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INTERFACES AND PSYCHOLOGICAL THEORY

The human-computer interface is a communications channel between the user and the computer. The interface includes both physical and conceptual components. PHYSICAL COMPONENTS include input devices such as keyboards, mice, touch panels, joy sticks, speech recognizers, eye trackers, and data gloves; and output devices such as visual displays and sound or speech synthesizers. CONCEPTUAL COMPONENTS include selection methods such as command languages, menus, or direct manipulation; and representation schemes such as screen layout and graphic/text mixes.

The field of human-computer interaction (HCI) is concerned with interface design and is highly interdisciplinary in nature. It involves researchers from psychology, computer science, information science, engineering, education, and communications. A central concern of HCI research is to determine the effects of human physical, cognitive, and affective characteristics on the interactions between users and computers for specific tasks. Thus, HCI researchers develop models of human activity and use these models in designing new interfaces.

The INFORMATION PROCESSING MODEL OF COGNITION prevalent in cognitive psychology provides a foundation for interface design. This model establishes that: (1) humans have a working memory limited to five to seven "chunks" of information; (2) humans must have their attention refreshed frequently; and (3) RECALLING information requires more cognitive effort than RECOGNIZING information. Computer interface styles consistent with this model include menus, query-by-example, and direct manipulation. Novices and casual users prefer menus to command languages because recognizing an appropriate option is easier than remembering a command. Direct manipulation interfaces (such as touch panels in information kiosks or input devices and graphic displays in most video games) overcome many psychological limitations because they share the "load" between physical and cognitive activity. In addition, their immediate feedback and easily reversibility invite user exploration.

The psychological theory of mental models has also been applied to interface design. Humans develop internal representations (mental models) for objects, events, and ideas. These mental models are active, called into play to explain the world and to predict which actions to take. Mental models are incomplete and often inaccurate, but they help people deal with the world on a daily basis. Users develop mental models for computer systems, and HCI researchers believe that the interface is the basis for the mental models that users develop. Designers are thus concerned with ways to assist users in quickly developing accurate and useful mental models for their systems.

A common approach is to define a metaphor that links existing user knowledge to system function. The desktop metaphor is perhaps the best known example, although more fundamental metaphors such as the screen as a scroll of paper or online interaction as human-to-human dialogue have had earlier and wider impact. Metaphors are useful, but they can also constrain the user's view of the unique aspects of a system. In effect, concern with ease of learning can eventually interfere with skilled use. HCI researchers have proposed a variety of solutions to the learning-using tension, including: minimal manuals, incremental learning through online help, and progressive disclosure of system features and capability. The most general solution is to develop interfaces that adapt to the users' abilities and needs. In addition to the many technical challenges such interfaces offer, there is a philosophical debate over whether the interface should adapt to the user automatically or only through specific user control.

PRINCIPLES FOR INTERFACE DESIGN

Psychological research has led to a number of design principles:

- (1) The interface should compensate for human physical and cognitive limitations whenever possible. However, the interface should be "transparent," not getting in the way of the user's actions or impeding his or her progress. The interface itself should not overload the user with complexity or unnecessary "bells and whistles" that interfere with or distract from the task at hand.

- (2) The physical components of the interface should be ergonomically designed, taking into account the comfort and health of the user as well as his or her special needs and characteristics. For example, a touch panel design for a word processing program demands far too much arm movement for lengthy sessions, but serves quite nicely in an information kiosk of a shopping mall when positioned to be touchable by users of various heights.

- (3) The interface should be consistent. For example, selection methods, positioning of important text and buttons, text fonts and styles, and window layout and management should be consistent in all parts of an interface.

- (4) Non-command interaction styles such as direct manipulation and menus are preferable to command languages, although the expert user should be given "type ahead" capability to quickly move through layers of menus.

- (5) The interface should handle errors by providing simple and concise error messages that assist the user in recovery and future avoidance.

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(6) The interface should support reversible actions (e.g., the UNDO capability in many systems).

(7) The interface should be subjected to usability testing early in the design process and as each iteration of the product evolves.

Perhaps the most basic principle is that the interface should be designed around the needs of the user rather than added on after a system has been completed, thus serving the constraints imposed by the system. This principle is sometimes expressed by the admonition to "know your user!"

TRENDS IN INTERFACE DESIGN

Computer systems are becoming increasingly interactive, and this trend will continue as new interfaces are developed. Interactivity will be supported by new input and output (I/O) devices that take fuller advantage of the many communication channels humans employ. For example, some of the devices that are under active investigation in HCI laboratories include:

*voice I/O

*pen-based input devices (handwriting, drawing)

*remote sensing devices that focus on personal transmitters (e.g., on finger rings) or that monitor physiological activity

*personal display monitors a few centimeters square

*three-dimensional displays

*eye tracking devices

*motion detectors, and

*lip reading systems.

Perhaps more significant than the many different types of I/O devices is the development of interfaces that support multiple I/O devices in parallel. Interface that accept voice and gesture concurrently will give richer control to users who must move about while controlling systems and make possible a variety of virtual reality applications. Likewise, video and sound output together provide a more powerful communication channel for information flow.

In addition to advances in physical interface components, there is active research in conceptual components such as interaction styles. Direct manipulation interfaces will continue to emerge and more robust adaptive systems will be developed that change according to the type of task and user experience level. Intelligent agents are also under development. Agents can be assigned specific tasks by the user and then sent out to execute those tasks. The next metaphor of the computer world may be the theatre or command center, where directors assign roles to software agents and examine the results of their subsequent performances.

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