User interface

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In the industrial design field of human–machine interaction, the **user interface** is the space where interaction between humans and machines occurs. The goal of interaction between a human and a machine at the user interface is effective operation and control of the machine, and feedback from the machine which aids the operator in making operational decisions. Examples of this broad concept of user interfaces include the interactive aspects of computer operating systems, hand tools, heavy machinery operator controls, and process controls. The design considerations applicable when creating user interfaces are related to or involve such disciplines as ergonomics and psychology.

A user interface is the system by which people (users) interact with a machine. The user interface includes hardware (physical) and software (logical) components. User interfaces exist for various systems, and provide a means of:

- Input, allowing the users to manipulate a system, and/or
- Output, allowing the system to indicate the effects of the users' manipulation.

Generally, the goal of human-machine interaction engineering is to produce a user interface which makes it easy, efficient, and enjoyable to operate a machine in the way which produces the desired result. This generally means that the operator needs to provide minimal input to achieve the desired output, and also that the machine minimizes undesired outputs to the human.

Ever since the increased use of personal computers and the relative decline in societal awareness of heavy machinery, the term user interface has taken on overtones of the (graphical) user interface, while industrial control panel and machinery control design discussions more commonly refer to human-machine interfaces.

Other terms for user interface include "human–computer interface" (HCI) and "man–machine interface" (MMI).

Contents

Introduction

To work with a system, users have to be able to control and assess the state of the system. For example, when driving an automobile, the driver uses the steering wheel to control the direction of the vehicle, and the accelerator pedal, brake pedal and gearstick to control the speed of the vehicle. The driver perceives the position of the vehicle by looking through the windshield and exact speed of the vehicle by reading the

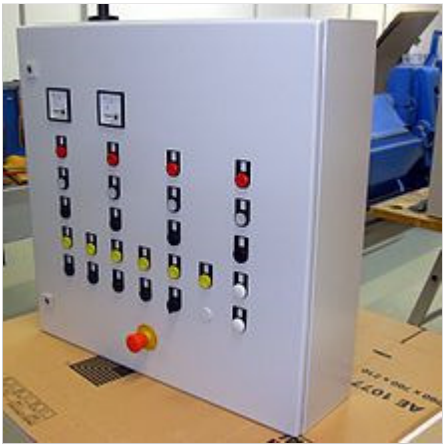
speedometer. The *user interface of the automobile* is on the whole composed of the instruments the driver can use to accomplish the tasks of driving and maintaining the automobile.

Terminology

There is a difference between a user interface and an operator interface or a human–machine interface.

- The term "user interface" is often used in the context of (personal) computer systems and electronic devices
  - Where a network of equipment or computers are interlinked through an MES (Manufacturing Execution System)-or Host.
  - An HMI is typically local to one machine or piece of equipment, and is the interface method between the human and the equipment/machine. An Operator interface is the interface method by which multiple equipment that are linked by a host control system is accessed or controlled.
  - The system may expose several user interfaces to serve different kinds of users. For example, a computerized library database might provide two user interfaces, one for library patrons (limited set of functions, optimized for ease of use) and the other for library personnel (wide set of functions, optimized for efficiency).

- The user interface of a mechanical system, a vehicle or an industrial installation is sometimes referred to as the human–machine interface (HMI). HMI is a modification of the original term MMI (man-machine interface). In practice, the abbreviation MMI is still frequently used although some may claim that MMI stands for something different now. Another abbreviation is HCI, but is more commonly used for human-computer interaction. Other terms used are operator interface console (OIC) and operator interface terminal (OIT). However it is abbreviated, the terms refer to the 'layer' that separates a human that is operating a machine from the machine itself.



HMI of a machine for the sugar industry with pushbuttons

In science fiction, HMI is sometimes used to refer to what is better described as direct neural interface. However, this latter usage is seeing increasing application in the real-life use of (medical) prostheses—the artificial extension that replaces a missing body part (e.g., cochlear implants).

In some circumstance computers might observe the user, and react according to their actions without specific commands. A means of tracking parts of the body is required, and sensors noting the position of the head, direction of gaze and so on have been used experimentally. This is particularly relevant to immersive interfaces.

Usability

> *Main article: Usability*
>
> *See also: mental model, human action cycle, usability testing, and ergonomics*. List of human-computer interaction topics

User interfaces are considered by some authors to be a prime ingredient of Computer user satisfaction.

The design of a user interface affects the amount of effort the user must expend to provide input for the system and to interpret the output of the system, and how much effort it takes to learn how to do this. Usability is the degree to which the design of a particular user interface takes into account the human

psychology and physiology of the users, and makes the process of using the system effective, efficient and satisfying.

Usability is mainly a characteristic of the user interface, but is also associated with the functionalities of the product and the process to design it. It describes how well a product can be used for its intended purpose by its target users with efficiency, effectiveness, and satisfaction, also taking into account the requirements from its context of use.

User interfaces in computing

In computer science and human-computer interaction, the *user interface (of a computer program)* refers to the graphical, textual and auditory information the program presents to the user, and the control sequences (such as keystrokes with the computer keyboard, movements of the computer mouse, and selections with the touchscreen) the user employs to control the program.

Types

Currently (as of 2009) the following types of user interface are the most common:

- **Graphical user interfaces** (GUI) accept input via devices such as computer keyboard and mouse and provide articulated graphical output on the computer monitor. There are at least two different principles widely used in GUI design: Object-oriented user interfaces (OOUIs) and application oriented interfaces.
- **Web-based user interfaces** or **web user interfaces** (WUI) are a subclass of GUIs that accept input and provide output by generating web pages which are transmitted via the Internet and viewed by the user using a web browser program. Newer implementations utilize Java, AJAX, Adobe Flex, Microsoft .NET, or similar technologies to provide real-time control in a separate program, eliminating the need to refresh a traditional HTML based web browser. Administrative web interfaces for web-servers, servers and networked computers are often called control panels.
- **Touchscreens** are displays that accept input by touch of fingers or a stylus. Used in a growing amount of mobile devices and many types of point of sale, industrial processes and machines, self-service machines etc.

User interfaces that are common in various fields outside desktop computing:

- **Command line interfaces**, where the user provides the input by typing a command string with the computer keyboard and the system provides output by printing text on the computer monitor. Used by programmers and system administrators, in engineering and scientific environments, and by technically advanced personal computer users.

- **Touch user interface** are graphical user interfaces using a touchpad or touchscreen display as a combined input and output device. They supplement or replace other forms of output with haptic feedback methods. Used in computerized simulators etc.

Other types of user interfaces:

- **Attentive user interfaces** manage the user attention deciding when to interrupt the user, the kind of warnings, and the level of detail of the messages presented to the user.
- **Batch interfaces** are non-interactive user interfaces, where the user specifies all the details of the *batch job* in advance to batch processing, and receives the output when all the processing is done. The computer does not prompt for further input after the processing has started.
- **Conversational Interface Agents** attempt to personify the computer interface in the form of an animated person, robot, or other character (such as Microsoft's Clippy the paperclip), and present interactions in a conversational form.

- **Crossing-based interfaces** are graphical user interfaces in which the primary task consists in crossing boundaries instead of pointing.
- **Gesture interface** are graphical user interfaces which accept input in a form of hand gestures, or mouse gestures sketched with a computer mouse or a stylus.
- **Intelligent user interfaces** are human-machine interfaces that aim to improve the efficiency, effectiveness, and naturalness of human-machine interaction by representing, reasoning, and acting on models of the user, domain, task, discourse, and media (e.g., graphics, natural language, gesture).
- **Motion tracking interfaces** monitor the user's body motions and translate them into commands, currently being developed by Apple[1]
- **Multi-screen interfaces**, employ multiple displays to provide a more flexible interaction. This is often employed in computer game interaction in both the commercial arcades and more recently the handheld markets.
- **Noncommand user interfaces**, which observe the user to infer his / her needs and intentions, without requiring that he / she formulate explicit commands.
- **Object-oriented user interface (OOUI)**
- **Reflexive user interfaces** where the users control and redefine the entire system via the user interface alone, for instance to change its command verbs. Typically this is only possible with very rich graphic user interfaces.
- **Tangible user interfaces**, which place a greater emphasis on touch and physical environment or its element.
- **Task-Focused Interfaces** are user interfaces which address the information overload problem of the desktop metaphor by making tasks, not files, the primary unit of interaction
- **Text user interfaces** are user interfaces which output text, but accept other form of input in addition to or in place of typed command strings.
- **Voice user interfaces**, which accept input and provide output by generating voice prompts. The user input is made by pressing keys or buttons, or responding verbally to the interface.
- **Natural-Language interfaces** - Used for search engines and on webpages. User types in a question and waits for a response.
- **Zero-Input interfaces** get inputs from a set of sensors instead of querying the user with input dialogs.
- **Zooming user interfaces** are graphical user interfaces in which information objects are represented at different levels of scale and detail, and where the user can change the scale of the viewed area in order to show more detail.

See also:

- Archy, a keyboard-driven modeless user interface by Jef Raskin, arguably more efficient than mouse-driven user interfaces for document editing and programming.

History

The history of user interfaces can be divided into the following phases according to the dominant type of user interface:

- Batch interface, 1945–1968
- Command-line user interface, 1969 to present[*citation needed*]
- Graphical user interface, 1981 to present — see History of the GUI for a detailed look[*citation needed*]

Consistency

A key property of a good user interface is consistency. Good user interface design is about getting a user to have a consistent set of expectations, and then meeting those expectations. Consistency can be bad if not used for a purpose and when it serves no benefit for the end user, though.[2]

There are three important aspects to consistency.[3]

First, the controls for different features should be presented in a consistent manner so that users can find the controls easily.[*citation needed*] For example, users find it difficult to use software when some commands are available through menus, some through icons, some through right-clicks, some under a separate button at one corner of a screen, some grouped by function, some grouped by "common," some grouped by "advanced." A user looking for a command should have a consistent search strategy for finding it. The more search strategies a user has to use, the more frustrating the search will be. The more consistent the grouping, the easier the search.

Second, the "principle of least astonishment" is crucial.[*citation needed*] Various features should work in similar ways.[4] For example, some features in Adobe Acrobat are "select tool, then select text to which apply." Others are "select text, then apply action to selection." [2] (http://help.adobe.com/en_US/Acrobat /8.0/Professional/gs.pdf) . Commands should work the same way in all contexts.

Third, consistency counsels against user interface changes version-to-version.[*citation needed*] Change should be minimized, and forward-compatibility should be maintained. For example, the change from the menu bars of Microsoft Office 2003 to the ribbon toolbar of Microsoft Office 2007 caused mixed reactions to the redesign, intended to enhance access to the most used functions.[5] [6][7]

Consistency is one quality to trade off in user interface design—not the only thing, but one of the most important. In some cases, a violation of consistency principles can provide sufficiently clear advantages that a wise and careful user interface designer may choose to violate consistency to achieve some other important goal. Generally, less mature software has fewer users who are entrenched in the status quo. Older, more broadly used software must more carefully hew to the status quo to avoid disruptive costs. The most experienced users, and the ones who derive most value from a program, are the users who tend to bear the greatest costs from change. However, of those trade-offs, consistency is one of the most important core principles, and it should be violated least often. Bad user interface design, and poorly implemented changes to an existing user interface, can impose staggering costs on users.

Modalities and modes

Main articles: Modality (human-computer interaction) and Mode (computer interface)

Two words are used in UI design to describe different ways in which a user can utilize a product. *Modality* refers to several alternate interfaces to the same product, while *mode* describes different states of the same interface.

A modality is a path of communication employed by the user interface to carry input and output. Examples of modalities:

- Input — computer keyboard allows the user to enter typed text, digitizing tablet allows the user to create free-form drawing
- Output — computer monitor allows the system to display text and graphics (*vision modality*), loudspeaker allows the system to produce sound (*auditory modality*)

The user interface may employ several redundant input modalities and output modalities, allowing the user to choose which ones to use for interaction.

A mode is a distinct method of operation within a computer program, in which the same input can produce different perceived results depending of the state of the computer program. For example, caps lock sets an input mode in which typed letters are uppercase by default; the same typing produces lowercase letters when not in caps lock mode. Heavy use of modes often reduces the usability of a user interface, as the user must expend effort to remember current mode states, and switch between mode states as necessary.

See also

- Accessibility and computer accessibility — user interface's suitability for people with special needs
- Adaptive user interfaces
- Brain-computer interface
- Computer user satisfaction
- Ergonomics and human factors — the study of designing objects to be better adapted to the shape of the human body
- Framebuffer
- Graphical User Interface
- Human-computer interaction links
- Icon design
- Information architecture — organizing, naming, and labelling information strctures
- Information visualization — the use of sensory representations of abstract data to reinforce cognition
- Interaction technique
- Interaction design
- Interface (computer science)
- Kinetic user interface
- Knowledge visualization — the use of visual representations to transfer knowledge
- List of user interface literature
- Natural user interfaces
- Ncurses, a semigraphical user interface.
- Unified Code for Units of Measure
- Usability links
- User Assistance
- User experience
- User experience design
- User interface design
- Virtual artifact
- Virtual user interface

References

1. ^ Appleinsider.com (http://www.appleinsider.com/articles/09/06/18/apple_exploring_motion_tracking_mac_os_x_user_interface.html)
2. ^ "How to avoid foolish consistency" (http://www.scottberkun.com/essays/5-how-to-avoid-foolish-consistency) . http://www.scottberkun.com/essays/5-how-to-avoid-foolish-consistency. "Making things look and work the same is pointless if the user can no longer accomplish their tasks. Rank making things useful above making them consistent"
3. ^ David E. Boundy, A taxonomy of programmers, ACM SIGSOFT Software Engineering Notes 16(4) 23-30 (October 1991)
4. ^ For example, inconsistent user interface was one of the major causes of the Three Mile Island nuclear accident in 1979. Some indicator lights indicated normal as red, some as green. [1] (http://www.iem-inc.com/TMI.pdf)
5. ^ It was said to cause "anger and frustration," and "major efforts in time, training and costs." “For one thing, Word 2007 uses the entirely new ribbon interface. … ‘People will get used to the new interface, but at major efforts in time, training and cost,' says [a] director of systems … When it came time to move [a user] from 2003 to 2007… ‘I might as well of hit her over the head with a bat,’ he says. ‘I could see anger and frustration.’” Power users said it "takes too much time and patience to learn" the new interface. Word 2007: Not Exactly a Must-Have (http://redmondmag.com/features/article.asp?editorialsid=2346)
6. ^ An online survey by an Excel user group reports that about 80% of respondents had a negative opinion of the change, and within that 80%, the self-estimated reduction in productivity was "about 35%"."Ribbon survey results" (http://www.exceluser.com/explore/surveys/ribbon/ribbon-survey-results.htm) . http://www.exceluser.com/explore/surveys/ribbon/ribbon-survey-results.htm. Among advanced users, nearly 80% "dislike" or "hate" the new interface, only 20% "like" or "love" it, and of that 80%, the average productivity loss is about 35%.

7. ^ On the other hand, average and less-intensive users who are not as dependent on old user interfaces are less bothered by the change. "'Other readers feel it's worth taking the time to learn the new interface. Once you do, they say, it actually makes creating professional-looking documents much easier for the average user.'" Word 2007: Not Exactly a Must-Have (http://redmondmag.com/features/article.asp?editorialsid=2346) The usual solution in providing a new user interface is to provide a backwards-compatibility mode, so that a product's most intensive users are not forced to bear the costs of the change.

External links

- Its bibliography (http://www.interaction-design.org/references/conferences/) covers a wide area of user interface publications
- Chapter 2. History: A brief History of user interfaces (http://www.catb.org/~esr/writings/taouu/html/ch02.html)

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