COMP10092

Human Computer Interaction

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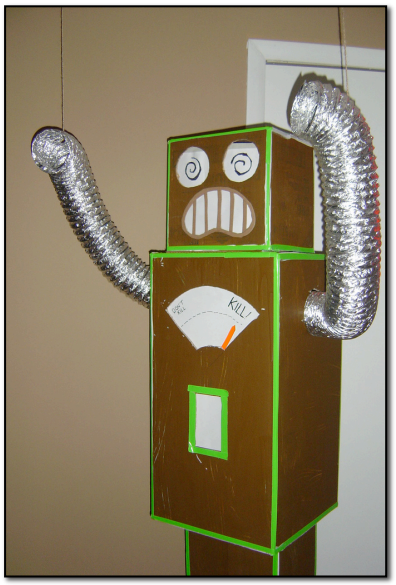
Why HCI?



To optimise performance of human and computer together as a system

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Resources

- Alan Dix, Janet Finlay, Gregory D. Abowd and Russell Beale. *Human-Computer Interaction* (3rd edition). Prentice Hall, 2004.
  - http://www.hcibook.com/e3/
- Ben Shneiderman. *Designing the user interface: Strategies for effective human-computer interaction (3rd ed.)*. Addison-Wesley Publishing, 1998
  - handouts
- Jakob Nielsen on Usability and Web Design
  - http://www.useit.com/
- Donald Norman *The design of everyday things*. Basic Books, 2002

What is HCI?

- "the study of the interaction between *people*, *computers* and *tasks*" (Johnson)
- "a very difficult business. It combines two awkward disciplines: *psychology* and *computer science*" (Thimbleby)
- "The ideal designer of an interactive system would have expertise in … *psychology* … *cognitive science* … *ergonomics* … *sociology* … *computer science* … *engineering* … *business* … *graphic design* … *technical writing* … and so it goes on" (Dix et. al)
- Teamwork and a recognition of non-Computer Science specialisms

Why is HCI Important?

- HCI can assist in building products/systems that are
  - *Useful*, accomplish what's required
  - *Usable*, do it easily and naturally
  - *Used*, make people want to use them
- Increasing participation
  - Ensuring interfaces and systems are accessible.
- International Directives and Standards (EC Directive 90/270/EEC; ISO 9241) place requirements on systems in terms of usability
- Safety and Security
  - Remember those robots…..

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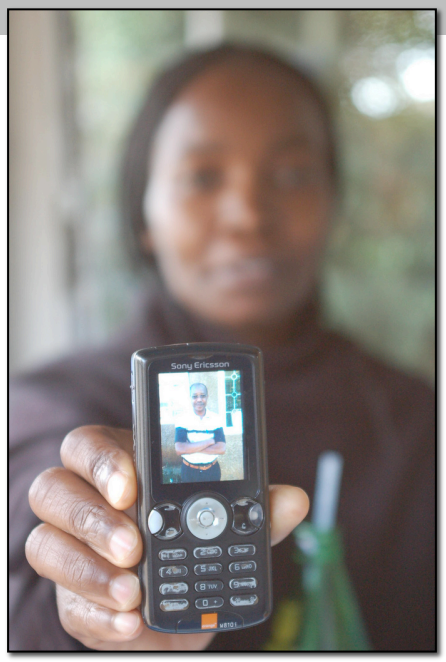

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Everyday things

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http://www.flickr.com/photos/tomasfano/2885450065/

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Alternatives

http://www.flickr.com/photos/soapbeard/2654965481/

http://www.flickr.com/photos/szudi/2473004057/

http://www.flickr.com/photos/8586443@N03/2450347082/ MP10092 HCI and Accessibility 10

Affordance

- Describes the perceived and actual properties of an object.
  - Buttons are for pushing
  - Slots are for inserting things into
  - Handles are for pulling
- Constraints
  - Limit the possibilities
  - Size of hole/slot

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http://www.flickr.com/photos/jmmason/2093621345/

Interaction

- Computer-Computer Interaction
  - Well-defined protocols (e.g. TCP/IP)
  - Restricted
  - No margin for error
- Human-Human Interaction
  - Evolving
  - Informal
  - Error-prone, but *corrective*
- Human-Computer Interaction
  - User's Conceptual Model (UCM)
  - Study of task: modelling
  - Evaluation of interfaces (experimentation)
  - Design Guidelines: distillation of design and experimental results
  - UI design must be an integral part of system design process, not a last-minute add-on.

Humans

- User's Conceptual Model (UCM)
  - of task and tool interface
  - skills, knowledge
  - prior experience
  - metaphors
  - patterns
  - associations
- Humans
  - make mistakes
  - change their minds
  - are inconsistent
  - forget things
  - overlook things

BUT…

- Humans are adaptable and able to learn
- Different kinds of users
- Different kinds of tasks
- Good UI design must account for Humans and their different needs!

Models

- *Models* can help us understand complex systems
  - Approximations that identify key characteristics of the system that we are observing
    - Model Human Processor; Semantic network (memory); Task Action Grammar (TAG): to describe interaction sequences; State Transition Networks; Process algebras; Temporal logics; Keystroke-level models, e.g. Fitts' Law; etc.
- Model Human Processor.
  - attempts to describe/approximate some (parts of) the system
  - assists in understanding how to build systems
  - informs our design choices
- *Experiments* help us in constructing such models.

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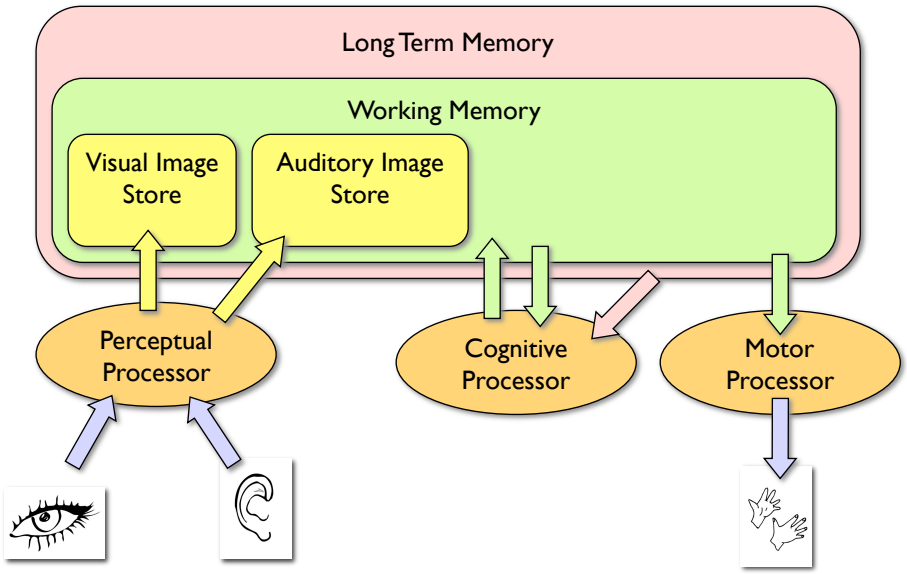
Model Human Processor

- Developed and tested via numerous experimental studies
- Card, Moran, Newell (1983) The Psychology of Human-Computer Interaction
- A simple "computer" architecture:
  - Perceptual processor
    - storage of signals from senses + brief memory
  - Cognitive processor
    - Working memory
    - Long-term memory (LTM)
    - Think, analyse, recall from LTM, store in STM
  - Motor processor
    - Transmit signals to muscles etc.

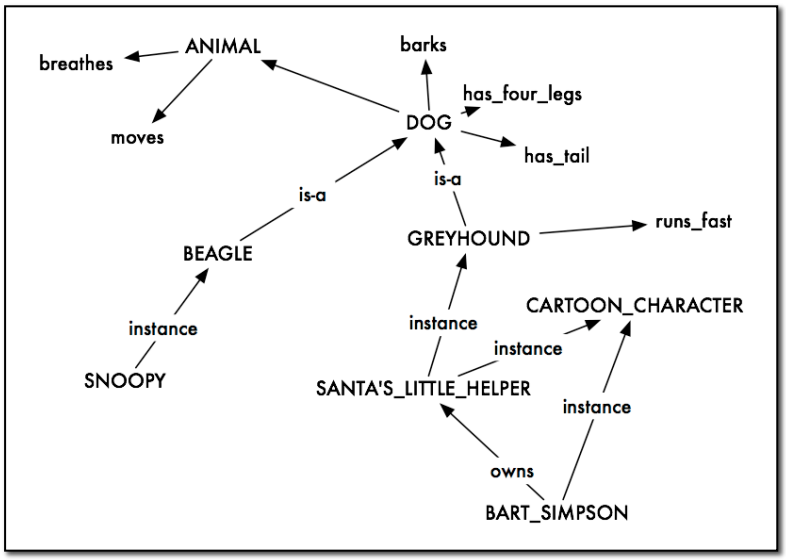
Model Human Processor



Model Human Processor

- Perceptual processor:
  - ~100ms cycle [50-200] attention; change blindness
- Cognitive processor:
  - ~70ms cycle [30-100]
  - Recognize-act cycle
- Working Memory
  - Limited capacity: 7 (plus or minus 2) items
  - Decay: ~ 7 secs
  - Chunking (cf experiments)
  - Interference reduces chances of retrieval
- Long-term Memory (LTM)
  - Links/associations
  - Capacity ~ ∞
  - Decay ~ ∞
  - Association; priming; gist
  - Interference reduces chances of retrieval
- Motor Processor:
  - ~ 70ms cycle [25-175]

Long Term Memory: Semantic Networks



Motor Processor: Mouse-Gesture Analysis

- Fitt's Law:

$$T_{move} = a + b.log(D/S + 1)$$

- *D*: distance to move
- *S*: size of target
- *a* and *b* constants depending on particular context.
- In other words, to reduce time taken:
  - Reduce the movement distance
  - Make the target bigger

Modelling Interaction

- Interaction models or frameworks can help:
  - in understanding what is going on when humans interact with a system.
  - identify points of failure and likely causes of difficulty.
- Interaction aids a user in accomplishing **goals** from a **domain**. **Tasks** manipulate concepts, and a **goal** is the desired output from a task. An **intention** is a specific action required to meet the goal.
- The **System** uses a **core language**, while the **User** uses a **task language** to describe relevant concepts.

Execution - Evaluation (Norman)

- User formulates a plan, which is then executed.

1. Establishing the goal
2. Forming the intention
3. Specifying the action sequence
4. Executing the action
5. Perceiving the system state
6. Interpreting the system state
7. Evaluating the system state with respect to the goals and intentions

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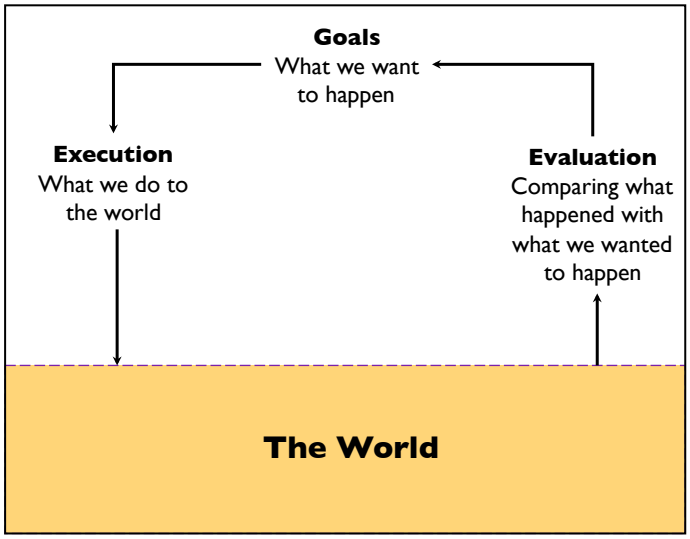
Execution - Evaluation



Execution - Evaluation

Gulf of Execution

Difference between user's formulation of the the actions to reach the goal and the actions allowed

Gulf of Evaluation

Distance between the physical presentation of the system state and the expectation of the user.

Psychological gap that needs to be crossed in order to interpret a user interface

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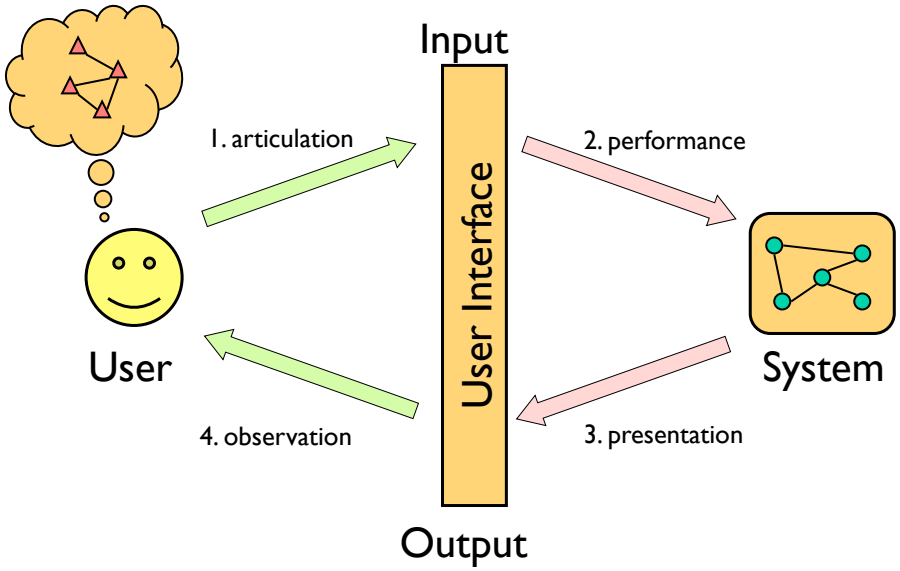
Slips and Mistakes

- If I understand a system, but mistype or accidently press the mouse button at the wrong time, I've made a *slip*.
  - I formulated the correct **action** but it was not **executed** correctly.
- If I don't understand the system, then I may make *mistakes*. E.g. I think this button:

is for search, but it actually magnifies the text. This is a mistake.
  - I haven't formulated the right **goal**.

Interaction Framework (Abowd & Beale)



Interaction Styles

- Command line
- Menus
- Natural Language
- Direct Manipulation
- Form-Fill

Command Line Interfaces

Advantages

- quick and powerful for experienced users
- user-controlled interaction
- minimal amount of typing (no mouse use)
- can be used in conjunction with other user interfaces

Disadvantages

- little or no prompting
- requires user's knowledge of system, programs
- relies on *recall* of commands and syntax
- difficult to learn
- error prone

Menu Interfaces

Advantages

- Users don't have to memorize complex commands
- Structured navigation benefits novices and casual users
- Can shorten user learning time and effort
- Supports *recognition* memory

Disadvantages

- May not be appropriate or efficient for some users and tasks
- Can force user through many levels of menus
- Users may get lost in menu hierarchies
- Menu terms and names may not be meaningful to users
- Use of modes forces users to follow the system's path

Direct Manipulation Interfaces

Advantages

- Visual presentation of task concepts
- Allows easy learning
- Encourages exploration

Disadvantages

- Can be hard to implement
- Requires graphics display/ pointing devices

Natural Language Interfaces

Advantages

- Relieves the burden of learning special syntax

Disadvantages

- Requires clarification
- More keystrokes
- Unpredictable

Form Fillin

Advantages

- Simplifies data entry
- Minimal training

Disadvantages

- Screen real estate

Guidelines

- Guidelines, heuristics and "golden rules" can help us in designing and building user interfaces that aim to fulfill the goals of optimising user/ system performance.
- They don't *guarantee* that your interface/system will work!

Schneiderman's Golden Rules

1. Consistency
2. Shortcuts for frequent/trained users
3. Provide informative feedback
4. Design dialogues to yield "closure"
5. Error prevention and handling
6. Easy reversal
7. Internal locus of control
8. Reduce short-term memory load

Nielsen's 10 heuristics

1. Visibility of system status
2. Match between system and the real world
3. User control and freedom
4. Consistency and standards
5. Error prevention
6. Recognition rather than recall
7. Flexibility and efficiency of use
8. Aesthetic and minimalist design
9. Errors: recognise, diagnose and recover
10. Help and documentation

http://www.useit.com/

Norman

- Make it easy to determine what actions are possible at any moment
  - well-designed things can only be put together certain ways (e.g. trapezoidal cable plugs, SIM cards)
  - menus only display the actions which can be carried out at that time (other options are dimmed).
- Follow *natural mappings* between intentions and the required actions, between actions and the resulting effect; and between the information that is visible and the interpretation of the system state
  - it should be obvious what the function of a button or menu is - use conventions already established, don't try to design something which changes what people are familiar with

In other words, make sure that the user can
1. figure out what to do, and
2. tell what is going on.

Users in Design

- Think "User"
  - Remember that *somebody* (and most likely *somebody else*) is going to use the system.
- Try it out
  - Sit a user down with an early version of the interface. Record what the user thinks/does
- Involve the users
  - Users will have lots of valuable knowledge about the domain. Get them to contribute.
- Iterate
  - Make early prototypes and be prepared to throw them away.

Evaluation: How Good is your UI?

- Observations
- Interviews
- Sound experimental methodology: how to obtain meaningful, reliable results

- Experiments:
- What to measure?
  - effectiveness,
  - efficiency,
  - learning,
  - errors,
  - aesthetics…
- When to measure it?
  - during design?
  - after design
  - prototyping?

HCI

- Should be integral to system design
- Models and understanding of users important
  - User's Conceptual Model
- Developed on a large body of scientific work
  - Guidelines distilled from scientific work can be useful
- Prototyping and Evaluation
- Future technology for interfaces
  - e.g. virtual reality; 3D; audio

- Further focus on this topic in 2nd Year (e.g. COMP20341)