HUMAN-COMPUTER INTERACTION

THIRD EDITION





chapter 9

evaluation techniques



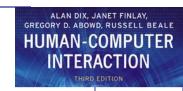


Evaluation Techniques

Evaluation

- tests usability and functionality of system
- occurs in laboratory, field and/or in collaboration with users
- evaluates both design and implementation
- should be considered at all stages in the design life cycle





Goals of Evaluation

- assess extent of system functionality
- assess effect of interface on user

identify specific problems

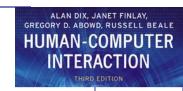




Evaluating Designs

Cognitive Walkthrough
Heuristic Evaluation
Review-based evaluation



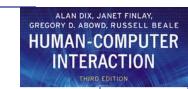


Cognitive Walkthrough

Proposed by Polson et al.

- evaluates design on how well it supports user in learning task
- usually performed by expert in cognitive psychology
- expert 'walks though' design to identify potential problems using psychological principles
- forms used to guide analysis





Cognitive Walkthrough (ctd)

- For each task walkthrough considers
 - what impact will interaction have on user?
 - what cognitive processes are required?
 - what learning problems may occur?
- Analysis focuses on goals and knowledge: does the design lead the user to generate the correct goals?

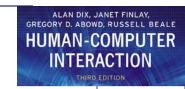




Heuristic Evaluation

- Proposed by Nielsen and Molich.
- usability criteria (heuristics) are identified
- design examined by experts to see if these are violated
- Example heuristics
 - system behaviour is predictable
 - system behaviour is consistent
 - feedback is provided
- Heuristic evaluation `debugs' design.





Review-based evaluation

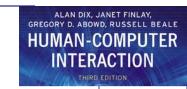
- Results from the literature used to support or refute parts of design.
- Care needed to ensure results are transferable to new design.
- Model-based evaluation
- Cognitive models used to filter design options e.g. GOMS prediction of user performance.
- Design rationale can also provide useful evaluation information





Evaluating through user Participation





Laboratory studies

- Advantages:
 - specialist equipment available
 - uninterrupted environment
- Disadvantages:
 - lack of context
 - difficult to observe several users cooperating
- Appropriate
 - if system location is dangerous or impractical for constrained single user systems to allow controlled manipulation of use





Field Studies

- Advantages:
 - natural environment
 - context retained (though observation may alter it)
 - longitudinal studies possible
- Disadvantages:
 - distractions
 - noise
- Appropriate
 - where context is crucial for longitudinal studies

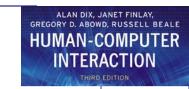




Evaluating Implementations

Requires an artefact: simulation, prototype, full implementation

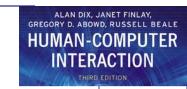




Experimental evaluation

- controlled evaluation of specific aspects of interactive behaviour
- evaluator chooses hypothesis to be tested
- a number of experimental conditions are considered which differ only in the value of some controlled variable.
- changes in behavioural measure are attributed to different conditions

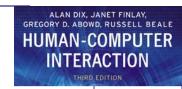




Experimental factors

- Subjects
 - who representative, sufficient sample
- Variables
 - things to modify and measure
- Hypothesis
 - what you'd like to show
- Experimental design
 - how you are going to do it

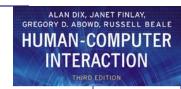




Variables

- independent variable (IV)
 - characteristic changed to produce different conditions
 - e.g. interface style, number of menu items
- dependent variable (DV)
 - characteristics measured in the experiment e.g. time taken, number of errors.





Hypothesis

- prediction of outcome
 - framed in terms of IV and DV

e.g. "error rate will increase as font size decreases"

- null hypothesis:
 - states no difference between conditions
 - aim is to disprove this

e.g. null hyp. = "no change with font size"

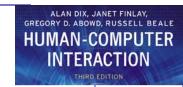




Experimental design

- within groups design
 - each subject performs experiment under each condition.
 - transfer of learning possible
 - less costly and less likely to suffer from user variation.
- between groups design
 - each subject performs under only one condition
 - no transfer of learning
 - more users required
 - variation can bias results.

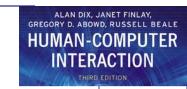




Analysis of data

- Before you start to do any statistics:
 - look at data
 - save original data
- Choice of statistical technique depends on
 - type of data
 - information required
- Type of data
 - discrete finite number of values
 - continuous any value

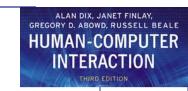




Analysis - types of test

- parametric
 - assume normal distribution
 - robust
 - powerful
- non-parametric
 - do not assume normal distribution
 - less powerful
 - more reliable
- contingency table
 - classify data by discrete attributes
 - count number of data items in each group

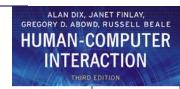




Analysis of data (cont.)

- What information is required?
 - is there a difference?
 - how big is the difference?
 - how accurate is the estimate?
- Parametric and non-parametric tests mainly address first of these





Experimental studies on groups

More difficult than single-user experiments

Problems with:

- subject groups
- choice of task
- data gathering
- analysis





Subject groups

larger number of subjects

⇒ more expensive

longer time to `settle down'
... even more variation!

difficult to timetable

so ... often only three or four groups





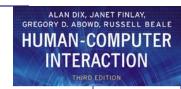
The task

must encourage cooperation
perhaps involve multiple channels
options:

- creative task
- decision games
- control task

- e.g. 'write a short report on ...'
- e.g. desert survival task
- e.g. ARKola bottling plant





Data gathering

several video cameras

+ direct logging of application

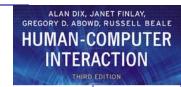
problems:

- synchronisation
- sheer volume!

one solution:

- record from each perspective





Analysis

N.B. vast variation between groups

solutions:

- within groups experiments
- micro-analysis (e.g., gaps in speech)
- anecdotal and qualitative analysis

look at interactions between group and media controlled experiments may `waste' resources!





Field studies

Experiments dominated by group formation

Field studies more realistic:

distributed cognition ⇒ work studied in context real action is situated action physical and social environment both crucial

Contrast:

psychology – controlled experiment sociology and anthropology – open study and rich data





Observational Methods

Think Aloud
Cooperative evaluation
Protocol analysis
Automated analysis
Post-task walkthroughs

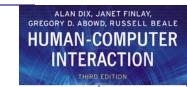




Think Aloud

- user observed performing task
- user asked to describe what he is doing and why, what he thinks is happening etc.
- Advantages
 - simplicity requires little expertise
 - can provide useful insight
 - can show how system is actually use
- Disadvantages
 - subjective
 - selective
 - act of describing may alter task performance





Cooperative evaluation

- variation on think aloud
- user collaborates in evaluation
- both user and evaluator can ask each other questions throughout
- Additional advantages
 - less constrained and easier to use
 - user is encouraged to criticize system
 - clarification possible





Protocol analysis

- paper and pencil cheap, limited to writing speed
- audio good for think aloud, difficult to match with other protocols
- video accurate and realistic, needs special equipment, obtrusive
- computer logging automatic and unobtrusive, large amounts of data difficult to analyze
- user notebooks coarse and subjective, useful insights, good for longitudinal studies
- Mixed use in practice.
- audio/video transcription difficult and requires skill.
- Some automatic support tools available

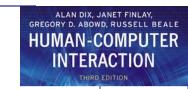




automated analysis - EVA

- Workplace project
- Post task walkthrough
 - user reacts on action after the event
 - used to fill in intention
- Advantages
 - analyst has time to focus on relevant incidents
 - avoid excessive interruption of task
- Disadvantages
 - lack of freshness
 - may be post-hoc interpretation of events





post-task walkthroughs

- transcript played back to participant for comment
 - immediately → fresh in mind
 - delayed → evaluator has time to identify questions
- useful to identify reasons for actions and alternatives considered
- necessary in cases where think aloud is not possible





Query Techniques

Interviews Questionnaires





Interviews

- analyst questions user on one-to -one basis usually based on prepared questions
- informal, subjective and relatively cheap
- Advantages
 - can be varied to suit context
 - issues can be explored more fully
 - can elicit user views and identify unanticipated problems
- Disadvantages
 - very subjective
 - time consuming





Questionnaires

- Set of fixed questions given to users
- Advantages
 - quick and reaches large user group
 - can be analyzed more rigorously
- Disadvantages
 - less flexible
 - less probing





Questionnaires (ctd)

- Need careful design
 - what information is required?
 - how are answers to be analyzed?
- Styles of question
 - general
 - open-ended
 - scalar
 - multi-choice
 - ranked





Physiological methods

Eye tracking Physiological measurement

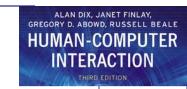




eye tracking

- head or desk mounted equipment tracks the position of the eye
- eye movement reflects the amount of cognitive processing a display requires
- measurements include
 - fixations: eye maintains stable position. Number and duration indicate level of difficulty with display
 - saccades: rapid eye movement from one point of interest to another
 - scan paths: moving straight to a target with a short fixation at the target is optimal

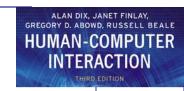




physiological measurements

- emotional response linked to physical changes
- these may help determine a user's reaction to an interface
- measurements include:
 - heart activity, including blood pressure, volume and pulse.
 - activity of sweat glands: Galvanic Skin Response (GSR)
 - electrical activity in muscle: electromyogram (EMG)
 - electrical activity in brain: electroencephalogram (EEG)
- some difficulty in interpreting these physiological responses - more research needed





Choosing an Evaluation Method

when in process: design vs. implementation

style of evaluation: laboratory vs. field

how objective: subjective vs. objective

type of measures: qualitative vs. quantitative

level of information: high level vs. low level

level of interference: obtrusive vs. unobtrusive

resources available: time, subjects,

equipment, expertise