4 Human Interface

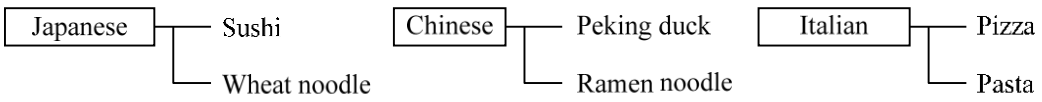
A human interface is the contact point between a human and a system (i.e., computer) or service. Particularly, a user interface that is the contact point between a human and a computer is emphasized in an interactive processing system. In order to create or provide a system or service that is easy for humans to use, it is necessary to have a sufficient understanding of the human interface.

4 - 1 Human Interface Technology

(1) Information architecture

Information architecture is a representation technique that is used to arrange information in an easy-to-search manner and transmit it in an easy-to-understand manner.
The information architecture starts from the task of arranging the information to be transmitted. The procedure of arranging general information is as shown below.

1) Organization of information
   Classify and arrange the information to be transmitted in alphabetical order and category order. For example, when information concerning a restaurant is to be transmitted, it is classified into categories, such as sushi, wheat noodle, Peking duck, ramen noodle, and pizza, pasta. At this time, the collection of the classified information is called a chunk and the name (e.g., sushi, wheat noodle) given to the collection of information is called a label.
2) Structuring of information
   Classify and arrange the organized information in a hierarchical order. For example, classify sushi and wheat noodle as Japanese, Peking duck and ramen noodle as Chinese, and pizza and pasta as Italian (this process is also referred to as “Tagging”).



In order to transmit information that is thus classified and arranged in an easy-to-understand manner, use navigation (mechanism of guiding to the destination). For example, on the Internet, by using a site map in which labels are displayed in a hierarchical order, a quick search for the target information is enabled.

A human interface is the contact point between a human and a system (i.e., computer) or service. In a human interface, consideration is given to the two points below.

(i) Usability

This is the "ease of use" for a user. In ISO 9241-11 (JIS Z 8521), the concept of usability is defined as described below.

[Concept of usability [ISO 9241-11 (JIS Z 8521)]]
Usability is defined as "extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use."

- Effectiveness:
  The accuracy and completeness with which users achieve specified goals
- Efficiency:
  The resources expended in relation to the accuracy and completeness with which users achieve goals
- Satisfaction:
  The freedom from discomfort, and positive attitudes towards the use of the product

(ii) Accessibility

This is the "ease of access" for a user. In ISO/IEC 24786 (JIS X 8341), the following considerations are required as information accessibility.

[Considerations for Information Accessibility [ISO/IEC 24786 (JIS X 8341)]]
Enable elderly and disabled persons to operate information and communications equipment along with software and to use services provided with them, without any obstruction.

ISO 9241-110 (JIS Z 8520) defines seven dialog principles that are necessary for designing an ergonomically desirable interactive system. These seven dialog principles constitute the policy for avoiding poor usability of usage difficulty in a user interface.

[Seven dialog principles [ISO 9241-110 (JIS Z 8520)]]
(1) Suitability for the task
(2) Self-descriptiveness
(5) Controllability
(6) Error tolerance

(2) Human interface

(3) Conformity with user expectations (7) Suitability for individualization

(4) Suitability for learning

Note: The numerical order (1) through (7) does not indicate any priority.

[Interactive system]

Since “interactive” means bidirectional, an interactive system is a system in which information is generally exchanged in both directions.

However, according to ISO 9241-110 (JIS Z 8520) as shown below, an interactive system is used in slightly restricted meaning that is defined in ISO 13407 (JIS Z 8530).

“Combination of hardware and software components that receive input from, and communicate output to, a human user in order to support his or her performance of a task”

When user information is entered in this interactive system, in addition to the use of the keyboard and mouse by the user, an interface that makes use of voice and video is used.

- Natural-language interface

  This is an interface through which humans enter information by using commonly used words (natural language). An example of this interface is a system in which processing progresses in a conversational mode through the use of voice recognition.

- Non-verbal interface

  This is an interface through which information is entered by using expressions and movements rather than words. An example of this interface is a system in which information is entered through the movement of eyes and hands by using image recognition and video recognition. During image recognition and video recognition, feature extraction, in which a pattern expressing the features of the image is extracted, is performed.

For thinking of a human interface, the analysis of user operation with reference to the “Five aspects of the human machine interface” advocated by Professor Yamaoka of Wakayama University is also effective.

[Five aspects of the human machine interface]

(1) Physical aspect

This is the body-related aspect (e.g., the height of the operating panel and the posture during operation).

(2) Information aspect

This is the aspect concerning exchange of information (e.g., the ease-of-understanding and ease-of-viewing information). Examine the information

display method in view of humans performing selective perception in which humans select and accept only interesting information and useful information.

(3) Temporal aspect

This is the aspect concerning time (e.g., the work time and operation reaction time). Learning functions that enable rapid reproduction of the same operation are effective in shortening the work time.

(4) Environmental aspect

This is the aspect concerning environment (e.g., lighting, ambient temperature, and noise).

(5) Organizational aspect

This is the aspect concerning the operations (e.g., manuals).

(3) GUI (Graphical User Interface)

GUI is a technique of improving the usability and accessibility of the system and services through the use of graphics (i.e., pictures). The Window and Icons shown in Figure 2-1 are also an example of GUI tools.

- Window

  It is possible to open several windows on the display and use each window as an independent single display.

- Icon

  An icon indicates a resource and a command (shortcut to each application) through an easy-to-understand figure or pattern. Since an icon can be used simply through selection by moving the arrow on the screen with the help of the mouse, a beginner can easily operate the icon.

- Radio button (Radio box)

  This is used to select only one item from the selection items (i.e., buttons).

- Check box

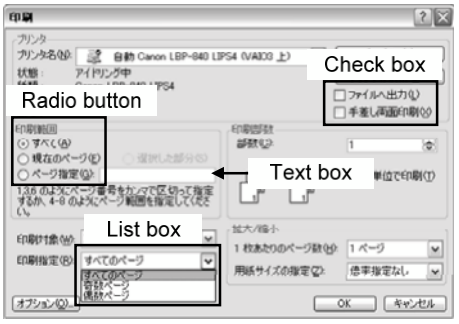
  This is used to select several (i.e., more than one) items simultaneously from the selection items (i.e., buttons).

- List box

  This is used to select only one item from the selection items (i.e., list).

- Text box

  This is used to enter characters.



• Menu bar

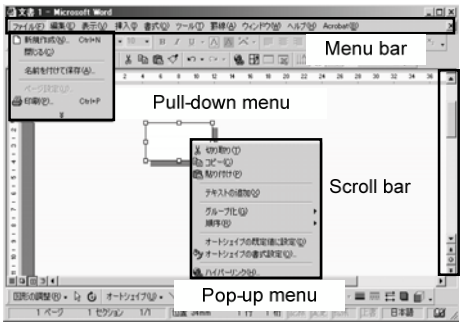
This displays a row of items (i.e., menus) that can be selected by arranging them in line.

• Pull-down menu

When a menu is selected from the menu bar, a more detailed menu that is arranged vertically is displayed.

• Pop-up menu

The menu is displayed as a pop-up by right-clicking at a specific location.



• Scroll bar

This is used to move the display area of the screen.

• Progress bar

This displays the progress status of the processing by using a graphical scale (i.e., length of the bar).

4 - 2 Interface Design

4-2-1 Screen Design and Form Design

(1) Screen design

Screen design refers to designing the content and layout to be displayed on the screen. During the interface design of the screen, the “Shneiderman’s Eight Golden Rules” are used very often.

[Shneiderman’s Eight Golden Rules]

(1) Strive for consistency
(2) Enable frequent users to use shortcuts
(3) Offer informative feedback
(4) Design dialog to yield closure
(5) Offer simple error handling
(6) Permit easy reversal of actions
(7) Support internal locus of control
(8) Reduce short-term memory load

In addition to the “Shneiderman’s Eight Golden Rules,” it is necessary to give consideration

to the screen layout and the information relationship displayed on the screen, in order to perform screen design.

[Points to be considered in screen design]

- Unify the display position of the titles and messages on the screen so as to standardize the screen layout (also standardize how to use the function keys.) ··· (1)
- Standardize the display location of error messages, but do not standardize the content (help to understand the cause of an error and the appropriate coping technique.) ··· (5)
- Arrange the reference items from left to right and from top to bottom. Also pay attention to the format of the original entry sheet, and arrange related items adjacent to each other.
- Enclose the items entered on the screen within blank box or brackets to emphasize the fact that these are input locations.
- Examine the use of the most appropriate GUI tools when data is entered on the screen. In addition to stepwise selection for beginners through the menu, enable direct selection using shortcut keys for skilled persons. ··· (2)
- Display the progress status during processing through a progress bar so as to notify the user about the proper operation of the system. ··· (4)
- Provide the Undo function to enable return to the previous status. ··· (6)

Also, it is necessary to give consideration to foolproof in the design of the input screen and examine the methods for input check of the data. The following are typical methods of an input check:

- Numeric check
  This ensures that data other than numeric values is not entered in numeric value items.
- Limit check
  This makes sure that a numeric value falls within the specified range.
- Format check
  This ensures that the data is in the specified format.
- Duplication check
  This ensures that the same data is not duplicated.
- Matching check
  This collates the data with the master file to ensure that the data is correct.
- Balance check
  This ensures that the separately tabulated totals are consistent with one another.
- Logical check (Validity check)
  This ensures that the data is logically correct.

- Sequence check
  This ensures that the numbers are arranged in a sequence (and no number is missing).
- Combination check
  This ensures that there is no contradiction in the combination of several related items that have been entered.
- Check digit check
  This uses the check character to inspect the input data.

(2) Form design

Form design is used to design the items and layout of the forms (e.g., reports) to be generated from the system. The basic procedure of form design is as follows:

1) Comprehensive consideration
   This process includes comprehensive consideration for the output purpose of the forms, output cycle (time period), output timing, distribution list, output volume (generated amount), and so on.
2) Decision concerning the output method and output medium
   This process decides the most appropriate output method and output medium on the basis of the comprehensive consideration. In addition to paper, writing to CD and screen display are considered as the output media.
3) Creation of output items and form layout
   This process considers the necessary output items and arranges them in an easy-to-understand manner on the forms. At this time, it registers the document model (e.g., borders and ruled lines) in the printer, and also considers the use of form overlay where data is superimposed and printed.

4-2-2 Code Design

In the code design, the data to be coded is selected from the data items used within a system and a code table is created for each target.

[Four functions that a code is required to have]

- Identification function: To enable differentiation of data
- Classification function: To enable classification of data
- Arrangement function: To enable determination of order of data
- Check function: To enable checking whether or not the data is correct (when a redundant bit for inspection is added to the code)

As a principle, a code is mainly composed of numbers and letters. Although double byte characters (e.g., Kanji characters) are effective in enabling an easy understanding of the meaning of codes, they are not appropriate from the viewpoint of retention and maintenance. Typical types of codes are as follows:

- Sequence code

  It is a code that is assigned sequentially from the first item.

  Example: Prefecture code {01: Hokkaido, 02: Aomori prefecture, 03: Iwate prefecture, ⋯}

- Block code (Classification code)

  It is a code that is divided into several blocks, and a serial number is assigned in each block.

  Example: University code
  0** National University {001: Tokyo University, 002: Hitotsubashi University, ⋯}
  1** Public University {101: Tokyo Metropolitan University , 102: Yokohama City University, ⋯}
  2** Private University {201: Meiji University, 202: Keio University, ⋯}

- Group classification code

  It is a code that imparts the meaning of major category, medium category, and minor category to each digit.

  Example: Member number
  First digit: Type (1: Individual member, 2: Corporate member, ⋯)
  Second digit: Course (1: Full time, 2: Daytime, 3: Nighttime, ⋯)
  Third to fifth digit: Registration order number
  Note: “21006” - A corporate member undergoing a full-time course (registration order is the sixth)

- Mnemonic code

  It is a code that uses the name and abbreviation of the data to be coded.

  Example: Product code

JP20CTV: 20-inch color TV made in Japan
FR16MTV: 16-inch monochrome TV made in France

- Synthetic code

  It is a code in which several types of codes are combined together.

During code design, the following points should be considered.

- Scope of the code

  When there is a possibility that the code may be used in a system other than the target system, do not make the code design in view of only the target system. Basically, systems should be able to use the codes commonly. If there is an existing code or standard code, it should be put to use.

- Usage period of the code

  Depending on the usage period of codes, the number of necessary codes may be extremely large. For example, when the product code is designed on the basis of the sequence code and the current number of product types is 800, it is possible to code 1,000 types of products in three-digit numbers, which may not be a problem. However, if as many as 50 types of new products are developed every year, the codes will become insufficient after four years.

- Maintenance of codes

  The maintenance method of codes is also taken into consideration in the code design stage. Particularly, the codes table is decided in consideration of the person in charge of creation and the creation timing so that no contradiction occurs in data.

- Importance of the code

  In the case of a code of important data, it is necessary to add a check digit in order to prevent an input error by the operator.

[Check digit]

Modulus 10 is a typical method of calculating the check digit to be added to a code.

<An example of calculating the check digit>

(1) Multiply each digit of the code "3612" with the weight (5, 4, 3, 2 in an order starting from the left of the code), and then add the result of each multiplication.

$3 \times 5 + 6 \times 4 + 1 \times 3 + 2 \times 2 = 46$

(2) Divide the added result by 10, and use the remainder as the check digit.
(There is another method in which the remainder is further subtracted from 10.)

$46 \div 10 = 4$ Remainder 6 → Code "36126"

Note: If you enter this code erroneously as "36026",

$(3 \times 5 + 6 \times 4 + 0 \times 3 + 2 \times 2 - 6) \div 10 = 3$ Remainder 7

then the remainder does not become 0, which indicates an error in the code.

4-2-3 Human Interface Techniques

(1) Web design

Web design refers to designing of a web page or website used on WWW (World Wide Web), which is a mechanism of transmitting information on the Internet.

(a) Web usability

It is the "ease of use" of a web page or website. The column "Alertbox" by Jakob Nielsen, Ph.D. may be referenced with regard to web usability. In this regard, the following are cited as the five quality components of web usability:

- Learnability: How easy is it for users to accomplish basic tasks the first time they encounter the design?
- Efficiency: Once users have learned the design, how quickly can they perform tasks?
- Memorability: When users return to the design after a period of not using it, how easily can they reestablish proficiency?
- Errors: How many errors do users make, how severe are these errors, and how easily can they recover from the errors?
- Satisfaction: How pleasant is it to use the design?

(b) Web accessibility

It is the “ease of accessing” a web page or website. Concerning web accessibility, W3C (WWW Consortium), which performs standardization of WWW recommends the following WCAG 2.0 (Web Content Accessibility Guidelines 2.0).

[WCAG 2.0 (excerpt)]

Principle 1: Perceivable (Information and user interface components must be presentable to the users in ways they can perceive.)
- 1.1 - Text alternatives
- 1.2 - Time-based Media
- 1.3 - Adaptable
- 1.4 - Distinguishable

Principle 2: Operable (User interface components and navigation must be operable.)
- 2.1 - Keyboard accessible
- 2.2 - Enough time
- 2.3 - Seizures
- 2.4 - Navigable

Principle 3: Understandable (Information and the operation of user interface must be understandable.)
- 3.1 - Readable
- 3.2 - Predictable
- 3.3 - Input assistance

Principle 4: Robust (Content must be robust enough that it can be interpreted reliably by a wide variety of user agents, including assistive technologies.)
- 4.1 - Robust

(c) Style sheet

It is a sheet that defines the document structure of a web page and decorative information (e.g., frame, font size, and line spacing) of a document. A web page is created by using HTML (HyperText Markup Language: Descriptive language for the web page). CSS (Cascading Style Sheets) are style sheets that can define the layout of a web page independent of HTML. By using a style sheet, it is possible to create a standardized website by only providing the information to be put up on the web page through a predetermined procedure. Although CSS is interpreted at the browser side, the operation may differ depending on the browser even for the same code. Therefore, a cross browser and progressive enhancement are used.

- Frame

  It is a presentation technique that the web page to be displayed is divided into several parts. It also represents decorative designs such as ornamental lines and ruled lines that are added to each frame.
- Cross browser

It is a technique of eliminating differences in operation depending on browser specifications so that the website and web applications operate normally. By performing a different process in each browser, the execution of a different operation by the same code is avoided.

- Progressive enhancement

  It is a concept of web design that the basic information is transmitted regardless of the PC environment, and an attempt is made to provide a rich experience to users who are using a high-function browser. It emphasizes the fact that information is transmitted accurately regardless of the browsing environment (i.e., browser), on the basis of a three-layer structure including "a logical structure that the text content is transmitted with authenticity," "visual design control," and "site behavior control."

(d) Navigation

Navigation in a website refers to a mechanism that enables fast and accurate access to the desired information (i.e., web page) on the site. The typical navigation used in a website includes the following:

- Site map

  It is a mechanism that enables fast search of the desired information by hierarchically displaying the labels added for understanding the information of web pages.

- In-site search

  It is a function that displays the relevant web page or the location within a web page when the search keyword is entered. It includes the full text search that targets the entire text and the index search that searches for the registered keyword.

(2) Human-centered design

Human-centered design is an approach to interactive system development that focuses specifically on making systems usable. It is established as ISO 13407 and translated as JIS Z 8530 (In 2010, IS0 13407 was integrated into ISO 9241 as ISO 9241-210.)

In ISO 13407 (JIS Z 8530), four characteristics are provided as the principles of human-centered design.

[Principles of human-centered design]

a) The active involvement of users and a clear understanding of user and task requirements
b) An appropriate allocation of function between users and technology
c) Iteration of design solutions
d) Multi-disciplinary design

Moreover, four processes are cited as human-centered design activities based on these principles. As shown in Figure 2-13, it is desirable that these human-centered design activities (i.e., processes) be started from an early stage of information processing system development and executed repeatedly until the requirements are fulfilled.

[Human-centered design activities]

a) Understand and specify the context of use
b) Specify the requirements of users and organizations
c) Produce design solutions
d) Evaluate designs against requirements

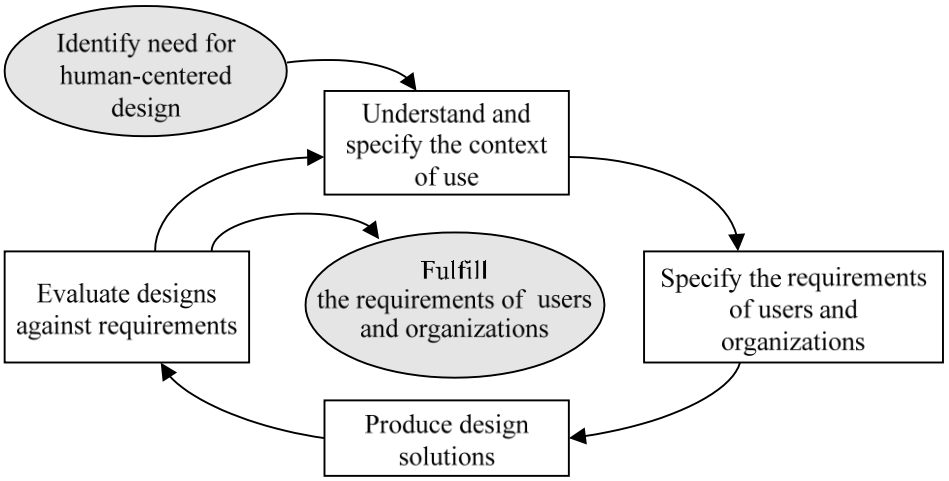


Figure 2-13 Interdependence of human-centered design activities

(3) Universal design

A universal design refers to a design that provides comfortable and easy-to-use environments and services to all persons regardless of the existence of differences in the age, culture, ability, and disabilities. The “Seven Principles of Universal Design” proposed by Dr. Ron Mace are frequently used to achieve universal designs.

[Seven principles of universal design]

(1) Equitable use: The design is useful and marketable to people with diverse abilities.
(2) Flexibility in use: The design accommodates a wide range of individual preferences and abilities.
(3) Simple and intuitive use: Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.
(4) Perceptible information: The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
(5) Tolerance for error: The design minimizes hazards and the adverse consequences of accidental or unintended actions.
(6) Low physical effort: The design can be used efficiently and comfortably and with a minimum of fatigue.
(7) Size and space for approach and use: Appropriate size and space is provided for approach, reach, manipulation, and use, regardless of user's body size, posture, or mobility.

Moreover, there are some more policies of universal design. WCAG 1.0 (1995) and WCAG 2.0 (2008) are compiled as guidelines for enabling access (i.e., setting in a high accessibility status) to web content particularly for persons with disabilities by an internal organization of W3C, WAI (Web Accessibility Initiative). WAI-ARIA (Web Accessibility Initiative-Accessible Rich Internet Applications) is also provided as specifications for accessibility of dynamic web content using video and sound.

The universal design is used to pursue not just ease-of-use (i.e., usability) but also ease-of-access (i.e., accessibility) by any person. For example, mechanisms are prepared for changing the font size and color for visually impaired people and enabling voice input for persons who cannot use the mouse because of being unable to use their hands.
Although the universal design is meant for all persons, there is another concept called information barrier free that targets elderly persons and persons with disabilities. While universal design is a concept that an obstacle-free environment is designed or provided right from the beginning, information barrier free is a concept that an information communication environment that does not have (is free of) any obstacles is provided by eliminating the obstructions (i.e., barriers) for elderly persons or persons with disabilities. The concept of information barrier free is stipulated in JIS X 8341 (Guidelines for elderly persons and persons with disabilities — Information and communications equipment, software, and services —).

4-2-4 Usability Evaluation

Usability evaluation refers to evaluation of the usability (i.e., ease-of-use) of a system and website that is created (or developed) on the basis of the human interface design.

(1) Qualitative evaluation

The qualitative evaluation in usability evaluation refers to the technical evaluation of the system and website interface. It is mainly implemented for the purpose of evaluating the "effectiveness" and "efficiency" of usability.

[Methods of qualitative evaluation]

- Usability test (user test)
  It is a method that a usability engineer assigns a task to a subject (i.e., user) and detects the problems of the user interface from the actions and speech of the subject during the course of the execution of the task. When a website is evaluated, a log data analysis method (access log analysis) that the access log (e.g., record of web page access information) is studied in order to analyze how the web page has transitioned is also used in combination.
- Heuristic evaluation
  It is a method that members, such as usability engineers and designers with abundant technical knowledge and experience, are gathered, and the user interface is evaluated on the basis of the existing empirical rules (i.e., heuristics). In this way, the problems are brought to light. It is one of the expert reviews (i.e., review by an expert) in which the opinion of the user is not reflected.

(2) Quantitative evaluation

The quantitative evaluation in usability evaluation refers to the method that the system and website are compared with others and evaluated relatively. It is mainly implemented for the purpose of evaluating the "satisfaction level of the user."

[Method of quantitative evaluation]

- Questionnaire survey/Interview method

  It is a method that the opinion of users who are using a system and website is collected through a questionnaire for several unspecified persons and face-to-face interviews. This makes it easier to collect information about dissatisfaction of the user that is compared with other systems and websites.