HCI Lecture 4:
Human capabilities: Conceptual models

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Key points:
- Reducing cognitive load
- Mental Models
- Metaphors
- Describing the conceptual model: objects and actions
- Deriving and applying conceptual models

Human constraints
- For successful interaction, an interface design should match human capabilities
- Have discussed match to perceptual, motor and memory systems, and how to ‘reduce the load’ on each, e.g.:
  - Minimise movement time by reducing distance, enlarging target
  - Allow successful visual search by enhancing visual salience with contrast rather than colour or detail
  - Don’t expect users to hold more than three things in memory
- Similarly, we might say our aim is to reduce the cognitive load, by minimising the complexity of processing
  - In later lectures will examine some attempts to define this ‘complexity’ explicitly

Human constraints
- In more general terms, we want the user experience to be productive and enjoyable
- This requires more than surface level design
- The starting point for design of any complex artifact or system should be a conceptual model

Conceptual model
- A conceptual model is the designer’s intended mental model for the user of the system: a set of ideas about how it is organized and operates.
- Norman (1986) called this the design model:
Mental models

- Affordances (previous lecture) are directly perceivable and easily recognised opportunities for action.

- More complex actions require some knowledge or understanding of how the artifact functions.

- We form a mental model of the function, which we use to predict the likely result of our actions, and hence choose what to do for a desired outcome.
  
    - Example: You walk into a cold house where the heating is off, and want to heat it as fast as possible. After switching the heating on, would you also turn up the thermostat setting?

Conceptual models and metaphor

- A powerful but risky method in design is to exploit the user's existing mental models by using metaphor, i.e. "X is like Y".

- This is a very natural mode of thought for humans.

- Examples:
  
    - Word processing vs. typewriter
    - The 'desk top'
    
      Domain: "Can I change the arrangement of my documents?"
      Semantic: "What is the wastebasket for?"
      Syntax: "What is the procedure for throwing a document away?"
      Lexical: "How do I perform the action of throwing a document away?";
        "How do I open a folder?"

    - Spreadsheets
      
        • Ledger sheet analogy proposed in 1979 (http://www.bricklin.com)
        • Extends from metaphor by adding interactivity and computation

Learning and Metaphor

- Exploiting existing knowledge for learning
  
    - Need entity resemblance to prompt appropriate metaphor
    - Need relational resemblance to support correct mapping

- Users prefer 'learning by doing' or ('learning by observing')
  
    - Metaphor provides obvious clues for systematic investigation

- Mismatches prompt investigation and learning
  
    - Correspondences, non-correspondence and indeterminate correspondence

- But can lead to very poor design...
Design and Metaphor

- A metaphor can have a big impact so should be carefully considered:
  - How much structure does it provide?
  - How much is really relevant to the problem?
  - Is it easy to represent?
  - How extensible is it?
- Problems:
  - Breaking conventional or cultural rules
  - Constrain designers in the problem space
  - Conflict with design principles
  - Forces user into one mode of understanding
  - May transfer over bad design
  - May limit imagination for new conceptual model

Conceptual models consist of objects and actions

The conceptual model should specify the following objects:
- metaphors or analogies used, if any
- the (user-level) concepts to be created and manipulated
- the relationships between concepts, e.g.
  - attributes has-a
  - specialisations is-a
  - containment contains
- the mappings between concepts and task domain

Conceptual models consist of objects and actions

The conceptual model should also specify/discuss the following actions:
- the functions performed and by whom: task allocation
- the relationship between functions
  - order relative position; sequential, parallel
  - importance frequency or conceptual importance
  - categorisations e.g., by action taxonomy, or object concerned
- how data is captured, transformed, and output

Example (sketch)

ONLINE LIBRARY

metaphor information is organised as a physical card catalogue
concepts item, book, periodical, issue, DVD, shelf-mark, user account, librarian, . . .
object relationships a book is a type of item;
periodicals contain issues
mappings item corresponds to a physical object;
shelf-mark to its physical location
functions issue item, return item, search item
function relationships issue before return for same item; for different items, in parallel, . . .
data new items added by typing data
Deriving conceptual models

- To determine the objects and actions a good approach is to try to elicit the user’s declarative knowledge about the task
- May be able to draw on established conventions or existing documentation to identify objects and actions
- Ask users to list objects and actions, or derive nouns and verbs from structured interviews, then sort into taxonomies
- Method of ‘laddering’:
  - Start with seed item: *typefaces*
  - Move down taxonomy using prompts:
    - Move down: *can you give examples of typefaces?*
    - Move across: *alternative ways to change text appearance?*
    - Move up: *what do Verdana and Helvetica have in common?*
- More formalised, this is a process of Task Analysis (next lecture)
- Example application is menu layout

Example

- Write down your own mental model of how a cash machine (ATM) works
- Answer the following:
  - What happens to prevent you taking out more than the limit by using several machines in turn?
  - What information is on the card itself, and how is it used?
  - Why are there pauses between steps, and why are they duration they are?
  - What happens to the card while in the machine?
  - Do you count the money? Why or why not?
- Now ask two other people the same questions and compare your mental models.


Summary

- A conceptual model
  - is a starting point for interaction design
  - should help the user “figure it out”
- It helps design team:
  - Not to become narrowly focused early on
  - Ask questions about how the conceptual model will be understood by users
  - Establish a set of common terms they all understand and agree upon (a standard lexicon for the project)
  - Develop a system and interface that users understand

See Johnson and Henderson (2002) for more motivation and methodology.

References/Further Reading

- Dix et al., 3rd ed: chapter 6 & 7