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Introduction to Human Computer Interaction

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Abstract: ***Human-computer interaction (HCI) is the study of how people design, implement, and use interactive computer systems and how computers affect individuals, organizations, and society. This encompasses not only ease of use but also new interaction techniques for supporting user tasks, providing better access to information, and creating more powerful forms of communication. It involves input and output devices and the interaction techniques that use them; how information is presented and requested; how the computer's actions are controlled and monitored; all forms of help, documentation, and training; the tools used to design, build, test, and evaluate user interfaces; and the processes that developers follow when creating Interfaces. HCI in the large is an interdisciplinary area. It is emerging as a specialty concern within several disciplines, each with different emphases: computer science (application design and engineering of human interfaces), psychology (the application of theories of cognitive processes and the empirical analysis of user behavior), sociology and anthropology (interactions between technology, work, and organization), and industrial design (interactive products).***

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1. Introduction

Research in Human-Computer Interaction (HCI) has been spectacularly successful, and has fundamentally changed computing. Just one example is the ubiquitous graphical interface used by Microsoft Windows 95, which is based on the Macintosh, which is based on work at Xerox PARC, which in turn is based on early research at the Stanford Research Laboratory (now SRI) and at the Massachusetts Institute of Technology. Another example is that virtually all software written today employs user interface toolkits and interface builders, concepts that were developed first at universities. Even the spectacular growth of the World-Wide Web is a direct result of HCI research: applying hypertext technology to browsers allows one to traverse a link across the world with a click of the mouse. Interface improvements more than anything else has triggered this explosive growth. Furthermore, the research that will lead to the user interfaces for the computers of tomorrow is happening at universities and a few corporate research labs.

The most famous definition of "Human Computer Interaction" is "Human-computer interaction is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them."

The Human Computer Interaction (HCI) program will play a leading role in the creation of tomorrow's exciting new user interface software and technology, by supporting the broad spectrum of fundamental research that will ultimately transform the human-computer interaction experience so the computer is no longer a distracting focus of attention but rather an invisible tool that empowers the individual user and facilitates natural and productive human-human collaboration.

Computer

A computer system comprises various elements, each of which affects the user of the system. Input devices for interactive use, allowing text entry, drawing and selection from the screen:

- Text entry: traditional keyboard, phone text entry, speech and handwriting
- Pointing: principally the mouse, but also touch pad, stylus, and others
- 3D interaction devices

Output display devices for interactive use:

- Different types of screen mostly using some form of bitmap display
- Large displays and situated displays for shared and public use
- Digital paper may be usable in the near future

Memory:

- Short-term memory: RAM
- Long-term memory: magnetic and optical disks
- Capacity limitations related to document and video storage
- Access methods as they limit or help the user

Processing:

- The effects when systems run too slow or too fast, the myth of the infinitely fast machine
- Limitations on processing speed
- Networks and their impact on system performance

Instead of workstations, computers may be in the form of embedded computational machines, such as parts of spacecraft cockpits or microwave ovens. Because the techniques for designing these interfaces bear so much relationship to the techniques for designing workstations interfaces, they can be profitably treated together. But if we weaken the computational and interaction aspects more and treat the design of machines that are mechanical and passive, such as the design of a hammer, we are clearly on the margins, and generally the relationships between humans and hammers would not considered part of human-computer interaction. Such relationships clearly would be part of general human factors, which studies the human aspects of all designed devices, but not the mechanisms of these devices. Human-computer interaction, by contrast, studies

both the mechanism side and the human side, but of a narrower class of devices.

Human
Humans are limited in their capacity to process information. This has important implications for design. Information is received and responses given via a number of input and output channels:

- Visual channel
- Auditory channel
- Haptic channel
- Movement

Information is stored in memory:

- Sensory memory
- Short-term (working) memory
- Long-term memory Information is processed and applied:
- Reasoning
- Problem solving
- Skill acquisition
- Error

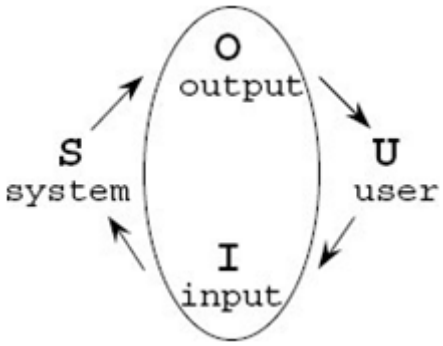
Emotion influences human capabilities.

Users share common capabilities but are individuals with differences, which should not be ignored.

If we allow the human to be a group of humans or an organization, we may consider interfaces for distributed systems, computer-aided communications between humans, or the nature of the work being cooperatively performed by means of the system. These are all generally regarded as important topics central within the sphere of human-computer interaction studies.

Interaction
The communication between the user and the system. Their interaction framework has four parts:

- User
- Input
- System
- Output



- Interaction models help us to understand what is going on in the interaction between user and system. They address the translations between what the user wants and what the system does.
- Ergonomics looks at the physical characteristics of the interaction and how these influence its effectiveness.
- The dialog between user and system is influenced by the style of the interface.
- The interaction takes place within a social and organizational context that affects both user and system.

Human-computer interaction is concerned with the joint performance of tasks by humans and machines; the structure of communication between human and machine; human capabilities to use machines (including the learnability of interfaces); algorithms and programming of the interface itself; engineering concerns that arise in designing and building interfaces; the process of specification, design, and implementation of interfaces; and design trade-offs. Human-computer interaction thus has science, engineering, and design aspects.

Goals
The goals of HCI are to produce usable and safe system, as well as functional systems. In order to produce computer system with good usability, developer must attempt to:

- **Understand** the factors that determines how people use technology
- **Develop tools** and technique to enable building suitable system
- **Achieve** efficient, effective and safe interaction
- **Put people first**

Human-computer interaction arose as a field from intertwined roots in computer graphics, operating systems, human factors, ergonomics, industrial engineering, cognitive psychology, and the systems part of computer science. Compute graphics was born from the use of CRT and pen devices very early in the history of computers. This led to the development of several human-computer interaction techniques.

Work on operating systems, meanwhile, developed techniques for interfacing input/output devices, for tuning system response time to human interaction times, for multiprocessing, and for supporting windowing environments and animation. This trends of development has currently given rise to "user interface management systems" and "user interface toolkits".

Cognitive Science is generally described as the interdisciplinary study of the acquisition and use of knowledge by an information processing system. All the fields that are involved in Cognitive Science share an interest in the mind. The five primary fields include: Psychology, Linguistics, Computer Science, Neuroscience, and Philosophy. Additional disciplines of study, such as Anthropology and Social Psychology, are also participating in Cognitive Science as they, too, research and develop formal structures and processes to represent the complex human system as it receives, stores, retrieves, transforms, and transmits information.

Cognition
Cognition is the processing of information from the world around us. It includes perception, attention, pattern matching, memory, language processing, decision making, and problem solving. Cognitive load is the amount of mental resources needed to perform a given task.

All user interfaces make cognitive demands on users. Users

must master special rules of system use, learn new concepts, and retain information in short-term memory. They must create and refine a mental model of how the system works and how they should use it. Systems that use purely auditory interfaces further challenge human memory and attention because they present information serially and non-persistently.

Successful user interface designs must respect the limitations of human cognitive processing. If a design requires the user to hold too many items in short-term memory or to learn a complex set of commands too quickly, it will fail.

There are three cognitive challenges you should consider as your design progresses:

- Conceptual complexity: How complex are the new concepts callers must learn? How well do new mental structures match concepts and procedures that users are already familiar with?
- Memory load: How much information must callers hold in their short-term memory? How much new material (e. g., commands, procedures) must they learn?
- Attention: Is it easy for the caller to attend to the most salient information? Will callers' attention be divided? If they are momentarily distracted (e. g., while driving), can they seamlessly continue their interaction with the system when they are ready?

Cognitive Frameworks

Cognition is the process by which we gain knowledge. The processes, which contribute to cognition, include:

- Understanding
- Remembering
- Reasoning
- Attending
- Being aware
- Acquiring skills
- Creating new ideas

A key aim of HCI is to understand how humans interact with computers, and to represent how knowledge is passed between the two.

The basis for this aspect of HCI is the science of cognitive psychology. The results of work of cognitive psychologists provide many lessons, which can be applied in the design of computer interfaces. These results are expressed in the form of cognitive frameworks. This section describes some of the important frameworks, which have been developed by psychologists.

Human Information Processing

HCI is fundamentally an information-processing task. The human information processing approach is based on the idea that human performance, from displayed information to a response, is a function of several processing stages. The nature of these stages, how they are arranged, and the factors that influence how quickly and accurately a particular stage operates, can be discovered through appropriate research methods.

Human information processing analyses are used in HCI in several ways.

- Basic facts and theories about information-processing capabilities are taken into consideration when designing interfaces and tasks
- Information-processing methods are used in HCI to conduct empirical studies evaluating the cognitive requirements of various tasks in which a human uses a computer
- Computational models developed in HCI are intended to characterize the information processing of a user interacting with a computer, and to predict, or model, human performance with alternative interfaces.

The Multi-Store Model of Memory

A model of memory formed of three ' buffers', which will store memories and control processes, which move information between the buffers. The three stores identified are:

- Sensory information store
- Short-term memory (more recently known as working memory)
- Long-term memory

The Model Human Processor

An important concept from cognitive psychology is the model human processor (MHP). This describes the cognitive process that people go through between perception and action. It is important to the study of HCI because cognitive processing can have a significant effect on performance, including task completion time, number of errors, and ease of use. This model was based on the human information-processing model.

The model human processor consists of three interacting systems. Each has its own memory and processor.

Perceptual processor

- Outputs into audio storage
- Outputs into visual storage Cognitive processor
- Outputs into working memory.
- Has access to:
  - Working memory
  - Long term memory

Motor processor

Carries out actions Distributed Cognition

Distributed cognition is a framework proposed by Hutchins (1991). Its basis is that to explain human behavior you have to look beyond the individual human and the individual task. The functional system is a collection of actors, technology, setting and the interrelations to one another. Examples of functional systems, which have been studied include:

- Ship Navigation
- Air Traffic Control
- Computer Programming Teams

The technique is used to analyze coordination of components in the functional system. It looks at

- Information and how it propagates through the system
- How it transforms between the different representational

states found in the functional system

User Interaction Design

Interaction design is about creating interventions in often complex situations using technology of many kinds including PC software, the web and physical devices

a) **Design involves:**
   - Achieving goals within constraints and trade-off between these
   - Understanding the raw materials: computer and human
   - Accepting limitations of humans and of design
b) **The design process has several stages and is iterative and never complete.**
c) **Interaction starts with getting to know the users and their context:**
   - Finding out who they are and what they are like. . .
   - Talking to them, watching them
d) **Scenarios are rich design stories, which can be used and reused throughout design:**
   - They help us see what users will want to do
   - They give a step-by-step walkthrough of users' interactions: including what they see, do and are thinking
e) **Users need to find their way around a system; this involves:**
   - Helping users know where they are, where they have been and what they can do next
   - Creating overall structures that are easy to understand and fit the users' needs
   - Designing comprehensible screens and control panels
f) **Complexity of design means we don't get it right first time:**
   - So we need iteration and prototypes to try out and evaluate
   - But iteration can get trapped in local maxima, designs that have no simple improvements, but are not good
   - Theory and models can help give good start points

Usability

"It is a measure of the effectiveness, efficiency and satisfaction with which specified user can achieve specified goals in a particular environment". It asks following:

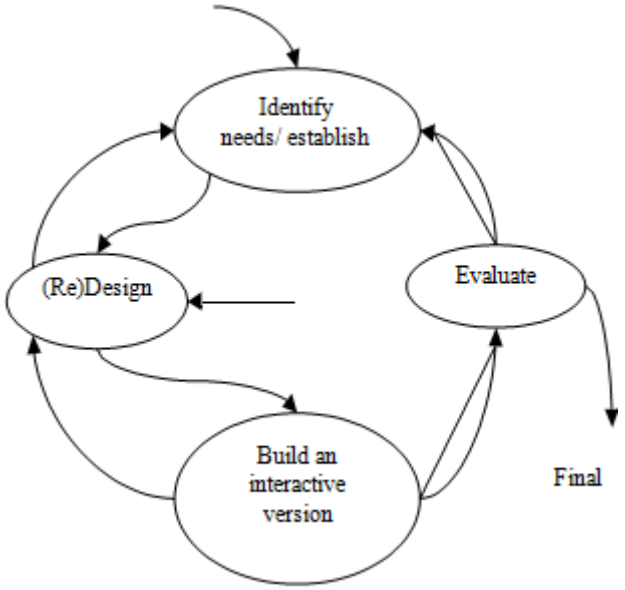
- Is effective to use
- Is efficient to use
- Is safe to use
- Has good utility
- Is easy to learn
- Is easy to remember how to use

Issues in Design
- Who are the users?
- What do we mean by needs?
- How do generate alternative design?
- How do we choose between design?

User Centered Development
- Data Collection
- Data Analysis
- User Modeling
- Design
- Prototyping
- Evaluation

Data Collection Techniques includes surveys, user questionnaires, Statistical Analysis. It collects all the information about users who going to use this product and environment they are working.

In data analysis phase, it characterize the people who will use your system, it analyze the tasks that user has to perform to accomplish their goals, environment analysis that where this product will work.



In User Modeling, a computational model for how people perform tasks and solveproblems based on psychological principles. For example, GOMS is a family of techniques for modeling and representing knowledge necessary for a person to perform a task.

In design phase, all the analysis are used to design a system. in interface design, it shows how this product present itself. And in interaction design, it tells how should this product works.

Rapids prototypes are early and inexpensive ways to identify usability problems before committing lots of resources. In interaction design main concern here is with usability. So using prototypes we can better understand the needs of user.

In usability testing and evaluation phase, users perform a variety of tasks with a prototype (or other system) while observers record notes on what each user does and says. Typical tests are conducted with one user at a time or two users working together. Testing may include collecting data on the paths users take to do tasks, the errors they make, when and where they are confused or frustrated, how fast they do a task, whether they succeed in doing the task, and how satisfied they are with the experience. The goal of most usability testing is to uncover any problems that users may encounter so those problems can be fixed.

Interaction Styles
Interaction can be seen as a dialogue between the computer and the user. Some applications have very distinct styles of interaction.

We can identify some common styles
- Command line interface
- Menus
- Natural language
- question/answer and query dialogue
- Form-fills and spreadsheets
- WIMP

Command Line Interface
Way of expressing instructions to the computer directly. Can be function keys, Single characters, short abbreviations, whole words, or a combination
- Suitable for repetitive tasks
- Better for expert users than novices
- Offer direct access to system functionality
- Command names/abbreviations should be meaningful

Menus
Set of options displayed on the screen. Options visible so demand less recall-rely on recognition so names should be meaningful. Selected by using mouse, numeric or alphabetic keys. Often options hierarchically grouped: sensible grouping is needed.

Menu systems can be
- Purely text based, with options presented as numbered choices, or
- can have graphical component, with menu appearing in box and choices made either by typing initial letter, or moving around with arrow keys

Natural language
An attractive option: familiar speech recognition or typed natural language can be used Problems:
- Vague
- Ambiguous

Form-Filling Interfaces
- Primarily for data entry or data retrieval.
- Screen like paper form.
- Data put in relevant place.
- Requires good design and obvious correction facilities.

WIMP Interface
- Windows
- Icon
- Menus
- Pointers

Windows
Areas of the screen that behave as if they were independent terminals
- can contain text or graphics
- can be moved or resized
- can overlap and obscure each other, or can be laid out next to one another
- Scrollbars allow the user to move the contents of the window up and down or from side to side
- Title bars describe the name of the window

Icons
Small picture or image, used to represent some object in the interface, often a window. Windows can be closed down to this small representation (iconised) allowing many windows to be accessible. Icons can be many and various-highly stylized or realistic representations.

Pointers
Important component, since WIMP style relies on pointing and selecting things such as icons and menu items.
- Usually achieved with mouse
- Joystick, trackball, cursor keys or keyboard shortcuts are also used
- Wide variety

Menus
Choice of operations or services that can be performed offered on the screen. Required option selected with pointer
- Problem-menus can take up a lot of screen space
- Solution-use pull-down or pop-up menus
- Pull-down menus are dragged down from a single title at the top of the screen
- Pop-up menus appear when a particular region of the screen is clicked on

Some menus are pin-up menus-they stay on the screen until explicitly requested to go away. Another type is the fall-down menu-similar to the pull-down, but the bar doesn't have to be explicitly selected.
- Also cascading menus-one menu selection opens another menu adjacent to it, and so on.
- Pie menus-menu options arranged in a circle.

Easier to select item (larger target area) and quicker Keyboard accelerators sometimes offered – key combinations that have same effect as selecting the menu item.

Interaction Devices
Different tasks, different types of data and different types of users all require different user interface devices. In most cases, interface devices are either input devices or output devices, though, for example, a touch screen combines both. In either case, the devices available provide the frameset for the interaction setting.

- Interface devices correlate to the human senses
- Nowadays, a device usually is designed either for input or for output Input Devices

Most commonly, personal computers are equipped with text input and pointing devices. For text input, the QWERTY keyboard is the standard solution, but depending on the purpose of the system, more specialized input devices like special keyboards, scanner with character recognition, pen or even voice input may be the better choice.

At the same time, the mouse is not the only imaginable

pointing device: Alternatives for similar but slightly different purposes include touch pad, trackball, joystick or even eye gaze.

Just for completeness, devices for 3D manipulation should be mentioned as well. Note that 3D manipulation is a matter of not only moving to a particular location, but also choosing a particular orientation. To determine pitch, yaw and roll, in addition to the location, requires six degrees of freedom, not only three

Output Devices

Output from a personal computer in most cases means output of visual data. Devices for "dynamic" visualization include the traditional cathode ray tube (CRT), liquid crystal display (LCD), or specialized devices like a pilot's head-up display. Printers are also a very important device for visual output, but they are substantially different from screens in that their output is static-it won't change over time except for the yellowing of paper. . .

In order to increase bandwidth for information reaching the user, it is an important goal to use more channels in addition to visual output. One commonly used supplement for visual information is sound, but its true potential is often not recognized. Audible feedback can make interaction substantially more comfortable for the user, providing unambiguous information about the system state and success or failure of interaction (e. g., a button press), without putting still more load onto the visual channel.

Future of Human Computer Interaction

Predicting the future is notoriously difficult. Suppose 100 years ago someone suggested that every home in the United States would soon have a bell that anyone in the world could ring anytime, day or night. Would you have believed it? Nevertheless, the telephone caught on and has become a technology conspicuous only by its absence.

So we can't say anything about future, where it will take us. It depends on both advancement in Computer industry and Psychology of human. We only know basics about human. If we can understand human more better then we can make better interaction designs.

New areas like AI and Virtual Reality are opening new doors for Human Computer Interaction. New interfacing devices like wearable clothes and etc. are the future of HCI.

2. Conclusion

The subject of Human Computer Interaction is very rich both in terms of the disciplines it draws from as well as opportunities for research. Discussed here was just a small subset of the topics contained within HCI. The study of user interface provides a double-sided approach to understanding how humans and machines interact. By studying existing interfaces (such as the graphical user interface or the command line interface), we gain an understanding of how the human mind processes information. We gain insight into how human memory deals with the information presented, as well as its limitations.

Alternatively, from studying how human physiology and psychology, we can design better interfaces for people to interact with computers. Work in this domain is only beginning (indeed the number of papers written on this topic has increased in the past few years), and there is much that we don't yet know about the way the human mind works that would allow more perfect user interfaces to be built.

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