**Human Computer Interaction**

**What is Human Computer Interaction (HCI)?**

* Multidisciplinary field of study on the design of computer technology and interaction between humans and computers.
* Concerned with the physical, physiological, and theoretical aspects of the process.
* Has since expanded to cover almost all forms of information technology design

**Errors/Mistakes in Computer Technologies still Exist Today**

* Focus on whether or not the technology works
* The concept is too cool/ground-breaking
* Functions are hard to utilize/process
* Specific people use things specifically
* Too much safety/security in the technology
* Too much focus on the design

**When creating technologies, it must be:**

* Suitable for the task
* Easy to use
* Adaptable to the user’s knowledge and experience
* Provides feedback on the performance
* Displays information in a format and pace understandable to the user
* Conforms to the principles of software ergonomics

**The idea of use is also necessary for HCI:**

* Useful – accomplish what Is required (play music, cook dinner, format a document)
* Usable – do it easily and naturally, without danger of error
* Used – make people want to use it, be attractive, engaging, fun

**Four Components of HCI**

1. **The Human (WHO)**

* Also known as the user/end-user
* Limited in their capacity to process information
* Has important implications for design
* Focuses on who the HCI is for
  1. Information is received and responses given via several input and output channels:
     + Visual
     + Auditory
     + Haptic Channel
     + Movement
  2. Information is stored in memory
     + Sensory memory
     + Short-term (working) memory
     + Long-term memory
  3. Information is processed and applied:
     + Reasoning
     + Problem Solving
     + Skill Acquisition
     + Error
  4. Emotion influences human capabilities
  5. Users share common capabilities but are individuals with differences

1. **The Computer (WHERE)**
   1. Focuses on where the HCI is found
   2. Comprises various elements, each of which affects the user of the system
      * Input devices
      * Output display
      * Virtual reality systems
      * Various displays (physical controls, haptic dieback, sensors)
      * Paper output and input
      * Memory
      * Processing
2. **The Interaction (WHAT)**
   1. Interaction models help us to understand what is going on in the interaction between user and system
   2. Address the translations between what the user wants and what the system does
   3. Focuses on what the HCI is
   4. Ergonomics are physical characteristics of the interaction and how these influence its effectiveness
   5. Dialog between user and system is influenced by the style of the interface
   6. Interaction takes place within a society and organizational context that affects both user and system
3. **The Context (HOW)**
   1. Also known as paradigms
   2. Examples of effective strategies for building interactive systems to design usable interactive systems
   3. Focuses on how the HCI will be formed
   4. Ranges from the introduction of timesharing computers, through the WIMP and web, to ubiquitous and context-aware computing

**Design of Everyday Things**

**Donald A. Norman**

* University professor, industry executive, company advisor, and board member;
* Electrical engineer, psychologist, computer scientist, cognitive scientist, designer;
* Speaker and author;
* Founder and Director of the Design Lab at the University of California, San Diego
* “We must design for people the way they are, not the way we wish them to be. Also, don’t be logical. Half the people in the world are below average.”
* **Donald A. Norman Principles**
  1. Gulf of Execution
     + Is the difference between the intentions of the users and what the system allows them to do or how well the system supports those actions?
     + In order to design the best interfaces, the gulf must be kept as small as possible.
  2. Gulf of Evaluation
     + Is the degree of ease with which a user can perceive and interpret whether or not the action they performed was successful?
     + The gap in finding our what is the current state of the system.
* **Six Principles of Design**
  1. Visibility
     + User should know, just by looking at an interface, what their options are and how to access them
  2. Feedback
     + Users should know, just by looking at an interface, what their options are and how to access them
  3. Affordance
     + Is the link between how things look and how they’re used? For example, a coffee mug has high affordance because instantly know how to hold it just by looking at it
  4. Mapping
     + Mapping is the relationship between control and effect. The idea is that with good design, the controls to something will closely resemble what they affect.
  5. Constraints
     + Restrict a particular form of user interaction with an interface with an interface
  6. Consistency
     + The same action has to cause the same reaction, every time.

**THE HUMAN**

**THE HUMAN**

* Human computer interaction starts with the human
* The central character is the human
* There is a need to understand:

1. Human Capabilities
2. Human Limitations

* There is a need to use a simplified model
* Select characteristics relevant to HCI:

1. Input-output channels (perceptual system)
2. Human memory
3. Human processing

**THE PERPETUAL SYSTEM**

* **Visual Processing (Sight)**
  1. Involves transformation and interpretation of a complete image
  2. Expectations affect the way an image is perceived
  3. Compensates for movement, color and brightness
  4. Helps resolve ambiguities
  5. Perception of size
  6. Familiarity
  7. Depth perception
  8. Color perception
  9. Reading

1. Perception and processing of text is a special case
2. Stages:

* Visual pattern of the word is perceived
* Decoded with an internal representation of the language
* Syntactic and semantic analysis

1. Example: Reading “IL”
2. Adults read 250 words per minute
3. Words are recognized by shape
4. Removing word shape clues by using all caps is detrimental to reading speed and accuracy

* **Hearing**

1. Human beings can hear sounds from 20 Hz to 15 kHz
2. Can distinguish frequency changes of less than 1.5 Hz at low frequencies
3. Less accurate at high frequencies
4. Can be selective
5. Can convey a lot of information
6. Not maximized in interface design

* **Touch**

1. Haptic perception - important means of feedback
2. If and object is seen but not felt, speed and accuracy of a response is reduced
3. Complaint of VR users

* **Taste**
* **Smell**

**HUMAN MEMORY**

* Second part of the model of the human as an information processor
* Three types:
* **sensory buffers**
* Iconic (visual) - persistence of the image after the stimulus has been removed
* Echoic (aural) - allows a brief “playback”
* Haptic - touch
* **short-term memory**
* Scratch-pad for temporary recall
* Used for information needed fleetingly
* Rapid access, limited capacity
* 7 +/- 2 chunks of information
* Patterns are useful memory aids
* **long-term memory**
* We store everything we “know” - factual information, experiential knowledge, procedural rules of behavior
* Huge, if not unlimited
* Relatively slow access time (1/10 second)
* Forgetting occurs more slowly
* **Structure**
* Episodic – memory of events stored sequentially; can reconstruct actual events
* Semantic – structure derived from facts, concepts, or skills; derived from episodic memory
* Can be organized to:

1. Semantic networks
2. Frames
3. Scripts
4. Production rules

* **Structure (Organization)**
* Semantic networks

1. Interconnections or associations among memories
2. Does not allow to model the complex objects or events composed of several activities
3. Example: what are the words currently associated with “dog”?

* Frames

1. Objects that contain slots or attributes
2. Attributes represent default, fixed or variable information
3. Example: dog
4. Fixed - Legs: 4
5. Default - Diet: Carnivorous, Sound: Bark
6. Variable – Size, Color

* Scripts

1. Represents default stereotypical information
2. Contains: entry conditions, results, props, roles, scenes, and tracks
3. Example:
4. Goal: To fill my mug with coffee
5. Entry conditions: My mug must first be empty
6. Results: My mug is full of coffee
7. Props: Mug, coffee machine, coffee
8. Roles:

* Secretary makes the coffee
* I fill my cup
* Production rules

1. Series of condition-action (if-then) statements
2. Examples:
3. IF it is raining THEN bring an umbrella
4. IF the high school is being dismissed THEN traffic will be horrible

* **PROCESSES**
* Storing

1. Total time hypothesis - amount learned is proportional to amount of time spent
2. Distribution of practice effect - learning time is most effective if distributed over time
3. Information must be meaningful for it to be stored

* Forgetting

1. Decay
2. Interference - old replaced by new or vice versa
3. Retroactive interference – new information replaces the old
4. Proactive inhibition – the old memory interferes with the new information

* Remembering

1. Recall - reproduced from memory
2. Recognition - the info has been seen before

**HUMAN THINKING**

* **Reasoning**
* Process of deriving new information from what is known
* Types:
* Deductive reasoning – two or more assertions that lead to a conclusion; mathematical certainty
* Inductive reasoning - arriving at generalizations from observations we have seen about cases we have not seen
* Abductive reasoning - formulation of hypotheses to explain a phenomena
* **Problem Solving**
* Process of finding a solution to an unfamiliar situation
* Three examples:
* Gestalt
* Problem space theory
* Analogy in problem solving

**GESTALT**

* People draw on previous experiences
* Have insights
* People as sense-makers
* Restructure the problem
* Theory lacked structure and support
* Does not explain insight and restructuring
* The whole is greater than the some of its parts
* People perform based on their understanding general principles of a situation
* If we perform on memorized facts, we make stupid mistakes

**PROBLEM SPACE THEORY**

* Problem is represented in terms of problem states
* Heuristics are employed to go from initial to goal state
* General problem solver works for well-structured domains
* Real-world problems are more complex

**SKILL ACQUISITION**

* Problem is represented in terms of problem states
* Heuristics are employed to go from initial to goal state
* General problem solver works for well-structured domains
* Real-world problems are more complex

**HUMAN ERROR**

* **Human v. Computer**
* **Human**
* Problem is represented in terms of problem states
* Heuristics are employed to go from initial to goal state
* General problem solver works for well-structured domains
* Real-world problems are more complex

**Computation**

* Less than 100 years old
* Reliable
* Consistent
* Based on mathematics
* **Computer**
* Less than 100 years old
* Reliable
* Consistent
* Based on mathematics

**Computation**

* Fast
* Not fault tolerant
* High speed
* Precise
* **The Concept of Error**
* The computer was given information it could not process
* Blame shifted on the human being
* Achieving a goal should be a cooperative endeavor
* Task is not to assess blame but to complete the task
* Types of Errors:
* **Slip –** results from automatic behavior. The types of slips are the ff:

1. **Capture Errors**

* A frequently done activity captures the one intended
* Example: mistakenly dialing telephone numbers with the same prefix

1. 426-6001 - Ateneo trunk line
2. 426-6071 - DISCS direct line
3. **Description Errors**

* An action is performed on the wrong artifact
* Example:

1. Bottles of shampoo and conditioner, especially if they have the same bottle design
2. **Data Driven Errors**

* Triggered by the arrival of sensory data
* Examples:

1. Typing what you are thinking / hearing / seeing and not what is intended
2. Calling someone by the wrong name
3. **Association Activation Errors (Freudian Slips)**

* Verbal / memory mistake that usually reveals the subconscious
* Example:

1. A child calling their teacher “Mom” or “Dad”
2. **Loss of Activation Errors**

* Act of forgetting to do something
* Example:

1. Walking somewhere to get something but forgetting the moment you step into the destination
2. **Mode Errors**

* Action sequence performed in the wrong mode
* Examples:

1. Typing in the password with CAPS LOCK on
2. Using different tools as if it were another

* **Mistake –** stems from conscious deliberation

1. Choice of inappropriate goals
2. Poor decision, misclassifies a situation, or fails to take all factors into account
3. Mental thought is not neat and orderly
4. The disorder leads to creativity, discovery, and great robustness of behavior

* **Failure to Detect Problems**
* User’s ability to detect errors is unreliable
* Relevance bias - people seek confirmatory evidence when evaluating a hypothesis
* Partial explanation - crude agreement between what the user expects and what he sees
* Overlap of model and world - mental model is partially consistent with the world

**DESIGNING FOR EMOTIONS**

* **Why Emotions?**
* Emotions makes the human smart
* Much of human behavior is subconscious
* Affective system helps make judgments
* People without emotions cannot choose between alternatives
* **Effects of Using Emotions for Design**
* Broadening of thorough processes
* Greater creativity
* Greater imagination
* More tolerant of minor difficulties
* **Levels of Emotion-Based Processing**
* **Visceral (Appearance)**
* Pre-conscious, pre-thought
* Appearance matters
* First impressions are formed
* Initial impact of the product (touch, feel, appearance)
* **Behavioral (Pleasure and Effective of Use)**
* Focuses on the use
* Experience with the product:

1. Function
2. Performance
3. Usability

* **Reflective (Self-Image, Personal Satisfaction, Memories)**
* Affected by culture, experience, education, and individual differences
* Can override the visceral and behavioral
* Sophistication vs. popularity
* Long-term relationships
* Consideration of the future

**THE HUMAN**

* Vision
* Hearing
* Touch
* Movement
* **Why do we need to understand Humans in HCI?**
* Humans are limited in their capacity to process information
* This has important implications for design
* Interacting with technology is cognitive
* Human Information Processing is referred to as cognition
* **Optical Illusions**
* These illusions demonstrate that our perception of size is not completely reliable
* **Human Memory**
* It is the ability to store and retrieve the information
* Much of our everyday activity relies on memory
* We need to understand some of the capabilities and limitations of human memory to answer these
* How does memory works?
* How do we remember some arbitrary list?
* Why do some people remember more easily than others?
* Human memory has limited capacity – 7 ± 2 chunks
* There are two methods for measuring memory capacity
* Recall the sequence in order
* Recall the sequence in any order
* **Memory Functions**
* Sensory Memories
* Short-Term Memory or Working Memory (Attention)
* Long-Term Memory (Rehearsal)
* Selection of stimuli governed by level of arousal.

**Human Behavior**

Failure (Unintended Action): Lack of Attention and Good Plan, Lousy Execution

* Slips
* Lapses

Failure (Unintended Action): Solve Problems, Lousy Plan, and Execution is not the Problem

* Mistake

Intended Action

* Mistake
* Violation
* Violation + Error = Disaster
* **Different types of violation:**
* Unintended
* Routine
* Situational
* Optimizing
* Exceptional

**The Three Levels of Emotional Processing**

* **Visceral Level**
* Unconscious, instinctive affective response to external stimuli;
* Completely unrelated to rationality and reasoning.
* **Behavioral Level**
* Analysis of an experience. Translated into an action;
* Ease of use or behavioral experience of a product or service.
* **Reflective Level**
* Conscious thought, interpretation and reasoning;
* Usually a statement of self-image.