
**Spatial orientation and direction of
movement — Ergonomic requirements**

Orientation spatiale et sens du mouvement — Exigences ergonomiques

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Contents

Page

Foreword.....	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	2
4 Design of spatial orientation and direction of movement	6
4.1 General.....	6
4.2 Ergonomic design of user interface (UI) with respect to orientation and direction	6
4.3 Steps in direction design	6
4.4 Design requirements/recommendations for human-machine interface (HMI)	7
4.5 Design recommendations for graphical user interfaces (GUI)	11
4.6 Design recommendations for combined control systems	17
5 Conformance	18
5.1 Applying requirements and recommendations	18
5.2 Evaluation of products	18
Annex A (informative) Constituent factors of usability	19
Annex B (normative) Reference model for spatial orientation and direction of movement.....	20
Annex C (informative) Flow of human-centred design activities	31
Annex D (informative) Spatial orientation and direction of movement design checklist	32
Bibliography	41

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 1503 was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 4, *Ergonomics of human-system interaction*.

This second edition cancels and replaces the first edition (ISO 1503:1977), which has been technically revised.

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Introduction

It is essential for the safety and usability of any system or product that the relationship between the direction of its controls intended by a user/operator and the resulting direction of movement of the target object be standardized.

For example, if the operation of fire-fighting equipment is not standardized, then swift and appropriate operation in the event of a fire is difficult. If a one-hand lever is to be moved forward in Model A and backward in Model B for speed-up of a railway electric car, frequent human error and, eventually, accidents are likely to be caused. If a computer does not respond in accordance with what is shown on its screen, then its usability and the efficiency of its user/operator will suffer. In construction work, effectiveness, efficiency and user/operator satisfaction will be diminished if the user/operator's intention to make a dynamic change of the target object is not well followed in the control of earth-moving machinery.

One of the purposes of this International Standard is to contribute to the enhancement of safety by preventing human error during use as well as maintenance of a system and/or product. Another is to improve effectiveness, efficiency and user/operator satisfaction by making the change of state and/or the movements of a target object consistent with the user/operator's intention.

The first edition of ISO 1503 was constructed mainly in the framework of geometry regarding the definition of three dimensional axes, geometrical orientation and the direction of control and display movements. This revised edition incorporates the ergonomic issues that affect direction design with the aim of making the standard more directly applicable in real-world situations. It deals with ergonomics design principles and requirements for direction for products and work systems in a combined way — both for conventional technical systems and newly developed information technology-related systems.

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Spatial orientation and direction of movement — Ergonomic requirements

1 Scope

This International Standard sets out design principles, procedures, requirements and recommendations for the spatial orientation and direction of movement of controls and displays used in tool machines, industrial robots, office machines, earth-moving machinery, transportation (automobiles, railway electric cars/rolling stock, aircraft, ships, etc.), information, daily commodities, public utilities and the operational components of building facilities.

It lays down basic requirements for determining the operating direction of controls and the moving directions or changing states of the target object, as well as other relations.

This International Standard

- defines three dimensional axes, the observer, viewing systems, linear movement, rotary movement, two-dimensional and three-dimensional movements in a dynamic space sequentially,
- describes the four principles for determining the operating direction of a control, the moving direction of a target object and/or display,
- provides GUI (graphical user interface) design requirements and recommendations that integrate the relationship between the computer operation and the movement of images on-screen in line with human characteristics and to promote safety and efficiency in computer-assisted tasks,
- sets out design principles and recommendations for determining the moving directions of a target object and the controls of a combined control system using a multi-direction control that easily realizes the complex operations intended by the user/operator as they are often seen in industrial apparatuses for business use, and
- gives principles and recommendations for the direction design of existing, as well as new, systems.

NOTE Ergonomics requirements or recommendations given in this International Standard can also be applied to designing the direction of movement of other industrial goods, such as medical equipment, TV or PC game devices and relevant machines/devices.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6385:2004, *Ergonomic principles in the design of work systems*

ISO 9241-110, *Ergonomics of human-system interaction — Part 110: Dialogue principles*

ISO 9355-2:1999, *Ergonomic requirements for the design of displays and control actuators — Part 2: Displays*

ISO 9355-4, *Ergonomic requirements for the design of displays and control actuators — Part 4: Location and arrangement of displays and control actuators* ¹⁾

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

3 Terms and definitions

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

3.1

axis

one of three assumed infinite mutually perpendicular straight lines through the centre point of the target object

NOTE The infinite straight lines run from behind to front, from left to right, and from top to bottom, corresponding to the longitudinal axis, X, transverse axis, Y and normal axis, Z, respectively (based on the Cartesian system of coordinates).

3.2

centre point

assumed reference point for the spatial orientation and determination of movements of a target object

NOTE The centre point is the primary standard provided by the intersecting point of three axes or three reference planes. This point corresponds to the viewpoint of the **observer** (3.10) in the **internal viewing system** (3.20.2), and can be located anywhere on the target object according to the purpose of observation in the **external viewing system** (3.20.1). The centre point need not coincide with the gravitational centre of the target object.

3.3

mono-direction control

single-direction control

one or a set of controls that control the movements of a target object only on one axis at a time

3.4

multi-direction control

control unit that alone can control a target object in two or more moving directions along X, Y and Z axes and in the planes composed of these axes or in the space composed of three planes

3.5

combined control system

control system in which two or more **multi-direction controls** (3.4) are applied

NOTE This system is seen typically in modern earth-moving machinery.

3.6

direction

position of a point in space relative to another point, independent of the distance between the two points

1) To be published.

3.7**human-centred design****user-centred design**

design approach that is characterized by the active involvement of users, a clear understanding of user and task requirements, an appropriate allocation of function between users and technology, iterations of design solutions, and multi-disciplinary design

NOTE 1 See ISO 13407:1999, 5.1, for its principles.

NOTE 2 Usability engineering is often used as a substitute for human-centred design. But, applying usability engineering methods does not necessarily prescribe the active user involvement that is the essence of human-centred design. In addition, usability engineering often over-emphasizes the role of evaluation methods. Human-centred design, on the other hand, refers to the process of analyzing context of use, eliciting user requirements, producing design solutions and evaluating the design against the requirements — all in an iterative fashion.

3.8**clockwise**, adv, adj**right-hand rotation**

direction of a rotary movement of a target object to the right when viewed in direction X

3.9**anticlockwise** GB, adv, adj**counter-clockwise** US, adv, adj**left-hand rotation**

direction opposite to **clockwise** (3.8) (right-hand) rotation

3.10**observer**

real or hypothetical person who views a target object from outside or inside of it when determining the direction or movement of a **target object** (3.14)

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3.11**user**

individual interacting with the system

[ISO 13407]

3.12**operator**

person given the task of installing, operating, adjusting, maintaining, cleaning, repairing or transporting machinery or a system

NOTE Within the context of this International Standard, the tasks performed concern the control of equipment or devices.

3.13**reference plane**

one of three perpendicular planes passing through the centre point of a **target object** (3.15) which, in each case, contains two axes of the target object

NOTE The planes that contain longitudinal axis X and transverse axis Y, longitudinal axis X and normal axis Z, and transverse axis Y and normal axis Z are called the basic plane, Pxy, longitudinal plane, Pxz, and transverse plane, Pyz, respectively.

3.14**spatial orientation**

direction-related inherent property of a **target object** (3.15)

NOTE Spatial orientation of a target object is characterized by pairs such as front-behind, right-left or up-down.

3.15
target object

object (including images) whose **spatial orientation** (3.14) or movements are to be defined, established or controlled

3.16
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]

NOTE 1 See Annex A.

NOTE 2 For the purposes of this International Standard, **user** (3.11) is interchangeable with **operator** (3.12) for those activities that involve movement of controls or target objects.

3.16.1
effectiveness

accuracy and completeness with which users achieve specified goals

[ISO 9241-11]

NOTE For the purposes of this International Standard, **user** (3.11) is interchangeable with **operator** (3.12) for those activities that involve movement of controls or target objects.

EXAMPLE The percentage of attained goals.

3.16.2
efficiency

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

[ISO 9241-11]

NOTE For the purposes of this International Standard, **user** (3.11) is interchangeable with **operator** (3.12) for those activities that involve movement of controls or target objects.

EXAMPLE The time needed to complete a task.

3.16.3
satisfaction

freedom from discomfort and positive attitudes towards the use of the product

[ISO 9241-11]

EXAMPLE The frequency of willingness to use.

3.16.4
context of use

users (3.11) or **operators** (3.12), tasks, equipment (hardware, software, and materials) and the physical and social environments by, with or in which, a product is used

3.17**user interface****UI****man-machine interface****MMI****human-machine interface****HMI****human-system interface****HSI**

component of an interactive system (software or hardware) that provides the information and controls necessary for the user to accomplish specific tasks with the interactive system

NOTE Adapted from ISO 9241-110.

3.18**viewing direction**

assumed direction to which an **observer** (3.10) looks, when determining the **direction** (3.6) of a **target object** (3.14)

3.18.1**viewing direction X(E)**

viewing direction from the front side of a **target object** (3.15) toward the **centre point** (3.2) along the longitudinal **axis** (3.1) in the **external viewing system** (3.19.1)

NOTE See Annex B.

3.18.2**viewing direction X(I)**

viewing direction from the **centre point** (3.2) of a **target object** (3.15) toward the front side along the longitudinal **axis** (3.1) in the **internal viewing system** (3.20.2)

NOTE See Annex B. <https://standards.iteh.ai/catalog/standards/sist/9fed9f91-dc5a-4f4d-9639-95d49f6f038a/iso-1503-2008>

3.18.3**viewing direction Y**

viewing direction along the transverse axis, Y, to the right

NOTE See Annex B.

3.18.4**viewing direction Z**

viewing direction along the normal axis, Z, below

NOTE See Annex B.

3.19**viewing point**

position of an **observer's** (3.10) eye

3.20**viewing system**

system in which position, posture and **viewing direction** (3.18) of the **observer** (3.10) are fixed with reference to the three axes of the **target object** (3.15) in order to render possible its **spatial orientation** (3.13) and determination of its directions of movement

3.20.1**external viewing system****EVS**

viewing system in which the location of the **observer** (3.10) is assumed to be outside the **target object** (3.15)

NOTE See Annex B.

3.20.2

internal viewing system

IVS

viewing system in which the location of the **observer** (3.10) is assumed to be inside the **target object** (3.15)

NOTE See Annex B.

4 Design of spatial orientation and direction of movement

4.1 General

This clause relates to direction design: basic ergonomics recommendations for user interfaces (4.2), the ergonomics steps for direction design (4.3), individual ergonomics requirements and recommendations for human-machine interfaces (4.4), and graphical user interface (4.5) and combined control (4.6) design recommendations.

Detailed requirements for spatial orientation and direction of movements are given in Annex B.

4.2 Ergonomic design of user interface (UI) with respect to orientation and direction

The ergonomic design of a UI includes

- anthropometric aspects (e.g. body size, hand reach envelopes, visual field),
- cognitive aspects (e.g. compatibility of information displays/controls, human error tolerance),
- physiological capability aspects in information processing (e.g. workload, information processing speed, accuracy), and
- environmental aspects (e.g. illumination, colour, noise).

UI design should be human-centred. Since the design of orientation and direction of movement of a target object is a crucial component of UI design, the displays and controls and their relationship should be easy to understand and use. The UI should be designed taking into account safety, usability and human characteristics (sensing, sensitive intention, perception, human communication, etc.).

Human-centred design features the following essential conditions (see ISO 13407 and Annex C):

- a) a clear understanding of the requirements/constraints of the user/operator and the task in question through the user's/operator's active involvement;
- b) an appropriate allocation of function between the user/operator and the machine for the accomplishment of the task;
- c) frequent review of the design based on feedback from the user/operator;
- d) collaboration among team members throughout the process.

4.3 Steps in direction design

Major goals of direction design are to ensure safety, efficiency, ease of use and comfort. The designer's first undertaking is to clarify the main goals of the direction design of the controls/displays within systems design. Safety should be given a high priority, among multiple goals, in the design. Direction of movement design is accomplished through specifying the task in question, determining the user(s)/operator(s) and determining the relative priorities of safety, efficiency, ease of use and comfort.

Direction of movement design includes the following steps.

- a) Define the task and function.
- b) Specify the user/operator in accordance with ISO 13407.
- c) Specify the task in terms of
 - 1) the movements/displays of the target object and controls to perform the task,
 - 2) relative priorities in conducting the task (safety, efficiency, ease of use or comfort),
 - 3) user's/operator's working posture in performing the task,
 - 4) work space where the task is performed,
 - 5) the flow of information for conducting the task, and
 - 6) environmental factors (e.g. ambient illumination, necessity of protective clothes).
- d) Define movements/displays of the target object and location of the controls.
 - 1) Specify an area as a specific layered zone, corresponding to the view area and the frequency and priority of the controls used within the area, in accordance with ISO 9355-2:1999, Figures 1 and 2.
 - 2) Specify the location of the displays and controls, according to priority of function in the task, in accordance with ISO 9355-2:1999, 4.1 and ISO 9355-4, 4.3.
 - 3) Specify the arrangement of the displays and the controls in accordance with ISO 9355-4, 4.4.

4.4 Design requirements/recommendations for human-machine interface (HMI)

ISO 1503:2008

4.4.1 General

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When designing an HMI, designers shall determine the operating directions of the controls and movements of the target object considering ergonomic design principles in accordance with ISO 6385:2004, 3.6.5, while taking into account the population stereotype. In case a stereotype does not exist, either the mental model or metaphor may be taken into account.

NOTE "Population stereotype" is a natural human sense with respect to the directions of movement and operations (see Reference [6]). For example, drivers expect that a car will turn right if they turn the steering wheel to the right, and when learning how to drive they are trained to use the brake as a knee-jerk reaction — which is how stereotypes are formed.

When arranging two or more displays units and controls, attention shall be paid to their directional consistency. The following is also recommended.

- a) Displays and controls should function in a manner to reduce the probability of human errors.
- b) Displays should be selected, designed and laid out in a manner compatible with the characteristics of human perception and the task to be performed.
- c) Controls should be selected, designed and laid out in such a way as to be compatible with the characteristics (particularly of movement) of that part of the body by which they are to be operated and the task to be performed. Skill, accuracy, speed and strength and dexterity requirements should be taken into account.
- d) Controls should be selected and arranged, where possible, within the constraints of the space available to suit the target population stereotype, sequence and movement of controls.