2 Management of change (HCD.7.1)

Facilitate, oversee and ensure the HCD aspects of system implementation.

NOTE This includes re-organisation of job design and working practices, group/teamwork, training, new business processes, reporting responsibilities etc.

6.8.3 Determine impact on organisation and stakeholders (HCD.7.2)

Assess the human and organisational impact of the system to be introduced.

6.8.4 Customisation and local design (HCD.7.3)

Provide support for customisation of the system to meet local cultural or operational needs. Provide support for customisation and configuration to meet the needs of specific users. Provide details of customisation to configuration management.

6.8.5 Deliver user training (HCD.7.4)

Deliver training and workshops to users to meet identified training needs and facilitate the transition to new designs of jobs and new teamworking arrangements.

6.8.6 Support users in planned activities (HCD.7.5)

Maintain contact with users and the client organisation throughout the definition, development and introduction of a system.

6.8.7 Ensure conformance to workplace ergonomic legislation (HCD.7.6)

Survey of workplaces, users and training programmes to ensure that the software, hardware and workplace meet the requirements of national legislation (see also HCD.6.5).

Annex A
(informative)

Associated work products

A.1 Lists of associated work products from human-centred lifecycle processes

The following sections list typical work products which are used by, and which originate from, human-centred lifecycle processes. Many of these products are elaborated or revised by subsequent processes. Because of the iterative nature of the human-centred lifecycle work products may be revised several times.

Table A.1 — Ensure HCD content in system strategy (HCD.1)

Input	Output
Company strategy	System/product vision
Market surveys	Original specification
Technology forecasts	Social and socio-technical demands in target groups
Demographic studies	Predicted context(s) of use
Expert forecasts	Market appraisals
HCD strategy methodologies	Trend analysis
	System accounting process
	Human-centred system strategy

Table A.2 — Plan and manage the HCD process (HCD.2)

Input	Output
Business plan Organisational resources Results of reviews Development plans for system Staff skills profiles Human-centred methods and tool descriptions Test method descriptions Project management statistics Project monitoring data General usability objectives Human and organisational requirements	List of human centred activities to be carried out Procedure for integrating human centred activities with other development activities The individuals and organisation(s) responsible for the human-centred design activities and the range of skills and viewpoints they provide Procedures for establishing communication on human-centred design activities as they affect other design activities and methods for recording these activities Milestones during the design and development process, e.g. through specification of life cycle documents Procedures for ensuring full use of feedback from all pilots, trials and evaluations Suitable timescales to allow feedback to be incorporated into the design schedule Assignment of usability objectives to elements of the system Definition of evaluation criteria following from usability objectives Indication of test method(s) for evaluations Advice on the degree of iteration Audit report [a] Human-centred human factors policy HCD process definitions HCD support technology specification

[a] Evidence for audits includes the following:

Confirmation of context of use information and requirements information by users or their representatives.

Evidence that the: context of use has driven the design process; user and organisational requirements have driven the design process; prototyping and evaluation results have been used to improve and refine the design; sufficient parts of the system were tested to give meaningful results for the system as a whole.

Adequacy of number of users and evidence of their representativeness of those identified in the context of use.

Appropriateness of test methods for the system and context of use, and of the treatment of test results.

Evidence of the competence of the assessor(s) and appropriate selection and use of relevant procedures.

Table A.3 — Specify the stakeholder and organisational requirements (HCD.3)

Input	Output
Project scope	The range and relevance of users and other personnel in the design
User representatives	Risk assessment
Work instructions	A statement of the human-centred design goals
Legislation	Stakeholder/User Requirements Specification
Industry, National and International standards	Organisational Requirements Specification
System strategy	Priorities for different requirements
Context of use	Specific, measurable usability goals
Competitor systems	Benchmarks against which the design can be tested
	List of statutory or legislative requirements
	The sources from which the user and organisational requirements were derived

Table A.4 — Understand and specify the context of use (HCD.4)

Input	Output
System Requirements	Specification of the range of intended users, tasks and environments
Stakeholder/User Requirements Specification	Stakeholder information
Organisational Requirements Specification	User information
Project scope	Task information
User representatives	Organisational analysis
Work instructions	The sources from which the context of use information was derived
Time and format of the provision of context of use information to the development team	

Table A.5 — Produce design solutions (HCD.5)

Input	Output
System Requirements Specification Stakeholder/User Requirements Specification Organisational Requirements Specification Context of use Measurable Usability Goals Ergonomic requirements Standards and Guides Style Guide(s) Expertise Feedback from evaluations	The sources of existing knowledge and the standards used, with an indication of how they have been incorporated (or why they have not been followed, if appropriate) User Interaction Specification Dialogue detail Look and feel Layout and other UI issues Simulations of specification Prototype(s) of parts and all of the system Task model Assignment of functions Worksystem design Evidence of revision in accordance with results of evaluations Training plans for users and maintainers of the system Definition of user support services for the system List of standards used and how applied Justification of deviations from any standard to meet particular requirements Report on how conflicts between design requirements and existing knowledge were dealt with in the design Means of feedback and use of results in other design activities The steps taken to ensure that the prototype(s) covered key requirements and followed good practice

Table A.6 — Evaluate designs against requirements (HCD.6)

Input	Output
Project plan System Requirements Specification Stakeholder/User Requirements Specification Organisational Requirements Specification Context of use statement Measurable Usability Goals Standards Legislation Guidelines Standards for HF activities Usability audit schedule Test criteria Testing staff Test specifications/plans Assessment tools Work instructions Working practices Users User details Questionnaires Roll-out objectives In-use user and organisational satisfaction objectives Long-term health, safety and well-being objectives Description of the usability, health and safety requirements	Which parts of the system are to be evaluated and how they are to be evaluated Context of evaluation Full description of the system tested and its status Number of users taking part in testing, including evidence of adequacy of number of users and their representativeness of those identified in the context of use Testing and data collection methods, including evidence of appropriateness of these methods for the system and context use Results in detail and appropriate statistical analysis. A report of major and minor non-compliances and observations and an overall assessment A clear pass/fail decision in relation to the requirements Evidence of the competence of the assessor(s) and the selection and use of relevant procedures Evidence that sufficient parts of the system were tested to give meaningful results for the system as a whole Source of evaluation feedback Usability and ergonomic defects Recommendations for improvement Video and audio tapes from trials User observation logs Trial plans and records Revisions to requirements Interview transcripts Measurements of ergonomic parameters Survey criteria Survey plan Survey report