
**Ergonomics of human-system
interaction —**

**Part 971:
Accessibility of tactile/haptic
interactive systems**

Ergonomie de l'interaction homme-système —

Partie 971: Accessibilité des systèmes interactifs tactiles/haptiques



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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

A list of all parts in the ISO 9241 series can be found on the ISO website.

Introduction

The tactile/haptic modality is the most widely used modality for inputs to interactive systems and is used as an important output modality for many contexts of use. Often, haptic devices and applications are designed for the “typical” or “average” user. It is important that interactive systems and their designs follow general ergonomic practice as well as meet the widest range of user needs, characteristics, and capabilities for tactile/haptic interactions.

Examples of the use of tactile/haptic inputs range from the use of keyboards, pointing devices (such as a mouse or track pad) and direct touch (gestures) to the use of non-touch gestures, eye-tracking, single-switch inputs, and whole-body movements. Examples of tactile/haptic outputs include the use of vibration and tactile pattern (e.g. braille) outputs. Tactile/haptic inputs/outputs can be combined (e.g. force feedback systems).

Achieving accessibility involves good ergonomic practice. This document works with other ISO and ISO/IEC standards relating to tactile/haptic interactions (such as ISO 9241-910, ISO 9241-920 and ISO 9241-960) and to accessibility (such as ISO 9241-171 and ISO/IEC 29136) to collect tactile/haptic-related accessibility requirements and recommendations and to provide more specific guidance relating to the accessibility of tactile/haptic interactions. It provides a means of addressing tactile/haptic-related user needs from ISO/IEC 29138-1. As such, it is intended to provide a comprehensive source of guidance on tactile/haptic accessibility.

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Ergonomics of human-system interaction —

Part 971:

Accessibility of tactile/haptic interactive systems

1 Scope

This document provides both general and specific ergonomic requirements and recommendations for accessible tactile/haptic interactive systems, including accessible tactile/haptic interactions.

This document provides guidance for increasing the accessibility of interactive systems making use of tactile/haptic input/output modalities such as gestures, vibration, and force feedback. The guidance provided also supports alternative input modalities and the use of different output representations.

This document provides guidance for tactile/haptic interactions that is applicable to a variety of interactive systems, including assistive technologies (AT).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 9241-171, *Ergonomics of human-system interaction — Part 171: Guidance on software accessibility*

ISO/IEC 29136, *Information technology — User interfaces — Accessibility of personal computer hardware*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1

accessibility

extent to which products, systems, services, environments and facilities can be used by people from a population with the widest range of user needs, characteristics and capabilities to achieve identified goals in identified contexts of use

Note 1 to entry: Context of use includes direct use or use supported by assistive technologies.

[SOURCE: ISO 9241-112:2017, 3.15]

3.2

assistive technology

AT

hardware or software added to, or incorporated within, a system that increases accessibility for an individual

EXAMPLE Braille display, screen reader, screen magnification software, eye tracking devices.

[SOURCE: ISO 9241-171:2008, 3.5]

3.3

tactile

appertaining to touch

[SOURCE: ISO 9241-910:2011, 2.5]

3.4

haptic

appertaining to *haptics* (3.5)

Note 1 to entry: While there is no difference between haptic and *tactile* (3.3) in most dictionary definitions, in the area of haptics, researchers and developers use haptic to include all haptic sensations, while tactile is limited to mechanical stimulation of the skin. In ISO 9241, the word haptic covers all touch sensations and tactile is used in a more specific manner. Also, both terms can be used together to assist in searches.

[SOURCE: ISO 9241-910:2011, 2.2]

3.5

haptics

sensory and/or motor activity based in the skin, muscles, joints and tendons

Note 1 to entry: Haptics consists of two parts: touch and kinaesthesia.

[SOURCE: ISO 9241-910:2011, 2.1]

3.6

force feedback

force presented to and detected by a user

Note 1 to entry: Although this does not necessarily involve feedback, the term “force feedback” is commonly used in this context.

[SOURCE: ISO 9241-910:2011, 2.9]

3.7

gesture

movement or posture, of the whole body or parts of the body

[SOURCE: ISO/IEC 30113-1:2015, 3.1]

3.8

interactive system

combination of hardware and/or software and/or services and/or people that users interact with in order to achieve specific goals

Note 1 to entry: This includes, where appropriate, packaging, user documentation, on-line and human help, support, and training.

[SOURCE: ISO 9241-11:2018, 3.1.5]

3.9

tactile cursor

tactile indication of where the user interaction via input device (e.g. keyboard or equivalent) occurs

3.10

sensory overload

user's experience where sensory experiences from the environment are too great for the individual's nervous system to successfully process or make meaning from

3.11**personal computer**

microcomputer primarily intended for stand-alone use by an individual

[SOURCE: ISO/IEC 29136:2012, 3.5]

3.12**reach envelope**

<tactile/haptic> three-dimensional space in which a person can reach an interface without discomfort with respect to a specified user position

Note 1 to entry: Different users can use different body parts such as the arm, leg or head to reach for an object while sitting or standing.

Note 2 to entry: Users can augment their reach envelope using different assistive technologies, prosthetics or tools.

4 Conformity

If an organization claims conformity with this document, then the decisions about how it addresses the requirements and recommendations in this document or the justifications for any course of action that deviates from any of the recommendations shall be documented.

Documentation of a claim of conformity with this document shall be specific about the basis on which the claim is made and shall provide evidence to support the claim. An organization can claim conformity based on a self-assessment or an assessment carried out by another party.

5 Physical accessibility

While most users can use tactile/haptic interactions to some extent, users vary considerably in their tactile/haptic capabilities. Some important tactile/haptic capabilities which can vary across users and across contexts of use include:

- a) reach;
- b) range of motion;
- c) accuracy of motion;
- d) coordination of motion;
- e) speed of interaction;
- f) strength;
- g) stamina/endurance;
- h) sensitivity to physical stimulation;
- i) attention to physical stimulation;
- j) processing of the physical stimuli.

While there can be many causes for limitations in these capabilities, the important goal for developers of tactile/haptic interactions is to create systems that remain accessible despite any such limitations.

6 General requirements and recommendations

6.1 Compatibility with other standards

6.1.1 General

This document is intended to work with other more general International Standards.

NOTE 1 The main International Standards dealing with the ergonomics of tactile and haptic interactions are ISO 9241-910 and ISO 9241-920.

NOTE 2 International Standards dealing with the accessibility of interactive systems are identified in various sub-clauses below.

6.1.2 Hardware accessibility

ISO/IEC 29136 shall apply for issues relating to personal computer hardware.

6.1.3 Software accessibility

ISO 9241-171 shall apply for issues relating to software accessibility.

6.2 Approachability of tactile/haptic interactive systems

6.2.1 Size and space for approach and use of tactile/haptic interactive systems

The environment of use should provide people with the widest range of user needs, characteristics and capabilities with:

- a) adequate room to fit themselves and their assistive products or assistive technologies;
- b) an accessible path and a means to position oneself within reach of installed products;
- c) the ability to adjust the location and position of devices and controls.

NOTE 1 ISO/IEC Guide 71 describes the goal of approachability as “a system is approachable if diverse users can overcome any physical or psychological barriers and physically or remotely access it to accomplish the task”.

NOTE 2 Further approachability-related user accessibility needs applying to tactile/haptic interactions are found in ISO/IEC 29138-1 and other International Standards and in related research literature.

NOTE 3 ISO 9241-500:2018, 4.2.3, states that “an environment of use shall be planned to enable the intended user population to perform a range of tasks comfortably and efficiently”. Further information on the design of environments of use is available in ISO 941-500.

6.2.2 Reachability

When the user is physically interacting with the system (including AT), tactile/haptic inputs and outputs should be located within the reach envelope of the user.

Users with the widest range of needs, characteristics, and capabilities should be considered when determining the expected reach envelope.

NOTE 1 It is important to consider standing as well as sitting positions when determining the user's reach envelope.

NOTE 2 The use of AT can modify the user's reach envelope. AT can be used to provide support of all or part of their body when reaching. For example, a user can use a prosthesis to support and stabilize their arm. This affects their reach envelope.

NOTE 3 ISO/IEC 29136:2012, 5.4.2, states that “a control to turn the device on/off should be placed in a position where it is easy to locate and activate but not to activate accidentally”.

6.2.3 Reachability by remote control

Users should be enabled to use a device to interact with the system remotely if inputs and outputs are not reachable.

6.2.4 Stability

Devices involving tactile/haptic components should provide stability for the system when positioned so that:

- a) they are stable during intended use;
- b) they are not unintentionally activated or deactivated due to instability;
- c) they remain reachable and usable in their position.

EXAMPLE A control panel that can be tilted is a tactile/haptic component. When used, it provides sufficient resistance that the tilt is not changed.

6.3 Presentation of tactile/haptic information

6.3.1 Presentation of physical information

Tactile/haptic systems should support the presentation of some or all information (including feedback and cues) in tactile form.

NOTE 1 This can be accomplished either directly or via the connection of a tactile/haptic output device to the system.

NOTE 2 It can be important to ensure that tactile alerts are available to notify users of the existence of critically important information (regardless of the modality of the information itself).

6.3.2 Multiple formats for presenting tactile/haptic information

Systems should support the presentation of tactile/haptic information in various formats.

NOTE Providing connectivity to a range of tactile/haptic output devices can increase the range of possible output formats.

EXAMPLE Formats of tactile/haptic information include embossed symbols, braille notations, pulses and vibrations.

6.3.3 Encoding of tactile/haptic information

The encoding of information within a tactile/haptic format should be designed to support the widest possible range of users.

NOTE 1 ISO 9241-920:2009, 4.2, provides guidance on specific tactile/haptic attributes for encoding information. ISO 9241-920:2009, 4.2.2 and 4.2.3, discuss human limits on the number of attribute values to use and attribute value discrimination.

NOTE 2 Individualization of tactile/haptic encoding is dealt with in [6.6](#).

EXAMPLE There are conditions (e.g. diabetes) where a person's haptic discrimination can be lowered so that they need stronger stimuli.

6.3.4 Contextual interference with tactile/haptic presentations

Systems should present tactile/haptic information in a manner that minimizes possible interference with the information by:

- a) presenting tactile information so that it can be perceived in the presence of background tactile/haptic information;
- b) avoiding creating tactile/haptic distractions that can prevent the user from focusing on or executing a task;
- c) limiting heat, cold and vibration from devices that can interfere with perception of tactile/haptic information.

6.4 Perceivability of tactile/haptic information

6.4.1 General

Tactile/haptic information shall be perceivable.

Tactile/haptic information is directly perceivable if diverse users in diverse contexts of use can sense the information and functionalities presented. When it is not directly perceivable, AT should be supported to address the needs, characteristics, and capabilities of the widest range of users.

A tactile/haptic interactive system should allow control of perceptible attributes of the tactile/haptic presentation to address the widest range of user needs, characteristics, and capabilities.

NOTE 1 Further perceivability-related user accessibility needs applying to tactile/haptic interactions are found in ISO/IEC 29138-1 and other International Standards as well as related research literature.

NOTE 2 ISO 9241-920:2009, 4.2 provides guidance on specific tactile/haptic attributes for encoding information.

EXAMPLE Tactile/haptic attributes include vibration frequency, amplitude and degrees of freedom.

6.4.2 Discoverability of tactile/haptic components and controls

The presence and purpose of tactile/haptic components and controls should be discoverable without accidentally activating them by touch.

Tactile/haptic components shall enable any On/Off controls for accessibility features to be discoverable without unintended activation.

6.4.3 Distinction between tactile/haptic components or controls

When multiple tactile/haptic components or controls are present in a system, they should be easily distinguishable from one another.

NOTE This can be accomplished by various techniques, including physical location, shape, or other distinguishing attributes sufficiently different from other tactile/haptic components.

EXAMPLE The start button of a photocopier can be distinguished separately from other buttons by a tactile cue.

6.4.4 Pausing and repeating tactile/haptic information

The system should provide a means for the user to pause, stop and resume continuously presented tactile/haptic output.

After a message has finished, users should be enabled to repeat the message.

6.4.5 Speed of tactile/haptic information

The system should provide a means for the user to control the speed of continuously presented tactile/haptic output.

NOTE Controlling the speed of the output allows different users to speed up or slow down the presentation of tactile/haptic information in different contexts of use to ensure that the information is accurately and completely perceived.

6.4.6 Location of tactile output

The location of tactile output should be as close as possible to the location of the control whose operation resulted in the output.

NOTE It is preferable if the tactile output can be provided at the same location as the control (see also [6.5](#)).

EXAMPLE In bimanual controls, users can detect the output of the system with different hands.

6.5 Controllability of tactile/haptic interactions

6.5.1 Controllability

A tactile/haptic system shall be controllable.

A tactile/haptic system is controllable if the user is able to initiate and complete the interaction(s) required to accomplish their task.

NOTE Controls allow users to be able to perform the task using various parts of the body and specific types of actions.

6.5.2 Support of sequential control

Users shall be enabled to fully operate the system in a manner that does not require simultaneous actions. A tactile/haptic system is controllable if the user is able to choose whether to operate it in parallel or sequentially; performing tasks one step at a time.

EXAMPLE Pressing the Shift key of a keyboard five times will activate the serial key input accessibility feature allowing the user to avoid the need to simultaneously press multiple keys (see [7.1.4](#)).

6.5.3 Physical attributes of tactile/haptic controls

The physical attributes of tactile/haptic controls should be designed so that they can be activated via various physical means (and not limited to the use of a user's hands).

NOTE ISO/IEC 29136:2012, 6.1.2 a), states that "controls should be designed in an appropriate size, shape and surface finish for easy operation by a user who uses their mouth, toe, or stick in place of their fingers".

6.5.4 Activating tactile/haptic controls

Tactile/haptic controls should be designed to be easily activated by users with the widest range of needs, characteristics, and capabilities when intended, but also to prevent inadvertent activation (see also [6.7.1](#) and [6.7.2](#)). This includes the inadvertent activation or deactivation of accessibility features.

Users should be enabled to operate tactile/haptic components and controls with limited body control (e.g. strength, tremors) without fatigue during normal operation (see [Clause 5](#)).

NOTE Achieving this trade-off between ease of activation and prevention of inadvertent activation can involve the use of multiple different design features.

EXAMPLE The on/off switch is located far from other controls to avoid inadvertent activation, while being designed to be easily activated with a minimum of pressure and being located within reach of the user.

6.5.5 Force for activating physical controls

The widest range of users possible, regardless of their abilities or disabilities, should be enabled to fully operate the system using minimal but sufficient force. Tactile/haptic controls should be easily and safely activated (see also [6.8.6](#) and [6.8.7](#)).

NOTE ISO/IEC 29136:2012, 6.1.2 b), recommends that the activation force of wall-mounted manual controls be less than 22,2 N ("The force required to activate controls should be suitable for users with disabilities and less than a maximum of 22,2 N").

6.5.6 Continuous force for activating physical controls

When designing tactile/haptic systems to be used with continuous force, users with the widest range of needs, characteristics and capabilities should be enabled to fully operate the system using:

- a) minimal duration of force;
- b) minimal unsupported static posture of any extremities;
- c) minimal force to operate (see also [6.5.5](#)).

6.5.7 Physical movements

The distance and accuracy of physical movements that are accepted as haptic inputs should be user controllable.

NOTE 1 Longer distances with lower accuracies can help users experiencing tremors and other influences that can relate to a lack of fine motor control.

NOTE 2 Shorter distances can help users with limited ranges of motion.

6.5.8 Activating controls without hands

Tactile/haptic components and controls should be operable without the use of hands.

EXAMPLE A user is able to control a tactile/haptic control with their foot.

6.5.9 Activating controls with only one hand

Tactile/haptic components and controls should be operable with only a left or only a right hand.

6.5.10 Timing of activating physical controls

Unless the timing of tactile/haptic inputs is based on the needs of real-time events, the time available to complete these inputs should be user controllable.

NOTE 1 While time-outs are typically used to identify the absence of any inputs, it is important for the user to be able to control the length used by such time-outs.

NOTE 2 ISO 9241-171:2008, 8.2.7, provides guidance related to the use of time-outs. This includes allowing the user to deactivate time-outs, adjust the length of a time-out up to at least ten times the length of the default time-out value and/or extend the length of a time-out before it expires. For example, a system that enables the user to set the time between taps needed for a double-tap gesture.

EXAMPLE Where time-outs exist, the user is warned before time expires, allowed to extend the time-out with a simple action (for example, "hit any key") and given at least 20 s to respond.

6.5.11 Taking breaks

The system should allow the user to take breaks between individual sequences of tactile/haptic interactions and to return to interacting at a later point in time with a minimum of additional work.

NOTE 1 Breaks are needed for users to attend to their environment.

EXAMPLE A user takes a break from the tactile system because they need their hands to participate in a sign language conversation.

NOTE 2 Users need to be able to interact with the system at one's own pace.

NOTE 3 Breaks are an important means of reducing accumulated physical and mental stresses that, if not reduced, can lead to increased errors and/or injuries to the user (see also [6.8](#)).

6.6 Individualization of tactile/haptic interactions

6.6.1 Individualization

A tactile/haptic system supports individualization if its components, functions, or operations can be tailored to meet the needs of individual users. Tactile/haptic systems shall be individualizable and take AT into account for individualisation to support the widest range of user needs, characteristics, and capabilities.

NOTE 1 ISO 9241-129 provides guidance on individualization.

NOTE 2 Individualization can be achieved by adaptation (where the user changes parameter values) or adaptivity (where the system changes parameter values on behalf of the user). This document is not about adaptivity.

EXAMPLE A touchscreen ATM includes an audio output port so it can be used by audio alone. When a user plugs in a headset as assistive technology, the ATM can be used through a built-in numeric keyboard.

6.6.2 Individualizing tactile/haptic parameters

- a) Where possible and appropriate to the task(s), mechanisms should be provided to adjust (individualize) the values of tactile/haptic parameters. The mechanism provided to adjust these values shall be accessible to the widest range of users.
- b) Where adjustments have a time limit, the user shall be informed how long their individualization will remain in effect. The user should be able to extend the length of this time.

NOTE 1 Providing the capability to individualize tactile/haptic parameters can prevent discomfort, pain, or injury to users of interactive systems.

NOTE 2 [Subclauses 6.4.4](#) and [6.5.10](#) recommend user controllability of timing. [Subclause 6.5.7](#) recommends user controllability of distance and accuracy of tactile/haptic movement. Other tactile/haptic parameters can also be individualized to improve the accessibility of specific tactile/haptic interactions.

6.6.3 Identifying the current parameter values

Where tactile/haptic parameters can be individualized, the current values (settings) of these parameters should be available to the user.

EXAMPLE A handheld device allows the user to review the setting of (i.e. playback) a vibrotactile pattern to identify a caller.

6.6.4 Default parameter values

Where tactile/haptic parameters can be individualized, default values (settings) shall be provided to address the widest range of user needs, characteristics, and capabilities.

EXAMPLE A tactile/haptic system has a variety of specialised user profiles (e.g. left-handed operation) to address specific needs.

6.6.5 Reverting to original default parameter values

Where tactile/haptic parameters can be individualized, it shall be possible to revert to their initial default values.

6.6.6 Saving modifications of parameter values

Where repeated use of a system is likely, the system should provide users a means of saving one or more sets of individualized tactile/haptic parameter values (settings) for their future use.

NOTE 1 ISO 9241-129:2010, 10.1.2, recommends that user profiles be used to save sets of user settings.

NOTE 2 ISO 9241-171:2008, 8.2, provides general guidance on the use of user preference profiles to save and reuse user preference settings.

6.6.7 Loading saved parameter values

Where sets of individualized tactile/haptic parameter values (settings) can be saved, the system shall provide a mechanism for selecting a specific set and loading it for individual use.

NOTE ISO 9241-129:2010, 10.2.2, states that “where a user account includes multiple user profiles, the system should provide a mechanism for selecting which profile should be automatically loaded as the user’s default profile”.

6.6.8 Changing individualized parameter values

When a user is changing the current set of individualized tactile/haptic parameter values (settings), either by directly changing a particular value or by loading a saved set of values, these changes should be immediately implemented without requiring the system to be restarted and without the user losing work that has already been completed.

6.6.9 Optimizing the number of adjustable parameters

To avoid user overload, the number of adjustable parameters available to users in different contexts of use should be considered.

NOTE There is usually a trade-off between the ease of use of the individualisation of the tactile/haptic system and its versatility (number of parameters available to individualise).

6.7 Error tolerance of tactile/haptic interactions

6.7.1 Error tolerance

A tactile/haptic system has error tolerance if, despite predictable errors, diverse users can complete the intended task or activity with either no, or minimal, corrective action or negative consequences.

A tactile/haptic system should enable the user to:

- a) detect when errors have been made;
- b) reset a system to an earlier or original condition as a means to responding to errors;

c) avoid errors by having negative consequences be obvious, easy to avoid, and difficult to trigger.

EXAMPLE 1 A tactile/haptic interactive system supports a user with tremor by allowing the user to undo an action.

EXAMPLE 2 A tactile/haptic system is designed to release its controls to support users with spasticity so that unintentional forceful movements do not break the device.

6.7.2 Avoiding unintentional activation of physical controls

A tactile/haptic system should provide and/or support the addition of mechanisms (including ATs) to avoid unintentional activations of tactile/haptic controls.

NOTE 1 One means of achieving this guideline is to provide a way for users to discover and correct errors and unintended consequences.

NOTE 2 Appropriate physical placements of components and controls is one way to design systems to reduce errors.

NOTE 3 ISO/IEC 29136:2012, 6.1.2 c), recommends that guards be added to a control to prevent unintended activation of the control.

EXAMPLE A tactile/haptic interactive system supports a user with tremor by allowing the user to individualise the responsiveness of the system.

6.7.3 Providing warnings on potentially dangerous actions

Tactile/haptic systems should provide warnings and ask for confirmation when a tactile/haptic action can lead to a potentially dangerous situation.

NOTE 1 Potentially dangerous situations can include situations that can be harmful to the user, the system, the information in the system and/or the operating environment of the system.

NOTE 2 The deactivation of an accessibility feature can have potentially dangerous consequences for users with disabilities. When an accessibility feature can be activated or deactivated unintentionally, the system needs to inform users and provide an opportunity to accept or cancel the activation or deactivation.

NOTE 3 Guidance on some specific situations is contained in [6.8](#).

6.7.4 Ignoring harmless actions

A tactile/haptic system should ignore actions which are below the threshold established for activating a tactile/haptic control.

NOTE See [6.5](#) for more information on activating tactile/haptic controls.

6.7.5 Undoing unintended or incorrect activations

A tactile/haptic system should provide a means that enables the user to undo at least the most recent tactile/haptic interaction.

NOTE Exploring a tactile/haptic virtual space can change the system's state (i.e. Midas touch). In this case, recovering from accidental actions can be more challenging. Just reversing the gesture does not generally recover from such actions. Designing "Undo" in a tactile/haptic system can involve a different modality taking into consideration effectiveness and efficiency, while reducing potential for fatigue.

6.8 Tactile/haptic safety

6.8.1 Safety

While the main emphasis of accessibility is making it possible for users to achieve their needs, it is also important to recognize that it is essential that these needs can be achieved in a safe manner. Lack of

safety leads to inaccessibility when considering vulnerable individuals and/or potentially dangerous contexts of use.

Tactile/haptic systems should enable the widest range of users possible, regardless of their abilities or disabilities, to operate its controls and components safely in the expected contexts of use.

NOTE To ensure safe use of a device, it is sometimes necessary to design a control in an unintuitive manner.

EXAMPLE The electronic controls for a car window are designed as flat lever switches rather than push buttons to ensure that no one is inadvertently trapped in the window as it closes. With this design, the user holds the switch down to open the window and lifts it up to close.

6.8.2 Avoiding sensory overstimulation

The system should avoid situations that can lead to unwanted stimulation and consequences due to high haptic intensity on the user, especially those that can result in fatigue or injury.

NOTE 1 ISO 9241-920:2009, 3.3, provides guidance related to unintentional user perceptions.

NOTE 2 See ISO/IEC 29138-1 for information on sensory overload.

6.8.3 Avoiding sensory overloads

The system should avoid situations that can lead to unwanted errors due to tactile overloads on the user, especially those that can result in either fatigue or in the understanding of one signal to be confused with or masked by other signals.

NOTE 1 ISO 9241-920:2009, 3.3, provides guidance related to unintentional user perceptions.

NOTE 2 See ISO/IEC 29138-1 for information on sensory overload.

6.8.4 Avoiding fatigue and repetitive stress injuries

The system should identify where the quantity of repeated tactile/haptic interactions within a time period can lead to fatigue or repetitive stress injuries and recommend to the user taking a break to physically recover before continuing (see also [6.5.5](#) and [6.5.6](#)).

NOTE 1 ISO 9241-960:2017, 4.1 b), states that “if repetitive gesturing is unavoidable, hazard identification, risk estimation, risk evaluation and risk reduction should be performed in order to avoid musculoskeletal disorders”.

NOTE 2 ISO 9241-920:2009, 3.1.6, provides further general considerations for minimizing fatigue.

6.8.5 Avoiding positioning and over extension injuries

Where tactile/haptic interactions can lead to injuries from the positioning or extension of body parts which cannot be designed out of the system, the environment of use should allow the addition of physical supports to reduce the negative effects of the necessary positioning or extension.

NOTE ISO 9241-910:2011, 9.2.14, provides guidance on working position and limb support.

6.8.6 Safe interaction with device

A tactile/haptic system (including AT) should be designed to avoid potential mechanical, chemical, electrical and thermal risks to the wellbeing of users and other individuals who can come into contact with them.

NOTE 1 For guidance on mechanical (including vibratory and acoustic), chemical, electrical and thermal safety, see ISO 9241-910.

NOTE 2 ISO/IEC 29136:2012, 5.9 b), recommends that devices not have hard edges or sharp corners that cause injury or inhibit device placement.

EXAMPLE A tactile/haptic force feedback device is designed with a maximum force strength to ensure users are not injured by the forces applied by the device.

6.8.7 Avoiding damage to the system

Tactile/haptic devices should be designed so that they are not damaged when more force is used on them than needed to activate them.

EXAMPLE A user presses a tactile control harder due to a spastic movement. The button does not break.

6.9 Tactile/haptic authentication

6.9.1 Security and authentication

Tactile/haptic systems can be used to provide accessible and secure authentication mechanisms.

Tactile/haptic authentication systems should enable the widest range of users possible, regardless of their abilities or disabilities, to operate its controls and components safely in the expected contexts of use.

EXAMPLE 1 A person with low muscle strength over their arm (e.g. due to paralysis or muscle weakness) needs support to operate a fingerprint authentication device to prevent the arm from falling down, which can lead to injury.

EXAMPLE 2 A person who has spasticity in their hand requires support to hold their hand open when operating a fingerprint authentication device in a manner that does not cause pain.

6.9.2 Accessible authentication

Tactile/haptic authentication systems should enable users to operate their controls and components privately and with independence such that the widest range of users possible, regardless of their abilities or disabilities, are enabled to authenticate without:

- a) broadcasting their credentials to others; and
- b) the assistance of others.

6.9.3 Alternatives to biometrics

When designing tactile/haptic controls and components for authentication, users with the widest range of needs, characteristics, and capabilities should be enabled to have alternatives to biometric means of identification.

EXAMPLE A device that can be unlocked using fingerprint authentication, can also be unlocked using a swipe pattern which can be completed with head gestures.

7 Input specific requirements and recommendations

7.1 Keyboard specific guidance

7.1.1 Text as a basis for interoperability

Text is the most universal means of communicating ideas. It can be rendered in the visual, auditory and tactile modalities. Therefore, physical and virtual keyboards are an important source of tactile/haptic inputs.

Tasks that require time-dependant analogue input shall support alternative means of providing that input.

7.1.2 Provision of keyboard equivalent inputs

- a) Unless the task requires time-dependent analogue input, the tactile/haptic system shall provide users with the option of activating all software-controlled functionality (including navigation) using only a non-time dependent keyboard (or keyboard-equivalent) input.

EXAMPLE A head gesture can allow all operation of software-controlled functionality.

- b) Unless the task requires time-dependent analogue input, tactile/haptic components and controls shall provide a keyboard alternative that enables keyboard (or keyboard-equivalent) control of the tactile/haptic components and controls movement and functions, in parallel with the standard device (see also ISO 9241-171:2008, 9.1.2).
- c) Unless the task requires time-dependent analogue input, tactile/haptic components and controls should provide a method for generating keyboard input from each standard input mechanism provided by the tactile/haptic system (see also ISO 9241-171:2008, 9.1.1).

7.1.3 The design of physical keys

- a) Physical keys shall comply with the requirements of ISO/IEC 29136.
- b) Keys should be designed in an appropriate size, shape and surface finish for easy operation by a user who uses their mouth, toe or stick in place of their fingers (see also ISO/IEC 29136:2012, 6.2.4).

7.1.4 Modifier key functions

Software shall enable users to lock or latch modifier keys (e.g. Shift, Ctrl, Command, Alt/Option, depending on the operating system and keyboard layout) so that multiple key combinations and key-plus-mouse button (or other tactile input device) combinations can be entered sequentially rather than by simultaneously pressing multiple keys (see also ISO 9241-171:2008, 9.3.3).

NOTE ISO/IEC 24786 identifies a number of keyboard accessibility operations that meet specific guidance in ISO 9241-171 regarding keyboard functions (including StickyKeys™, SlowKeys™, BounceKeys™, FilterKeys™, MouseKeys™, RepeatKeys™, ToggleKeys™)¹⁾ and provides guidance on their use.

7.1.5 Virtual keyboards

Virtual keyboards should comply with ISO/IEC 22121-2.

7.2 Pointing device specific guidance

- a) Tactile/haptic systems should provide a method to fully operate the system without requiring the use of a pointing device.
- b) Tactile/haptic systems should provide a pointing-device-based alternative to the keyboard that includes pointing device control of latching and locking of key presses (see also ISO 9241-171:2008, 9.1.3).

NOTE 1 This allows users who cannot use the keyboard and can only use a pointing device to type.

EXAMPLE 1 A person who cannot use the keyboard can operate the device completely with a head-operated mouse.

EXAMPLE 2 An operating system includes a virtual keyboard that allows the user to perform the equivalent of pressing, latching and locking all keyboard keys using only a pointing device.

1) StickyKeys™, SlowKeys™, BounceKeys™, FilterKeys™, MouseKeys™, RepeatKeys™, ToggleKeys™, SoundSentry™, ShowSounds™ and SerialKeys™ are trademarks of the University of Wisconsin. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO. Equivalent products may be used if they can be shown to describe user interface features that have the functionality and behaviour described in this document, ISO 9241-171 and ISO/IEC 24786. For more information, see ISO 9241-171:2008, Annex E.

- c) Tactile/haptic systems should enable all user-initiated actions that can be accomplished with simultaneous pointing device operations (e.g. hold and drag) to be accomplishable with an alternative pointing device method that does not require simultaneous operations (see also ISO 9241-171:2008, 9.4.5).
- d) The size of targets intended to be selected with a pointing device should be optimized to maintain adequate selection, grouping and separation of the target from adjacent user-interface elements (see also ISO 9241-171:2008, 9.4.3).

NOTE 2 WCAG 2.1 SC 2.5.5 "Target size" recommends the target size for pointing devices be at least 44 by 44 CSS pixels.

7.2.1 Avoiding need for fine motor skills

Tactile/haptic devices and interactions should not require the user to have fine motor skills to interact with them.

7.3 Motion tracking specific guidance

- a) Tactile/haptic systems shall enable users to adjust the speed or ratio at which the pointer moves in response to a movement of the pointing device (see also ISO 9241-171:2008, 9.4.10).
 EXAMPLE Virtual reality systems allow users to change the virtual environment so that small movements can be scaled, as per user requirements.
- b) Tactile/haptic systems should enable users to adjust the minimum pointer movement while the pointing device button is held down, such that this is registered as a drag event (see also ISO 9241-171:2008, 9.4.8).
- c) Tactile/haptic systems should enable users to adjust the direction at which the pointer moves in response to a movement of the pointing device (see also ISO 9241-171:2008, 9.4.12).

7.4 Gesture specific guidance

7.4.1 Considerations for gestures

Tactile/haptic systems should be designed to enable gesture-based control by users with the widest range of needs, characteristics, and capabilities.

For accessible tactile/haptic systems with gestures, users should:

- a) have a method to fully operate the system without tight grasping, pinching, or twisting; and
- b) be enabled to operate the system without the use of hands and with only a left or only a right hand.

7.4.2 Considerations for gesture controls

- a) Where suitable tactile/haptic devices are available, the system should support gesture control.
- b) Gestures should be consistent in meaning and composition regardless of the technology used to interact with the tactile/haptic system.
- c) All gestures should involve a clear and identifiable start, one or more action(s) and a clear and identifiable end.
- d) Users should be able to indicate the beginning of an intentional gesture clearly, so that the user is able to avoid the unintentional start of some functionality of the tactile/haptic system.
- e) The gesture interface of a tactile/haptic system should be designed to support a sufficient variety of movements while being able to distinguish between intentional and unintentional gestures.

- f) The duration of a gesture should not affect its functionality unless speed is included as a parameter of the gesture.
- g) The gesture-based interface should provide at least one cancelation method that can be used during the input of a gesture.
- h) To minimize misunderstanding of gesture input, the gesture-based interface of the tactile/haptic system should provide criteria for ignoring very small or large unintentional movements when a gesture is formed.
- i) To accommodate individual capabilities, the gesture-based interface of the tactile/haptic system should allow a user to modify the criteria for ignoring very small and very large movements when a gesture is formed.

7.5 Single-switch specific guidance

7.5.1 General

The tactile/haptic system should provide a means of connecting and using single-switch devices.

NOTE ISO/IEC 22121-2 provides guidance relating to single-switch support for using virtual keyboards to interact with a system.

EXAMPLE Single-switch devices include sip-puff devices, eye-blink tracking devices, and head gestures.

7.5.2 Single switch devices and time-dependent actions

Time-dependent actions should be designed to allow single-switch device users sufficient time to activate the switch. See also [6.5.10](#).

NOTE ISO 9241-171:2008, 8.2.7, provides guidance related to the use of time-outs. This includes allowing the user to deactivate time-outs, adjust the length of a time-out up to at least ten times the length of the default time-out value, and/or extend the length of a time-out before it expires.

EXAMPLE A tactile/haptic system enables the user to set the time between inputs needed for a double-tap gesture.

7.5.3 Simultaneous multi-device input guidance

Where interactions involve simultaneous use of multiple tactile/haptic controls (e.g. moving a mouse and pressing a mouse key), an alternative method should be provided to achieve the same result with a series of interactions with a single tactile/haptic control at a time (see also ISO 9241-171:2008, 9.4.5).

8 Output specific guidance

8.1 Vibration specific guidance

8.1.1 Combinations of modalities

A tactile/haptic system should avoid situations that can lead to unwanted consequences for the user due to combinations of output modalities on the user, especially those that can result in either fatigue or unintentional user perceptions (see also [6.8](#)).

EXAMPLE Video, sound, and vibration are examples of the visual, auditory and tactile output modalities.