Understanding Users – Psychological and Cognitive Perspectives

COMP2044: Human-Computer Interaction (2024-2025)

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Overview

- What is usability?
- The Cognitive Building Blocks:
  - Attention;
  - Memory;
  - Perception.
- Gestalt Principles and their implications for UI design.

Usability

"The capability in human functional terms to be used easily and effectively by the specified range of users, given specified training and user support, to fulfil the specified range of tasks, within the specified range of environmental scenarios."

(Shackel, 2009)

"Usability Evaluation focuses on how well users can learn and use a product to achieve their goals. It also refers to how satisfied users are with that process."

usability.gov

"Usability is a measure of how well a specific user in a specific context can use a product/design to achieve a defined goal effectively, efficiently and satisfactorily."
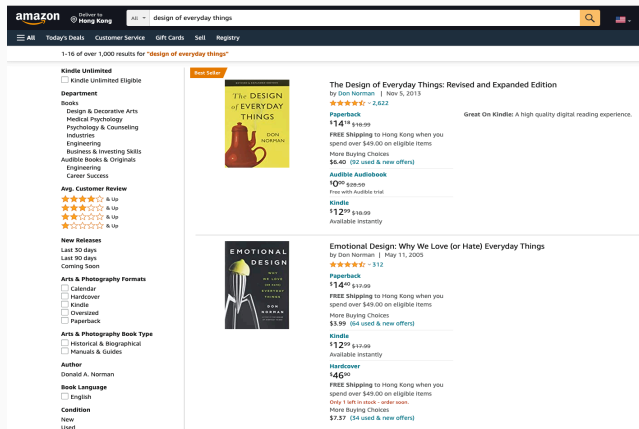
Interaction Design Foundation

Figure 1: A screenshot of Amazon search results for "design of everyday things". On the left is a sidebar with filters such as category, format and customer reviews. The main pane shows two books: "The Design of Everyday Things: Revised and Expanded Edition" as a bestseller and "Emotional Design: Why We Love (or Hate) Everyday Things, both by Don Norman, with prices, ratings and formats.

- This question forms the basis of the contents we'll cover in this module.
- According to the NNGroup, there are five quality components of usability:
  1. **Learnability** - How easy is it for users to accomplish basic tasks the first time they encounter the design?
  2. **Efficiency** - Once users have learned the design, how quickly can they perform tasks?
  3. **Memorability** - When users return to the design after a period of not using it, how easily can they re-establish proficiency?
  4. **Errors** - How many errors do users make, how severe are these errors, and how easily can they recover from the errors?
  5. **Satisfaction** - How pleasant is it to use the design?
- What we'd like you to consider is - how do we measure these components?

Psychological and Cognitive Perspectives

Remember the "H" in HCI?

> 💡 Reflect critically on your group project.
>
> How much have you considered the "Human" during the course of your project's development, thus far?

- The "Human" is often overlooked by developers and designers of interactive systems.
- During this and the next few lectures, we'll consider how usable something is/will be, by considering certain human psychological and cognitive perspectives, including:
    - Basic capabilities;
    - Cognitive processes;
    - The process of completing the task – thinking about what to do, taking the time to do it, etc.
- We'll also introduce predictive models for understanding the process and so not needing to involve users, at least initially.

Cognitive Building Block: Attention

- Human attention is the cognitive process of selectively focusing on something while ignoring other things.
- Attention is limited and selective, so interface designers need to be careful about how they design interfaces to avoid information overload and ensure that important information is easily noticed.
- Modern HCI research uses eye-tracking technology to understand how users visually scan interfaces.
    - Attention leans to the left on websites
        - https://www.youtube.com/watch?v=qJmqwxx6hVo
    - It's interesting to note that attention can be influenced by culture, language and changing trends in interface design - a potentially self-reinforcing cycle.

Cognitive Building Block: Memory

Human Memory

- There are generally three 'types' of memory:
    - **Sensory Memory** - The initial stage of memory in which sensory information from the environment is registered briefly (up to a few seconds).
        - **Computing analogy**: *Buffer/Cache.*
    - **Short Term Memory (STM)/Working Memory (WM)** -These terms are often used interchangeably, but they have different characteristics. STM refers to the temporary storage of information (seconds). WM not only temporarily stores information, but also actively processes and manipulates it.
        - This distinction is crucial in HCI for designing interfaces that take into account the limited capacity of WM and ensure that users can effectively interact with and process information.
        - **Computing analogy**: STM is *RAM*, WM is the interaction between *RAM* and the *CPU*.
    - **Long Term Memory (LTM)** - This is where information is stored for long periods of time, from minutes to a lifetime. LTM has virtually unlimited capacity.
        - It can be difficult to transfer information from STM/WM to LTM, which has implications for interface design.
        - **Computing analogy**: *HDD/SSD.*

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A Simplified Model of Working Memory (A. Baddeley, 2000)
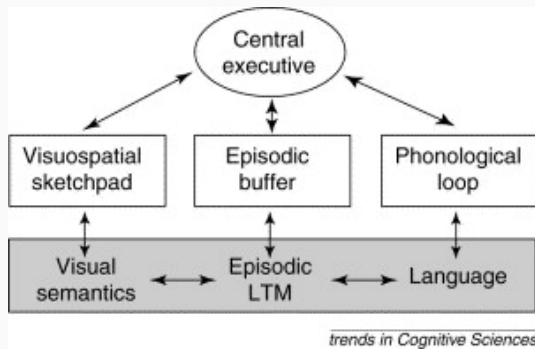

trends in Cognitive Sciences

Figure 2: A diagram of a working memory model originally published in Baddeley's 2000 paper (A. Baddeley, 2000). The model describes three levels, with the top level representing the control centre that oversees the system. The middle level consists of three subsystems responsible for different types of information processing and temporary storage. The bottom level represents the specific content domains with which each of the middle subsystems interacts.

- Often referred to as "Miller's Law" after George A. Miller's 1956 paper (Miller, 1956).
- Miller, a cognitive psychologist, research identified that the average number of objects an average human can hold 7 ± 2 'chunks' of information in their working memory.
  - A 'chunk' is a meaningful unit of information such as a word, a number, or a phrase.
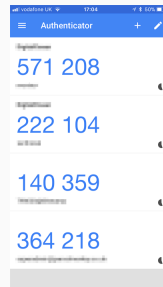- In interface design, we can use Miller's Law to inform the number of items we present to users at any one time.

Figure 3: A mobile APP that displays numeric 2FA codes. Each number/code is split into two chunks of three digits, making it easier to remember and recall the displayed numbers when navigating away from the application.

- Recall is the ability to retrieve information from memory without any cues.
- Recognition is the ability to identify information that has been previously learned after encountering it again.
- Recognition is generally easier than recall. When designing interfaces, we should aim to promote recognition over recall, whenever possible.

Figure 4: A Google search bar with predictive text suggestions dropping down from it. The search bar is partially filled with the misspelled text 'olyimpi', but the suggestions underneath correctly predict 'olympics' and other options. This demonstrates the interface's design to recognize intent and aid correct spelling without the need for exact recall.

Cognitive Building Block: Perception

Human Perception

- Human perception enables individuals to interpret and understand the world around them through sensory information.
- This sensory information is gathered primarily through the five senses: sight, sound, touch, taste and smell.
- The link between perception and HCI is fundamental.
  - Design principles for visual interfaces, such as colour contrast, font size and layout, are deeply rooted in our understanding of visual perception.
  - Similarly, auditory perception guides the creation of sound design, such as feedback tones and alert signals.
  - The study of tactile feedback and haptic interfaces continues to be a vibrant area of HCI research.
- Our discussion today will focus primarily on visual perception, and in particular the Gestalt principles derived from it.

Gestalt Principles

> ### i Gestalt Principles
>
> Gestalt Principles are design principles based on human visual perception that describe how humans group, recognise and process imagery when perceiving objects (when we see *things*). UI designers can use these principles to design interfaces that can be easily understood and visually appealing.

- Gestalt means "Shape" or "Form" in the German language.
- These principles are a set of principles developed by German psychologists in 1920s.
- They focus on visual perception.
- Note - Many of the images in this section are taken from the NN Group's excellent articles on the subject. These are also linked at the end of this PDF.

- Our brain groups objects that are close together.
- We assume that there is a relationship between these objects, or that they are different from other objects shown.
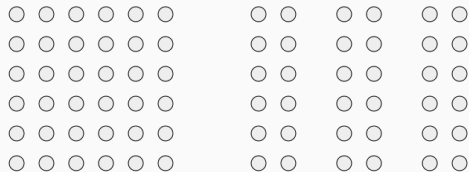- In the example, we perceive the dots as forming three separate groups.

Figure 5: Here we see many identically shaped dots aligned to form columns. Dots closer together are perceived as grouped, creating a visual distinction between the three clusters on the right and the single group on the left.

- Design elements that appear similar in some way.
- Colour, shape, size indicate similarity between objects.
- Presence or absence of this property may indicate grouping.
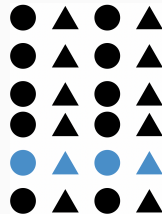
Figure 6: A grid of black shapes, with the exception of a single row of blue shapes. The principle of similarity suggests that we group similar things together, so we naturally see the blue shapes as a different group to the black ones, despite the fact that they are arranged identically.

- People perceive objects as complete, rather than focusing on the gaps that the object might contain.
- In the example, we perceive the two shapes as a circle and a rectangle - but they are not.

Figure 7: The principle of closure suggests that our perception fills in the missing parts of a visual image to create a complete object. We can recognise shapes such as circles and triangles even though they are not complete because our mind fills in the gaps to create familiar patterns.

- Here, the mind perceives objects as symmetrical, forming around a centre.
- In UIs, the elements are distributed symmetrically in relation to the central imaginary axis.
- The Rubin vase is a famous optical illusion that plays on our perception's tendency to seek closure. What do you see?

Figure 8: On the left is a yellow vase with a symmetrical shape. On the right, a white space on a black background forms a similar symmetrical shape. The interpretation of each image can vary depending on what we focus on. Sometimes we see a vase, sometimes we see two faces facing each other.

- Items within a boundary are perceived as a group and are assumed to share a common characteristic or functionality.
- In the example, we assume that the three shaded circles are (more) related to each other than to the unshaded circles.
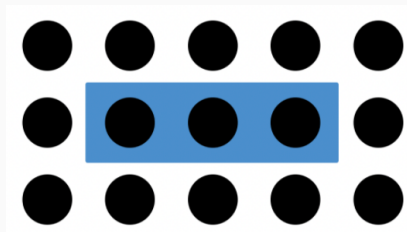
Figure 9: A collection of black circles arranged in a grid, with a horizontal blue rectangle in the centre, enclosing three of these circles. The elements in the blue rectangle are perceived as grouped together, distinguishing them as a separate entity, as they share a common region.

Continuity

- The law of continuity states that we perceive lines, curves or a sequence of shapes as relationships between design elements.
- This can manifest itself as positive/negative space:
    - Positive space is the space in a design that consists of the subject - the image we are including.
    - Negative space is the rest of the space around and between the edges of that object. When we look at a design layout, our eyes tend to draw a line that connects different elements.
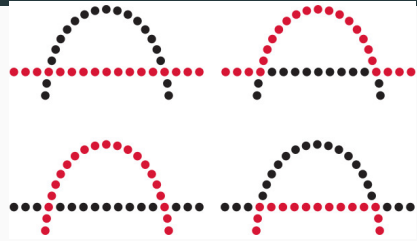

Figure 10: A collection of dots arranged in a 2x2 grid, each forming the shape of an 'A'. Some dots are black, others are red. Because of the principles of continuity, we see that the arrangement of the different colours makes the groups of shapes look different or we perceive them as forming separate shapes.

- **Grouping** - group related items close together and separate unrelated items (Similarity, Proximity, Common Region).
- **Alignment** - place related items along an imaginary line. Align items of equal importance and indent subordinate items (Continuity).
- **Consistency** - make related items look the same (Similarity).
- **Contrast** - make unrelated items look different (Similarity).
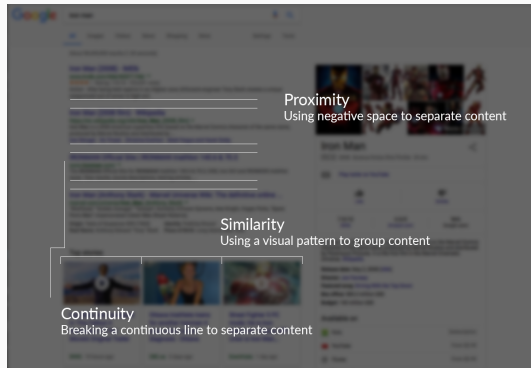- **Combination** - more than one can make the relationship stronger (Similarity, Proximity, Common Region).

Figure 11: A google search result page overlaid with examples of design decisions which have been informed by human visual perception. Image Credit - vladmargulis on Medium

Applying Gestalt Principles

Revisit the Amazon search results page and identify how Gestalt Principles have been applied in the design of the page.
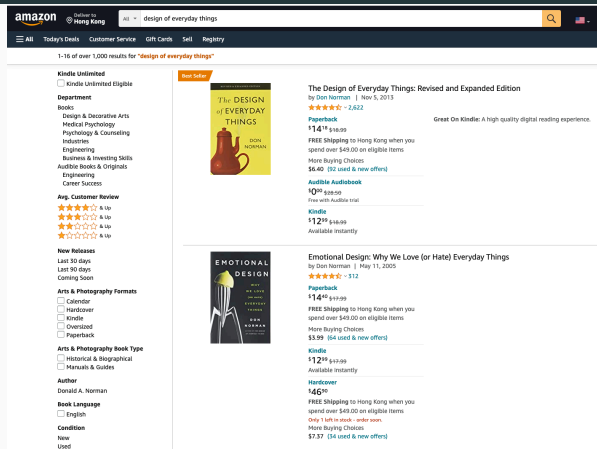

Figure 12: The same screenshot as Figure 1.

- This remote control follows the principles of Gestalt. Should it be considered an example of good design?
- Remember, these are principles derived from observed behaviours in the way the human visual system perceives things.
- They do not necessarily mean that designs that follow these principles will be good.
- But these principles can be used to inform design.

Figure 13: A ~50cm, 399 button TV remote control, with colour coding of the buttons potentially indicating common functionality. Although this is an artistic concept, it illustrates that shape alone does not guarantee that a product is well designed. Image credit and further information - artlebedev

Figure 14: A US tax return form with poor spacing between fields makes the form difficult to complete. The close proximity of the fields makes it difficult for the person completing the form to distinguish between the fields. This could be solved by increasing the spacing (proximity) between unrelated lines/fields. Image Credit - NN Group

Summary

- Usability is a measure of how well a specific user in a specific context can use a product/design to achieve a defined goal effectively, efficiently and satisfactorily. We haven't yet discussed how to measure this yet.
- We've covered the basic cognitive building blocks of attention, memory and perception, and how their limitations and characteristics can inform interface design.
- Gestalt principles are design principles based on human visual perception that describe how humans group, recognise and process imagery when perceiving objects. We discussed how these principles can inform visual interface design.

Reference Material

Web Articles

- Usability 101: Introduction to Usability
    - https://www.nngroup.com/articles/usability-101-introduction-to-usability/
- Working Memory Model (Baddeley And Hitch)
    - https://www.simplypsychology.org/working-memory.html
- Memory Recognition and Recall in User Interfaces
    - https://www.nngroup.com/articles/recognition-and-recall/
- NN Groups Articles on Gestalt Principles:
    - https://www.nngroup.com/articles/gestalt-similarity/
    - https://www.nngroup.com/articles/common-region/
    - https://www.nngroup.com/articles/gestalt-proximity/
    - https://www.nngroup.com/articles/principle-closure/

Baddeley, A. (2000). The episodic buffer: A new component of working memory? *Trends in Cognitive Sciences*, *4*(11), 417–423.

Baddeley, A. D., & Hitch, G. (1974). *Working memory* (G. H. Bower, Ed.; Vol. 8, pp. 47–89). Academic Press. https://doi.org/10.1016/S0079-7421(08)60452-1

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review*, *63*(2), 81.

Shackel, B. (2009). Usability–context, framework, definition, design and evaluation. *Interacting with Computers*, *21*(5-6), 339–346.