DEPARTMENT OF COMPUTER SCIENCE
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HUMAN-COMPUTER INTERACTION

Lecture 11

DESIGN AND ENVISIONMENT; METAPHORS AND MENTAL MODELS

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11.1 “Task analysis” of the future — Envisionment

Envisionment is the production of scenarios or other artifacts such as scripts, storyboards, or interactive prototypes for interface visualization

Envisionment for designing interfaces
- Visualizing concepts
- Exploring alternatives
- Resolving feature details
- Developing interaction scenarios (e.g., “Day in the Life”)

Envisionment for pre-testing interfaces
- Can you read or interpret this?
- Can you follow this?
- Can you make this work?
- Do you understand what is going on?

Envisionment for presenting interface ideas
- To interface designers, for discussion
- To programmers, to guide implementation
- To marketing and management, to guide product design
- To users, to get early feedback

Another term... “smoke and mirrors” *(But don't you be fooled!)*

Envisionment tools for interface visualization
- Scripts, scenarios... “A Day in the Life”
- Role-playing exercises
- Drawings, sketches, screen shots
- Storyboards
- Collections of post-its and cut-outs
- Physical models
- Computer animation
- Interact. software prototypes (e.g., w. HyperCard, Director)

11.2 Interdisciplinary design

Why interdisciplinary design?
- Need for understanding of users and tasks
- Need for communication with users
- Need for envisionment of design possibilities
- Need for creation of rich, sensual, interactive media
- Need for evaluation of system and interface success

These needs require many skills and perspectives not normally possessed by most computer scientists

Need for clash, synergy of perspectives and priorities
- Example: Computer science and graphic design
  - Computer scientists value the program and how it works
  - Graphic designers value the picture, screen, interaction and how it looks and feels

Disciplines contributing to user interface design
- Computer science
- Psychology
- Sociology
- Organizational behaviour
- Anthropology
- Linguistics
- Graphic design
- Industrial design
- Task specialists, “users”

Need for accessibility of prototyping media to people who are not computer specialists

11.3 The development of interface ideas

Envisionment for interface visualization
- Scenarios, prototypes
- The role of prototyping media

But where do ideas come from?
- From imagination
- From observations of current work practice
- From observations of current systems
- From insights from other media, e.g., film, animation, graphic design, information display, industrial design, theatre, architecture
- From analogies and metaphors (11.5)

Views of a system become conceptual (mental) models (11.6), enabling users to understand the system

11.4 A successful interface metaphor and mental model

Electronic desktops pioneered by Xerox Star, Apple Macintosh
- Familiar users' conceptual model on a “simulated desktop”
- Electronic equivalents of *paper, filefolder, filing cabinets, trash cans*

Key cognitive issues
- *Users' conceptual (mental) model*
- Building parallels to office concepts, objects, and operations:
  - A *computer system* **is** an *electronic office*
  - (a metaphor)

11.5 Metaphors

What are mental models? How can they be conceptualized?

Often they relate the structure and function of a system to that of another, “simpler” system with which we should be familiar

The goal is to exploit specific prior knowledge that users have of this other domain

We use *metaphor* (an X is a Y) meaning X is like Y in certain (many) respects

Examples:
- Football is (like) war
- War is (like) football
- Text editor is (like) a typewriter
- Text editor (line oriented) is (like) writing on cards in card file
- Memory is (like) a set of pigeonholes
- Screen is (like) a television
- Screen is (like) a desktop in an office
- LOGO procedures are (like) cooperating “little people”
- For other examples, see Table 11.1

But $X \neq Y$, otherwise we would have an identity, not a metaphor

Interesting aspects of metaphor are areas of mismatch, breakdown
- Division into 3 sets:
  - { Metaphor works, doesn't work, not applicable }

Example: Editor is a typewriter
- Works: Input of text, form of text, appending text
- Doesn't work: Instead of *type over,* there is *insert* or *change*
- No parallel: *Block move* (cut & paste of pieces of paper)

Table 11.1 Examples of commercially available and prototype software systems illustrating key metaphors (from article by Carroll, Mack, and Kellogg in Handbook of Human-Computer Interaction*, 1988, p. 68)*

TYPE THIS IN!!!!!

11.6 Mental models

Metaphors and mental models

> "Metaphors function as natural models, allowing us to take our knowledge of familiar, concrete objects and experiences and use it **to give structure to more abstract concepts**." (Erickson, L, p. 66)

Definition of mental models (Carroll, 1984):

> "...structures and processes imputed to a person's mind in order to account for that person's behaviour and experience."

More generally (Carroll & Olson, 1988):

> "...all of what a user knows about using a particular piece of software, including *how to use it*, and how it works."

Role of mental models – To answer questions like:

- What is X?
- What happens when you do Y?
- Why do Z?

Example: Mental model of a simple line drawing system

- Objects: Page, line, point
- Relations
  - Page contains 0 or more lines
  - Line connects 2 points
- Actions on objects
  - Page: Clear
  - Points and lines: Create, delete, move
- Attributes of objects
  - Line: Color, style, weight
  - Point: Type
- Actions on attributes
  - Line: Change color, style, weight
  - Point: Change type

Examples: HyperCard, Director
HyperCard's central model is that of card, stack of cards
Director's is that of sequencing images through time

Designer=====> System <======> User

We need to think very precisely, distinguishing between:
1) System
2) *Designers' Conceptual Model* of the System
3) Users' Image of the System – *System Image*
4) *Users' Mental Model* of the System
5) Scientist's *Conceptualization* of that Mental Model
(will ignore for now)

1) System built by designer

2) Designers' conceptual model – ideally, a coherent structure behind the design

3) System Image –view of system seen by user
Objects, commands, options, states, etc.
Not necessarily coherent, logic may not be apparent
For learners, a view through a peephole, system emerges little by little through training, use, exploration

4) Users' mental model – Eventually, if structure is there, user may discover it, induce a coherent model of the system

If design is appropriate, if learning environment works, users' mental model will reflect designers' conceptual model

Goal of design is often to hide the system image, as for example replacing controls over flow of hot and cold water taps with temperature and flow of one water stream

Remarks re (users') mental models (Norman, BB, pp. 241-244)
- Incomplete
- Unstable, decays through forgetting
- Can't be “run” perfectly
- Similar devices have overlapping mental models
- "Unscientific" – Coloured by superstitious beliefs
- Goal of parsimony – People build the simplest mental models they can get away with

Attempt to build more and more complete, formal, and precise models of cognitive processes of user, of their mental models, and of the methods such as metaphor that assist in the development of mental models (later in term)

11.7 A mental model for a memory prosthesis

Assume you can carry a personal digital assistant that can keep track of events in your work life

Research, such as that described earlier on memory problems, asserts that we remember events in terms of memory schemas and that they have five kinds of properties:

- Time of event
- Subject experiencing event
- Location of event
- People present at event
- Focus of event, e.g., meeting, document, phone call, etc.

Forget-Me-Not prototype built around this mental model of events and that of *threads* linking sequences of events (Figure 11.1)

Each location, person, document, etc. is an object, and each object has a thread linking all events in a user's autobiography in which the object took part, so there are threads for the Conference Room, a phone, a memo, etc.

See N&L, Case Study B, for details on how this is applied

Figure 11.1 The Threads model (N&L, 1995, Fig. B.10, 432)

11.8 From envisionment and mental models to systems

Envisionment and experimentation with various metaphors and mental models requires flexible tools for rapidly constructing prototypes of new systems and interfaces

We therefore need powerful tools for rapid prototyping

The ultimate systems are complex and must interact rapidly and reliably with their users, and must be flexible and robust enough to deal with all kinds of unanticipated behaviour from their users

We therefore need powerful tools for developing user interfaces

Sometimes these tools are the same, often they are different

This is our next topics