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Ergonomics — General approach, principles and concepts

Ergonomie — Approche générale, principes et concepts

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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.

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

ISO 26800 was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 1, *General ergonomics principles*.

Introduction

Human, technological, economic, environmental and organizational factors all affect the behaviour, activities and well-being of people in work, domestic and leisure contexts. The science of ergonomics has evolved from its origins in the context of work to embrace many other fields of application, such as home and leisure. However, whatever the context, the underlying principles of ergonomics remain the same, although the relative emphasis placed on them will vary. These principles are fundamental to the design process wherever human involvement is expected, in order to ensure the optimum integration of human requirements and characteristics into a design. This International Standard considers systems, users, workers, tasks, activities, equipment and the environment as the basis for optimizing the match between them. These principles and concepts serve to improve safety, performance and usability (effectiveness, efficiency and satisfaction), while safeguarding and enhancing human health and well-being, and improving accessibility (e.g. for elderly persons and persons with disabilities).

Ergonomics covers a wide range of issues, including physical, cognitive, social and organizational. These are ideally addressed within an integrated framework. A substantial number of ergonomics standards have been developed to cover specific issues and different application domains. All depend upon the basic principles and concepts that are fundamental to the ergonomics approach to design. This International Standard has been developed in order to provide an integrated framework, bringing together the basic principles and concepts of ergonomics in one document, and thus providing a high-level view of the way in which ergonomics is applied.

NOTE 1 ISO 6385[2] remains a high-level International Standard for work systems.

NOTE 2 A complete list of current published ergonomics International Standards can be accessed via http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_tc_browse.htm?commid=53348&published=on&includesc=true.

Ergonomics — General approach, principles and concepts

1 Scope

This International Standard presents the general ergonomics approach and specifies basic ergonomics principles and concepts. These are applicable to the design and evaluation of tasks, jobs, products, tools, equipment, systems, organizations, services, facilities and environments, in order to make them compatible with the characteristics, the needs and values, and the abilities and limitations of people.

The provisions and guidance given by this International Standard are intended to improve the safety, performance, effectiveness, efficiency, reliability, availability and maintainability of the design outcome throughout its life cycle, while safeguarding and enhancing the health, well-being and satisfaction of those involved or affected.

The intended users of this International Standard are designers, ergonomists and project managers, as well as managers, workers, consumers (or their representatives) and procurers. It also serves as a reference standard for standards developers dealing with ergonomics aspects.

This International Standard provides the basis for other, more detailed, context-specific ergonomics International Standards.

2 Terms and definitions

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

2.1
accessibility
extent to which products, systems, services, environments and facilities can be used by people from a population with the widest range of characteristics and capabilities to achieve a specified goal in a specified context of use

NOTE 1 Context of use includes direct use or use supported by assistive technologies.

NOTE 2 Adapted from ISO/TR 22411:2008, definition 3.6.

2.2
ergonomics
human factors
scientific discipline concerned with the understanding of interactions among human and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance

NOTE This definition is consistent with that given by the International Ergonomics Association[21].

2.3
environment
physical, chemical, biological, organizational, social and cultural factors surrounding one or more persons

2.4
external load
external conditions and demands in a system which influence a person's physical and/or mental internal load

NOTE 1 In ISO 6385:2004, “external load” is called “work stress”.

NOTE 2 External load is a neutral term. Its effects can be positive, neutral or negative.

2.5
fatigue
impairing non-pathological manifestation of internal load, completely reversible with rest

NOTE Fatigue can be mental, physical, local and/or general.

2.6
internal load
internal response of a person to being exposed to the external load, depending on his/her individual characteristics (e.g. body size, age, capacities, abilities, skills, etc.)

NOTE 1 In ISO 6385:2004, “internal load” is called “work strain”.

NOTE 2 Internal load is a neutral term. Its effects can be positive, neutral or negative.

2.7
system
combination of interacting elements organized to achieve one or more stated purposes

NOTE 1 In ergonomics, the “elements” of a system are often called “components”.

NOTE 2 A system can consist of products, equipment, services and people.

NOTE 3 The word “system” can be qualified by adding a context-dependent term (e.g. aircraft system).

NOTE 4 Adapted from ISO/IEC 15288:2008, definition 4.31.

2.8
target population
people for whom the design is intended, specified according to relevant characteristics

NOTE Relevant characteristics include, for example, the skill level, intelligence or physical characteristics — such as anthropometric dimensions — of these people. Gender and age can be related to variations in these characteristics. In addition to these intrinsic characteristics, extrinsic factors (e.g. cultural differences) could also be relevant.

2.9
usability
extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use

[ISO 9241-210:2009, 2.13]

NOTE This definition is usually applied to systems, products or services, but not to work systems. It could, however, relate to the design and evaluation of work equipment within a work system.

2.10
user
person who interacts with a system, product or service

NOTE 1 Adapted from ISO 9241-110:2008, definition 3.8, and ISO 9241-11:1998, definition 3.7.

NOTE 2 The person who uses a service provided by a work system, such as a customer in a shop or passenger on a train, can be considered a user.

NOTE 3 A user who is using a system is not a component of that system. However, both the user and the system used can be considered as components of a higher-level system.

2.11
worker
person performing one or more activities to achieve a goal within a work system

[ISO 6385:2004, 2.8]

2.12
work system
system comprising one or more workers and work equipment acting together to perform the system function, in the workspace, in the work environment, under the conditions imposed by the work tasks

[ISO 6385:2004, 2.16]

3 The ergonomics approach

Ergonomics (or human factors) has been defined by the International Ergonomics Association (IEA), the federation of ergonomics and human factors societies from around the world, as "the scientific discipline concerned with the understanding of the interactions among human and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance"[21]. This includes the specific goals of facilitating task performance, safeguarding and enhancing the safety, health and well-being of the worker, or the user/operator of products/equipment, by optimizing tasks, equipment, services, the environment or, generally speaking, all elements of a system and their interactions. Achieving these goals potentially contributes to sustainability and to social responsibility (see Annex A).

NOTE 1 Throughout this International Standard, the use of singular terms to refer to a human in different roles (e.g. worker, operator, user, consumer) in different domains (e.g. the private and work domains) is intended to include multiples of humans as well as higher aggregation levels such as groups, teams or organizations.

Ergonomics addresses the interactions between the humans and other components of a system, such as other humans, machines, products, services, environments and tools, as appropriate. This includes taking into account the following factors:

— purpose of the system, product or service (see 4.2);

— characteristics of the intended target population (see 4.2.2);

— goals to be achieved and tasks to be performed (see 4.2.3);

— existing constraints (e.g. legacy equipment or processes, economic or legal issues);

— factors of the physical, organizational and social environment (see 4.2.4);

— life cycle and any dynamic changes within it (see Clause 6).

In order to achieve optimized system performance, all these factors shall be taken into account. Figure 1 provides an example of factors to be taken into account in an ergonomics approach. It shows the activity of a person as central to the functionality of the system. Additional factors might be identified for a particular context.

NOTE 2 A textual description of Figure 1 is given in B.2.

NOTE 3 The analysis of variations in activities in the context of use helps in the understanding of potential effects on health and safety and, on the other hand, quantitative and qualitative results.

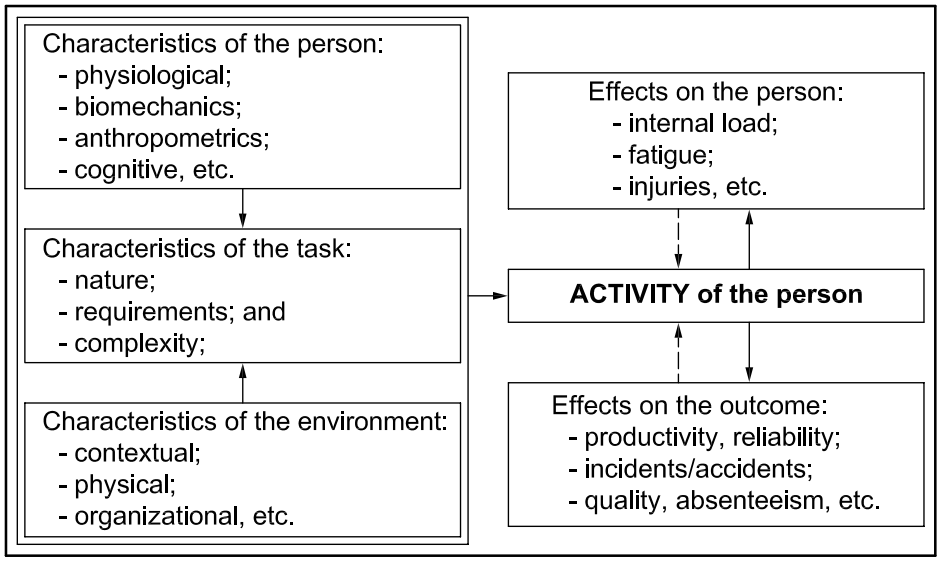

Figure 1 — Example of factors to be taken into account in optimizing system performance

In its simplest form, the system consists of a human and at least one other element (human, machine or environment) interacting within a specific context. More complex systems involve further elements (e.g. humans, machines or equipment). All such systems can be found in different contexts such as work, public life, leisure, etc. In the context of work, these systems are called *work systems*.

NOTE 4 An example of a simple system is given in 5.2 and Figure 2 (see also Annex B).

NOTE 5 A more detailed account of designing work systems can be found in ISO 6385[2].

This International Standard includes both principles (see Clause 4) and concepts (see Clause 5). The principles are fundamental to an ergonomics-oriented design process (see Clause 6) and serve to distinguish an ergonomics approach from other approaches that do not observe these principles.

To meet the main goal of ergonomics, i.e. optimizing system performance, the principles presented in Clause 4 shall be applied.

Concepts provide the means for interpreting, addressing and evaluating design from an ergonomics perspective. Those presented in this International Standard have previously been successfully applied in specific contexts to achieve an ergonomic design outcome that meets ergonomics goals and can be helpful in other contexts, although they are not necessarily universally applicable.

The concepts described in Clause 5 shall be applied where appropriate.

4 Principles of ergonomics

4.1 General

This clause presents the principles which are fundamental to an ergonomics approach. These place the human at the centre of the ergonomics approach to design (human-centred, see 4.2), taking into account the diversity of the human population (target population, see 4.2.2) and the implications of the task for the human (task oriented, see 4.2.3), as well as the environment in which the outcome of the design is to be used (environmental context, see 4.2.4). Finally, it emphasises the basic ergonomics criteria which need to be applied in evaluating the design (criteria-based evaluation, see 4.3).

4.2 Human-centred

4.2.1 General

An ergonomics approach to design shall be human-centred.

This means that all designable components of a system, product or service are fitted to the characteristics of the intended users, operators or workers, rather than selecting and/or adapting humans to fit the system, product or service. This should be done by consideration of

— the intended target population,

— the task, goal or intended outcome of the system, product or service, and

— the environment in which the design is to function.

From an ergonomics point of view, selection and training strategies are no substitute for an appropriate design of systems, products or services, although some selection and training can still be required.

Those affected by the design (e.g. workers or users) should be involved throughout the whole design process, including evaluation. This will help to optimize solutions (e.g. by providing specific experience and requirements). Their early and continued participation and involvement is regarded as an efficient design strategy within ergonomics.

NOTE For a more detailed description of the human-centred approach for interactive systems, see, for example, ISO 9241-210[8].

4.2.2 Target population

The target population shall be identified and described.

The human population is very diverse. Humans vary in their physical dimensions and in their biomechanical, sensory and cognitive capabilities. This is why ergonomics design is usually orientated towards a specified target population, not towards one individual or the entire population. Discrimination leading to unfair treatment (e.g. on the basis of gender, age or disability) shall be avoided in identifying and specifying the target population (see ILO Convention No.111[22]).

NOTE 1 In particular circumstances (e.g. rehabilitation), the target population might be one person.

NOTE 2 Target populations may change over time and any such trends need to be considered.

NOTE 3 The inclusion of older persons and people with disabilities in the target population and designing accordingly can help to improve the accessibility of a system, product or service (see ISO/IEC Guide 71[20] and ISO/TR 22411[17]).

The characteristics of the target population relevant to the design shall be identified and their range of variation within the intended target population specified (e.g. body size, visual abilities, literacy, skills, knowledge).

NOTE 4 For more detailed descriptions of sources of variability, see, for example, ISO 14738[12] for anthropometric requirements of workers and ISO/TR 22411[17] for ergonomics data of elderly or disabled persons.

In ergonomics, the variation within the target population is commonly accounted for by using the 5th and/or 95th percentiles of important design characteristics (e.g. body size, visual abilities, literacy), with the intention of accommodating at least 90 % of the target population. In some circumstances, a different percentile range is used. For example, in many safety-related applications, the 1st and 99th percentiles are used.

NOTE 5 In most instances, the use of average values is not an adequate way of accommodating the range of values to be found associated with a particular characteristic.

NOTE 6 It is important to recognize that uncritical use of univariate percentiles, where simultaneous accommodation of multiple characteristics is necessary, might lead to a smaller range of the population being included than had been intended. The degree to which an ergonomic solution is compromised by using univariate percentiles depends upon the correlations between these characteristics. When correlations are low, it can be advisable to use wider percentile ranges or multivariate models of population variation to establish design criteria.