HUMAN – COMPUTER INTERACTION

Sandeep R Sreenivasan

Student, XII Grade, National Hill View Public School Unit I, RR Nagar, Bangalore, India.

Abstract: *Human interact with computer in many ways, and the interface between the two is crucial to facilitate an interaction. The purpose of this research paper is to revisit the field of Human-Computer Interaction (HCI). In the conclusion, the idea of how HCI plays a big role in revamping and building on the world of technology shall be established.*

I. Introduction

HCI is the study of how people interact with computers and to what extent computer technology is developed for successful interaction with human beings. A remarkable number of academic institutions and corporations now study HCI. HCI is also sometimes termed *human – machine interface (HMI), man-machine interface (MMI) or computer-human interaction (CHI)* . Desktop applications, internet browsers, laptops and computers make use of the prevalent graphical user interface (GUI) present. Voice user interfaces (VUI) are used in speech recognition in search engines to make surfing on the internet much easier. The emerging multi-modal and Graphical user interfaces (GUI) allow humans to engage with embodied character agents in a way that cannot be achieved with other interface paradigms.

II. Evolution of HCI

HCI Particularly pertains to the **design of technology**. It overlaps user-centered design, UI, and UX to create intuitive products and technologies. People who major in HCI come up with ideas of how to design and implement computer systems that **satisfy human users**. Most research in this field aims to improve human–computer interaction by improving how an interface is used and understood by humans. HCI helps to develop interfaces that increase one's productivity, enhance user experience and cut down risks in safety-critical systems. Poorly designed systems and machines run into many unexpected problems ,which leads to user frustration and sometimes, chaotic disasters.

Therefore, HCI is on the rise. As we have become more dependent on technologies, even just the smartphone or internet, HCI has become a key part of designing tools that can be used in a safe and effective way on a daily basis.

The human – computer interaction systems have passed through many challenges to reach at the stage these systems today appear. There were times when noone could imagine an interaction between humans and a machine. Today, this is the reality as over the last few decades, this field has grown tremendously. New and more sophisticated systems have been introduced. They have further facilitated an easy flow of communication between man and machine. In the beginning, the focus of all HCI allocations was on improving hardware-user interface. This gradually gave place to improving software-user interface. Then the priority was given to the user. All HCI activities were made user-friendly so that users can make best utilization of technology. Today, human-computer interaction systems are so advanced that it is very simple to:

- create and share graphics and visuals,
- to open and share e-mail attachments and images with a single click,
- to make use of synthetic speech,
- digital libraries,
- virtual environments, and
- artificial intelligence.

However, this is just a beginning, and this field of human-computer interaction has a long way to go. The future of this technology seems to be even more exciting and promising than its past.

III. Uses and Applications of HCI

The broadness of HCI is such that it reaches almost every industry. It often overlaps areas like user-centered design (UCD), user interface (UI) design, and user experience (UX) design. Some consider HCI to be the forerunner to UX design.

Research applications in this field focus on:

- How to design improved computer interfaces that are optimized for qualities, such as learnability, findability, and usability.
- How to evaluate and compare different interfaces in terms of their usability
- How to determine if a user is human or computer
- How to study the sociocultural implications of human-computer interactions

The most notable industries that rely on HCI are:

- Virtual and Augmented Reality, and others

- Ubiquitous and Context-Sensitive Computing
- Healthcare technologies
- Education-based technologies
- Security and cybersecurity
- Voice User interfaces and speed recognition technologies

More companies around the world are implementing HCI research and principles into their development processes, and its already in use by companies like Google and Nintendo. Researchers show how technologies like the Smartwatch, 3D printers, Voice Search Apps, and more, all apply HCI design principles.

IV. Components of HCI

HCI includes three intersecting: a **human**, a **computer**, and the **interactions** between them. Humans interact with the computer's interface to get tasks done. A computer interface is what enables communication between any user and a computer. In order to build effective interfaces, the limitations, and capabilities of both components much be listed out. Humans and computers have different input-output channels.

Humans:

- Long-term memory
- Short-term memory
- Sensory memory
- Visual perception

- Auditory perception
- Tactile perception
- Speech and voice

Computers:

- Text input devices
- Speech recognition
- Mouse / touchpad / keyboard
- Eye-tracking
- Display screens
- Auditory displays
- Printing abilities

Human-computer interaction puts a lot of importance on these intersecting features. One important HCI factor is that different users form different conceptions or mental models about their interactions and have different ways of learning and keeping knowledge and skills (different "cognitive styles" as in, for example, "left-brained" and "right-brained" people). In addition, cultural and national differences play a part. Another consideration in studying or designing HCI is that user interface technology changes rapidly, offering new interaction possibilities to which previous research findings may not apply. Finally, user preferences change as they gradually master new interfaces.

How can we map human abilities to a computer's abilities? How do humans and computers interact? There are several models that researchers have put forth. Let's examine one in detail.

Norman’s model of interaction

The Donald Norman Modal of Interaction (sometimes also called the execution - evaluation cycle) is the most influential model in the field of Human – Computer Interaction. It was first introduced in 1988. It proposes that a user first establishes a goal and then performs actions using the system to achieve that goal.

A system then reflects the output of those actions on the interface. The user observes the interface and evaluates if their goal has been met. If not, a new goal is then established, and the cycle is repeated. This model of interaction is divided into seven primary stages:

- Establish the goal
- Formulate the intention
- Specify actions
- Execute actions
- Perceive system state
- Interpret system state
- Evaluate system state

``Norman's HCI Model Norman defines two issues with these seven stages: the gulf of execution and the gulf of evaluation. It helps us to understand where things go awry in our design.

- **Gulf of execution:** There is a difference between user actions and those that the system can perform. An effective interface allows a user to perform an action without system limitations.
- **Gulf of evaluation:** There is a difference between the presentation of an output and the user's expectations. An effective interface can be easily evaluated by a user.
- **Human error:** The system is performing correctly, but the user has inputted an error. Errors can be avoided by improving interface design or providing better user support.

Ergonomics of Interaction

Another key component of HCI is ergonomics (process of designing or arranging workplaces, products, and systems so that they fit the people who use them) . Once we understand how a computer and user interact via an interface, we need to better understand how to enhance user performance. There are many ergonomic factors that come into play when designing a system:

- **Controls and display:** Display sections and controls should be grouped logically according to human perception. The logic of arrangement depends on the application and the domain, such as by type, sequence, its function, or frequency.
- **Colors:** Since humans are limited by visual perception, it is necessary to incorporate colors properly in designs. Colors should always be distinct, and the distinction of colors should remain unaffected by changing contrast. Common color conventions should also be used (for example, red for a warning and green form success).

V. Design Process Steps

This Design Process also called as interaction design (IxD) is what designers use to create solutions centered on users' needs, aims and behavior when interacting with products. The IxD process involves 5 stages: discovering what users need/want, analyzing it, prototyping, implementing and deploying it.

With the IxD process, you can build highly intuitive, recognizable interfaces that provide seamless experiences for users. Here are five stages the IxD process typically involves:

1. **Find the users' needs/wants** – It is easy to assume you know what users want and their relevant context. Discover their real requirements:
    a. Observe people
    b. Interview people
    c. Examine existing solutions – while remembering it's hard to envisage future needs, technologies, etc.

2. **Do analysis to sort and order your findings so they make sense**. This may be brought through a:
    a. Narrative/story of how someone uses a system.
    b. Task analysis, breaking down user's steps/sub-steps.

3. **Design a potential solution according to design guidelines and fundamental design principles** (e.g., giving appropriate feedback for users' actions). Use the best techniques to match how users will interact with it in terms of, for example, navigation.

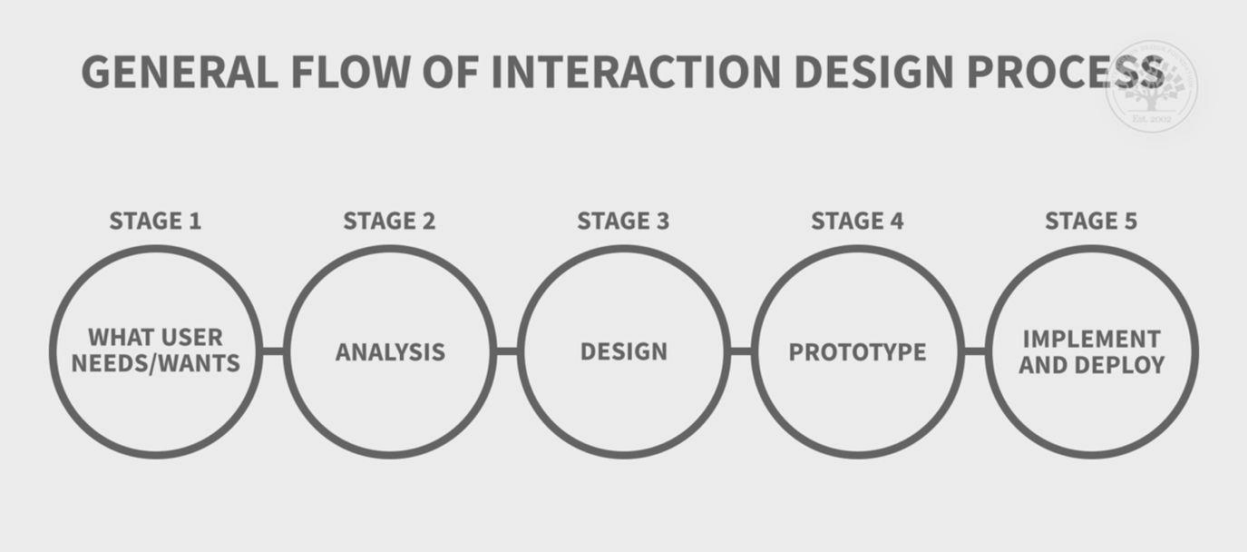
4. **Start prototyping** - Give users an idea of what the product will look like and let them test it, and/or give it to experts to evaluate its effectiveness using heuristics.

5. Implement and deploy what you have built.

The IxD process is iterative—nobody designs anything right the first time, especially regarding more innovative solutions. It may indeed take many iterations before you pinpoint the ideal version of a solution. So, you (and your design team) should continue testing and adapting appropriate changes around an ever-clearer understanding of your users' needs. For example, you could gather user feedback and monitor support chats to find areas for improvement.

It's important to understand the interaction design process is a general idea of how you can start from your users' needs and progress towards a fitting solution. Similar design processes exist. **Design thinking** is one of the more notable of these, where you work to gain and leverage vital insights to fine-tune optimal features. Only

when you know your users and empathize with them can you appreciate their real-world needs, desires and pain points.



VI. HCI Design Rules and Practices

There are many best practices and rules that have been established by HCI researchers and designers. These rules include abstract design principles, to common-place standards, and design guidelines. Let's examine the most important design rules for HCI.

Design for learnability and familiarity

Learnability and familiarity principles determine how easily a novice user can learn to interact with a system. To achieve this, a system should be predictable. Any user should be able to predict the results of future actions based on the knowledge of their interaction history.

Similarly, a user should be able to map experiences with other computing systems to a new system. Familiarity determines whether a user can initiate interaction. Metaphors (usually visual) are a common way that systems achieve this principle. For example, a trash bin icon should represent the action to delete items, as it is familiar and predictable.

Make elements legible and accessible

All characters and objects must be perceptible in order to be used effectively. Multiple modes of "legibility" should be used to represent information (visual, verbal, and haptic). Similarly, a system must equally be useful to users with diverse abilities. For

example, users with visual impairment should be provided with equivalent support systems.

Tolerance of error

Users will make errors, but they should not change the system state or impact an interaction disastrously. Warnings should be provided to prevent potential mistakes, and a system should not have a critical situation that can be reached easily by the user. A system must also help when potential errors arise.

Flexibility

Any design should provide multiple ways to perform a given task. This allows the user to interact with a device according to their ability or preference. Users need options to choose methods that best fit their pace and experience. Systems that are flexible are more useful for a wide range of users.

Don’t reinvent the wheel

It’s important to innovate but not at the expense of learnability and accessibility. Users have developed old habits from other interfaces that will transfer to well-designed systems. A design that uses ready-made standards will be a more intuitive, useful product.

VII. Examples of HCI

Technological development has brought to light several tools, gadgets, and devices such as wearable systems, voice assistants, health trackers, and smart TVs that have advanced human-computer interaction technology. Let's look at some prominent examples of HCI that have accelerated its evolution.

IoT technology

IoT devices and applications have significantly impacted our daily lives. According to a May 2022 report by IoT Analytics, global IoT endpoints are expected to reach 14.4 billion in 2022 and grow to 27 billion (approx.) by 2025. As users interact with such devices, they tend to collect their data, which helps understand different user interaction patterns. IoT companies can make critical business decisions that can eventually drive their future revenues and profits.

A recent development in the field of HCI introduced the concept of '**pre-touch sensing**' through pre-touch phones. This means the phone can detect how the user holds the phone or which finger approaches the screen first for operation. Upon detecting the user's hand movements, the device immediately predicts the user's intentions and performs the task before the user gives any instructions.
Another HCI-related development is that of '**Paper ID**'. The paper acts as a touchscreen, senses the environment, detects gestures, and connects to other IoT devices. Fundamentally, it digitizes the paper and executes tasks based on gestures by focusing on man-machine interaction variables.

Eye - tracking technology

Eye-tracking is about detecting where a person is looking based on the gaze point. Eye-tracking devices use cameras to capture the user's gaze along with some embedded light sources for clarity. Moreover, these devices use machine learning algorithms and image processing capabilities for accurate **gaze detection**.

Businesses can use such eye-tracking systems to monitor their personnel's visual attention. It can help companies manage distractions that tend to trouble their employees, enhancing their focus on the task. In this manner, eye-tracking technology, along with HCI-enabled interactions, can help industries monitor the daily operations of their employees or workers.

Other applications include **'driver monitoring systems'** that ensure road security. Moreover, in the future, HCI-enabled eye-tracking systems may allow users to scroll through a computer screen just by rolling their eyeballs.

Speech recognition technology

Speech recognition technology interprets human language, derives meaning from it, and performs the task for the user. Recently, this technology has gained significant popularity with the emergence of chatbots and virtual assistants.

For example, products such as **Amazon's Alexa, Microsoft's Cortana, Google's Google Assistant,** and **Apple's Siri** employ speech recognition to enable user interaction with their devices, cars, etc. The combination of HCI and speech recognition further fine-tune man-machine interactions that allow the devices to interpret and respond to users'

commands and questions with maximum accuracy. It has various applications, such as transcribing conference calls, training sessions, and interviews.

AR/VR technology

AR and **VR** are immersive technologies that allow humans to interact with the digital world and increase the productivity of their daily tasks. For example, smart glasses enable hands-free and seamless user interaction with computing systems. Consider an example of a chef who intends to learn a new recipe. With smart glass technology, the chef can learn and prepare the target dish simultaneously.

Moreover, the technology also reduces system downtime significantly. This implies that as smart AR/VR glasses such as 'Oculus Quest 2' are supported by apps, the faults or problems in the system can be resolved by maintenance teams in real-time. This enhances user experience in a minimum time span. Also, the glasses can detect the user's response to the interface and further optimize the interaction based on the user's personality, needs, and preferences.

Thus, AR/VR technology with the blend of HCI ensures that the task is accomplished with minimal errors and also achieves greater accuracy and quality. Currently, HCI research is targeting other fields of study, such as **brain-computer interfaces** and **sentiment analysis,** to boost the user's AR/VR experience.

A recent development in this regard has been enabled via '**Dexta Haptic Gloves**.' These VR gloves can sense and process touch parameters such as surface hardness, softness, etc. These gloves can memorize a user's finger movements by locking and unlocking the finger joints as they interact in the VR environment. Later, the gloves can replicate the recorded data of feelings across various degrees in real life.

Cloud computing

Today, companies across different fields are embracing **remote task forces**. According to a 'Breaking Barriers 2020' survey by Fuze (An 8×8 Company), around 83% of employees feel more productive working remotely. Considering the current trend, conventional workplaces will witness a massive rejig and transform entirely in a couple of decades. Thanks to cloud computing and human-computer interaction, such flexible offices have become a reality.

Moreover, an employee can access data on the cloud from any physical location by exploiting **cloud-based SaaS** services. Such virtual settings streamline workflows and support seamless collaboration with remote teams across industry verticals without impacting productivity. Thus, with time, the idea of traditional offices will cease to exist, mainly because of SaaS and HCI.

VIII. Goals of HCI

The principal objective of HCI is to **develop functional systems** that are usable, safe, and efficient for end-users. The developer community can achieve this goal by fulfilling the following criteria:

- Have sound knowledge of how users use computing systems
- Design methods, techniques, and tools that allow users to access systems based on their needs
- Adjust, test, refine, validate, and ensure that users achieve effective communication or interaction with the systems

- Always give priority to end-users and lay the robust foundation of HCI

To realize the above points, developers must focus on two relevant areas: **usability** and **user experience**.

Usability is key to HCI as it ensures that users of all types can quickly learn and use computing systems. User experience is a subjective trait that focuses on how users feel about the computing system when interacting with it. Here, user feelings are studied individually so that developers and support teams can target particular users to evoke positive feelings while using the system.

IX. Conclusion

Cleverly designed computer interfaces motivate users to use digital devices in this modern technological age. HCI enables a two-way dialog between man and machine. Such effective communication makes users believe they are interacting with human personas and not any complex computing system. Hence, it is crucial to build a strong foundation of HCI that can impact future applications such as personalized marketing, eldercare, and even psychological trauma recovery.

RESOURCES

INTRODUCTION:

Wikipedia contributors. (2022, September 17). Human–computer interaction. In *Wikipedia, The Free Encyclopaedia*. Retrieved 05:17, September 28, 2022, from

https://en.wikipedia.org/w/index.phptitle=Human%E2%80%93computer_interaction&oldid=1110776218

TechTarget Contributor. (2005, September). **HCI (human-computer interaction).** In *TechTarget.* Retrieved: 04:45, September 28, 2022, from

https://www.techtarget.com/searchsoftwarequality/definition/HCI-human-computer-interaction

EVOLUTION OF HCI, USES AND APPLICATIONS:

Priya Chetty. (2013, October 9). **The emergence of human-computer interaction.** In *Project Guru.* Retrieved: 04:56, September 29, 2022, from

https://www.projectguru.in/emergence-human-computer-interaction/

Amanda Fawcett. (2021, February 12). **Introduction to Human-Computer Interaction & Design Principles.** In *educative.* Retrieved: 04:53, September 29, 2022, from

https://www.educative.io/blog/intro-human-computer-interaction

DESIGN PROCESS:

Interaction Design Process. In *Interaction Design Foundation.* Retrieved: 10:25, October 1, 2022, from

https://www.interaction-design.org/literature/topics/interaction-design-process

EXAMPLES OF HCI:

Vijay Kanade. (2022, July 22). **What Is HCI (Human-Computer Interaction)? Meaning, Importance, Examples, and Goals.** In *spiceworks.* Retrieved: 10:59, October 1, 2022 from

https://www.spiceworks.com/tech/artificial-intelligence/articles/what-is-hci/