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Ergonomics of human-system interaction —

Part 400: Principles and requirements for physical input devices

Ergonomie de l'interaction homme-système —

*Partie 400: Principes et exigences pour les dispositifs d'entrée
physiques*



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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 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 9241-400 was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 4, *Ergonomics of human-system interaction*.

This first edition of ISO 9241-400, together with ISO 9241-410, ISO 9241-411¹⁾, ISO 9241-420¹⁾ and ISO 9241-421¹⁾, partially replaces ISO 9241-4:1998 and ISO 9241-9:2000, technically revised as follows:

- terms and definitions from ISO 9241-4 and ISO 9241-9 have been transferred to ISO 9241-400;
- all guiding principles have been incorporated into ISO 9241-400 and unified so that they correspond to the scope of the new ISO 9241 series;
- these principles are applied in ISO 9241-410 in order to generate provisions for product design.

ISO 9241 consists of the following parts, under the general title *Ergonomic requirements for office work with visual display terminals (VDTs)*:

- *Part 1: General introduction*
- *Part 2: Guidance on task requirements*
- *Part 3: Visual display requirements*
- *Part 4: Keyboard requirements*
- *Part 5: Workstation layout and postural requirements*
- *Part 6: Guidance on the work environment*
- *Part 7: Requirements for display with reflections*
- *Part 8: Requirements for displayed colours*

1) Planned or under preparation. (See Annex A)

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- *Part 9: Requirements for non-keyboard input devices*
- *Part 11: Guidance on usability*
- *Part 12: Presentation of information*
- *Part 13: User guidance*
- *Part 14: Menu dialogues*
- *Part 15: Command dialogues*
- *Part 16: Direct manipulation dialogues*
- *Part 17: Form filling dialogues*

ISO 9241 also consists of the following parts, under the general title *Ergonomics of human-system interaction*:

- *Part 20: Accessibility guidelines for information/communication technology (ICT) equipment and services*
- *Part 110: Dialogue principles*
- *Part 151: Guidance on World Wide Web user interfaces*
- *Part 171: Guidance on software accessibility*
- *Part 300: Introduction to requirements and measurement techniques for electronic visual displays*
- *Part 302: Terminology for electronic visual displays*
- *Part 303: Requirements for electronic visual displays*
- *Part 304: User performance test methods*
- *Part 305: Optical laboratory test methods for electronic visual displays*
- *Part 306: Field assessment methods for electronic visual displays*
- *Part 307: Analysis and compliance test methods for electronic visual displays*
- *Part 400: Principles and requirements for physical input devices*
- *Part 410: Design criteria for products for physical input devices*

The following parts, under the general title *Ergonomics of human-system interaction*, are under preparation:

- *Part 308: Surface-conduction electron-emitter displays (SED) [Technical Report]*
- *Part 411: Laboratory test and evaluation methods for the design of physical input devices*
- *Part 420: Selection procedures for physical input devices*
- *Part 421: Workplace test and evaluation methods for physical input devices*
- *Part 920: Guidance on haptic and tactile interactions*

Introduction

Input devices are means whereby users can enter data into interactive systems. Generally speaking, an input device is a sensor that can detect changes in user behaviour (gestures, moving fingers, etc.) and transform them into signals to be interpreted by the interactive system.

Input devices are utilized for the sole purpose they have been designed for, e.g. a keyboard for entering character codes. Under certain circumstances they may be used also for other purposes. However, in this case, generally their efficiency and/or effectiveness is restricted to a certain degree (e.g. keyboard for pointing). An input device can also be used in combination with others if needed to enhance the capabilities of users. Utilizing a keyboard and a mouse for drawing straight lines is an example of the latter.

Whether or not an input device or a combination of input devices is acceptable from an ergonomic point of view is to be determined following the rationale of the usability concept. This concept postulates that an entity has no inherent usability, but one in a specified context of use, for specified goals and specified users. A product may be designed for an intended user population and for a restricted context of use, e.g. for children in moderately conditioned indoor spaces. Specifying goals for using a device needs additional considerations, however.

Goals that the users of input devices need to achieve may be defined as high-level tasks such as "word processing" or "multimedia". A definition in this level, however, may be too abstract to design, test or select a device on the basis of usability. For this reason, this standard specifies "task primitives" such as "pointing", "dragging" or "code input".

Design and selection equipment requires a fit to be achieved between a range of task requirements and the needs of users. The concept of *fit* as defined in ISO 9241-5:1998 concerns the extent to which equipment (visual display units, input devices, etc.) can accommodate individual users' needs. Good fit is needed for the intended user population, including users with special needs, e.g. people with disabilities, if the use of a certain device is not limited to a specified user population and task. Since a variety of input devices exists that may enable a user to achieve the same usability for the same task by creating input through different bodily abilities (e.g. hand, foot, speech or eye control) the required fit can be achieved by utilizing any device that offers the required level of usability. Depending on the character of the special needs, a combination of different devices may be necessary, e.g. a foot- and an eye-controlled input device instead of a mouse for a person who cannot use his or her hands for whatever reason.

This part of ISO 9241 specifies generic ergonomic principles valid for the design and use of input devices.

To be able to formulate recommendations for groups or types of input devices, a set of typologies is introduced, based on aspects according to which possible designs can be differentiated:

- physical variables carrying the information (relative/absolute position, force, velocity, acceleration, etc.);
- bodily part used for operation;
- dimensionality of control (degrees of freedom);
- multiplicity of control (number of parallel control variables);
- control modality (discrete/continuous);
- control monitoring (one-shot or continuous time, holds last value or returns to nominal value, sequential or skip-out the continuum output, etc.);
- control distance function (monotonic, non-monotonic, uni/bipolar, etc.);

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- mapping, straightforwardness;
- psychological nature of control (causality, exploratory or goal-oriented control).

It also specifies properties relevant for the usability of input devices and typologies in consideration of different aspects (e.g. degrees of freedom, property sensed etc.). Guidance on the application of these principles on product design is given in ISO 9241-410. The ergonomic guidance for the design of products is given without including aspects related to a particular context (e.g. using keyboards at CAD workstations). Selecting the intended context of use is part of the design process and not the subject of this part of ISO 9241.

ISO 9241-411²⁾ is to specify methods for determining conformance through observation, performance and by measurement of the physical attributes of the various devices.

NOTE This part of ISO 9241 will be supported by the following methods (ISO 9241-411):

- usability test for text and data input using stationary keyboards (currently given in ISO 9241-4);
- generic usability test for keyboards for non-touch typing tasks;
- input device selection, usability testing and analysis (currently given in ISO 9241-9);
- testing of efficiency and effectiveness of physical input devices (based on the methods specified in ISO 9241-9);
- assessment of comfort (currently given in ISO 9241-4 and ISO 9241-9);
- additional evaluation methods.

Guidance on the application of these principles for selecting appropriate products for a given context of use is described in ISO 9241-420²⁾ in the form of ergonomic selection and combination criteria for using single or multiple input devices at the same work-station.

This part of ISO 9241 does not include test and evaluation methods. These will be developed and published in separate documents for the two target groups "manufacturers, designers, and test houses" and "user organizations", since such methods can be subject to frequent change.

ISO 9241 was originally developed as a seventeen-part International Standard on the ergonomics requirements for office work with visual display terminals. As part of the standards review process, a major restructuring of ISO 9241 was agreed to broaden its scope, to incorporate other relevant standards and to make it more usable. The general title of the revised ISO 9241, "Ergonomics of human-system interaction", reflects these changes and aligns the standard with the overall title and scope of Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 4, *Ergonomics of human-system interaction*. The revised multipart standard is structured as a series of standards numbered in the "hundreds": the 100 series deals with software interfaces, the 200 series with human centred design, the 300 series with visual displays, the 400 series with physical input devices and so on.

See Annex A for an overview of the entire ISO 9241 series.

2) Planned. (See Annex A)