HCI Lecture 1:
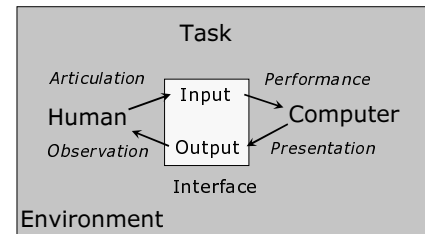**Principles and Guidelines**

Barbara Webb

- Complex problem: we don't have a full theory of the parts, or their interactions
- Note that a particular desired outcome may be best achieved by changing any one of these factors or interactions.


Related fields

- *"Human-computer interaction is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them."* Association for Computing Machinery
  - Equivalent terms are CHI and MMI
  - Usability Engineering focuses on design and implementation process
- Earlier fields of Human Factors & Ergonomics
  - More stress on physical issues; and on optimising (work) processes; concerns interaction with all kinds of human artifacts
- User Interface Design
  - Focus on interface, i.e. tends to assume deeper function is fixed
- User/Human Centred Design
  - Approach to software engineering with user focus at all stages
  - Participatory Design explicitly includes users in design process
- Interaction Design
  - Wider scope than computer, and more emphasis on cognitive/experiential factors than traditional HF.

HCI in the design process

- Waterfall model
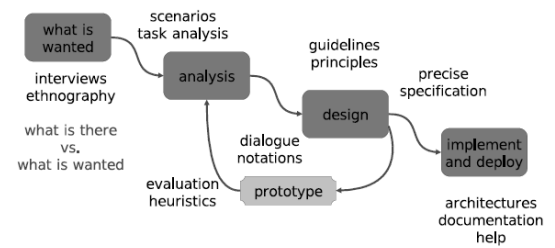
[Dix et al, p.195]

HCI in the design process

- The spiral lifecycle model (Boehm, 1988): importance of iteration in good design

  Fig 9.9 in Sharp, Preece & Rogers, 2007, p.451

- Agile development e.g. eXtreme Programming (agilemanifesto.org): emphasises tight iteration in short timescales, close collaboration with customer

  Fig 9.14 in Sharp, Preece & Rogers, 2007, p.458

Design Rules for HCI

- Many sets of rules have been proposed to encapsulate understanding and best practice
  - Operate at various levels
- principles
  - abstract design rules
  - "an interface should be easy to navigate"
- guidelines
  - advice on how to achieve principle
  - may conflict; understanding theory helps resolve
  - "use colour to highlight links"
- standards
  - specific rules, measurable
  - "MondoDesktop links are RGB #1010D0"

- **ISO 9241**, *Ergonomics of Human System Interaction*, adopts traditional usability categories with specific measures, e.g.:

Usability objective	Effectiveness measures	Efficiency measures	Satisfaction measures
Suitability for the task	Percentage of goals achieved	Time to complete a task	Rating scale for satisfaction
Appropriate for trained users	Number of power features used	Efficiency relative to expert user	Rating scale for ease of learning
Learnability	Percentage of functions learned	Time to learn criterion	Rating scale for ease of learning
Error tolerance	Percentage of errors corrected successfully	Time spent on correcting errors	Rating scale for error handling

Shneiderman's 8 Golden Rules (1987):
1. Strive for consistency
2. Enable frequent users to use shortcuts
3. Offer informative feedback
4. Design dialogs to yield closure
5. Offer error prevention and simple error
6. Permit easy reversal of actions
7. Support internal locus of control
8. Reduce short-term memory load

Norman's 7 Principles (1988):
1. Use both knowledge in the world and knowledge in the head.
2. Simplify the structure of tasks.
3. Make things visible.
4. Get the mappings right.
5. Exploit the power of constraints, both natural and artificial.
6. Design for error.
7. When all else fails, standardize.

Nielsen's 10 Usability Heuristics (1994):
1. Visibility of system status
2. Match between system and the real world
3. User control and freedom
4. Consistency and standards
5. Help users recognize, diagnose and recover from errors
6. Error prevention
7. Recognition rather than recall
8. Flexibility and efficiency of use
9. Aesthetic and minimalist design
10. Help and documentation

E.g. Consistency (Nor 7,Shn 1, Nie 4)

- **Learnability**
  - the ease with which new users can begin effective interaction and achieve maximal performance
- **Flexibility**
  - the multiplicity of ways the user and system exchange information
- **Robustness**
  - the level of support provided to the user in determining successful achievement and assessment of goal-directed behaviour

Learnability (1 & 2)

Predictability — determinism and operation visibility
- System behaviour is observably deterministic:
  - *Non-deterministic delays should be avoided*
  - *Operation effect determinable by interaction history*
- operation visibility:
  - *user actions should be matched by a response*
  - *logical constraints should be used to indicate available actions*:

Synthesisability: the user can assess effect of past actions
- Users like Direct Manipulation (DM) interfaces because of their promise of *immediate honesty*, but sometimes have to satisfied with *eventual honesty*
- Command Line (CL) interfaces are never honest:

Learnability (3)

Familiarity: match the interface to users' expectations:
- how prior knowledge applies to new system
  - *guessability of the system*
  - *e.g. regions on the screen which denote buttons should be shaded to give a three-dimensional appearance*

- knowledge of task and of other systems
- use of metaphor (e.g. tab-stops in word-processor)
- use of natural language syntax

Learnability (4 & 5)

Consistency — likeness in input/output behaviour arising from similar situations or task objectives
- challenge (and danger): consistency not self-contained
  - consistency within screens
  - consistency within applications
  - consistency within desktop
  - . . .
- Examples: consistent patterns in layout; same short-cut keys for similar action; same placement for recurrent menu options
  - *Always place the Quit command as the last item in the leftmost menu*

Generalizability — extending specific interaction knowledge to new situations
- a form of consistency?
- UI standards and guidelines assist/enforce generalizability
  - *applications should offer the Cut/Copy/Paste operations whenever possible*

Flexibility (1 & 2)

Dialogue initiative: give user control of the dialogue flow
  - *user should be able to abandon, suspend or resume tasks at any point*
  - *minimise system pre-emptive dialogue and maximise user pre-emptive dialogue*

Multi-threading: provide support for simultaneous tasks
- concurrent vs. interleaving; multimodality
  - *provide multiple task contexts*

Flexibility (3)

Task migratability: negotiability of function allocation between user and system
  - People get bored doing routine tasks and stop concentrating
  - *automate routine tasks, but don't fix function allocation*

People are better at	Machines are better at
Detecting small sensory inputs	Responding quickly to signals
Improvising and using flexible procedures	Following procedures repeatedly, precisely
Reasoning inductively	Reasoning deductively
Selective information recall	Total information recall
Exercising judgement	Following orders

Flexibility (4 & 5)

Substitutability: equivalence for different forms of input expression
  - *don't force users to refer to objects by name if they can point to them*

Customisability: interface is capable of being adapted to suit different needs
 - *provide choice of methods; allow short cuts; permit users to change system features -- 'deferred design'*

Observability: user should be able to evaluate the internal state of the system from its perceivable representation

- E.g., *Where[3]What* of navigation:
  - **W**here am I? — immediate honesty wrt system state
  - **W**here am I going? — operation predictability
  - **W**here have I been? — synthesisability
  - **W**hat can I do now? — predictability

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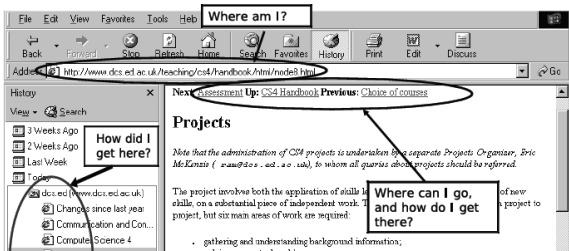
Recoverability: support for undoing errors

- ability of user to take corrective action once an error has been recognized
- reachability
  - *user should be able to undo back to any point*
- supported by reducing scope for making errors
  - *avoid free-form input where possible*
  - *validate input immediately, allowing correction*
- . . . and ability of user to understand errors
  - *error messages should be concise, informative, specific, constructive*

Poor error message	**Better error message**
Error 404: document not found	The requested URL http://www.xyz.com/blah.html is not valid.
	This may be because the URL is incorrect or because the information pointed to no longer exists.

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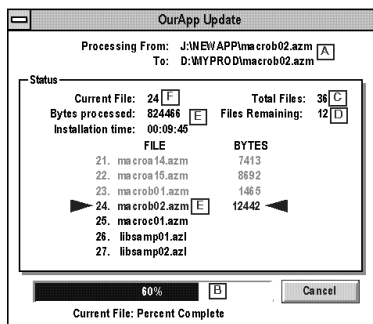**Responsiveness**: feedback should be commensurate with action

- sensitivity to delay depends on context:
  - Echoing input < 0.1 secs
  - Page turning < 0.5 secs
  - String search < 4 secs

- Provide time *affordances* if delays are unpredictable
A. Acceptance
B. Initiation and Heartbeat
C. Scope
D. Remainder
E. Progress
F. Completion

Task conformance: interface functionality should match common user tasks

- Few general purpose commands, long methods, simple
- Many highly tuned commands, short methods, complex
  - *Identify core tasks and provide a command for each one*
- But core task set tends to grow over time, language becomes baroque as command lexicon expands
  - UNIX CL, once based upon a small set of composable commands, now has over 700; 10% account for 90% of all usage
  - Word command lexicon now includes text formatting, drawing, annotating, WWW related commands, etc.

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Where do these rules come from?

- Many seem like common sense - but often violated
  - Home exercise: pick one everyday object and one piece of software and assess with respect to these rules
- Some are grounded in our understanding of how humans perceive, think and learn (c.f. next lectures)
- Some are the result of empirical study (e.g. Nielsen's heuristics are based on factor analysis of 249 usability problems)
- Some are derived from particular characterisations of the nature of human action (e.g. Norman's principles are closely related to his theory of action)
- Some are collections of experience (e.g. Shneiderman's rules)
- In this course we will study the background and justification of these rules and elaborate on how they can be applied in specific contexts.

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References/Further Reading

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

- H. Sharp, Y. Rogers & J. Preece (2007) Interaction Design. John Wiley & Sons, Chichester. (See also www.id-book.com)
- Shneiderman (1987) Designing the user interface: strategies for effective human computer interaction. Addison-Wesley, Reading MA.
- D.A. Norman (1988) The Design of Everyday Things. Doubleday, New York.
- Nielsen (1994) Enhancing the explanatory power of usability heuristics. Proceedings of the ACM CHI'94 Conference (see also www.useit.com)

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