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 — 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* ⇒ 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