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Ergonomic requirements for office work with visual display terminals (VDTs) —

Part 16:
Direct manipulation dialogues

Exigences ergonomiques pour travail de bureau avec terminaux à écrans de visualisation (TEV) —

Partie 16: Dialogues de type manipulation directe

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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.

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

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*

— *Part 9: Requirements for non-keyboard input devices*

— *Part 10: Dialogue principles*

— *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*

Annex A of this part of ISO 9241 is for information only.

Introduction

ISO 9241 deals with several aspects of the use of visual display terminals (VDTs). Currently, the individual parts can be grouped in the following categories:

ISO 9241-1: General introduction

ISO 9241-2: Guidance on task requirements

ISO 9241-5 and ISO 9241-6: Workstation and environment

ISO 9241-3, ISO 9241-4, ISO 9241-7, ISO 9241-8 and ISO 9241-9: Ergonomics pertaining to hardware

ISO 9241-10 through ISO 9241-17: Ergonomics pertaining to software interfaces

This part of ISO 9241 is concerned with the ergonomic design of direct manipulation dialogues where users perform operations by acting on displayed objects in ways analogous to manipulating physical entities.

This part of ISO 9241 serves the following types of user

a) the user interface designer, who will apply this part of ISO 9241 during the development process;

b) the buyer, who will reference this part of ISO 9241 during the product procurement process;

c) evaluators responsible for ensuring that products meet the recommendations in this part of ISO 9241;

d) designers of user interface development tools to be used by interface designers;

e) end-users who will gain from the potential benefits provided by this part of ISO 9241.

This part of ISO 9241 consists of a number of recommendations, some of which are conditional, concerning direct manipulation dialogues. Conditional recommendations are recommendations that should be met only within the specific context for which they are relevant (e.g. particular kinds of users, tasks, environments, technology).

It should be noted that ISO 9241-10 describes dialogue principles that are relevant for the design of direct manipulation dialogues. These principles provide the designer and evaluator with additional information concerning the ergonomic rationale for the various recommendations in this part of ISO 9241 and, therefore, assist in making trade-offs. However, it may be necessary to base trade-offs on other considerations as well.

Ergonomic requirements for office work with visual display terminals (VDTs) —

Part 16:
Direct manipulation dialogues

1 Scope

This part of ISO 9241 provides guidance on the design of direct manipulation dialogues. In direct manipulation dialogues the user directly acts on objects on the screen; for example, by pointing at them, moving them and/or changing their physical characteristics (or values) via the use of an input device. Such objects are typically concrete, often graphical, representations of abstract software structures or capabilities and generally fall into two categories.

a) Task object — a metaphorical representation of a real-world artefact manipulated to support the user's task (e.g. a sheet of paper, pen, spanner, graph).

b) Interface object — an object introduced into the interface so that the user can perform tasks related to the use of the computer application or system. This introduced object may be a real-world object but the metaphor is not directly related to the user's real work task (e.g. button, slider, window, screen).

Objects and their representations on the display are referred to as objects, except where it is necessary to make a clear distinction.

Interfaces that use stereoscopic or virtual reality-type interfaces are not covered in this part of ISO 9241.

In practice, the term direct manipulation is often used interchangeably with graphical user interfaces (GUIs). However, within GUIs other dialogue techniques, such as menu dialogues or command dialogues, are often implemented as well. Though GUIs can provide many direct manipulation features, not every user input in GUIs can be interpreted as direct manipulation. For example, printing a document by moving a document icon upon a printer icon implies a higher degree of direct manipulation than a mouse click on a push button labelled "print".

This part of ISO 9241 covers usability issues of direct manipulation dialogues. Recommendations on GUI components are given only if they are related specifically to features of direct manipulation.

Features of direct manipulation dialogues such as step-by-step input may be inefficient (e.g., if one wishes to delete all files starting with "d"). Therefore, other interaction techniques; for example, command input or menus, may be more appropriate and are typically used to supplement direct manipulation.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 9241. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 9241 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 9241-12:1998, *Ergonomic requirements for office work with visual display terminals (VDTs) — Part 12: Presentation of information.*

ISO 9241-13:1998, *Ergonomic requirements for office work with visual display terminals (VDTs) — Part 13: User guidance.*

ISO 9241-14:1997, *Ergonomic requirements for office work with visual display terminals (VDTs) — Part 14: Menu dialogues.*

ISO/IEC 11581-1:—[1)], *Information technology — User System Interfaces — Icon symbols and functions — Part 1: Icons — General.*

ISO/IEC 11581-2:—[1)], *Information technology — User System Interfaces — Icon symbols and functions — Part 2: Object icons.*

ISO/IEC 11581-3:—[1)], *Information technology — User System Interfaces — Icon symbols and functions — Part 3: Pointers.*

3 Terms and definitions

For the purposes of this part of ISO 9241, the following terms and definitions apply.

3.1
attribute
property of an object or its representation (e.g. colour) which may be modified by user actions in certain contexts

3.2
choice list
list containing a number of items which a user can select

NOTE Single selection or multiple selection may be possible. The number of items may be fixed or may change during the dialogue.

3.3
clicking
operation of pressing and immediately releasing a button on a pointing device without moving the pointer off the selected input-sensitive area

3.4
control
graphic, often analogous to physical controls such as dials, radio buttons, which allows a user to directly manipulate data, other objects or their attributes

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[1)] To be published.

3.5
cursor
visual indication of the focus for alphanumeric input

3.6
direct manipulation
dialogue technique by which the user has the impression of acting directly on objects on the screen; for example by pointing at them, moving them and/or changing their physical characteristics (or values) via the use of an input device

3.7
dragging
moving or changing an object after attaching the object or a portion of it to the pointer

3.8
double clicking
operation of pressing and immediately releasing a button of a pointing device twice in succession within a specified time period

3.9
handle
permanent or temporary graphical indication of a control point on an object

3.10
icon
graphic on a visual display terminal that represents an object, action or a function

3.11
input focus
in relation to a given input device, the indication of the object upon which the user directs input

3.12
metaphor
use of concepts and properties which are already familiar to the user and from which the user can predict the function, behaviour and organizational structure of the system

3.13
object
entity which is presented to the user during the dialogue

NOTE Both entities relevant for the task (such as a letter, a sales order, electronic parts, a wiring diagram) and entities of the user interface (such as an icon, a window, a push button) are regarded as objects. Different object types are text objects, graphical objects or control objects. It may be possible for the user to directly manipulate some of these objects.

3.14
pane
working area within a window frame

NOTE Panes can be split to create multiple panes within one window.

3.15
pointer
graphical symbol that is moved on the screen according to operations with a pointing device

NOTE Users can interact with elements displayed on the screen by moving the pointer to that location and starting a direct manipulation.

3.16
pointing
operation of positioning the pointer on an object or position by using a pointing device

3.17
pointing device
device that translates a human controlling operation to a controlling operation on the display

NOTE Depending on the applied technology, not only machine devices but also parts of the human body (e.g. fingers, arms) can currently be used as pointing devices.

3.18
scaling
operation of sizing proportionally

3.19
scroll bar
control that allows a user to view objects that extend beyond the size of a displayed related window or list by moving the objects into or out of the available display area; the scroll bar also indicates whether additional information is available

3.20
selecting
operation of choosing one or more objects from a visually presented set of objects

3.21
selection indication
visual or other cue that indicates the selected element on the display, to which the user may apply a subsequent action

3.22
sizing
operation of changing one or more dimensions of objects arbitrarily

3.23
state of objects
status of an object which is related to possible modifications

EXAMPLE Such states include "active", "available", "selected", "unavailable".

3.24
window
independently controllable area on the display screen used to present objects and/or conduct a dialogue with a user

4 Application of this part of ISO 9241

4.1 Appropriateness of direct manipulation dialogues

Direct manipulation dialogues are especially appropriate for one or more of the following conditions (or requirements), which have been grouped to reflect user, task and system issues. The applicability of direct manipulation dialogues becomes greater as more conditions are met.

a) User characteristics

1) Users may not possess the relevant reading or writing skills but have the necessary sensorimotor capabilities for direct manipulation.

2) User performance is improved by visual cues that assist recall.

3) User performance is better with graphical representations instead of textual descriptions.

b) Task characteristics[2]

1) Real-world task objects, their properties and operations can be simulated; i.e., there is an appropriate metaphor for the application.

2) Complex attributes of objects are hard to transform into common language in single terms; for example "pointing to a pattern" is easier than "describing the pattern".

3) The task sequence is not predetermined and requires flexibility in order to be accomplished.

4) Tasks require the user to be able to exercise control over objects.

5) Required input (e.g. a command) is hard to describe and to remember, but can be easily visualized.

6) Tasks are more easily accomplished using visible objects and direct manipulations.

7) The task requires transformation of visual attributes of objects.

8) Tasks are infrequently performed.

9) Tasks allow entities to be treated as singular objects, which remain complete units during direct manipulations, and portions of the entities (e.g. pixels of an icon) are typically not directly manipulated independently.

c) System capabilities

1) Screen resolution and input devices allow precise and accurate direct manipulations. In most cases, this implies hardware with graphics facilities and pointing devices (though direct manipulation interfaces may also be designed if only alphanumeric display and cursor keys are available),

2) The technical capability to produce graphical representations of objects is sufficiently effective,

3) The system is sufficiently capable to provide immediate feedback for direct manipulations of users.

4.2 Applying the recommendations

General ergonomic design objectives are provided in clauses 5 through 9. The individual recommendations aimed at achieving these objectives should be applied within the specific context for which they are relevant (e.g., particular kinds of users, tasks, environments, technology). The format for the individual recommendations is: statement of the recommendation, examples (if appropriate), and notes (if appropriate). Examples provided for the various recommendations generally depict an implementation that embodies the recommendation. Some examples also indicate preferred solutions.

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[2] During direct manipulation dialogues, human perception and interaction are especially supported by the following characteristics:

— the user input is accomplished by directly manipulating visually displayed entities (e.g., a displayed object moves on the screen in direct relationship to corresponding movements with the pointing device),

— input and output are connected through immediate feedback (e.g., the movement of an icon is displayed continuously on the screen; the icon does not jump suddenly from the start position to the target position),

— modifications of displayed objects correspond to real-world experiences (e.g., the simulated borderline of a text document can be modified by changing a border marking similar to those on mechanical typewriters).

Individual recommendations should be evaluated for their applicability and, if judged to be applicable, should be implemented in the relevant direct manipulation dialogue unless there is evidence that to do so would cause deviation from the design objectives or would result in an overall degradation in usability. When determining applicability, the recommendations generally should be evaluated in the order presented in the relevant clause or subclause. In judging whether applicable recommendations have been met, evaluators should evaluate the product or observe representative users of the product in the context of accomplishing the user's tasks via the direct manipulation dialogue. Sample procedures which support the determination of applicability and for judging whether a recommendation has been followed are provided in annex A.

4.3 Evaluation of products

If a product is claimed to have met the applicable recommendations in this part of ISO 9241, the procedure used in establishing requirements for developing, and/or evaluating the direct manipulation dialogue shall be specified. The level of specification of the procedure is a matter of negotiation between the involved parties.

Users of this part of ISO 9241 can either utilize the procedures provided in annex A, or develop another procedure tailored to their particular development and/or evaluation environment.

5 General information

5.1 Metaphors

Metaphors should create an impression of acting upon the objects of the task domain themselves. They are often used to aid in the design of direct manipulation dialogues. However, the way people perform control operations in the real-world may not always be appropriate as a method for a direct manipulation dialogue, especially if the intention of the interface is to "streamline" a real-world process (e.g., when the user wants to go to a specific topic in an electronic book, navigating according to the book metaphor, page by page, may be less efficient than clicking on a keyword that leads immediately to the corresponding section).

In the following recommendations the objectives for the design of metaphors should enable users to anticipate how to use the system by providing familiar concepts that facilitate their understanding of the system. Metaphors employed should guide users in planning and carrying out tasks.

5.1.1 Providing a framework

If metaphors are used, they should provide a framework and status information that are consistent with the real-world analogy and support the user's understanding of possible direct manipulations and their effects.

EXAMPLE 1 In a room metaphor, an opened door indicates that the user has access to elements in this room.

EXAMPLE 2 A document icon is moved to a printer icon in order to initiate printing. While the document is being printed, a sheet of paper is shown running through the printer icon.

EXAMPLE 3 Within a customer administration application, a tabbed notebook metaphor is used to group different sets of related customer data and to indicate direct access to data via the tabs of the notebook.

EXAMPLE 4 To delete a document in an office environment, the user can select the document icon, drag it over to the waste-paper can and drop the document in the can in order to "throw it away".

5.1.2 Recognizable metaphors

If a metaphor is used, its representation should be sufficiently recognizable.

EXAMPLE If a notebook metaphor is used, the data sheets and navigation control icons are designed to look like pages and tabbed dividers which the user can select directly in order to move to a specific page.

5.1.3 Limits of metaphors

If a metaphor is not applicable to some parts of the system, this should be clearly indicated to the user. If the extent of these limitations is such as to cause potential confusion to the user, the appropriateness of using the metaphor at all should be considered.

EXAMPLE 1 In a desktop metaphor, icons are used both for moveable objects and for action buttons which are not moveable. These differences are indicated by different frame types around the icons.

EXAMPLE 2 Dragging an object into a folder results in different effects which are dependent on the target position (moving vs. copying). These differences in the metaphor are clearly indicated to the user by corresponding system messages.

EXAMPLE 3 Whilst there is a desktop metaphor where a document can be dragged to a shredder for deletion, a system feedback indicates that an application cannot be shredded but should be deinstalled.

5.2 Appearance of objects used in direct manipulation

In direct manipulation dialogues, the presentation of information should help users to perform tasks such as accessing, searching, discriminating and recognizing objects and direct manipulations easily and accurately. In order to meet these objectives, the recommendations in this subclause should be applied. In addition the "Characteristics of presented information" of ISO 9241-12:1998, 4.1 should be applied.

5.2.1 Appropriate size of manipulable areas

Selectable and manipulable areas should be large enough to allow users to select them rapidly and accurately with a pointer [see ISO 9241-14:1997, 7.5.1b)].

NOTE The appropriate size may differ for different kinds of pointers, input devices (e.g. finger, mouse pointer), and contexts of use.

5.2.2 Distinctiveness of object representations and direct manipulation control icons

The visual design in direct manipulation interfaces should not only enable users to clearly identify objects that can be directly manipulated from other elements that are not changeable but should also clearly indicate which kinds of direct manipulations can be applied to a selected object.

EXAMPLE 1 A border is used to distinguish text objects from textual elements which cannot be directly manipulated. In addition, the pointer image is changed to an I-beam only when the pointer is moved into the area of the manipulable text object.

EXAMPLE 2 The possibility to directly manipulate a graphical object is indicated by different object handles that appear after selection of this object and by changing the shape of the pointer, as long as the pointer is positioned upon one of these handles.

5.2.3 Appearance of unavailable objects and control icons

If appropriate to the task, objects, attributes, or direct manipulation control icons that are currently unavailable should remain on the display. Coding should be used to indicate their temporary unavailability which is consistent with (visual) cues used for other dialogue techniques implemented in the same application (e.g. menu dialogues).

EXAMPLE 1 The symbol of a printer which has run out of paper is dimmed to indicate that it is not available at the moment and that print commands cannot be executed.

EXAMPLE 2 Buttons are dimmed if they cannot be activated in connection with the currently selected object.

5.2.4 Obscuring less important objects

If appropriate for the task, temporarily less important objects may be overlapped, hidden or placed at the periphery of the display area as a result of a direct manipulation, but

a) the objects' state should not change until another user input is made, and

b) some means should be provided to access these objects when they are required again.

EXAMPLE Selected cells in a spreadsheet remain selected, even if the user scrolls through the document and the selected cells therefore become invisible. Only when the user selects another cell are the status of the previously selected ones changed.

5.2.5 Representation of objects

If the number or size of objects to be processed would make a task difficult to complete, the user should be able to choose between different representations of the objects which still allow direct manipulations.

EXAMPLE Viewing objects in a container as icons is appropriate for a small number of different object types. If the number of objects is very large and mostly of the same type, iconic presentations can be difficult to distinguish and need much space. A textual representation of the objects can be handled more efficiently in this case. Also zooming to a view where more icons can be seen at a time could improve the user's efficiency.

5.3 Feedback

Feedback should provide dynamic and context-specific information about the effects and consequences of each direct manipulation and thus guide users through required dialogue sequences. In order to meet these objectives, the recommendations in this subclause should be applied. In addition, the recommendations on "feedback" in ISO 9241-13:1998, clause 7, should be applied.

5.3.1 Pointers indicating direct manipulation types

If a direct manipulation of an object or a part of an object results in a predefined, unambiguous action, the pointer type should indicate this action (see ISO/IEC 11581-3 which covers pointers and ISO 9241-12:1998, 6.2).

EXAMPLE

— pointing is indicated by an arrow;

— moving a single object is indicated by an arrow with a miniature object;

— moving multiple objects is indicated by an arrow with a stack of miniature objects;

— resizing is indicated by a double-ended arrow;

— drawing is indicated by a pencil;

— jumping to a cross-reference in a hypertext is indicated by a horizontal arrow.

5.3.2 Pointers indicating unavailability

The pointer type should indicate whether direct manipulations can be performed on a particular object or not.

EXAMPLE 1 The shape of the pointer is changed to an hourglass or a watch to indicate that no further direct manipulations are possible until the application has finished the current system process.

EXAMPLE 2 During a drag operation, the shape of the pointer is changed to a "prohibited" sign to indicate that the dragged object cannot be dropped at the current position of the pointer.

5.3.3 Prompting for required options

If an operation requires more data than can be specified through direct manipulation, then

a) the system should prompt for these data, and if possible and appropriate for the task

b) the system should provide selectable options for the user, and

c) the system should indicate default values to the user and ask for confirmation.

EXAMPLE After the user drops an object on a printer, the application prompts for values such as number of copies, selection of pages, etc. Within these prompts, the target printer is already selected within a list of possible printers and the system suggests a single copy of all pages as default value.

5.3.4 Immediate and continuous feedback for different parts of direct manipulations

The system should provide

a) continuous feedback on the progress of a direct manipulation, and

b) immediate feedback on the completion of each discrete part of a direct manipulation.

EXAMPLE 1 Continuous feedback. If an object like a window, icon, etc. is dragged from one position to another, the object itself or an outline of this object is continuously moved over the display corresponding to the movements of the pointing device.

EXAMPLE 2 Immediate feedback. As soon as the user has selected a document icon, it becomes highlighted, indicating that the document is selected. As soon as the document is deleted, its icon disappears from the display.

EXAMPLE 3 Immediate and continuous feedback. When the mouse pointer is moved onto a push button, an additional frame is displayed around the push button to indicate that this area is input sensitive. When the mouse button is pressed, the push button is highlighted immediately to indicate its selection. If the pointer is moved off the push button while the mouse button is still pressed, the highlighting and the additional frame disappear, indicating that the selection has been cancelled. When the mouse button is released while the pointer is on the highlighted push button, the highlighted area blinks twice to indicate that the activated action is now being processed by the system.

5.3.5 Display of newly created or opened objects

Unless it is inappropriate for the task, the results of direct manipulations to create or open objects should be displayed in the foreground of the display and should be positioned such that the results can be manipulated directly by the user.

EXAMPLE If a new window is opened, it is displayed in front of all other objects on the screen and automatically receives the input focus.

5.4 Input devices

Appropriate input devices, such as a mouse, a trackball or the use of a finger on a touch panel, should be selected to provide the feeling of directness and naturalness of manipulations required by the task. In order to meet this objective, the recommendations in 5.4.1 to 5.4.4 should be applied.

5.4.1 Alternative devices

All direct manipulations should be accessible at least by one pointing device. If alternative input devices are available, those direct manipulations, which are better suited to such a device, should also be assigned to these devices.

EXAMPLE For gross direct manipulations like moving an object over a distance, the mouse is used. For fine direct manipulations like exact positioning of an object, cursor keys are used to move the pointer.

5.4.2 Equivalent keyboard techniques

For users who may experience difficulties in operating pointing devices (such as a mouse etc.), equivalent techniques should be provided to achieve the same results with a keyboard or keyboard equivalent device. Such techniques need not be based on direct manipulation.

EXAMPLE To open a document, the user may double click on the document icon with the pointing device. Alternatively, the user may select the document icon with the tab key, select a menu item to open the document with the cursor keys, and activate it with the return key.

5.4.3 Minimal alternation between input devices

Direct manipulation dialogues should be designed to minimize the need for users to alternate between different input devices.

EXAMPLE To fill in a form, a user selects every field with the mouse and then enters text by choosing an item from a list of possible field values. As experience grows, the user moves the cursor from field to field with the tab-key and enters text with the keyboard. Thereby the need for the user to alternate between input devices is minimized and efficiency is increased.

NOTE Alternation between different input devices can be a way to increase variation in physical load and thereby decrease the risk of musculoskeletal problems.

5.4.4 Multiple buttons

For input devices that have multiple buttons, selecting should be assigned to the button which has been defined as the primary button (by convention or user preference).

6 Manipulation of objects

6.1 General considerations

Dialogue design based on direct manipulation of objects should minimize learning time and enhance user performance. Users should be able to see immediately the results of their direct manipulations, and should be able to change easily to other direct manipulations. The number and values of attributes of objects define the user's possibilities to customize and directly manipulate objects. Therefore, user interface design should also enable easy access and changeability of attributes. In order to meet these objectives, the following recommendations should be applied.

6.1.1 Generic direct manipulations

If the task requires similar operations on different object types, consistent generic direct manipulations should be provided.

EXAMPLE 1 "Text" objects and "file" objects can be deleted by selecting the object and dragging it to a waste paper can.

EXAMPLE 2 The characteristics of text within a page layout (borders, columns, tabular space) are directly changeable by moving corresponding handles, markers or other symbols within the document.

6.1.2 Sequence of direct manipulation of objects

Unless an alternative order is required by the task, modification of objects should be done consistently in the following order: first object selection, then direct manipulation.

EXAMPLE A document is selected before the control icon for "print" is activated by the user.

6.1.3 Automatic prompting of available objects or direct manipulations

If the user does not follow the expected order (e.g., attempting a direct manipulation without having selected an object), the system should prompt the user with available input options or should provide information on how to obtain these options.

EXAMPLE In a dialling system, icons of people represent customers and a phone icon represents the operation of dialling. The requested input sequence is to select a customer before the phone icon is activated; but if the user activates the phone icon first, the system prompts with available customers instead of producing an error message.

6.1.4 Direct manipulation of output

If appropriate for the task, the result of a direct manipulation should be displayed in such a way that it can be further modified by direct manipulation.

EXAMPLE 1 A bar chart is created from data in a spreadsheet. Data can be entered either in the spreadsheet or by resizing one of the bars directly with the pointing device.

EXAMPLE 2 Double clicking the icon representation of a container object opens a window that displays the list of contained objects. These can also be directly manipulated; e.g. copied, moved, edited.

EXAMPLE 3 A user creates a text document. As long as the user does not define any name for the document, the system uses a default name like "untitled document 1" which is already selected so that the user can directly overwrite it.

6.1.5 Returning to states prior to direct manipulations

Wherever possible, users should be able to use a direct manipulation in order to return to the state prior to a previous direct manipulation.

EXAMPLE 1 If an object is selected, it can be deselected.

EXAMPLE 2 If a file is dragged into a waste-paper can, it can be dragged back out as long as no operation to empty the waste-paper can has been carried out.

NOTE This recommendation does not relieve designers from considering other methods for returning to previous states (e.g. an undo-function; for details on error management see also ISO 9241-13:1998, clause 9).

6.1.6 Direct manipulation of attributes

If efficiency is important and if appropriate for the task, visible attributes of an object should be directly manipulated so that the object's appearance is changed immediately. Other attributes may be made accessible by separate windows or menus.

EXAMPLE 1 The height of a bar in a bar chart can be modified by dragging the top directly at the intended value.

EXAMPLE 2 A specific window has been designed to display all required data simultaneously. In this case, users may still change the window's attribute "position" directly by dragging, but may not change the height or width of that window.

EXAMPLE 3 If a monochrome screen is used, the colours of an object cannot be displayed directly. The current or default colour values can be indicated in a separate location.

NOTE If a visible attribute of an object is modified in a separate window, it might be useful to keep the window open, thus enabling the user to further modify or correct this attribute.

6.2 Pointing and selecting

Users should be able to choose manipulable objects easily by pointing and selecting. In order to meet this objective, the following recommendations should be applied.

6.2.1 Visualization of pointing and selecting

Pointing and selecting should be illustrated by a sequence of appropriate visual cues. It should be apparent to the user:

a) during pointing: which component will be selected at the current position of the pointer, and

b) during selection: which object or objects are being selected, and

c) after the selection process: which objects are selected.

EXAMPLE:

a) The position of the tip of the pointer arrow is used to determine which of the elements that are displayed beneath the current location of the pointer will be selected.

b) As long as the user moves the pointer while keeping a mouse button pressed, a rectangle is displayed which indicates that objects within this area are being selected.

c) After the mouse button is released, the line disappears and the selected objects are highlighted.

6.2.2 Pointing at and between objects

If appropriate for the task, the user should be able not only to point to and select objects, but also to point at other areas in order to move the input focus.

EXAMPLE 1 In order to insert text, the user is able to position the text cursor directly between characters.

EXAMPLE 2 In order to copy a file icon from a container onto the desktop, the user is able to select with the pointing device any target position on the desktop between other file icons.

6.2.3 Single selection mechanisms

If a user has to select exactly one option from a list of options or one object from a group of objects, any selection of an item should deselect a previously selected item. If in addition it is meaningful to have no item selected, mechanisms should be provided to cancel any selection.

6.2.4 Multiple selection mechanisms

If a user is allowed to select more than one option from a list of options or more than one object from a group of objects, visual cues should indicate the possibility of multiple selection and a mechanism should be provided, that allows both

a) the selection of a continuous range of items, and

b) any combination of items.

EXAMPLE In a list of items, the user selects five subsequent items by dragging the selection indicator from the first to the fifth item, but by a different mechanism the user can also select a subset; e.g., the first, the fourth and the sixth item.

6.2.5 Simultaneous direct manipulation of several objects

If appropriate for the task and/or objects, direct manipulations available for individual objects should also be available for multiple selected objects of the same type.

EXAMPLE Multiple files can be printed by dragging the selected group of file icons to the printer icon.

6.2.6 Selectable areas for the direct manipulation of objects

In order to enable direct manipulation of objects, objects that can be directly manipulated should have areas which

a) can be easily recognized and discriminated by the user as selectable, and

b) can be easily selected.

EXAMPLE 1 A graphical object that can be resized has visible handles attached to its edges. Different handles enable the user to resize height, length, radius or angle.

EXAMPLE 2 Resizable windows have markings in one or more corners of the border to indicate that the window can be resized. To indicate when the resizable region has been reached and can be selected, the pointer image is modified.

6.2.7 Structuring for object selection

If the number or size of objects becomes too large for easy selection and direct manipulation, structuring facilities (e.g. grouping) should be provided.

EXAMPLE When document icons are put into folders, all documents of this folder can be selected and directly manipulated just by selecting and directly manipulating this folder.

6.2.8 Access to overlapped objects

If a displayed object becomes partly or completely overlapped by other objects, the user should be able to bring this object to the foreground of the display or to move or remove the objects hiding it via direct manipulation.

EXAMPLE 1 A text document currently being processed is partly hidden because the user has activated a dictionary in order to check spelling in the document. The user can make this document visible again by moving the dictionary.

EXAMPLE 2 The system displays a message window with a progress indicator automatically in the centre of the screen. This message window can be closed or dragged to a different position, so that the user can continue to work with the overlapped information.

6.2.9 Efficiency mechanisms

The system should provide short cuts where appropriate for the task and appropriate for the level of user expertise.

EXAMPLE 1 Instead of changing several attributes of an object individually, users can copy groups of attributes from one object to another by a single direct manipulation.

EXAMPLE 2 Multiple clicking is used for extended selections of objects that form a certain hierarchy (double clicking to extend from character selection to word selection; triple clicking to extend to sentence selection, etc.).

EXAMPLE 3 In a database application, the user often has to search for updated records, always applying identical search criteria. For this, the user can create a filter-object (displayed as an icon) that represents the specified set of search criteria. Instead of entering the criteria from scratch, the user activates the search simply by moving the filter-object onto the database object.

6.2.10 Use of double clicking

If double clicking is used as a method for implicitly selecting an object and executing an action upon it, an alternative method should be provided allowing users to select an object and execute an action explicitly in separate steps.

6.2.11 User configuration for multiple time-dependent clicking

If multiple clicking is provided for specific direct manipulations, the specified time period between consecutive clicks should be modifiable by the user.

6.2.12 Continuous selection of objects

If appropriate for the task, an object should remain selected after any direct manipulation, so that the user can continue to directly manipulate it without having to repeat the selection again.

6.2.13 Reassignment of input focus

If an object is removed from the display, the system should automatically reassign the input focus to the object that the user is most likely to work on. If the most likely object is not known, the input focus should be assigned automatically to an object based on a logical choice of available objects.

EXAMPLE 1 A user is working on a set of documents within an application. When the user closes one document, the input focus goes to another document window within the same application. The document window chosen for input focus is one that the user was working on immediately prior to working on the document that was closed.

EXAMPLE 2 A user is changing data in a window that is displayed when the object's icon on the desktop has been opened. No other applications are currently open. When the user closes the window for the object, input focus goes to the desktop, where the icon for the previously opened object is selected so the user can continue to directly manipulate it without having to select the icon again.

6.3 Dragging

Dragging should allow users to change the positions of displayed objects either to rearrange the display itself or to directly activate system commands. In order to meet these objectives, the recommendations in 6.3.1 to 6.3.8 should be applied.

6.3.1 Visualization of dragging

During dragging, the progress of the direct manipulation should be illustrated by a sequence of appropriate visual cues. They should indicate:

a) before dragging, which object is becoming selected,

b) during the drag operation, the objects that are being dragged,

c) which locations or objects on the screen are potential targets, and

d) whether or not the dragged objects may be dropped at their current location.

EXAMPLE A document is dragged to a printer in order to activate a print command. The direct manipulation is illustrated by the following system behaviour. When the document is selected its icon becomes highlighted. During dragging, the icon is greyed while an outline of the document icon is attached to the pointer and moved towards a printer icon. As long as the pointer is moving over objects where dropping of the document has no meaning, the pointer is changed to a "prohibited" symbol. While the pointer is moved over the printer icon, a frame is displayed around the icon to indicate that it is a possible target.

6.3.2 Dragging a group of objects

If the spatial relationship between a selected group of objects is relevant to the task, this spatial relationship should be maintained during and after dragging.

6.3.3 Semantic differences in dragging

If dragging is used for purposes other than to move the selected object, visual cues should indicate this difference.

EXAMPLE If a user wants to create a copy of a displayed object by direct manipulation, the user has to press a modifier key while dragging this object. In this case, the source object remains unchanged but a copy of the object is dragged. This is indicated by a different pointer which represents a copy command.

6.3.4 Predefined interactions between objects

Operations to directly manipulate one object by using another object should be related to the chosen metaphor.

EXAMPLE 1 In order to send a file to the printer, the file icon is dropped on the printer icon and not vice versa.

EXAMPLE 2 In order to erase parts of a graphic, an eraser icon is dragged across the drawing.

EXAMPLE 3 In order to move a file into a folder, the file icon is dropped into the folder icon and not the folder icon into the file icon.

6.3.5 User control of object positions

If appropriate to the task and chosen metaphor, it should be possible to position objects freely on the screen, even if objects overlap one another.

EXAMPLE 1 When working with two documents in two different windows which are too large to be completely displayed on the screen simultaneously, the user can partially obscure one window with the other.

EXAMPLE 2 In order to place a graphic or any portion of text at a different location within a document, the user can drag the selected object directly to any target position within the document.

6.3.6 Access to hidden objects

If objects or portions of objects can be hidden or positioned outside the current screen display, the user should be able to access and to reposition these objects onto the screen.

EXAMPLE 1 Hidden file icons in a file container can be repositioned onto the display area by directly manipulating the corresponding scroll bar.

EXAMPLE 2 A large map is displayed in a window. Since the map is larger than the window display area, the user can zoom or resize the window or scroll invisible parts of the map into the window display area. Any of these solutions can be carried out by dragging.

6.3.7 Automatic display of objects within windows

If the attributes of objects or the container for objects require a positional relationship between objects,

a) dragged objects should be automatically placed for the user, and

b) the part of the window containing the dragged objects should be automatically displayed.

EXAMPLE The user drags a file into a file browser that has been set for alphabetical ordering. The user can drop the icon for the file at any location in the file browser and it will automatically be alphabetized for the user. The viewport for the window is automatically positioned so that the file is displayed.

6.3.8 Manual placement of objects within windows

If the attributes of objects or containers do not require a positional relationship between objects, dragged objects should remain at the position where they were dropped by the user.

EXAMPLE The user drags a circle from one drawing to another. The circle remains at the location where the user released the button of the pointing device ending the drag operation.

6.4 Sizing of objects

Sizing should allow users to change the size of displayed objects either to rearrange the display itself or to manipulate their representation directly. In order to meet these objectives, the following recommendations should be applied.

6.4.1 Visualization of sizing

During sizing, the progress of the direct manipulation should be illustrated by a sequence of appropriate visual cues. They should indicate:

a) before and after sizing, areas where selected objects can be sized, and if appropriate

b) during sizing, which is the original size and which size has been reached so far.

EXAMPLE When an ellipse is selected in a drawing application, handles are displayed enabling the user to size the object. During sizing, a dotted frame is displayed which is continuously changed according to pointer movements. Afterwards the handles are displayed again.

6.4.2 Sizing mechanisms

If the task requires sizing of objects, the system should provide mechanisms that allow sizing of single dimensions and multiple dimensions simultaneously.

EXAMPLE Selecting a rectangular graphical object at its corners allows the resizing of height and width simultaneously, whereas selecting it between its corners only enables the resizing of one of these dimensions.

6.4.3 Size indicator

If users need to monitor the dimensions of an object exactly during a sizing manipulation, a quantitative indicator should be provided that continuously shows the object's current size during the resizing operation.

6.4.4 Complementary direct manipulations of sizing

Direct manipulations to resize graphical objects should be applicable both for increases and decreases in size.

6.4.5 Scaling

If appropriate to the task, users should be allowed to change the scale of displayed objects either to provide access to an appropriate level of displayed details or to manipulate their representation directly in one single step.

6.4.6 Direct manipulation of the scaling factor

If the task requires the scaling of displayed objects, mechanisms for direct manipulation of the scaling factor should be provided where the changing size is indicated by a smooth and continuous motion that corresponds to the user’s direct manipulation.

EXAMPLE Possible ways of scaling the contents of a window are to use a slider control or to use zoom in/zoom out buttons.

6.5 Rotating

Rotating should allow users to change the orientation of displayed objects either to rearrange the display itself or to manipulate their representation directly. In order to meet these objectives, the following recommendations should be applied.

6.5.1 Visualization of rotating

During rotating, the progress of the direct manipulation should be illustrated by a sequence of appropriate visual cues. They should indicate:

a) before and after rotating, areas where selected objects can be rotated, and

b) during rotating, which is the original orientation and which orientation has been reached so far.

6.5.2 Rotating objects

If appropriate for the task, mechanisms for direct manipulation of the objects’ orientation should be provided where the rotation is indicated by a smooth and continuous motion that corresponds to the user’s direct manipulation.

7 Additional recommendations for direct manipulation of text objects

7.1 Pointing and selecting

If text is edited in direct manipulation dialogues, single characters can be treated as objects as well as words, sentences or paragraphs. Users should be able to choose text objects which are suitable for the task easily by pointing and selecting. In order to meet this objective, the recommendations in 7.1.1 and 7.1.2 should be applied.

7.1.1 Positioning the text cursor

The user should be able to position the text cursor with the pointing device either between characters or upon any character.

7.1.2 Accelerated selection of text objects

In order to directly manipulate text efficiently, mechanisms should be provided to select text by referring to text objects that are familiar to the user.

EXAMPLE In addition to a generic selection mechanism, a text processor provides mechanisms to select words (by a double click), sentences (by a triple click), lines, columns, paragraphs, pages and the whole document in single steps.

7.2 Sizing of text

Sizing can be an appropriate means to allow users to change layout dimensions of displayed text by direct manipulation similar to the direct manipulation of graphical objects. In order to meet this objective, the recommendations in 7.2.1 and 7.2.2 should be applied.

7.2.1 Direct change of page layout attributes

If appropriate to the task, the user should be able to change attributes of a page layout (e.g. borders, columns, tabular space) simply by directly manipulating corresponding handles, markers or other symbols within the document.

7.2.2 Direct manipulation of text attributes

If appropriate to the task, the user should be able to manipulate text objects directly as graphical objects (e.g. changing size, scale, shape).

EXAMPLE In a drawing application, text objects are treated similarly to rectangles, circles, etc. As soon as the object is selected, handles appear that allow the user to resize the object. If a handle of the text object is dragged, the text object size is increased or decreased gradually.

8 Additional recommendations for direct manipulation of windows

Subclauses 8.1 to 8.3 provide recommendations concerning direct manipulation of windows. In addition, recommendations about the visual design of windows, window layout and information presentation within windows (see ISO 9241-12:1998, 5.3) should be applied.

8.1 General considerations

Windows are used to give the user simultaneous access to multiple views of data and multiple objects relevant for the task. Windows should help the user to adapt the working environment and to distinguish between independent task areas. In order to meet these objectives, the following recommendations should be applied.

8.1.1 Moving window contents in multiple units

If a window allows users to move its contents horizontally or vertically, and the associated information greatly exceeds that area which can be displayed within the window at its current size, a mechanism should be provided to scroll in steps corresponding to meaningful multiple and single units.

EXAMPLE Text can be scrolled in steps corresponding to single pages or to the size of the current window pane as well as in steps of single lines or columns.

8.1.2 Moving window contents by scrollbars

If scrollbars are used to move the window contents, then the moving viewport method should be applied, i.e., the viewport is repositioned over the underlying data display.

EXAMPLE Clicking the up-arrow of the vertical scroll bar in a window moves the data downwards and vice versa.

8.2 Pointing and selecting

Users should be able to choose windows, directly manipulable parts of windows and directly manipulable contents of windows easily by pointing and selecting. In order to meet this objective, the following recommendations should be applied.

8.2.1 Rearrangement of displayed window contents according to user selection

If the range of objects the user is selecting by direct manipulation extends beyond the edge of the current window, the window should automatically move/scroll until the user stops selecting.

EXAMPLE A text can be selected by dragging the selection indication over the text. When the selection indication reaches the edge of the window and selection continues, further text is scrolled into the visible area and selected.

8.2.2 Minimal user input

The initiation of frequently performed direct manipulations on windows should be designed to require minimal mouse clicks, key strokes, and/or cursor positioning.

EXAMPLE

Users are allowed

— to make hidden parts of a window visible, just by clicking on the visible part of the window;

— to hide a window by simply activating a corresponding window control icon.

8.3 Sizing of windows

Sizing of windows should allow users to change the working area displayed in windows directly and thereby to enlarge or reduce the access to objects. In order to meet this objective, the following recommendations should be applied.

8.3.1 Direct manipulation of the size of windows

The system should provide mechanisms that allow a window to be sized either horizontally, vertically or in both dimensions simultaneously.

EXAMPLE Changing height and width is achieved by dragging window borders (for changes of a single dimension) or corners (for simultaneous change of both dimensions) to different screen positions.

8.3.2 Minimum and maximum limits of window size

The system should prevent the user from directly manipulating a window's size beyond meaningful minimum and maximum limits as appropriate to the task.

8.3.3 Sizing short cuts

Mechanisms should be provided to change a window's size to appropriate minimum, maximum or other task relevant sizes in a single step.

EXAMPLE Selectable icons on the window border allow users to change the window size to a maximum value by a single click.

8.3.4 Scaling

If appropriate to the task, users should be allowed to scale the working area displayed in windows directly in one step.

8.3.5 Sizing effects on window contents

When a window is resized, the contents should be adapted according to the method that is most appropriate for the user's task.

Method a
The displayed window content is scaled in the same proportion as the window itself. The identical content remains visible, but in a different size.

or

Method b
The displayed content keeps its size, but is rearranged to fit into the new window size as much as possible. However, only parts may remain visible.

or

Method c
The displayed window content is not scaled. It keeps its original size and arrangement and therefore may be only partly visible, if the window is resized.

9 Additional recommendations for direct manipulation of control icons

Aspects concerned with direct manipulation of control icons are described in 9.1. For the description of typical control icons, see also ISO/IEC 11581.

9.1 Pointing and selecting

If control icons are used to enhance user recognition of available direct manipulations, such representations and access to control icons should be unambiguous, conform to user expectations and be suitable for the task. In order to meet these objectives, the following recommendations should be applied.

9.1.1 Activation of control icons

Direct manipulations represented by control icons should be executable by means of a pointing device.

9.1.2 Indicating direct manipulation types

Visual cues should be provided to indicate to the user how each control icon can be directly manipulated.

EXAMPLE 1 A three-dimensional layout of a push button indicates that it could be clicked.

EXAMPLE 2 A rotary knob indicates that it could be rotated.

EXAMPLE 3 A slider indicates that it could be dragged.

9.1.3 Indicating user's tasks

Analogies represented by control icons should be clearly related to the user's task.

EXAMPLE 1 A push button allows users to execute commands.

EXAMPLE 2 A rotary knob or slider may be used for setting the volume of sound.

9.1.4 Indication of availability

The user should be provided with an indication of the availability of control icons.

EXAMPLE Dimming the corresponding control icon or control label indicates that the user cannot select and execute this control.

9.1.5 Separation of selection and activation

To prevent inadvertent activation of control icons, users should be enabled to perform selection (i.e., to position a pointer or cursor) and activation of control icons separately.

9.1.6 Appropriate use of controls

Control icons should be applied in such a way that the direct manipulation of a control is consistent with its effects on represented data.

EXAMPLE In a hypertext application using a book metaphor, a push button with a horizontal arrow to the left is used to go to the previous page in a German language environment. In a Japanese language environment, this push button is used to go to the next page.

Annex A
(informative)

Sample procedure for assessing applicability and adherence

A.1 Introduction

This annex provides an example of a procedure for determining whether the applicable recommendations in this part of ISO 9241 have been met. It should be noted that the procedure described below is provided as guidance and is not a rigid process to be used as a substitute for the standard itself. This procedure provides a two-stage process for

1) determining which recommendations are relevant, and

2) determining whether those relevant recommendations have been adhered to.

Interface design depends upon the task, the user, the environment, and the available technology. Consequently, this part of ISO 9241 cannot be applied without a knowledge of the design and use context of the interface and it is not intended to be used as a prescriptive set of rules to be applied in their entirety. Rather, it assumes that the designer has proper information available concerning task and user requirements and understands the use of available technology (this could require consultation with a qualified ergonomics professional as well as empirical testing with real users).

The evaluation procedure should be based on an analysis of typical users, their typical and critical tasks, and their typical usage environments. Direct manipulation dialogue evaluations generally fall into the two following categories:

a) When users and user tasks are known, evaluators evaluate the product or observe representative users of the product in the context of accomplishing typical and critical user tasks in a typical usage environment.

b) When specific users and user tasks are not known, evaluators evaluate all types of direct manipulation used in the product being evaluated.

Determination of whether a product meets a given recommendation should be based on the types of direct manipulation encountered during the evaluation described above. Direct manipulation dialogues that can be shown to be better than ones that meet the recommendations described in this part of ISO 9241 would also be accepted as meeting the recommendations of the standard.

Users of this part of ISO 9241 could demonstrate how they met the recommendations by listing

— the types of direct manipulation evaluated,

— the method used to judge applicability (as described in A.2);

— the method used to judge adherence (as described in A.4); and

— the results.

A.2 Applicability

The applicability of a recommendation is based on two factors:

a) Whether the conditional statement, if included as part of the provision, is true. A particular recommendation is (or is not) applicable when the conditional if-statement is (or is not) true.

b) The design environment. A particular recommendation may not be applicable because of user, task, environment and technology constraints, such as unknown user community, variations in tasks, noisy office, screen resolution, lack of a pointing device. However, if the design environment did involve user characteristics, tasks, or technology features addressed by a particular recommendation, that recommendation would be applicable.

The methods which are appropriate to determine the applicability of a particular recommendation are

— system documentation analysis,

— documented evidence,

— observation,

— analytical evaluation,

— empirical evaluation.

Clause A.3 describes each of the applicability methods in more detail.

A.3 Description of applicability methods

A.3.1 System documentation analysis

System documentation analysis refers to the analysis of any documents which may describe the general and specific properties of the direct manipulation dialogue. Such documents may include design documents containing system and user requirements, manuals, user guides, etc.

A.3.2 Documented evidence

Documented evidence refers to any relevant documented information about the task requirements or characteristics, flow of work, user skills, user aptitudes, existing user conventions or biases, test data from the design of similar systems, etc. Such information may be used to determine whether a given recommendation is applicable.

A.3.3 Observation

Observation means simply to examine or inspect the direct manipulation dialogue for the presence of a particular observable property. Observations can be made by anyone who has the necessary skill to systematically check the direct manipulation dialogue and determine if it has the particular properties associated with the applicability of given conditional recommendations. Due to their obvious nature, such observations can readily be confirmed by another person.

A.3.4 Analytical evaluation

Analytical evaluation pertains to "informed" judgements concerning the properties of a direct manipulation dialogue by a relevant expert (i.e., of those properties). This method is typically used for the evaluation of properties which can be judged only in the context of other information or knowledge. In addition, analytical evaluation may be appropriate when the system exists only in terms of design documents, user populations are not available for empirical evaluation, or time and resources are constrained. Analytical evaluation can be used to determine whether a particular recommendation is applicable.

Analytical evaluation can be performed by any suitably qualified person who has the necessary skill and experience to judge the relevant property of the direct manipulation dialogue. Where these properties concern the application of ergonomic principles, the expert needs to possess appropriate skills in software ergonomics. If the properties concern the work environment, system characteristic, or other aspects of the design, the person needs to be an expert in the particular relevant domain.

A.3.5 Empirical evaluation

Empirical evaluation refers to the application of test procedures using representative end users to determine the applicability of a recommendation. This method is most appropriate when a prototype or the actual system is available, and potential or actual user population representatives are available. Many kinds of test procedures could be used, but in each case the test subjects need to be representative of the end user population and be of sufficient number that the results can be generalized to the user population as a whole.

It should be noted that empirical evaluation needs to be conducted by individuals possessing appropriate skills in testing methodology and evaluation techniques.

A.4 Adherence

If a recommendation is applicable on the basis of the criteria described in A.2, it is then necessary to determine whether or not the recommendation has been met. Adherence is determined by using one or more of the methods listed below.

NOTE The methods which are appropriate to determine adherence for a particular recommendation are listed in conjunction with that recommendation in the Checklist in Table A.1:

— measurements;

— observation;

— documented evidence;

— analytical evaluation;

— empirical evaluation.

It is important to note that the results of applicability tests are often important in determining adherence. The various adherence methods are further described in A.5.

A.5 Description of adherence methods

A.5.1 Measurements

Measurements refer to measuring or calculating a variable concerning properties of the direct manipulation dialogue. Adherence is determined by comparing the obtained value from the measurement with the value stated in the recommendation.

A.5.2 Observation

Observation means simply to examine or inspect the direct manipulation dialogue to confirm that a particular observable condition has been met. Observations could be made by anyone who has the necessary skill to systematically check the direct manipulation dialogue and determine if a statement concerning an observable property has been consistently applied. The observed property is compared with the stated recommendation to determine adherence.

A.5.3 Documented evidence

For adherence, documented evidence refers to any relevant documented information related to the direct manipulation dialogue's adherence to the appropriate conditional recommendations. Such evidence may include existing user conventions or biases, prototype test data, test data from the design of similar systems, etc.

A.5.4 Analytical evaluation

As stated in A.3.4, analytical evaluation pertains to "informed" judgements concerning the properties of a direct manipulation dialogue by a relevant expert (i.e., of those properties). This method is typically used for the evaluation of properties which can be judged only in the context of other information or knowledge. In addition, analytical evaluation can be an appropriate adherence method when the system exists only in terms of design documents, user populations are not available for empirical evaluation, or time and resources are constrained.

As stated in A.3.4, analytical evaluation can be performed by any suitably qualified person who has the necessary skill and experience to judge the relevant property of the direct manipulation dialogue. For adherence, the expert also needs to have the skills and knowledge necessary to reliably judge the appropriateness and usability of a particular design solution. It also should be noted that analytical evaluation can verify the tenability of a design, but cannot validate the design. Validation can be accomplished only by using empirical evaluation.

A.5.5 Empirical evaluation

Empirical evaluation refers to the application of test procedures using representative end users to determine the adherence of a recommendation. As stated in A. 3.5, this method is most appropriate when a prototype or the actual system is available and potential or actual user population representatives are available. Many kinds of test procedures could be used, but in each case the test subjects need to be representative of the end user population and be of sufficient number that the results can be generalized to the user population as a whole. The task performance of end-users using the direct manipulation dialogue could be analysed to determine adherence with the various conditional recommendations. Such tests could be performed both during the development process (e.g. by rapid prototyping) and after the design and implementation of the system (e.g. by system evaluation techniques) and could be based on both objective and subjective user data. Special tests also could be designed to measure the adherence to a particular recommendation.

Typically, empirical evaluations are used to determine adherence by comparing the test results against specific direct manipulation dialogue recommendations. However, it is often necessary to also evaluate test results in terms of effectiveness (e.g. the direct manipulation dialogue supports the user in his/her task in a manner which leads to improved performance, results in a difficult task being performed with less difficulty, or enables the user to accomplish a task that he/she would not have been able to accomplish otherwise).

A.6 Procedure

The following procedure (also see Figure A.1) can be followed in evaluating a particular direct manipulation dialogue with respect to the recommendations in this part of ISO 9241.

A.6.1 "If clause" conditional recommendations

a) **Applicability** — Each recommendation has an if-condition either in the statement itself, or implied in the title to a subclause. For each conditional recommendation, the applicability of the if-statement should be determined using the methods proposed to test if the if-condition is true or not. Also, when there is a set of optional conditional recommendations, the applicable approach should be determined using the proposed method(s).

b) **Adherence** — For each applicable conditional recommendation as defined in a), the adherence of the recommendation should be determined using the proposed methods.

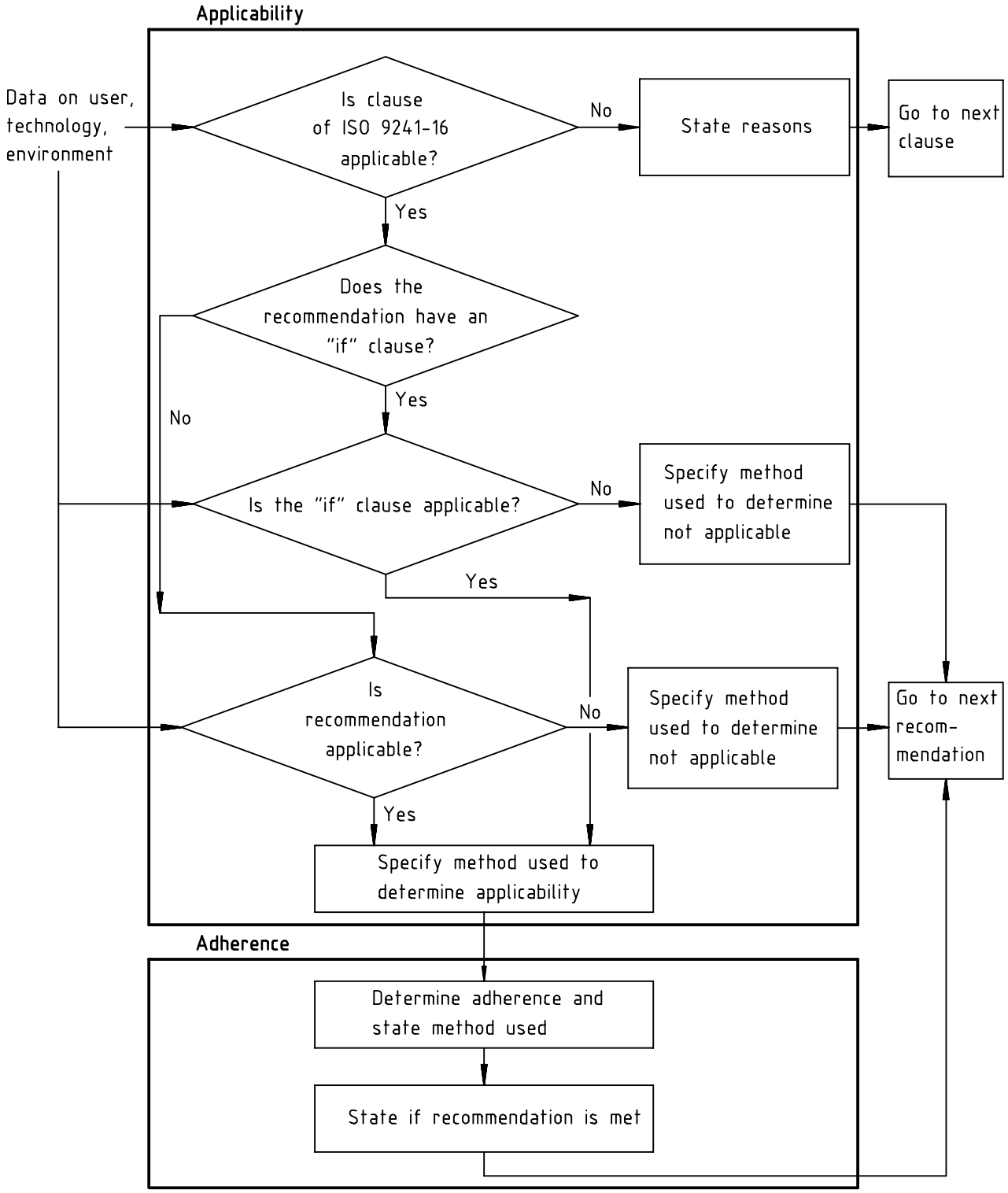

Figure A.1 — Decision process — Evaluation situation

A.6.2 Other conditional recommendations

a) Applicability — Non-“if” statement conditional recommendations are generally appropriate to any direct manipulation dialogue. However, a number of the subclauses are applicable only if the direct manipulation dialogue utilizes such features.

b) Adherence — For each non-“if” statement conditional recommendation as determined in a), information about adherence to the recommendation as described in A.6.1 b) is necessary. If there are valid reasons for not following the proposed recommendation, both the reasons and the design solution chosen also would be of interest to users of this part of ISO 9241.

As an aid for applying the procedures described above, a checklist is provided in Table A.1.

A.7 Checklist

NOTE Users of this part of ISO 9241 may freely reproduce the checklist in this annex so that it can be used for its intended purpose and may further publish the completed checklist.

The checklist in Table A.1 is intended as an aid for both designers and evaluators of direct manipulation dialogues in evaluating both the applicability of, and adherence to, the conditional recommendations in this part of ISO 9241. This checklist contains a "short version" of all of the recommendations of this part of ISO 9241 and provides a logical structure to assist users in determining applicability.

A.7.1 Description of the checklist

A.7.1.1 Recommendations column

The first column of the checklist contains the "short version" conditional recommendations separated by subclause. Since each conditional recommendation is numbered with its clause number, users can look up the full text easily in the relevant subclauses and clauses, of this part of ISO 9241.

A.7.1.2 Applicability Columns

The first two columns of the Applicability portion of the checklist are provided for recording the result of the applicability determination by a checkmark in the "Y" or "N" column. In addition, this part of the checklist indicates which of the applicability methods are relevant for each of the conditional recommendations and provides space to "check off" the method used by the designer or evaluator. Methods that are not relevant for a particular recommendation are shaded to make the checklist easier to use. The codes used for the applicability methods are:

— S = System documentation analysis

— D = Documented evidence

— O = Observation

— A = Analytical evaluation

— E = Empirical evaluation

— DM = Different Method (method other than above used)

If a different method is used (i.e., "DM" is checked), that method can be described in the Comments column. It also should be noted that checking off the applicability methods used is considered an optional feature of the checklist.

A.7.1.3 Adherence columns

This part of the checklist indicates which methods are appropriate for determining adherence to each of the conditional recommendations and provides space for designers or evaluators to "check off" the method used.

Methods that are not relevant for a particular recommendation are shaded to make the checklist easier to use. If the result of the adherence test is positive, the "P" column is checked (for "passed") and if the result is negative, the "F" column is checked (for "failed"). The codes used for the adherence methods are:

— M = Measurement

— O = Observation

— D = Documented evidence

— A = Analytical evaluation

— E = Empirical evaluation

— DM = Different Method (method other than above used)

As for applicability, if a different method is used ("DM" checked), that method can be described in the Comments column. Also as noted for applicability, checking off the methods used to evaluate adherence is considered an optional feature of the checklist.

A.7.1.4 Comments

The comment column provides space for additional statements and comments pertaining to each of the conditional recommendations and can be used to indicate the source of the assessment (e.g. name of expert, title of documented evidence) as well as for describing "Different Methods" when used. Since different solutions (methods) can be appropriate, in specific situations, it is best to describe such unique solutions in the comments column. This description can include how these solutions relate to the direct manipulation dialogue design recommendations and appropriate dialogue principles.

A.7.2 Summary data

Users of the Applicability and Adherence Checklist could summarize the results of the evaluation by computing an adherence rating (AR). The AR is the percentage of the applicable recommendations successfully adhered to (i.e., the number of checkmarks in the "P" column divided by the number of checkmarks in the "Y" column). It is highly recommended that all of the data (i.e., number of Ps and the number of Ys) be reported in conjunction with the ARs. Depending on the complexity of the direct manipulation dialogues, it may be useful to complete a checklist for each type of direct manipulation dialogue used in the system and then average the ARs across the direct manipulation dialogue types to determine the average AR for the entire application. However, it should be noted that the AR is no more than an arithmetic count which cannot be used as a reliable measurement of the degree of adherence with applicable recommendations without taking into account the respective weights of the items (both by themselves and in the context of use).

Table A.1 — Applicability and Adherence Checklist

Recommendations		Applicability								Adherence								Comments (including sources)
		Results		Method used						Method used						Results		
		Y	N	S	D	O	A	E	DM	M	O	D	A	E	DM	P	F	
5	General information																	
5.1	Metaphors																	
5.1.1	Providing a framework																	
5.1.2	Recognizable metaphors																	
5.1.3	Limits of metaphors																	
5.2	Appearance of objects used in direct manipulation																	
5.2.1	Appropriate size of manipulable areas																	
5.2.2	Distinctiveness of object representations and direct manipulation control icons																	
5.2.3	Appearance of unavailable objects and control icons																	
5.2.4	Obscuring less important objects																	
5.2.5	Representation of objects																	
5.3	Feedback																	
5.3.1	Pointers indicating direct manipulation types																	
5.3.2	Pointers indicating unavailability																	
5.3.3	Prompting for required options																	
5.3.4	Immediate and continuous feedback for different parts of direct manipulations																	
5.3.5	Display of newly created or opened objects																	
5.4	Input devices																	
5.4.1	Alternative devices																	
5.4.2	Equivalent keyboard techniques																	
5.4.3	Minimal alternation between input devices																	
5.4.4	Multiple buttons																	
6	Manipulation of objects																	
6.1	General considerations																	
6.1.1	Generic direct manipulations																	
6.1.2	Sequence of direct manipulation of objects																	
6.1.3	Automatic prompting of available objects or direct manipulations																	
6.1.4	Direct manipulation of output																	
6.1.5	Returning to states prior to direct manipulations																	
6.1.6	Direct manipulation of attributes																	
6.2	Pointing and selecting																	
6.2.1	Visualization of pointing and selecting																	
6.2.2	Pointing at and between objects																	
6.2.3	Single selection mechanisms																	

Recommendations		Applicability								Adherence								Comments (including sources)
		Results		Method used						Method used						Results		
		Y	N	S	D	O	A	E	DM	M	O	D	A	E	DM	P	F	
6.2.4	Multiple selection mechanisms																	
6.2.5	Simultaneous direct manipulation of several objects																	
6.2.6	Selectable areas for the direct manipulation of objects																	
6.2.7	Structuring for object selection																	
6.2.8	Access to overlapped objects																	
6.2.9	Efficiency mechanisms																	
6.2.10	Use of double clicking																	
6.2.11	User configuration for multiple time-dependent clicking																	
6.2.12	continuous selection of objects																	
6.2.13	Reassignment of input focus																	
6.3	Dragging																	
6.3.1	Visualization of dragging																	
6.3.2	Dragging a group of objects																	
6.3.3	Semantic differences in dragging																	
6.3.4	Predefined interactions between objects																	
6.3.5	User control of object positions																	
6.3.6	Access to hidden objects																	
6.3.7	Automatic display of objects within windows																	
6.3.8	Manual placement of objects within windows																	
6.4	Sizing of objects																	
6.4.1	Visualization of sizing																	
6.4.2	Sizing mechanisms																	
6.4.3	Size indicator																	
6.4.4	Complementary direct manipulations of sizing																	
6.4.5	Scaling																	
6.4.6	Direct manipulation of the scaling factor																	
6.5	Rotating																	
6.5.1	Visualization of rotating																	
6.5.2	Rotating objects																	
7	Additional recommendations for direct manipulation of text objects																	
7.1	Pointing and selecting																	
7.1.1	Positioning the text cursor																	
7.1.2	Accelerated selection of text objects																	
7.2	Sizing of text																	
7.2.1	Direct change of page layout attributes																	

Recommendations		Applicability								Adherence								Comments (including sources)
		Results		Method used						Method used						Results		
		Y	N	S	D	O	A	E	DM	M	O	D	A	E	DM	P	F	
7.2.2	Direct manipulation of text attributes																	
8	Additional recommendations for direct manipulation of windows																	
8.1	General considerations																	
8.1.1	Moving window contents in multiple units																	
8.1.2	Moving window contents by scrollbars																	
8.2	Pointing and selecting																	
8.2.1	Rearrangement of displayed window contents according to user selection																	
8.2.2	Minimal user input																	
8.3	Sizing of windows																	
8.3.1	Direct manipulation of the size of windows																	
8.3.2	Minimum and maximum limits of window size																	
8.3.3	Sizing short cuts																	
8.3.4	Scaling																	
8.3.5	Sizing effects on window contents																	
9	Additional recommendations for direct manipulation of control icons																	
9.1	Pointing and selecting																	
9.1.1	Activation of control icons																	
9.1.2	Indicating direct manipulation types																	
9.1.3	Indicating user's tasks																	
9.1.4	Indication of availability																	
9.1.5	Separation of selection and activation																	
9.1.6	Appropriate use of controls																	

NOTE Users of ISO 9241-16 may freely reproduce this checklist so that it can be used for its intended purpose and may further publish the completed checklist.

Key

Y = Yes (if applicable)
N = No (if not applicable)
S = System documentation analysis
D = Documented evidence
O = Observation
A = Analytical evaluation
E = Empirical evaluation
DM = Different method
M = Measurement
P = Pass (met recommendation)
F = Failed (did not meet recommendation)

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