



HUMAN-COMPUTER INTERACTION

THIRD
EDITION

DIX
FINLAY
ABOWD
BEALE



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 through' 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 e.g. *'write a short report on ...'*
- decision games e.g. desert survival task
- control 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 \Rightarrow 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