Human Computer Interface Introduction

Human Computer Interface (HCI) was previously known as the man-machine studies or man-machine interaction. It deals with the design, execution and assessment of computer systems and related phenomenon that are for human use.

HCI can be used in all disciplines wherever there is a possibility of computer installation.

Some of the areas where HCI can be implemented with distinctive importance are mentioned below −

- **Computer Science –** For application design and engineering.
- **Psychology –** For application of theories and analytical purpose.
- **Sociology –** For interaction between technology and organization.
- **Industrial Design –** For interactive products like mobile phones, microwave oven, etc.

Objective

The intention of this subject is to learn the ways of designing user-friendly interfaces or interactions. Considering which, we will learn the following −

- Ways to design and assess interactive systems.
- Ways to reduce design time through cognitive system and task models.
- Procedures and *heuristics* for interactive system design.

Historical Evolution

From the initial computers performing batch processing to the user-centric design, there were several milestones which are mentioned below −

- **Early computer (e.g. ENIAC, 1946) –** Improvement in the H/W technology brought massive increase in computing power. People started thinking on innovative ideas.
- **Visual Display Unit (1950s) –** SAGE (semi-automatic ground environment), an air defense system of the USA used the earliest version of VDU.
- **Development of the Sketchpad (1962) –** Ivan Sutherland developed Sketchpad and proved that computer can be used for more than data processing.
- **Douglas Engelbart introduced the idea of programming toolkits (1963) –** Smaller systems created larger systems and components.
- **Introduction of Word Processor, Mouse (1968) –** Design of NLS (oNLine System).
- **Introduction of personal computer Dynabook (1970s) –** Developed *smalltalk* at Xerox PARC.
- **Windows and WIMP interfaces –** Simultaneous jobs at one desktop, switching between work and screens, sequential interaction.
- **The idea of metaphor –** Xerox star and alto were the first systems to use the concept of metaphors, which led to spontaneity of the interface.
- **Direct Manipulation introduced by Ben Shneiderman (1982) –** First used in Apple Mac PC (1984) that reduced the chances for syntactic errors.
- **Vannevar Bush introduced Hypertext (1945) –** To denote the non-linear structure of text.

- **Computer Supported Cooperative Work (1990s) –** Computer mediated communication.
- **WWW (1989) –** The first graphical browser (Mosaic) came in 1993.
- **Ubiquitous Computing –** Currently the most active research area in HCI. Sensor based/context aware computing also known as pervasive computing.

Guidelines in HCI

Shneidermans Eight Golden Rules

Ben Shneiderman, an American computer scientist consolidated some implicit facts about designing and came up with the following eight general guidelines −

- Strive for Consistency.
- Cater to Universal Usability.
- Offer Informative feedback.
- Design Dialogs to yield closure.
- Prevent Errors.
- Permit easy reversal of actions.
- Support internal locus of control.
- Reduce short term memory load.

These guidelines are beneficial for normal designers as well as interface designers. Using these eight guidelines, it is possible to differentiate a good interface design from a bad one. These are beneficial in experimental assessment of identifying better GUIs.

Norman's Seven Principles

To assess the interaction between human and computers, Donald Norman in 1988 proposed seven principles. He proposed the seven stages that can be used to transform difficult tasks. Following are the seven principles of Norman −

- Use both knowledge in world & knowledge in the head.
- Simplify task structures.
- Make things visible.
- Get the mapping right (User mental model = Conceptual model = Designed model).
- Convert constrains into advantages (Physical constraints, Cultural constraints, Technological constraints).
- Design for Error.
- When all else fails − Standardize.

Heuristic Evaluation

Heuristics evaluation is a methodical procedure to check user interface for usability problems. Once a usability problem is detected in design, they are attended as an integral part of constant design processes. Heuristic evaluation method includes some usability principles such as Nielsens ten Usability principles.

Nielsen's Ten Heuristic Principles

- Visibility of system status.
- Match between system and real world.
- User control and freedom.
- Consistency and standards.
- Error prevention.
- Recognition rather than Recall.

- Flexibility and efficiency of use.
- Aesthetic and minimalist design.
- Help, diagnosis and recovery from errors.
- Documentation and Help

The above mentioned ten principles of Nielsen serve as a checklist in evaluating and explaining problems for the heuristic evaluator while auditing an interface or a product.

Interface Design Guidelines

Some more important HCI design guidelines are presented in this section. General interaction, information display, and data entry are three categories of HCI design guidelines that are explained below.

General Interaction

Guidelines for general interaction are comprehensive advices that focus on general instructions such as −

- Be consistent.
- Offer significant feedback.
- Ask for authentication of any non-trivial critical action.
- Authorize easy reversal of most actions.
- Lessen the amount of information that must be remembered in between actions.
- Seek competence in dialogue, motion and thought.
- Excuse mistakes.
- Classify activities by function and establish screen geography accordingly.
- Deliver help services that are context sensitive.
- Use simple action verbs or short verb phrases to name commands.

Information Display

Information provided by the HCI should not be incomplete or unclear or else the application will not meet the requirements of the user. To provide better display, the following guidelines are prepared −

- Exhibit only that information that is applicable to the present context.
- Don't burden the user with data, use a presentation layout that allows rapid integration of information.
- Use standard labels, standard abbreviations and probable colors.
- Permit the user to maintain visual context.
- Generate meaningful error messages.
- Use upper and lower case, indentation and text grouping to aid in understanding.
- Use windows (if available) to classify different types of information.
- Use analog displays to characterize information that is more easily integrated with this form of representation.
- Consider the available geography of the display screen and use it efficiently.

Data Entry

The following guidelines focus on data entry that is another important aspect of HCI −

- Reduce the number of input actions required of the user.
- Uphold steadiness between information display and data input.
- Let the user customize the input.
- Interaction should be flexible but also tuned to the user's favored mode of input.
- Disable commands that are unsuitable in the context of current actions.
- Allow the user to control the interactive flow.
- Offer help to assist with all input actions.
- Remove "mickey mouse" input.

About interaction design: makeup of interaction design, working together as multidisciplinary team

Human-Computer Interaction (HCI) design, and more specifically **interaction design (IxD)**, is a crucial sub-discipline within the broader field of UX (User Experience) design. It focuses on shaping the "dialogue" between a user and a digital product or service, ensuring that this conversation is intuitive, efficient, and enjoyable.

The Makeup of Interaction Design (IxD)

Interaction design goes beyond just how something looks (UI design) or the overall user journey (UX design). It delves into the specific moments of interaction and how the system responds. The Interaction Design Foundation often cites the "5 Dimensions of Interaction Design" as a helpful framework:

1. **Words (1D):** This refers to the text used in the interface, such as button labels, error messages, instructions, and any microcopy. Words should be clear, concise, and communicate information effectively without overwhelming the user.
2. **Visual Representations (2D):** This includes all the graphical elements that aid interaction, such as images, typography, icons, and visual hierarchies. These elements guide the user's eye and provide visual cues about functionality.
3. **Physical Objects/Space (3D):** This dimension considers the physical medium through which users interact with the product. For example, a laptop involves a keyboard and mouse, a mobile phone involves touch and finger gestures, and a smart device might involve voice. It also accounts for the physical context in which the interaction occurs.
4. **Time (4D):** This refers to media that changes over time, such as animations, videos, and sounds. Animations can provide feedback, guide attention, or enhance the perceived responsiveness of a system. Sound can also provide auditory cues for successful actions or errors.
5. **Behavior (5D):** This is arguably the most critical dimension, encompassing how the product behaves in response to user input and how the user's emotions and actions are influenced. It's about designing the logic of the interaction, including feedback mechanisms, error handling, and overall system responsiveness. It seeks to predict and manage how users will react and feel during their experience.

In essence, interaction design aims to create a seamless and natural flow for users to achieve their goals. This involves:

- **Understanding user needs and goals:** Through user research, designers identify who the users are, what they want to accomplish, and their pain points.
- **Defining user flows:** Mapping out the step-by-step paths users will take to complete tasks.
- **Designing interactive elements:** Crafting buttons, menus, forms, and other UI components to be intuitive and functional.
- **Providing clear feedback:** Ensuring the system communicates its state and responses to user actions (e.g., a button changing color when clicked, a loading spinner, a success message).
- **Ensuring consistency:** Maintaining a consistent design language and interaction patterns across the entire product.
- **Anticipating and preventing errors:** Designing systems that minimize user mistakes and provide helpful ways to recover if errors occur.

Working Together as a Multidisciplinary Team

HCI design, especially interaction design, is inherently multidisciplinary. No single individual possesses all the knowledge and skills required to create a truly effective and user-centered product. A successful HCI design team typically brings together professionals from various backgrounds, each contributing their unique expertise:

- **UX Researchers:** They are the "empathy experts," conducting user interviews, surveys, usability testing, and other research methods to understand user behaviors, needs, motivations, and pain points. They provide crucial data to inform design decisions.
- **Interaction Designers (IxD):** As described above, they focus on the specific interactions within the product, designing the logic, feedback, and overall behavior of the interface. They often create wireframes, prototypes, and user flows.
- **UI Designers (User Interface Designers):** They are responsible for the visual aesthetics and layout of the product. They focus on colors, typography, iconography, spacing, and overall visual appeal, ensuring the interface is visually engaging and consistent with the brand.
- **UX Writers/Content Strategists:** They craft the language within the product, ensuring it's clear, concise, helpful, and aligns with the brand voice. This includes microcopy, error messages, labels, and onboarding text.
- **Product Managers/Owners:** They define the product vision, strategy, and roadmap, ensuring the design aligns with business goals and user needs. They bridge the gap between business, technology, and design.
- **Software Engineers/Developers:** They bring the design to life by coding and implementing the product. Their understanding of technical constraints and possibilities is crucial for practical and feasible designs. Collaboration with them ensures designs are technically viable and optimized for performance.
- **Graphic Designers:** While UI designers handle the interface visuals, graphic designers might contribute to overall branding, illustrations, or marketing materials that complement the product.
- **Cognitive Psychologists/Human Factors Specialists:** These experts contribute a deep understanding of human perception, cognition, memory, and decision-making, informing how users process information and interact with systems. This is particularly relevant in complex or safety-critical systems.
- **Accessibility Specialists:** They ensure the product is usable by people with diverse abilities, adhering to accessibility guidelines and best practices.

Why is this multidisciplinary approach crucial?

- **Holistic Understanding:** Each discipline brings a unique perspective, leading to a more comprehensive understanding of the problem space, user needs, and potential solutions.
- **Innovation:** Diverse perspectives spark creativity and lead to more innovative and effective design solutions.
- **Problem Solving:** Complex design challenges benefit from varied approaches to problem-solving.
- **Feasibility:** Engineers ensure designs are technically achievable, while business stakeholders ensure they align with organizational goals.
- **User-Centeredness:** By involving users and incorporating insights from various fields, the team can truly put the user at the center of the design process.
- **Reduced Rework:** Addressing potential issues from different angles early in the design process reduces costly rework later on.

Effective multidisciplinary teams communicate constantly, share knowledge, provide constructive feedback, and iterate on designs. This collaborative synergy is what drives the creation of truly impactful and successful human-computer interactions.

The Human: I/O channels – Memory

In human-computer interaction (HCI), understanding the human side, particularly their I/O channels, memory, and cognitive processes like reasoning and problem-solving, is crucial for designing effective interfaces. These aspects dictate how humans perceive and interact with technology, influencing usability and overall experience.

1. I/O Channels:

- **Input:**

Humans receive information from the computer through various channels, including visual (displaying information), auditory (sound), haptic (touch, like vibration or pressure), and movement (gestures or physical actions).

- **Output:**

Humans provide input to the computer through similar channels. For example, typing on a keyboard is a visual and tactile input, while speaking into a microphone is an auditory input.

- **Multimodal Interaction:**

Effective HCI often involves using multiple input and output channels simultaneously to create a more intuitive and natural interaction.

2. Memory:

- **Sensory Memory:**

Briefly stores sensory information (visual, auditory, etc.) before it's processed further.

- **Short-Term Memory (Working Memory):**

Holds a limited amount of information for a short period, actively used during tasks.

- **Long-Term Memory:**

Stores information for extended periods, accessed for recall and knowledge application.

- **Memory and HCI:**

Understanding memory limitations and capabilities is vital for designing interfaces that minimize cognitive load and support efficient information processing.

3. Reasoning and Problem-Solving:

- **Reasoning:**

Humans use various reasoning methods, including inductive, deductive, and abductive reasoning, to make sense of information and solve problems.

- **Problem-Solving:**

Involves identifying a problem, developing solutions, and evaluating the outcomes. Effective problem-solving requires understanding the problem, generating potential solutions, and selecting the best course of action.

- **HCI and Problem-Solving:**

HCI design should support users in their problem-solving process by providing clear information, intuitive tools, and feedback mechanisms.

4. Key Principles and Considerations:

- **Ergonomics:**

Consider the physical and cognitive capabilities of users when designing interfaces.

- **Usability:**

Ensure that interfaces are easy to learn, efficient to use, and satisfying for users.

- **User-Centered Design:**

Focus on understanding user needs and preferences throughout the design process.

- **Accessibility:**

Ensure that interfaces are usable by people with a wide range of abilities.

- **Error Handling:**

Design interfaces that minimize errors and provide helpful feedback when errors occur.

By considering these aspects of the human user, HCI researchers and designers can create more effective and user-friendly interfaces that enhance human-computer interaction.

The Human: I/O channels – Memory

What is Input/Output channel?

A person‘s interaction with the outside world occurs through information being received and sent: input and output. In an interaction with a computer the user receives information that is output by the computer, and responds by providing input to the computer – the user‘s output becomes the computer‘s input and vice versa. Input in the human occurs mainly through the senses and output through the motor control of the effectors.

What are the types of memory or memory function?

(i) Sensory buffers ,(ii) Short-term memory or working memory, (iii) Long term memory

What is meant by sensory memory?

The sensory memories act as buffers for stimuli received through the senses. A sensory memory exists for each sensory channel: *iconic memory* for visual stimuli, *echoic memory* for aural stimuli and *haptic memory* for touch. These memories are constantly overwritten by new information coming in on these channels.

What is iconic memory?

We can demonstrate the existence of iconic memory by moving a finger in front of the eye. Can you see it in more than one place at once? This indicates a persistence of the image after the stimulus has been removed. A similar effect is noticed most vividly at firework displays where moving sparklers leave a persistent image. Information remains in iconic memory very briefly, in the order of 0.5 seconds.

Write brief on existence of echoic memory.

The existence of echoic memory is evidenced by our ability to ascertain the direction from which a sound originates. This is due to information being received by both ears. However, since this information is received at different times, we must store the stimulus in the meantime. Echoic memory allows brief ‗play-back‘ of information.

Write short notes on short term memory or working memory.

Short-term memory or working memory acts as a _scratch-pad‘ for temporary recall of information. It is used to store information which is only required fleetingly. For example, calculate the multiplication 35 × 6 in your head. Short-term memory can be accessed rapidly, in the order of 70 ms. However, it also decays rapidly, meaning that information can only be held there temporarily, in the order of 200 ms. Short-term memory also has a limited capacity. There are two basic methods for measuring memory capacity. The first involves determining the length of a sequence which can be remembered in order.

What are the two types of long term memory?

 Episodic memory

 Semantic memory

Reasoning and problem solving and Remaining Topics in Unit 1

State Reasoning. What are the types of reasoning?

Reasoning is the process by which we use the knowledge we have to draw conclusions or infer something new about the domain of interest. There are a number of different types of reasoning:

1. deductive 2.inductive 3.abductive

What is problem solving?

Reasoning is a means of inferring new information from what is already known, problem solving is the process of finding a solution to an unfamiliar task, using the knowledge we have. Human problem solving is characterized by the ability to adapt the information we have to deal with new situations. However, often solutions seem to be original and creative.

State Gestalt theory.

Psychology concept is used in training. It proposes that what is 'seen' is what appears to the seer and not what may 'actually be there,' and that the nature of a unified whole is not understood by analyzing its parts. It views learning as a reorganizing of a whole situation in contrast to the behavioral psychology view that learning consists of associations between stimuli and responses. Gestalt experiments show that the brain does not act like a sponge but actively filters, structures, and matches all incoming information against known patterns to make sense of it.

What are the basic levels of skill in Anderson's ACT* model?

1. The learner uses general-purpose rules which interpret facts about a problem. This is slow and demanding on memory access.

2. The learner develops rules specific to the task.

3. The rules are tuned to speed up performance.

List out all text entry devices.

1.Thealphanumeric keyboard,2.Chord keyboards,3.Phone pad and T9 entry,4.Handwriting recognition, 5.Speech recognition.

What are touch screens?

Touch screens are another method of allowing the user to point and select objects on the screen as they detect the presence of the user's finger, or a stylus, on the screen itself. They work in one of a number of different ways: by the finger (or stylus)

interrupting a matrix of light beams, or by capacitance changes on a grid overlaying the screen, or by ultrasonic reflections. The touch screen is very fast, and requires no specialized pointing device. Because the screen acts as an input device as well as an output device, there is no separate hardware to become damaged or destroyed by dirt; this makes touch screens suitable for use in hostile environments.

What is Eyegaze?

Eyegaze systems allow you to control the computer by simply looking at it. Some systems require you to wear special glasses or a small head-mounted box. A low-power laser is shone into the eye and is reflected off the retina. The reflection changes as the angle of the eye alters, and by tracking the reflected beam the eyegaze system can determine the direction in which the eye is looking. Eyegaze is a very fast and accurate device, but the more accurate versions can be expensive.

What is icon wars?

Icon wars, occurs on window systems. The user clicks the mouse on a menu or icon, and nothing happens; for some reason the machine is busy or slow. So the user clicks again, tries something else and then, suddenly, all the buffered mouse clicks are interpreted and the screen becomes a blur of flashing windows and menus. This time, it is not so much that the response is too slow – it is fast enough when it happens – but that the response is variable. The delays due to swapping programs in and out of main memory typically cause these problems.

What are the limitations on interactive performance?

1.Computational bound, 2.Storage channel bound, 3.Graphics bound, 4.Network capacity

What are the stages in Norman's model of interaction?

1. Establishing the goal.
2. Forming the intention.
3. Specifying the action sequence.
4. Executing the action.
5. Perceiving the system state.
6. Interpreting the system state.
7. Evaluating the system state with respect to the goals and intentions.

State Ergonomics.

Ergonomics (or human factors) is traditionally the study of the physical characteristics of the interaction: how the controls are designed, the physical environment in which the interaction takes place, and the layout and physical qualities of the screen. A primary focus is on user performance and how the interface enhances or detracts from this. In seeking to evaluate these aspects of the interaction, ergonomics will certainly also touch upon human psychology and system constraints.

What are the common interface styles?

Common interface styles includes,

1. command line interface
2. menus
3. natural language
4. question/answer and query dialog
5. form-fills and spreadsheets
6. WIMP
7. point and click
8. three-dimensional interfaces.

Write notes on WIMP interface.

WIMP stands for windows, icons, menus and pointers (sometimes windows, icons, mice and pull-down menus), and is the default interface style for the majority of interactive computer systems in use today, especially in the PC and desktop workstation arena. Examples of WIMP interfaces include Microsoft Windows for IBM PC compatibles, MacOS for Apple Macintosh compatibles and various X Windows-based systems for UNIX.