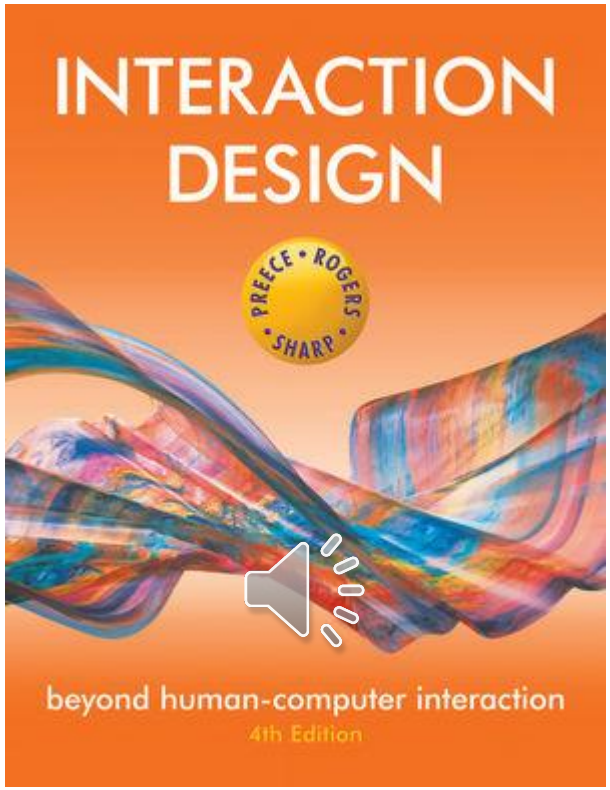


Chapter 7

GATHERING DATA
ID: p. 226 - 274

Five key issues

1. Setting goals
   - Decide how to analyze data once collected
2. Identifying participants
   - Decide who to gather data from
3. Relationship with participants
   - Clear and professional
   - Informed consent when appropriate
4. Triangulation
   - Look at data from more than one perspective
   - Collect more than one type of data, eg qualitative from experiments and qualitative from interviews
5. Pilot studies
   - Small trial of main study

Data recording

- Notes, audio, video, photographs can be used individually or in combination:
  - Notes plus photographs
  - Audio plus photographs
  - Video
- Different challenges and advantages with each combination

Interviews

- Unstructured - are not directed by a script. Rich but not replicable.
- Structured - are tightly scripted, often like a questionnaire. Replicable but may lack richness.
- Semi-structured - guided by a script but interesting issues can be explored in more depth. Can provide a good balance between richness and replicability.
- Focus groups – a group interview

Interview questions

- Two types:
  - ‘closed questions’ have a predetermined answer format, e.g.. ‘yes’ or ‘no’
  - ‘open questions’ do not have a predetermined format
- Closed questions are easier to analyze
- Avoid:
  - Long questions
  - Compound sentences - split them into two
  - Jargon and language that the interviewee may not understand
  - Leading questions that make assumptions e.g.. why do you like …?
  - Unconscious biases e.g.. gender stereotypes

Running the interview

- *Introduction* – introduce yourself, explain the goals of the interview, reassure about the ethical issues, ask before you record, present the informed consent form.
- *Warm-up* – make first questions easy and non-threatening.
- *Main body* – present questions in a logical order
- *A cool-off period* – include a few easy questions to defuse tension at the end
- *Closure* – thank interviewee, signal the end, eg. switch recorder off.

Enriching the interview process

- Props - devices for prompting interviewee, e.g. use a prototype, scenario

Questionnaires

- Questions can be closed or open
- Closed questions are easier to analyze, and may be distributed and analyzed by computer
- Can be administered to large populations
- Disseminated by paper, email and the web
- Sampling can be a problem when the size of a population is unknown as is common online evaluation

Questionnaire design

- The impact of a question can be influenced by question order. Can randomize question order.
- You may need different versions of the questionnaire for different populations. Eg. Adults, elderly, children.
- Provide clear instructions on how to complete the questionnaire.
- Strike a balance between using white space and keeping the questionnaire compact.
- Avoid very long questionnaires
- Decide on whether phrases will all be positive, all negative or mixed.

Question and response format

- 'Yes' and 'No' checkboxes
    - Typically used for demographics, gender, age (categorized).
- Rating scales
    - Likert scales, useful for measuring attitudes, opinions, beliefs, user satisfaction (1 strongly agree, 2 agree, 3 neutral, 4 disagree, 5 strongly disagree).
    - Semantic differential scales – Explores a range of bipolar attitudes about a particular item. Each pair of attitudes is represented as adjectives: Attractive _ _ _ _ _ _ _ _ _ _ _ Ugly
        - Place a cross between one of the extremes to indicate agreement.
- Open-ended responses

Encouraging a good response

- Make sure purpose of study is clear
- Promise anonymity
- Ensure questionnaire is well designed
- Offer a short version for those who do not have time to complete a long questionnaire
- Follow-up with emails, phone calls, letters
- Provide an incentive

Advantages of online questionnaires

- Relatively easy and quick to distribute
- Responses are usually received quickly
- No copying and postage costs
- Data can be collected in database for analysis
- Time required for data analysis is reduced
- Errors can be corrected easily

Example of an online questionnaire

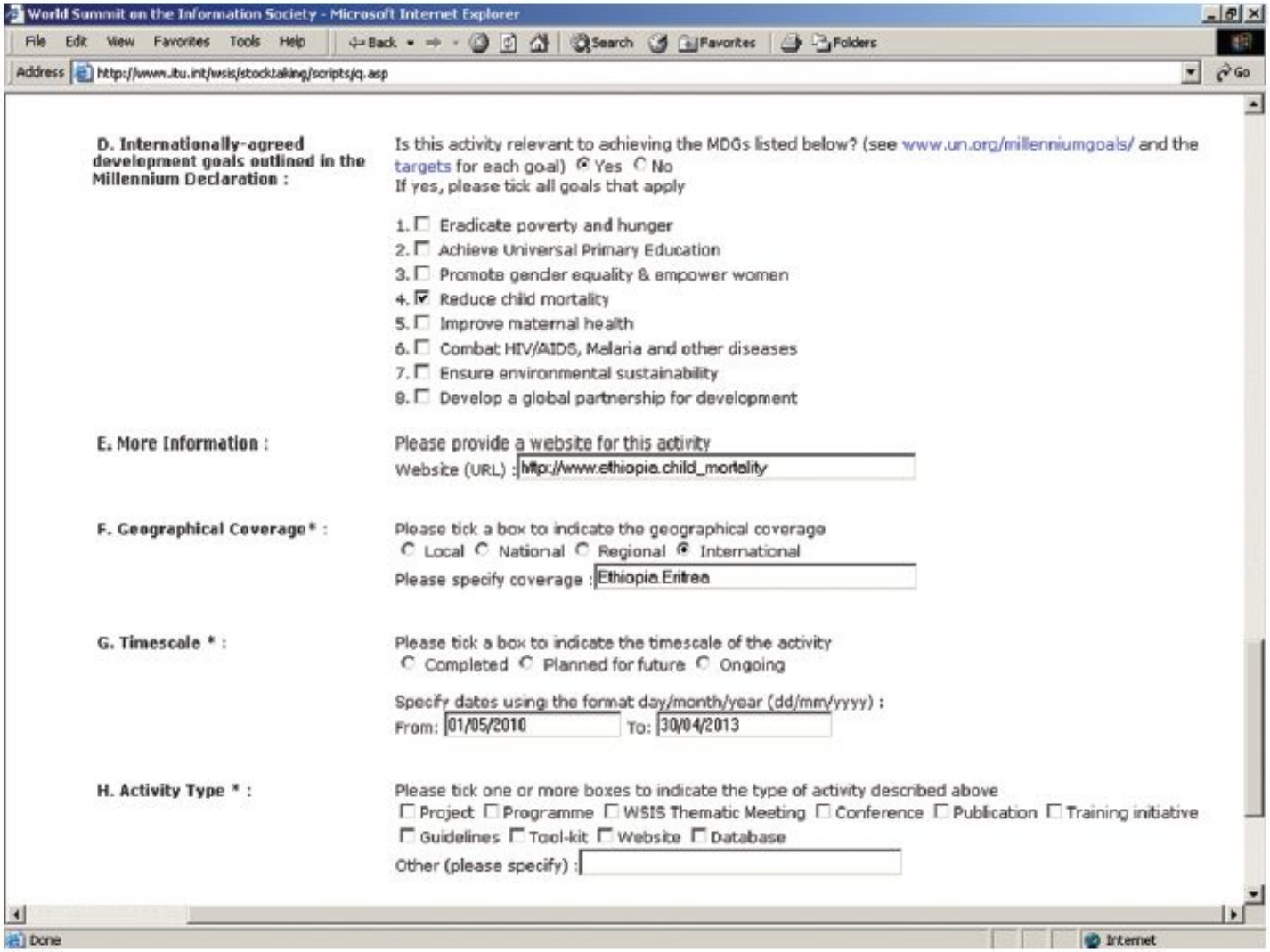


Figure 7.8 An excerpt from a web-based questionnaire showing check boxes, radio buttons, and pull-down menus

Problems with online questionnaires

- Sampling is problematic if population size is unknown
- Preventing individuals from responding more than once can be a problem
- Individuals have also been known to change questions in email questionnaires

Observation

- Direct observation in the field
  - Structuring frameworks
  - Degree of participation (insider or outsider)
  - Ethnography
- Direct observation in controlled environments
- Indirect observation: tracking users' activities
  - Diaries
  - Interaction logging
  - Video and photographs collected remotely by drones or other equipment

Observation

- Scenarios

1. A usability consultant joins a group of tourists and studies how they use a wearable navigation device to walk around Stockholm and find restaurants that they are interested in. Usability consultant observes that the interface is a little difficult to use, but users find it useful and enjoyable to find restaurants nearby.
2. A usability consultant observes how participants perform a pre-planned task using the wearable navigation device in a usability laboratory. The task requires users to find a specific restaurant, he records the time it takes to complete the task, and records and interacitons.

What are the advantages and disadvantages of these two types of obeservations?

When might each type of observation be useful?

Scenario 1:

- Observer saw how the device is used to solve real problems in the real world.
- The Observer was an insider, and may not be objective in her assessment.
- The data is qualitative and how useful are they?
- Maybe she was having such a good time that her judgment was clouded and she missed hearing negative comments. If you wanted to reconduct the study, it would be impossible to replicate.

Scenario 2:

- This type of study is easy to replicate, so users can perform the same task, specific usability problems can be identified, users' performance can be compared, and averages for time to do the task, number of errors can be calculated.
- The observer can be more objective, because she is an outsider.
- Disadvantage: study is artificial and doesn't say anything about how the device would be used in the real environment.

Structuring frameworks to guide observation

- Three easy-to-remember parts:
  - The person: Who is using this technology at a particular time?
  - The place*:* Where are they using it?
  - The thing*:* What are they doing with it?
- A more detailed framework (Robson, 2014):
  - Space: What is the physical space like and how is it laid out?
  - Actors: What are the names and relevant details of the people involved?
  - Activities: What are the actors doing and why?
  - Objects: What physical objects are present, such as furniture
  - Acts: What are specifi c individual actions?
  - Events: Is what you observe part of a special event?
  - Time: What is the sequence of events?
  - Goals: What are the actors trying to accomplish?
  - Feelings: What is the mood of the group and of individuals?

Planning and conducting observation in the field

- Decide on how involved you will be: passive observer to active participant
- How to gain acceptance
- How to handle sensitive topics, eg. culture, private spaces, etc.
- How to collect the data:
  - What data to collect
  - What equipment to use
  - When to stop observing

Observation

Figure 7.9 Mars Exploration Rover

Source: Reproduced by permission of NASA Jet Propulsion Laboratory (NASA-JPL).

Ethnography Example

(a)

(b)

Figure 7.10 (a) The situation before MERboard; (b) A scientist using MERboard to present information

Source: J. Trimble, R. Wales and R. Gossweiler (2002): "NASA position paper for the CSCW 2002 workshop on Public, Community and Situated Displays: Merboard".

Ethnography (1)

- Ethnography is a philosophy with a set of techniques that include participant observation and interviews
- Ethnographers immerse themselves in the culture that they study
- A researcher's degree of participation can vary along a scale from 'outside' to 'inside'
- Analyzing video and data logs can be time-consuming
- Collections of comments, incidents, and artifacts are made

Ethnography (2)

- Co-operation of people being observed is required
- Informants are useful
- Data analysis is continuous
- Interpretivist technique
- Questions get refined as understanding grows
- Reports usually contain examples

Observations and materials that might be collected (Crabtree, 2007)

- Activity or job descriptions.
- Rules and procedures that govern particular activities.
- Descriptions of activities observed.
- Recordings of the talk taking place between parties.
- Informal interviews with participants explaining the detail of observed activities.
- Diagrams of the physical layout, including the position of artifacts.
- Other information collected when observing activities:
  - Photographs of artifacts (documents, diagrams, forms, computers, etc.)
  - Videos of artifacts.
  - Descriptions of artifacts.
  - Workflow diagrams showing the sequential order of tasks.
  - Process maps showing connections between activities.

Online Ethnography

- Virtual, Online, Netnography
- Online and offline activity
- Interaction online differs from face-to-face
- Virtual worlds have a persistence that physical worlds do not have
- Ethical considerations and presentation of results are different

Observation in a controlled environment

- Direct observation
  - Think aloud techniques
- Indirect observation – tracking users' activities
  - Diaries
  - Interaction logs
  - Web analytics
- Video, audio, photos, notes are used to capture data in both types of observations

Web analytics

- A system of tools and techniques for optimizing web usage by:
  - Measuring,
  - Collecting,
  - Analyzing, and
  - Reporting web data
- Typically focus on the number of web visitors and page views.

A section of Google analytics dashboard for id-book.com

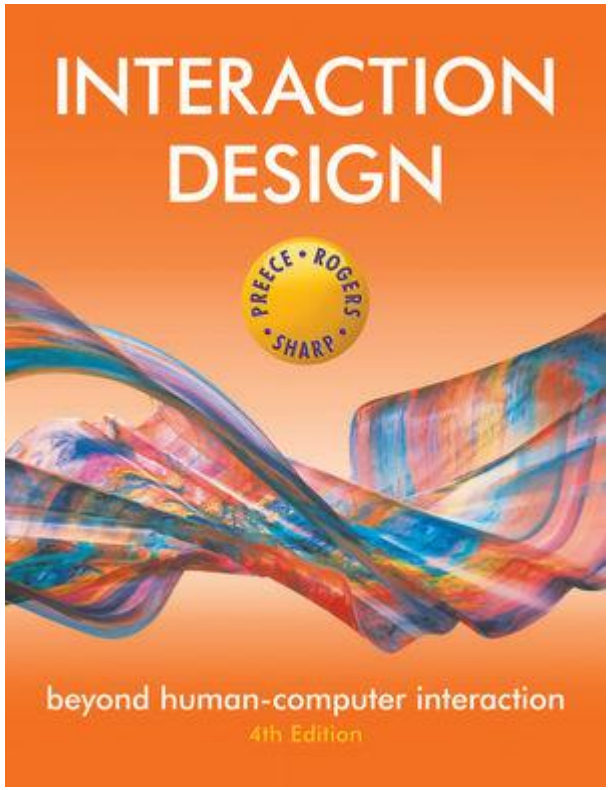
Figure 7.14 Segments of the Google Analytics dashboard for id-book.com in September 2014 (a) audience overview, (b) screen resolution of mobile devices used to view the website

Choosing and combining techniques

- Depends on the:
  - Focus of the study
  - Participants involved
  - Nature of the technique(s)
  - Resources available
  - Time available

Summary

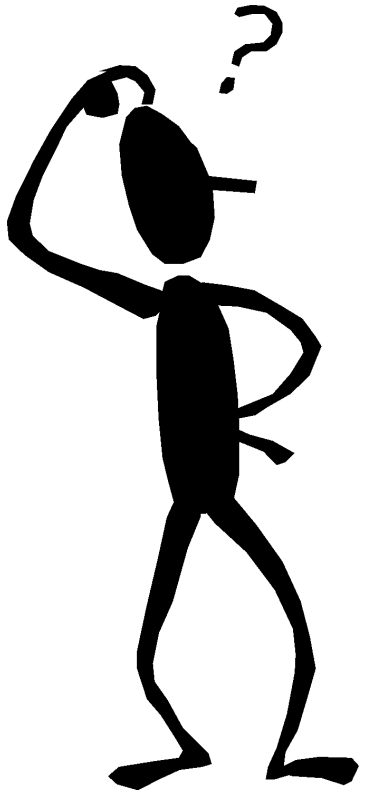
- Data gathering sessions should have clear goals.
- An informed consent may be needed.
- Five key issues of data gathering are: goals, choosing participants, triangulation, participant relationship, pilot.
- Data may be recorded using handwritten notes, audio or video recording, a camera, or any combination of these.
- Interviews may be structured, semi-structured or unstructured
- Focus groups are group interviews
- Questionnaires may be on paper, online or telephone
- Observation may be direct or indirect, in the field or in controlled settings.
- Techniques can be combined depending on the study focus, participants, nature of technique, available resources and time.



Chapter 9

THE PROCESS OF INTERACTION DESIGN

Overview



- What is involved in Interaction Design?
  - Importance of involving users
  - Degrees of user involvement
  - What is a user-centered approach?
  - Four basic activities
- Some practical issues
  - Who are the users?
  - What are 'needs'?
  - Where do alternatives come from?
  - How to choose among alternatives?
  - How to integrate interaction design activities in other lifecycle models?

What is involved in Interaction Design?

- It is a process:
  - a goal-directed problem solving activity informed by intended use, target domain, materials, cost, and feasibility
  - a creative activity
  - a decision-making activity to balance trade-offs
- Generating alternatives and choosing between them is key
- Four approaches: user-centered design, activity-centered design, systems design, and genius design

Importance of involving users

- Expectation management
  - Realistic expectations
  - No surprises, no disappointments
  - Timely training
  - Communication, but no hype
- Ownership
  - Make the users active stakeholders
  - More likely to forgive or accept problems
  - Can make a big difference to acceptance and success of product

Degrees of user involvement

- Member of the design team
  - Full time: constant input, but lose touch with other users
  - Part time: patchy input, and very stressful
  - Short term: inconsistent across project life
  - Long term: consistent, but lose touch with other users
- Newsletters and other dissemination devices
  - Reach wider selection of users
  - Need communication both ways
- User involvement after product is released
- Combination of these approaches

What is a user-centered approach?

User-centered approach is based on:

- Early focus on users and tasks: directly studying cognitive, behavioral, anthropomorphic & attitudinal characteristics
- Empirical measurement: Early in development, users' reactions and performance to scenarios, manuals, simulations & prototypes are observed, recorded and analysed. Later on, users interact with simulations and prototypes and their performance and reactions are observed, recorded and analyzed.
- Iterative design: when problems are found in user testing, fix them and carry out more tests

Four basic activities in Interaction Design

1. Establishing requirements
2. Designing alternatives
3. Prototyping
4. Evaluating

A simple interaction design lifecycle model

Exemplifies a user-centered design approach

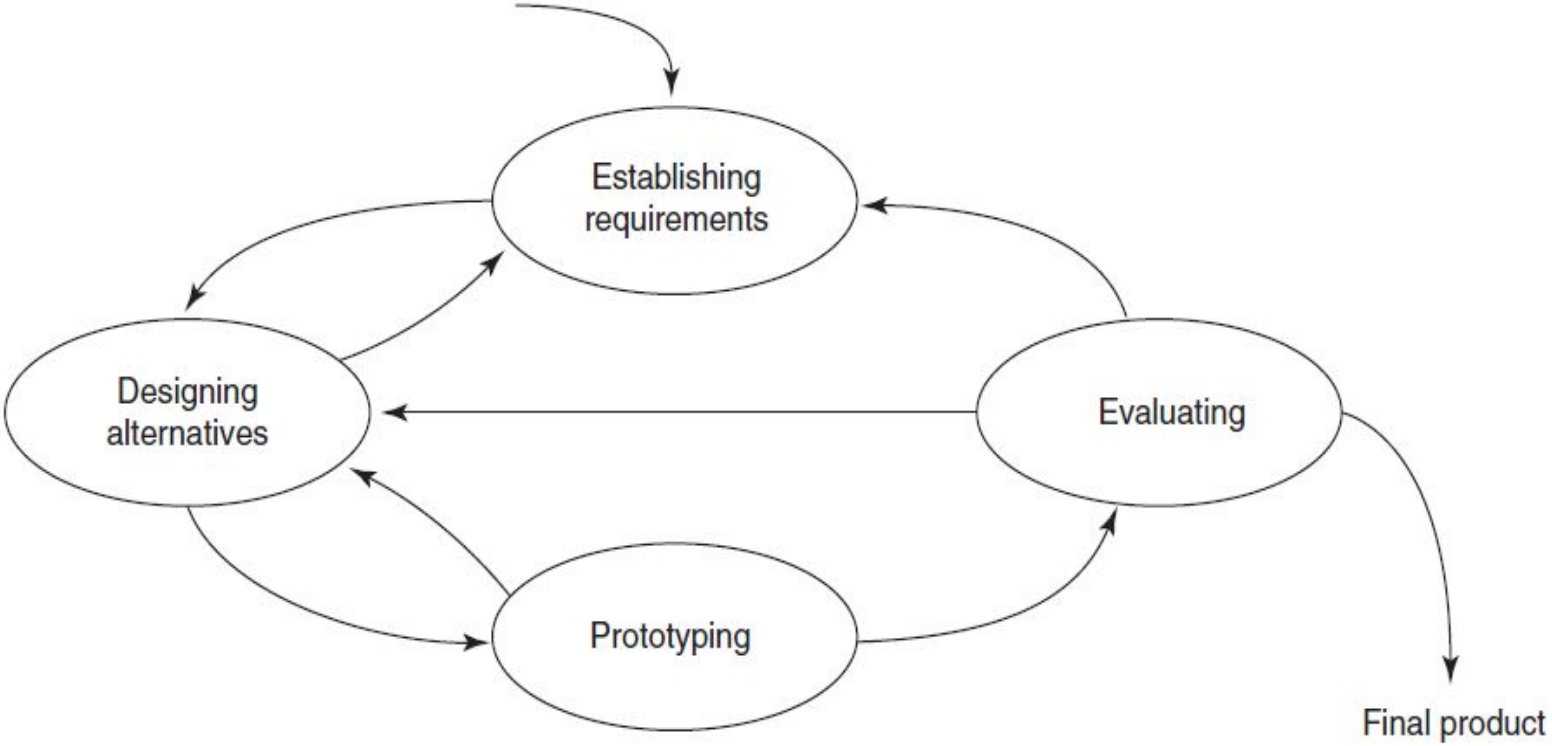


Figure 9.3 A simple interaction design lifecyle model

Some practical issues

- Who are the users?
- What do we mean by ‘needs’?
- How to generate alternatives
- How to choose among alternatives
- How to integrate interaction design activities with other lifecycle models?

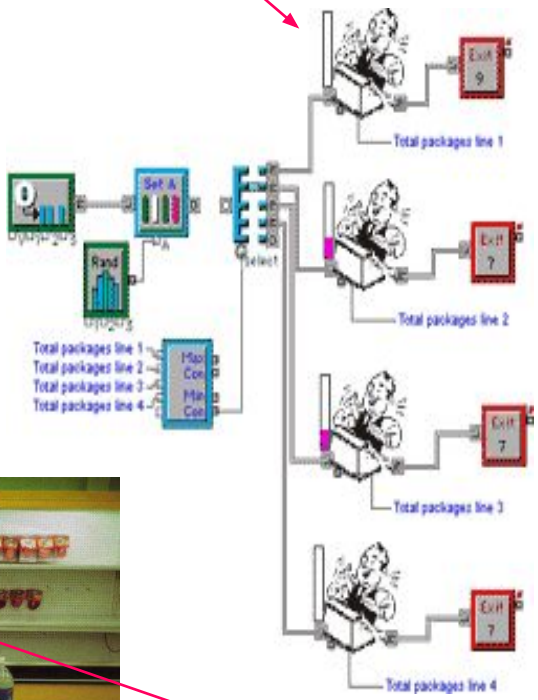
Who are the users/stakeholders?

- Not as obvious as you think:
  - those who interact directly with the product
  - those who manage direct users
  - those who receive output from the product
  - those who make the purchasing decision
  - those who use competitor's products
- Three categories of user (Eason, 1987):
  - primary: frequent hands-on
  - secondary: occasional or via someone else
  - tertiary: affected by its introduction, or will influence its purchase

Who are the stakeholders?

- Suppliers
- Local shop owners

Check-out operators



Managers and owners

Customers

What do we mean by ‘needs’?

- Users rarely know what is possible
- Users can’t tell you what they ‘need’ to help them achieve their goals
- Instead, look at existing tasks:
  - their context
  - what information do they require?
  - who collaborates to achieve the task?
  - why is the task achieved the way it is?
- Envisioned tasks:
  - can be rooted in existing behaviour
  - can be described as future scenarios

How to generate alternatives

- Humans stick to what they know works
- But considering alternatives is important to ‘break out of the box’
- Designers are trained to consider alternatives, software people generally are not
- How do you generate alternatives?
  - ‘Flair and creativity’: research and synthesis
  - Seek inspiration: look at similar products or look at very different products

How to choose among alternatives

- Evaluation with users or with peers, e.g. prototypes
- Technical feasibility: some not possible
- Quality thresholds: Usability goals lead to usability criteria set early on and check regularly
  - safety: how safe?
  - utility: which functions are superfluous?
  - effectiveness: appropriate support? task coverage, information available
  - efficiency: performance measurements
  - learnability: is the time taken to learn a function acceptable to the users?
  - memorability: can infrequent users remember how to achieve their goal?

How to integrate interaction design in other models

- Integrating interaction design activities in lifecycle models from other disciplines needs careful planning
- Several software engineering lifecycle models have been considered
- Integrating with agile software development is promising
  - it stresses the importance of iteration
  - it champions early and regular feedback
  - it handles emergent requirements
  - it aims to strike a balance between flexibility and structure

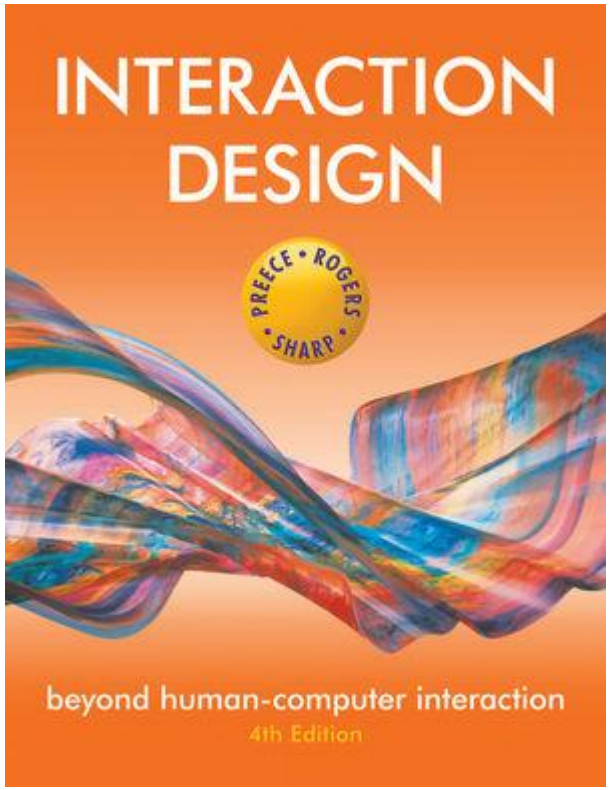
Summary

Four basic activities in the design process

1. Establishing requirements
2. Designing alternatives
3. Prototyping
4. Evaluating

User-centered design rests on three principles

5. Early focus on users and tasks
6. Empirical measurement using quantifiable & measurable usability criteria
7. Iterative design



Chapter 10

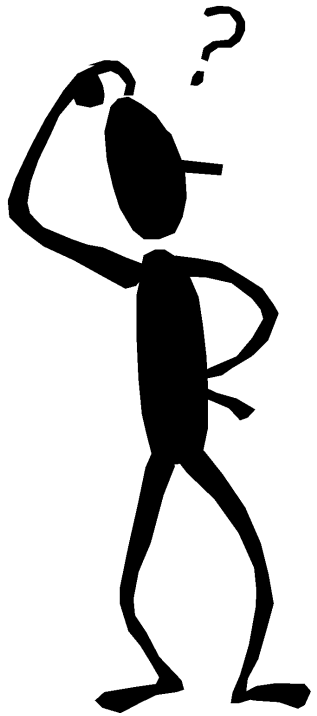
ESTABLISHING REQUIREMENTS

Overview

- The importance of requirements
- Different types of requirements
- Data gathering for requirements
- Data analysis and presentation
- Task description: Scenarios

  Use Cases

  Essential use cases
- Task analysis: HTA



Establishing requirements

- What do users want? What do users 'need'?

  Requirements need clarification, refinement, completion, re-scoping

  Input: Requirements document (maybe)

  Output: stable requirements

- Why 'establish'?

  Requirements arise from understanding users' needs

  Requirements can be justified & related to data

Volere shell

Requirement #: **75** Requirement Type: **9** Event/use case #: **6**

Description: **The product shall issue an alert if a weather station fails to transmit readings.**

Rationale: **Failure to transmit readings might indicate that the weather station is faulty and needs maintenance, and that the data used to predict freezing roads may be incomplete.**

Source: **Road Engineers**
Fit Criterion: **For each weather station the product shall communicate to the user when the recorded number of each type of reading per hour is not within the manufacturer's specified range of the expected number of readings per hour.**

Customer Satisfaction: **3** Customer Dissatisfaction: **5**

Dependencies: **None** Conflicts: **None**

Supporting Materials: **Specification of Rosa Weather Station**

History: **Raised by GBS, 28 July 99**

Volere

Volere requirements template

PROJECT DRIVERS

1. The Purpose of the Product
2. The Stakeholders

PROJECT CONSTRAINTS

3. Mandated Constraints
4. Naming Conventions and Definitions
5. Relevant Facts and Assumptions

FUNCTIONAL REQUIREMENTS

6. The Scope of the Work
7. Business Data Model and Data Dictionary
8. The Scope of the Product
9. Functional and Data Requirements

NON-FUNCTIONAL REQUIREMENTS

10. Look and Feel Requirements
11. Usability and Humanity Requirements
12. Performance Requirements
13. Operational and Environmental Requirements
14. Maintainability and Support Requirements
15. Security Requirements
16. Cultural and Political Requirements
17. Legal Requirements

PROJECT ISSUES

18. Open Issues
19. Off-the-Shelf Solutions
20. New Problems
21. Tasks
22. Migration to the New Product
23. Risks
24. Costs
25. User Documentation and Training
26. Waiting Room
27. Ideas for Solutions

Different kinds of requirements

- Functional:
  - —What the system should do
- (Non-functional: security, response time...)
- Data:
  - —What kinds of data need to be stored?
  - —How will they be stored (e.g. database)?

Different kinds of requirements

Environment or context of use:

- physical: dusty? noisy? vibration? light? heat? humidity? …. (e.g. ATM)
- social: sharing of files, of displays, in paper, across great distances, synchronous, privacy for clients
- organisational: hierarchy, IT department's attitude and remit, user support, communications structure and infrastructure, availability of training

Different kinds of requirements

Users: Who are they?

- Characteristics: nationality, educational background, attitude to computers
- System use: novice, expert, casual, frequent
  - Novice: prompted, constrained, clear
  - Expert: flexibility, access/power
  - Frequent: short cuts
  - Casual/infrequent: clear menu paths

What are the users' capabilities?

Humans vary in many dimensions:

— size of hands may affect the size and positioning of input buttons

— motor abilities may affect the suitability of certain input and output devices

— height if designing a physical kiosk

— strength - a child's toy requires little strength to operate, but greater strength to change batteries

— disabilities (e.g. sight, hearing, dexterity)

Personas

- Capture a set of user characteristics (user profile)
- Not real people, but synthesised from real users
- Should not be idealised
- Bring them to life with a name, characteristics, goals, personal background
- Develop a small set of personas with one primary

Example Persona

CAPLIN

Ginnie

BACKGROUND

- 15, Female
- Ongoing Private Education
- Ambitious
- Comfortable using technology to communicate

MOTIVATIONS

- Keeping in touch with her network
- Fashion/street cred
- Keeping up with peers.

FRUSTRATIONS

- Sad people trying to be 'friends' on Facebook
- Having to be in bed @ 11pm
- Being swamped in friends updates
- Missing important status updates

Receives private tutoring in Maths and English as these are not her strong subjects. Enjoys playing for the school's 2nd teams for netball and Lacrosse and is good at art.

She loves recording her favourite shows: ER and Sun Valley High on Sky+ and spends some of her time on her Laptop that Daddy bought her watching videos on YouTube, downloading music, keeping up to date with her friends on Facebook and chatting via MS IM to her cousin who is at University in Leeds.

She loves Ugg boots and Abercrombie & Fitch and uses the Internet to shop and find the cheapest prices.

"I want to easily hook up with my friends whilst watching TV"

Data gathering for requirements

- Interviews:
  - Props, e.g. sample scenarios of use, prototypes, can be used in interviews
  - Good for exploring issues
  - Development team members can connect with stakeholders
- Focus groups:
  - Group interviews
  - Good at gaining a consensus view and/or highlighting areas of conflict
  - But can be dominated by individuals

Data gathering for requirements

- Questionnaires:
  - Often used in conjunction with other techniques
  - Can give quantitative or qualitative data
  - Good for answering specific questions from a large, dispersed group of people
- Researching similar products:
  - Good for prompting requirements

Data gathering for requirements

- Direct observation:
  - Gain insights into stakeholders' tasks
  - Good for understanding the nature and context of the tasks
  - But, it requires time and commitment from a member of the design team, and it can result in a huge amount of data
- Indirect observation:
  - Not often used in requirements activity
  - Good for logging current tasks

Data gathering for requirements

Studying documentation:

— Procedures and rules are often written down in manuals

— Good source of data about the steps involved in an activity, and any regulations governing a task

— Not to be used in isolation

— Good for understanding legislation, and getting background information

— No stakeholder time, which is a limiting factor on the other techniques

Contextual Inquiry

- An approach to ethnographic study where user is expert, designer is apprentice
- A form of interview, but
  - — at users' workplace (workstation)
  - — 2 to 3 hours long
- Four main principles:
  - — Context: see workplace & what happens
  - — Partnership: user and developer collaborate
  - — Interpretation: observations interpreted by user and developer together
  - — Focus: project focus to understand what to look for

Data gathering guidelines

- Focus on identifying the stakeholders' needs
- Involve all the stakeholder groups
- Involve more than one representative from each stakeholder group
- Use a combination of data gathering techniques
- Support the process with props such as prototypes and task descriptions

Data interpretation and analysis

- Start soon after data gathering session
- Initial interpretation before deeper analysis
- Different approaches emphasize different elements e.g. class diagrams for object-oriented systems, entity-relationship diagrams for data intensive systems

Task descriptions

- Scenarios
  - an informal narrative story, simple, ‘natural’, personal, not generalizable
- Use cases
  - assume interaction with a system
  - assume detailed understanding of the interaction
- Essential use cases
  - abstract away from the details
  - does not have the same assumptions as use cases

Scenario for travel organizer

“The Thomson family enjoy outdoor activities and want to try their hand at sailing this year. There are four family members: Sky (10 years old), Eamonn (15 years old), Claire (35), and Will (40). One evening after dinner they decide to start exploring the possibilities. They all gather around the travel organizer and enter their initial set of requirements – a sailing trip for four novices in the Mediterranean. The console is designed so that all members of the family can interact easily and comfortably with it. The system’s initial suggestion is a flotilla, where several crews (with various levels of experience) sail together on separate boats. Sky and Eamonn aren’t very happy at the idea of going on vacation with a group of other people, even though the Thomsons would have their own boat. The travel organizer shows them descriptions of flotillas from other children their ages and they are all very positive, so eventually, everyone agrees to explore flotilla opportunities. Will confirms this recommendation and asks for detailed options. As it’s getting late, he asks for the details to be saved so everyone can consider them tomorrow. The travel organizer emails them a summary of the different options available.”

Scenarios and Personas

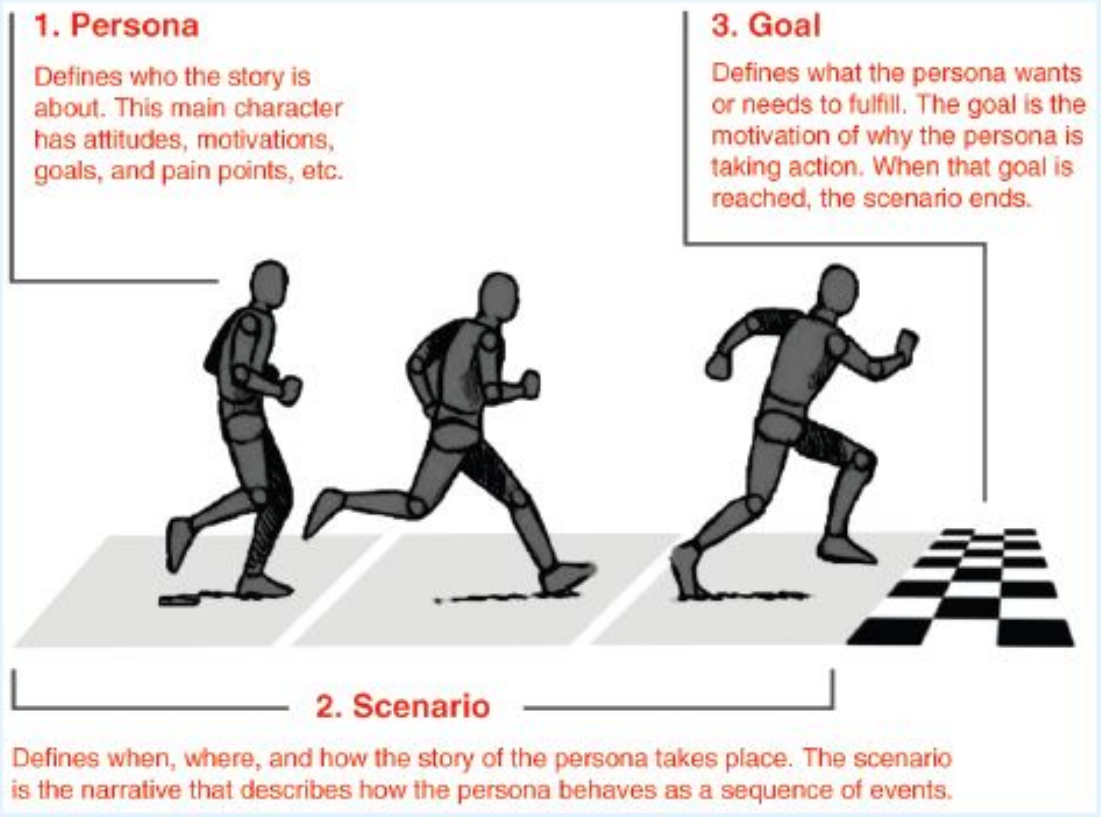


Figure 10.10 The relationship between a scenario and its associated persona

Source: http://www.smashingmagazine.com/2014/08/06/a-closer-look-at-personas-part-1/

Use case for travel organizer

1. The system displays options for investigating visa and vaccination requirements.
2. The user chooses the option to find out about visa requirements.
3. The system prompts user for the name of the destination country.
4. The user enters the country's name.
5. The system checks that the country is valid.
6. The system prompts the user for her nationality.
7. The user enters her nationality.
8. The system checks the visa requirements of the entered country for a passport holder of her nationality.
9. The system displays the visa requirements.
10. The system displays the option to print out the visa requirements.
11. The user chooses to print the requirements.

Alternative courses for travel organizer

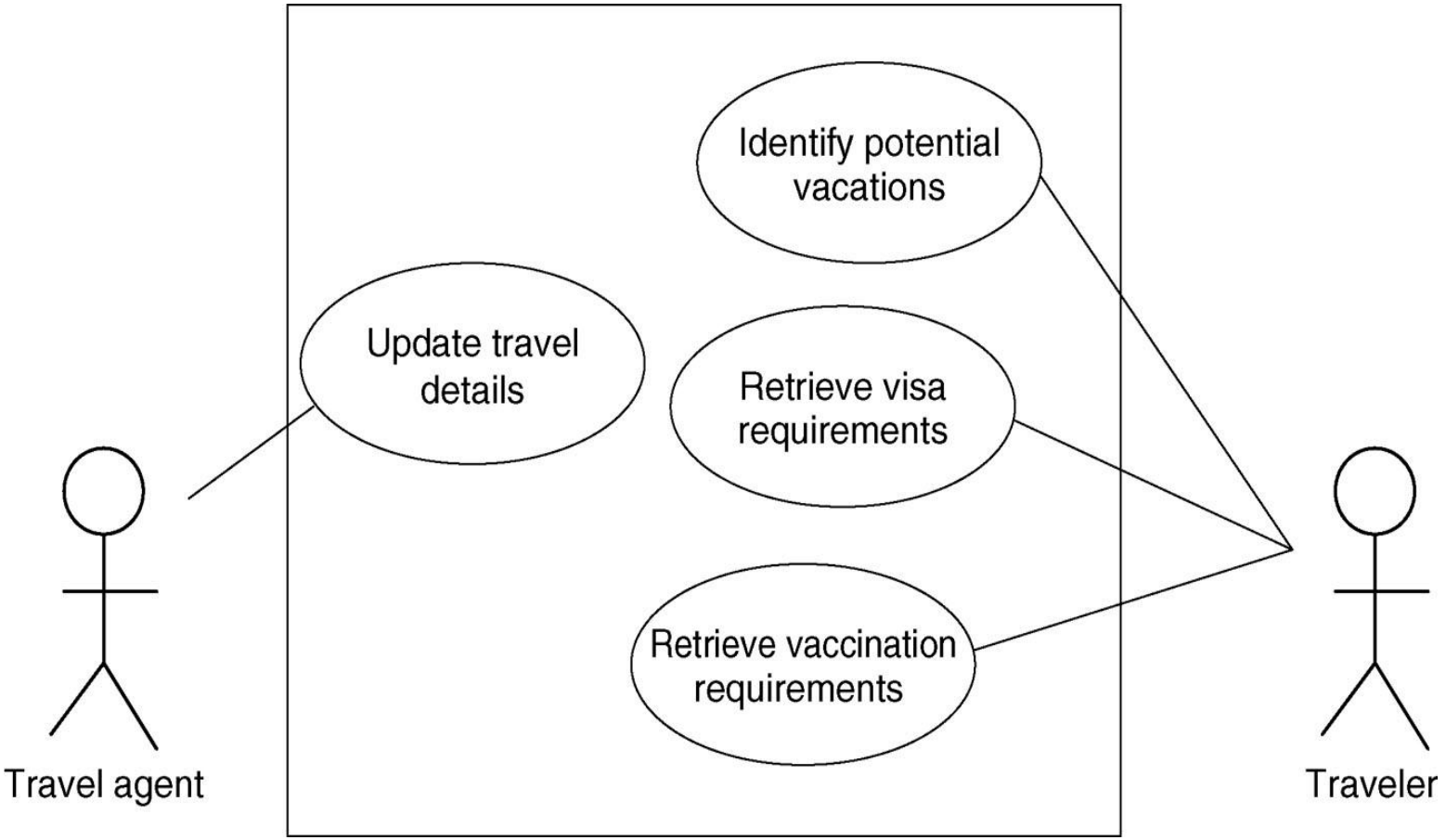
Some alternative courses:

6. If the country name is invalid:
    6.1 The system displays an error message.
    6.2 The system returns to step 3.

8. If the nationality is invalid:
    8.1 The system displays an error message.
    8.2 The system returns to step 6.

9. If no information about visa requirements is found:
    9.1 The system displays a suitable message.
    9.2 The system returns to step 1.

Example use case diagram for travel organizer



Example essential use case for travel organizer

retrieve Visa

USER INTENTION	SYSTEM RESPONSIBILITY
find visa requirements	request destination and nationality
supply required information	
	obtain appropriate visa info
obtain copy of visa info	
	offer info in different formats
choose suitable format	
	provide info in chosen format

Task analysis

- Task descriptions are often used to envision new systems or devices
- Task analysis is used mainly to investigate an existing situation, not to envision new products.
- It is important not to focus on superficial activities
  - What are people trying to achieve?
  - Why are they trying to achieve it?
  - How are they going about it?
- Many techniques, the most popular is Hierarchical Task Analysis (HTA)

Hierarchical Task Analysis

- Involves breaking a task down into subtasks, then sub-sub-tasks and so on. These are grouped as plans which specify how the tasks might be performed in practice
- HTA focuses on physical and observable actions, and includes looking at actions not related to software or an interaction device
- Start with a user goal which is examined and the main tasks for achieving it are identified
- Tasks are sub-divided into sub-tasks

Example Hierarchical Task Analysis

0. In order to buy a DVD
1. locate DVD
2. add DVD to shopping basket
3. enter payment details
4. complete address
5. confirm order

plan 0: If regular user do 1-2-5.
If new user do 1-2-3-4-5.

Example Hierarchical Task Analysis (graphical)

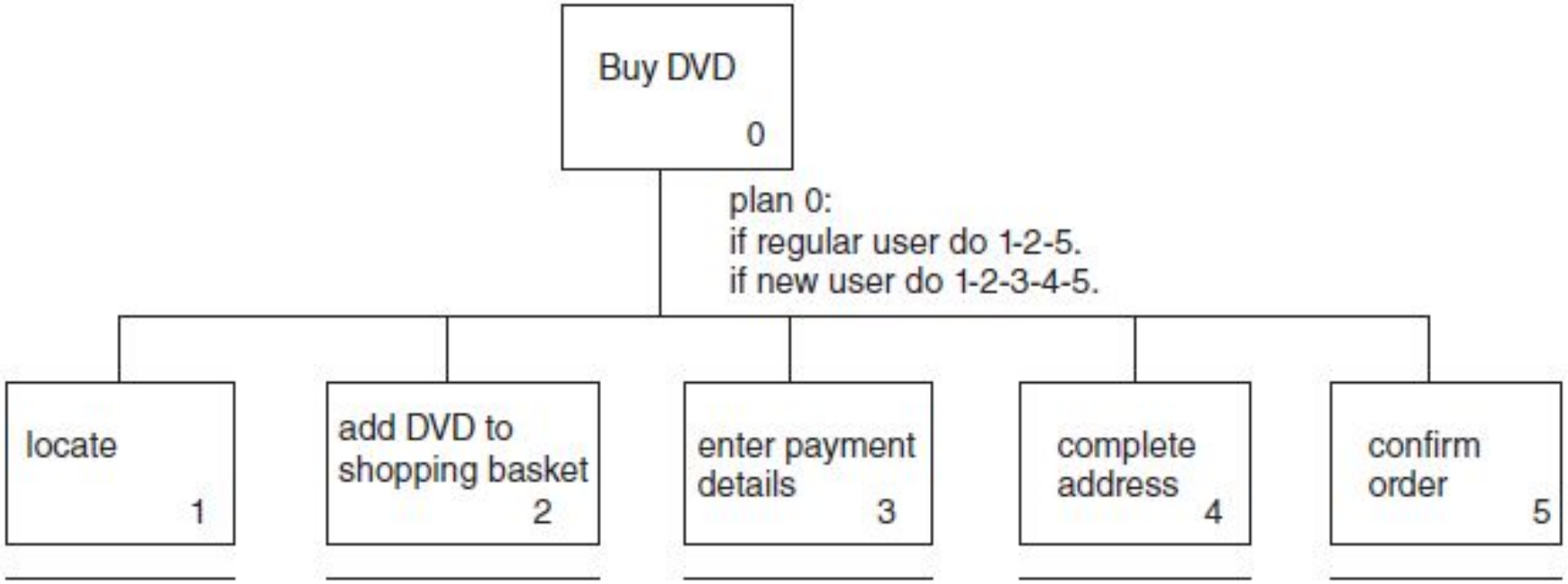
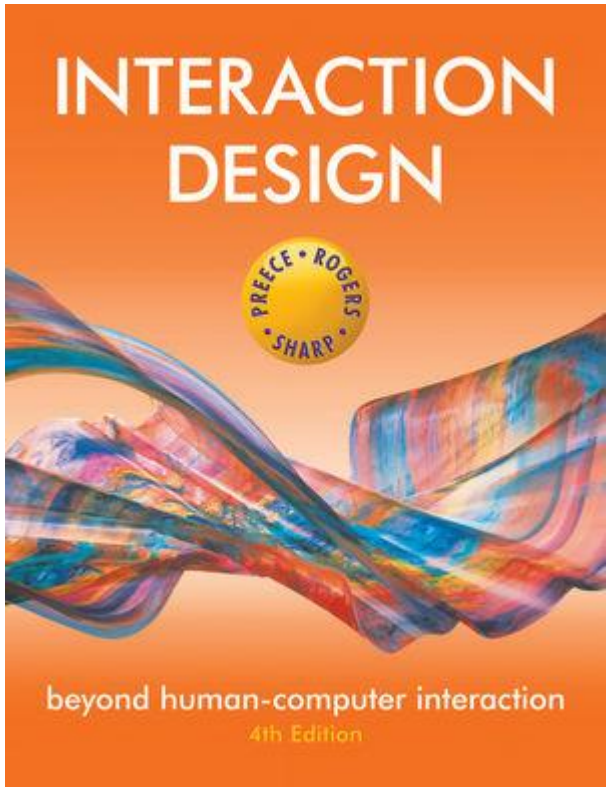


Figure 10.15 A graphical representation of the task analysis for buying a DVD

Summary

- Getting requirements right is crucial
- There are different kinds of requirement, each is significant for interaction design
- The most commonly-used techniques for data gathering are: questionnaires, interviews, focus groups, direct observation, studying documentation and researching similar products
- Scenarios, use cases and essential use cases can be used to articulate existing and envisioned work practices.
- Task analysis techniques such as HTA help to investigate existing systems and practices

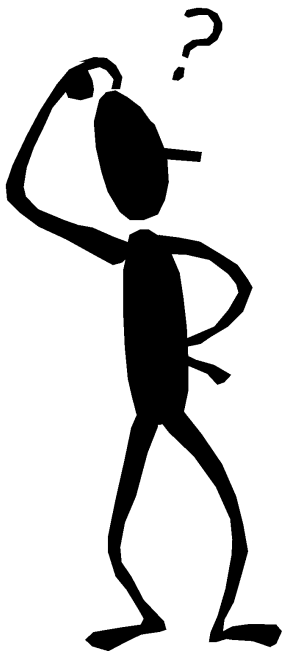


Chapter 11

DESIGN, PROTOTYPING and CONSTRUCTION

Overview

- Prototyping
- Conceptual design
- Concrete design
- Using scenarios
- Generating prototypes
- Construction



Prototyping

- What is a prototype?
- Why prototype?
- Different kinds of prototyping
  - Low fidelity
  - High fidelity
- Compromises in prototyping
  - Vertical
  - Horizontal
- Final product needs to be engineered

What is a prototype?

In other design fields a prototype is a small-scale model:

- a miniature car
- a miniature building or town
- the examples here come from a 3D printer

(a)

Figure 11.1 (a) Color output from a 3D printer: all the gears and rods in this model were 'printed' in one pass from bottom to top, and when one gear is turned, the others turn too.

Source: (a) The Computer Language Company, Inc., courtesy of Alan Freedman

(c) A teddy bear 'printed' from a wireframe design http://www.disneyresearch.com/project/printed-teddy-bears/

(c) Courtesy of Scott Hudson, Human–Computer Interaction Institute, Carnegie Mel· Ion University.

What is a prototype?

In interaction design it can be (among other things):

- a series of screen sketches
- a storyboard, i.e. a cartoon-like series of scenes
- a Powerpoint slide show
- a video simulating the use of a system
- a lump of wood (e.g. PalmPilot)
- a cardboard mock-up
- a piece of software with limited functionality written in the target language or in another language

Why prototype?

- Evaluation and feedback are central to interaction design
- Stakeholders can see, hold, interact with a prototype more easily than a document or a drawing
- Team members can communicate effectively
- You can test out ideas for yourself
- It encourages reflection: very important aspect of design
- Prototypes answer questions, and support designers in choosing between alternatives

Filtering dimensions of prototyping

Filtering dimension	Example variables
Appearance	size; color; shape; margin; form; weight; texture; proportion; hardness; transparency; gradation; haptic; sound
Data	data size; data type (e.g., number; string; media); data use; privacy type; hierarchy; organization
Functionality	system function; users' functionality need
Interactivity	input behavior; output behavior; feedback behavior; information behavior
Spatial structure	arrangement of interface or information elements; relationship among interface or information elements – which can be either two-or three-dimensional, intangible or tangible, or mixed

Manifestation dimensions of prototyping

Manifestation dimension	Definition	Example variables
Material	Medium (either visible or invisible) used to form a prototype	Physical media, e.g. paper, wood, and plastic; tools for manipulating physical matters, e.g. knife, scissors, pen, and sand-paper; computational prototyping tools, e.g. Macromedia Flash and Visual Basic; physical computing tools, e.g. Phidgets and Basic Stamps; available existing artifacts, e.g. a beeper to simulate a heart attack
Resolution	Level of detail or sophistication of what is manifested (corres-ponding to fidelity)	Accuracy of performance, e.g. feedback time responding to an input by a user (giving user feedback in a paper prototype is slower than in a computer-based one); appearance details; interactivity details; realistic versus faked data
Scope	Range of what is covered to be mani-fested	Level of contextualization, e.g. website color scheme testing with only color scheme charts or color schemes placed in a website layout structure; book search navigation usability testing with only the book search related inter-face or the whole navigation interface

Table 11.2 The definition and variables of each manifestation dimension

What to prototype?

- Technical issues
- Work flow, task design
- Screen layouts and information display
- Difficult, controversial, critical areas

Low-fidelity Prototyping

- Uses a medium which is unlike the final medium, e.g. paper, cardboard
- Is quick, cheap and easily changed
- Examples:
  - sketches of screens, task sequences, etc
  - ‘post-it’ notes
  - storyboards
  - ‘Wizard-of-Oz’

Storyboards

- Often used with scenarios, bringing more detail, and a chance to role play
- It is a series of sketches showing how a user might progress through a task using the device
- Used early in design

Example storyboard

Type	Advantages	Disadvantages
Low-fidelity prototype	Lower development cost Evaluates multiple design concepts Useful communication device Addresses screen layout issues Useful for identifying market requirements Proof of concept	Limited error checking Poor detailed specification to code to Facilitator-driven Limited utility after requirements established Limited usefulness for usability tests Navigational and flow limitations
High-fidelity prototype	Complete functionality Fully interactive User-driven Clearly defines navigational scheme Use for exploration and test Look and feel of final product Serves as a living specification Marketing and sales tool	More resource-intensive to develop Time-consuming to create Inefficient for proof-of-concept designs Not effective for requirements gathering

Table 11.3 Advantages and disadvantages of low- and high-fidelity prototypes

Sketching

- Sketching is important to low-fidelity prototyping
- Don't be inhibited about drawing ability. Practice simple symbols

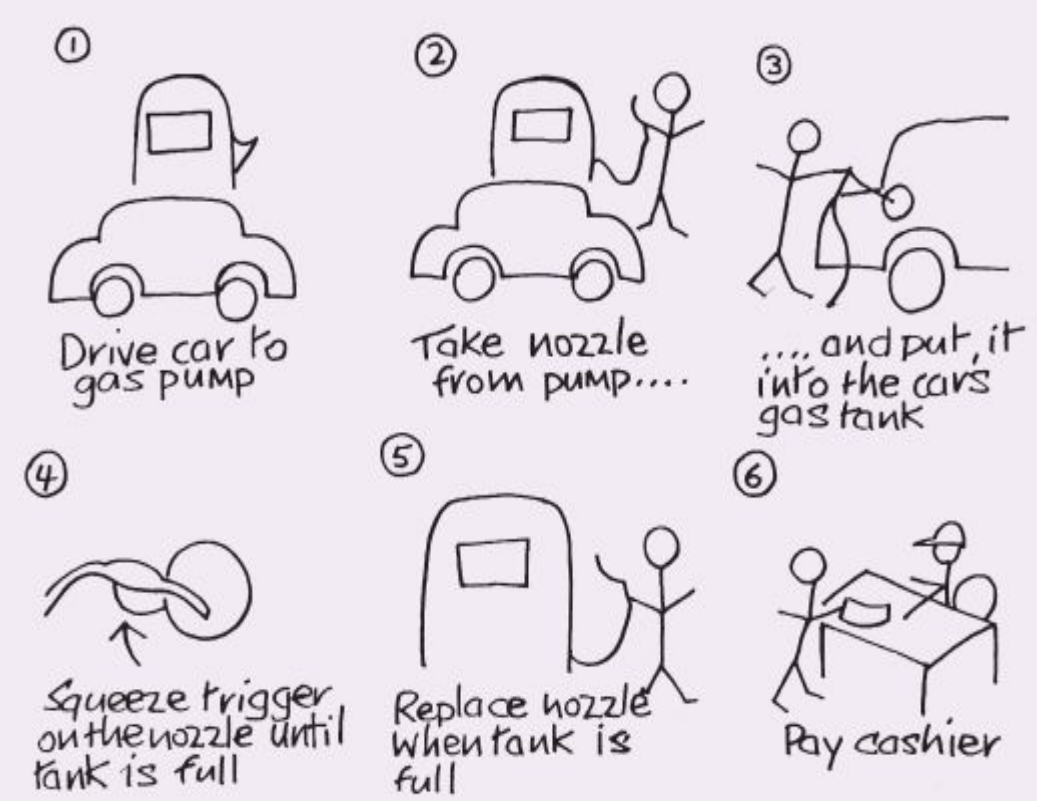
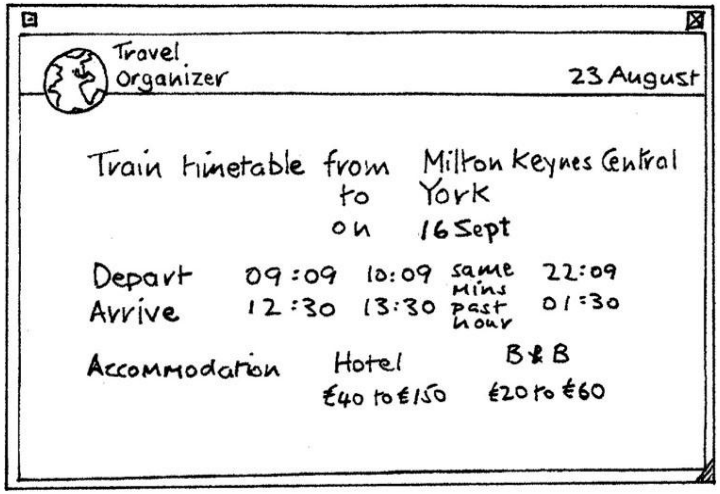


Figure 11.5 A storyboard depicting how to fill a car with gas

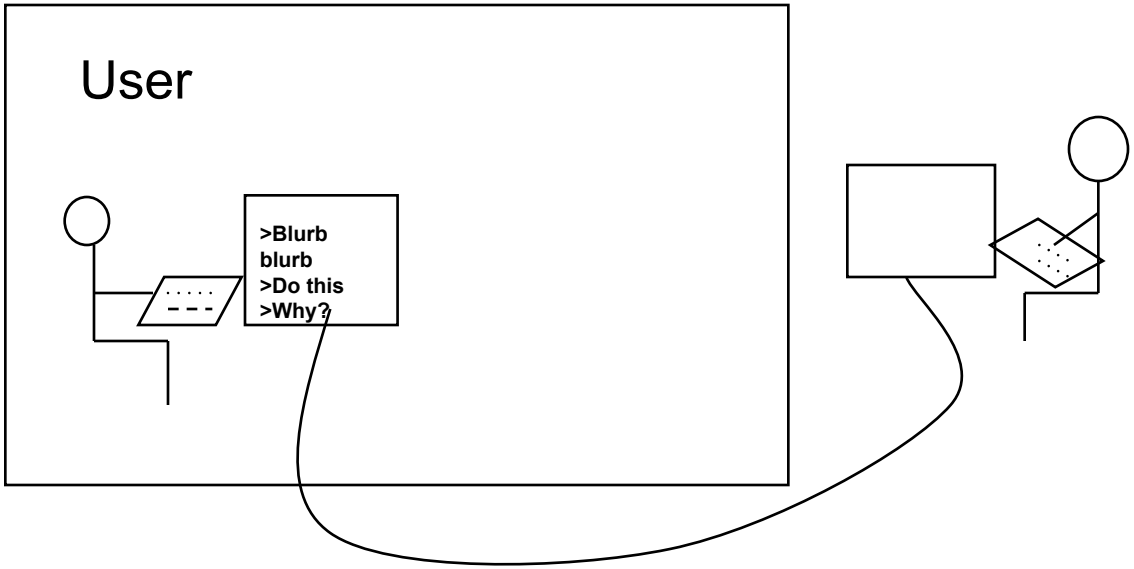
Card-based prototypes



- Index cards (3 X 5 inches)
- Each card represents one screen or part of screen
- Often used in website development

‘Wizard-of-Oz’ prototyping

- The user thinks they are interacting with a computer, but a developer is responding to output rather than the system.
- Usually done early in design to understand users’ expectations
- What is ‘wrong’ with this approach?



High-fidelity prototyping

- Uses materials that you would expect to be in the final product
- Prototype looks more like the final system than a low-fidelity version
- High-fidelity prototypes can be developed by integrating existing hardware and software components
- Danger that users think they have a complete system…….see compromises

Compromises in prototyping

- All prototypes involve compromises
- For software-based prototyping maybe there is a slow response? sketchy icons? limited functionality?
- Two common types of compromise
  - horizontal: provide a wide range of functions, but with little detail
  - vertical: provide a lot of detail for only a few functions
- Compromises in prototypes mustn't be ignored. Product needs engineering

Conceptual design

- Transform user requirements/needs into a conceptual model
- A conceptual model is an outline of what people can do with a product and what concepts are needed to understand and interact with it
- Mood board may be used to capture feel
- Consider alternatives: prototyping helps

Is there a suitable metaphor?

- Interface metaphors combine familiar knowledge with new knowledge in a way that will help the user understand the product.
- Three steps: understand functionality, identify potential problem areas, generate metaphors
- Evaluate metaphors:

  How much structure does it provide?

  How much is relevant to the problem?

  Is it easy to represent?

  Will the audience understand it?

  How extensible is it?

Considering interaction and interface types

- Which interaction type?
  - How the user invokes actions
  - Instructing, conversing, manipulating or exploring
- Do different interface types provide insight?
  - shareable, tangible, augmented reality, etc.

Expanding the initial conceptual model

- What functions will the product perform?
  - What will the product do and what will the human do (task allocation)?
- How are the functions related to each other?
  - Sequential or parallel?
  - Categorisations, e.g. all actions related to privacy on a smartphone
- What information is needed?
  - What data is required to perform the task?
  - How is this data to be transformed by the system?

Concrete design

- Many aspects to concrete design
  - Color, icons, buttons, interaction devices etc.
- User characteristics and context
  - Accessibility, cross-cultural design
- Cultural website guidelines

successful products “are … bundles of social solutions. Inventors succeed in a particular culture because they understand the values, institutional arrangements, and economic notions of that culture.”

Using scenarios

- Express proposed or imagined situations
- Used throughout design in various ways
  - as a basis for overall design
  - scripts for user evaluation of prototypes
  - concrete examples of tasks
  - as a means of co-operation across professional boundaries
- Plus and minus scenarios to explore extreme cases

Generate storyboard from scenario

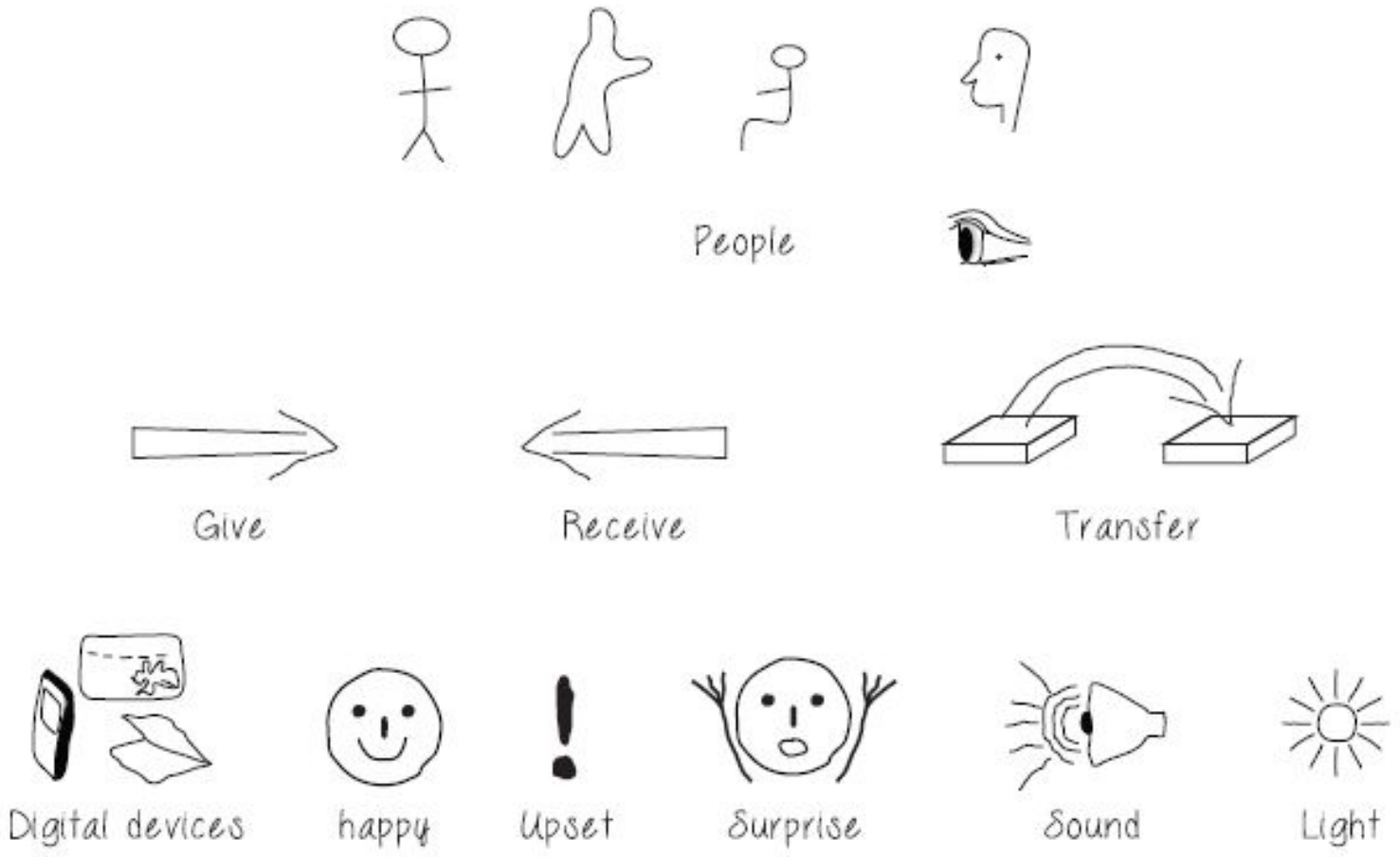


Figure 11.4 Some simple sketches for low-fidelity prototyping

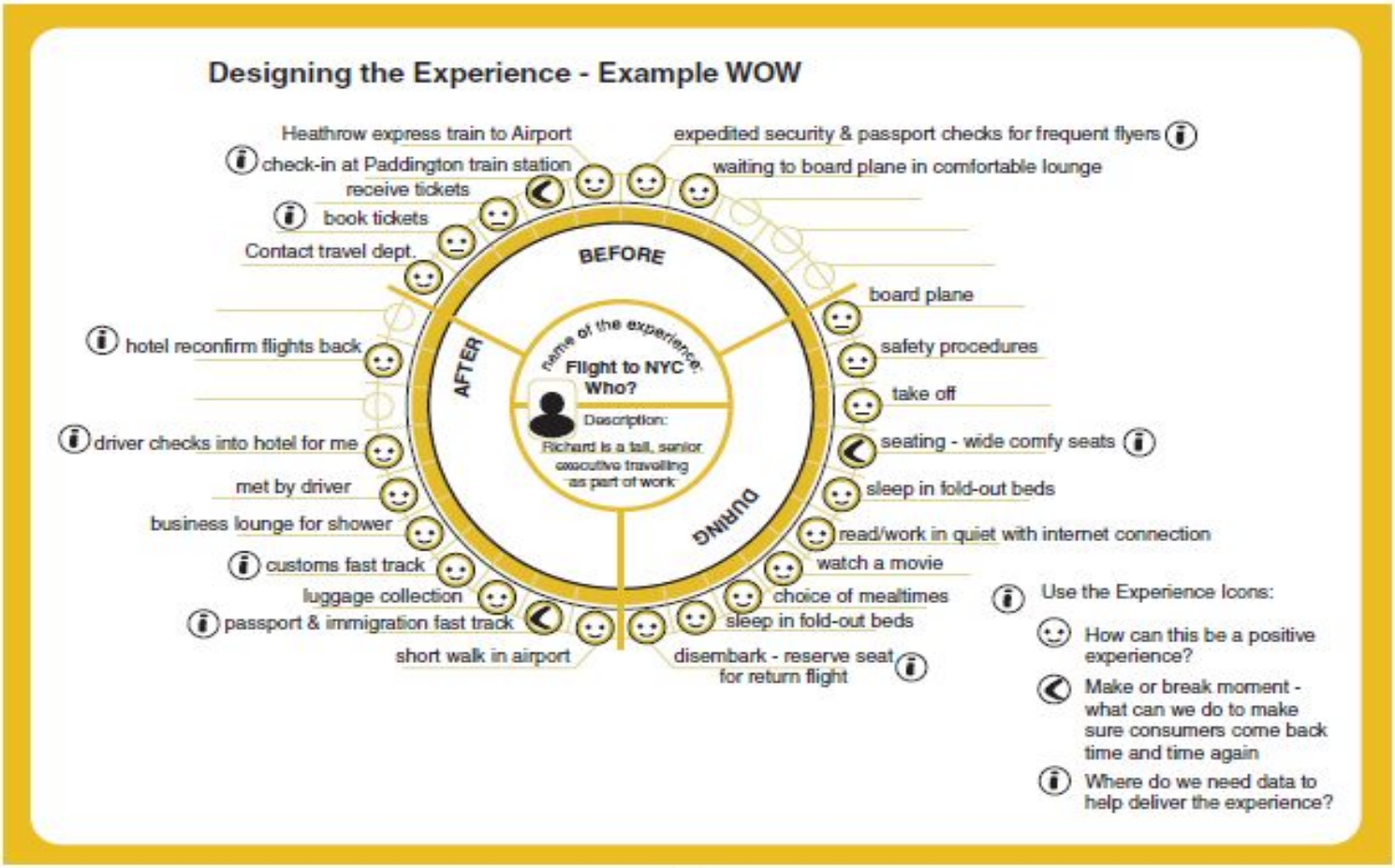
Generate card-based prototype from use case

Figure 11.6 Prototype developed for cell phone user interface

Explore the user's experience

- Use personas, card-based prototypes or stickies to model the user experience
- Visual representation called:
  - design map
  - customer/user journey map
  - experience map
- Two common representations
  - wheel
  - timeline

An experience map drawn as a wheel

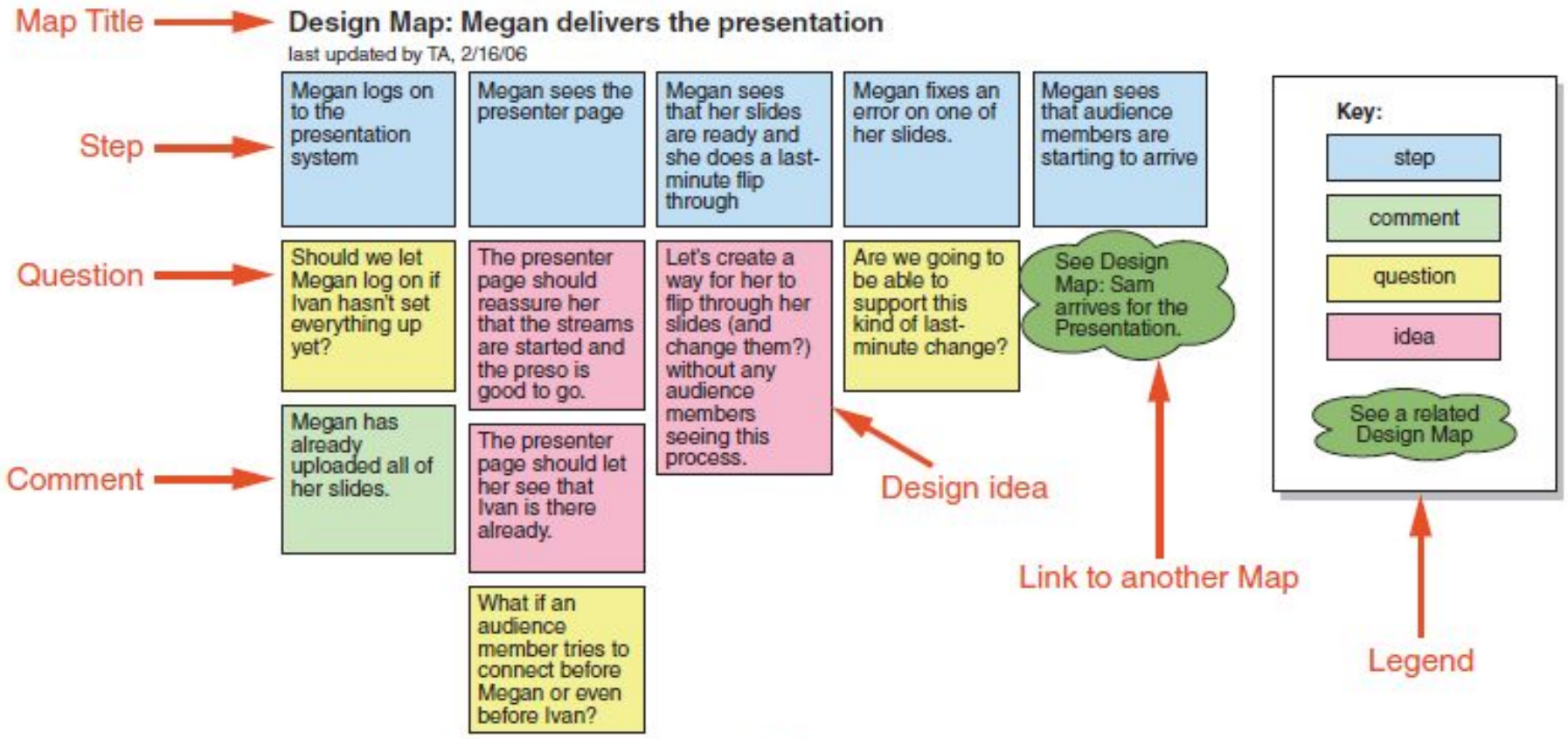


(a)

Figure 11.19 (a) An experience map using a wheel representation. (b) An example timeline design map illustrating how to capture different issues.

Source: (a) http://www.ux-lady.com/experience-maps-user-journey-and-more-exp-map-layout/ (b) Adlin, T. and Pruitt, J. (2010) *The Essential Persona Lifecycle: Your guide to building and using personas*. Morgan Kaufmann p. 134.

An experience map drawn as a timeline



(b)

Figure 11.19 Continued

Construction: physical computing

- Build and code prototypes using electronics
- Toolkits available include
  - Arduino
  - LilyPad (for fabrics)
  - Senseboard
  - MaKey MaKey
- Designed for use by wide range of people

Physical computing kits

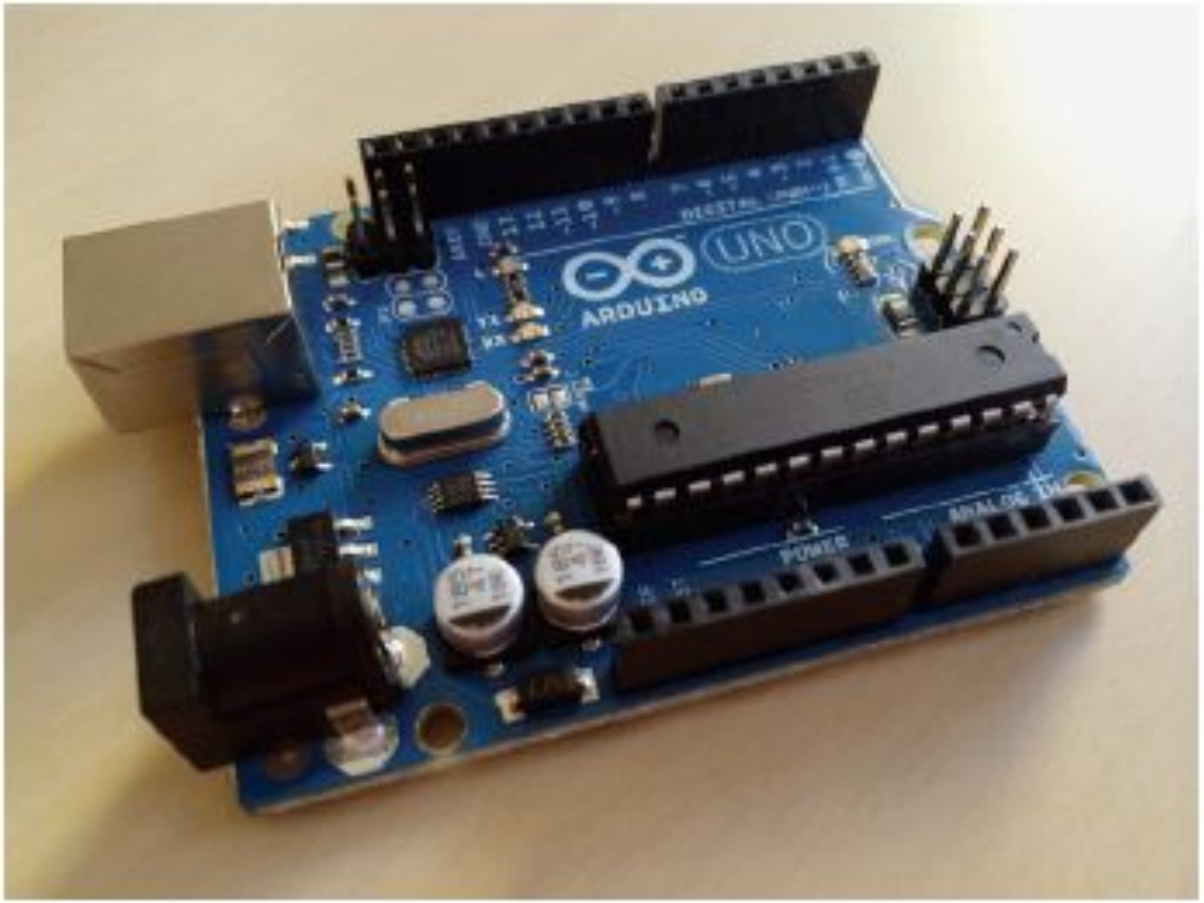


Figure 11.22 The Arduino board

Source: Courtesy of Nicolai Marquardt

Physical computing kits

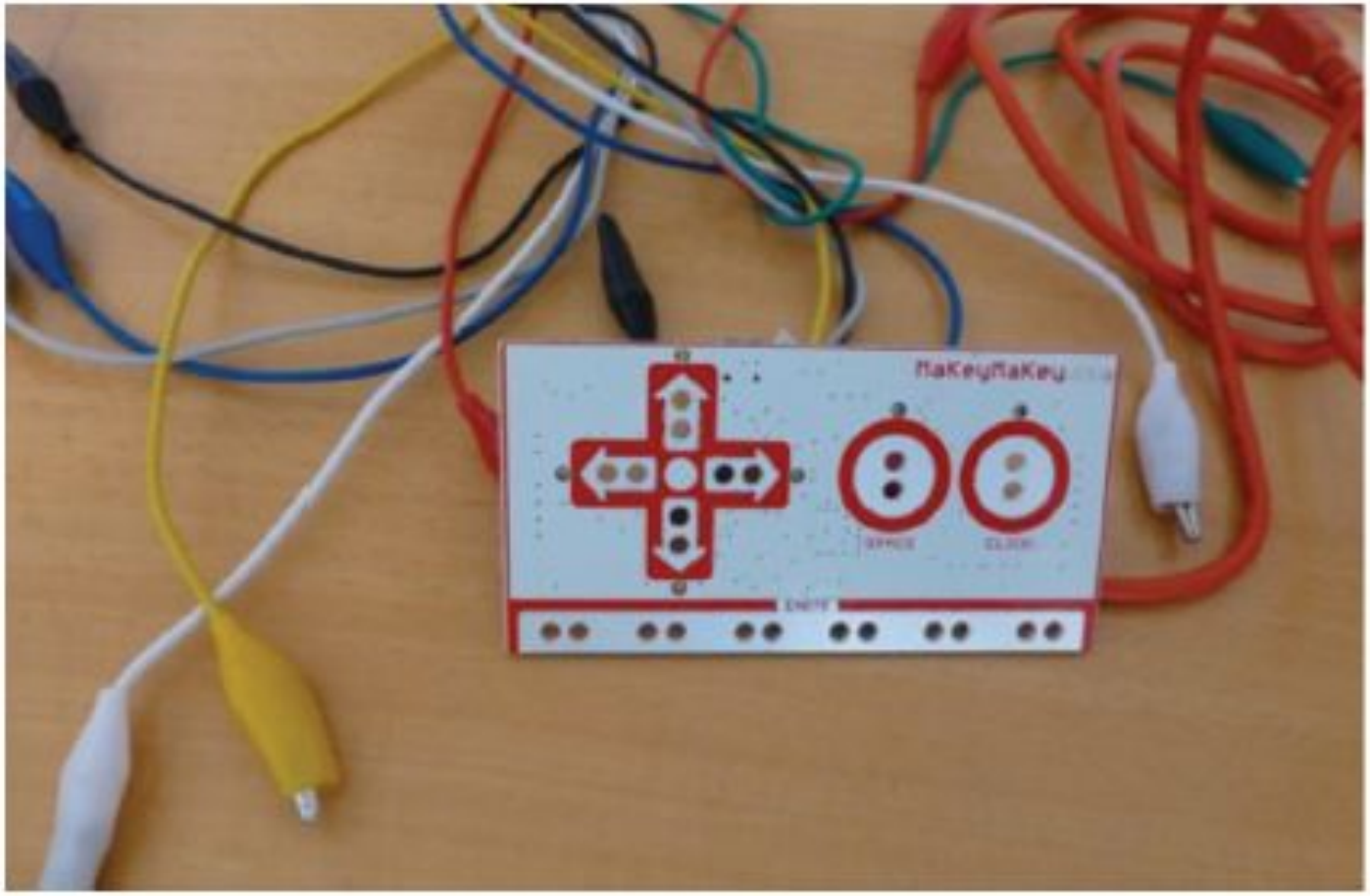


Figure 11.24 The MaKey MaKey toolkit

Physical computing kits

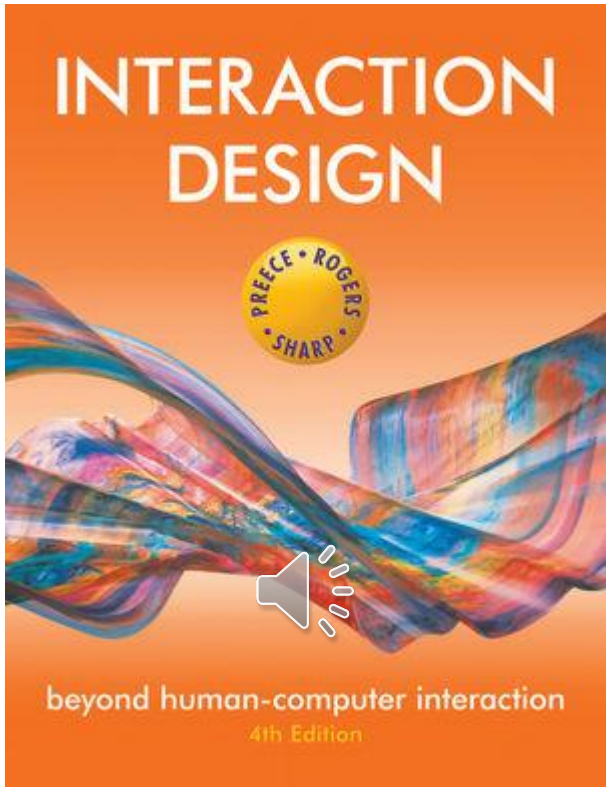
Figure 11.25 A group of retired friends playing with a MaKey MaKey toolkit

Construction: SDKs

- Software Development Kits
  - programming tools and components to develop for a specific platform, e.g. iOS
- Includes: IDE, documentation, drivers, sample code, application programming interfaces (APIs)
- Makes development much easier
- Microsoft's Kinect SDK has been used in research

Summary

- Different kinds of prototyping are used for different purposes and at different stages
- Prototypes answer questions
- The final product must be engineered appropriately
- Two aspects of design: conceptual and concrete
- To generate conceptual design, consider interface metaphors, interaction types and interface types
- Storyboards can be generated from scenarios
- Card-based prototypes can be generated from use cases
- Physical computing kits and SDKs facilitate transition from design to construction



Chapter 14
Evaluation Studies:
From Controlled to Natural Settings

The aims:

- Explain how to do usability testing
- Outline the basics of experimental design
- Describe how to do field studies

Usability testing

- Involves recording performance of typical users doing typical tasks.
- Controlled settings.
- Users are observed and timed.
- Data is recorded on video & key presses are logged.
- The data is used to calculate performance times, and to identify & explain errors.
- User satisfaction is evaluated using questionnaires & interviews.
- Field observations may be used to provide contextual understanding.

Experiments & usability testing

- Experiments test hypotheses to discover new knowledge by investigating the relationship between two or more variables.

- Usability testing is applied experimentation.

- Developers check that the system is usable by the intended user population for their tasks.

Usability testing & research

Usability testing

- Improve products
- Few participants
- Results inform design
- Usually not completely replicable
- Conditions controlled as much as possible
- Procedure planned
- Results reported to developers

Experiments for research

- Discover knowledge
- Many participants
- Results validated statistically
- Must be replicable
- Strongly controlled conditions
- Experimental design
- Scientific report to scientific community

Usability testing

- Goals & questions focus on how well users perform tasks with the product.
- Comparison of products or prototypes is common.
- Focus is on time to complete task & number & type of errors.
- Data collected by video & interaction logging.
- Testing is central.
- User satisfaction questionnaires & interviews provide data about users' opinions.

Testing conditions

- Usability lab or other controlled space.
- Emphasis on:
  - selecting representative users;
  - developing representative tasks.
- 5-10 users typically selected.
- Tasks usually around 30 minutes
- Test conditions are the same for every participant.
- Informed consent form explains procedures and deals with ethical issues.

Types of data

- Time to complete a task.
- Time to complete a task after a specified time away from the product.
- Number and type of errors per task.
- Number of errors per unit of time.
- Number of times online help and manuals accessed.
- Number of users making an error.
- Number of users successfully completing a task.

How many participants is enough for user testing?

- The number is a practical issue.
- Depends on:
  - schedule for testing;
  - availability of participants;
  - cost of running tests.
- Typically 5-10 participants.
- Some experts argue that testing should continue until no new insights are gained.

Usability lab with observers watching a user & assistant

Figure 14.1 A usability laboratory in which evaluators watch participants on a monitor and through a one-way mirror

Portable equipment for use in the field

Figure 14.3 The Tracksys lab-in-a-box system, which comprises components that pack into a heavy duty padded flight case plus a PC system

Source: Courtesy of Harry Brignull.

Portable equipment for use in the field

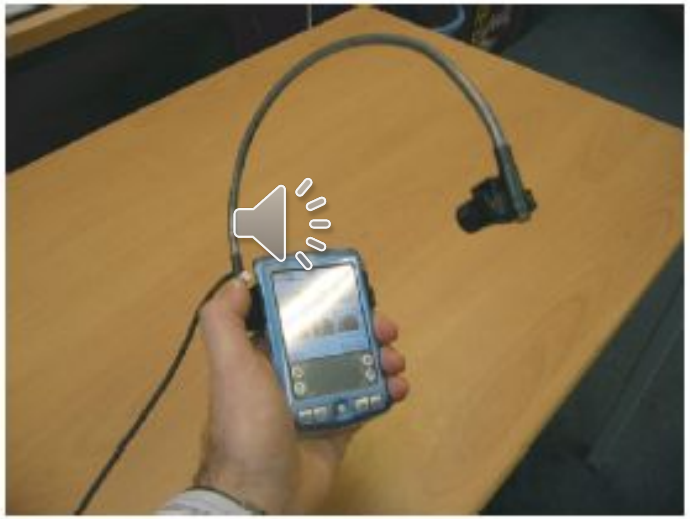


Figure 14.4 The Tracksys system being used with a mobile device camera that attaches to a flexible arm, which mounts on a mobile device, and is tethered to the lab

Source: Courtesy of Harry Brignull.

Mobile head-mounted eye tracker

Figure 14.5 The mobile head-mounted eye-tracker

Source: Picture courtesy of SensoMotoric Instruments (SMI), copyright 2010.

Usability testing the iPad

- 7 participants with 3+ months experience with iPhones
- Signed an informed consent form explaining:
  - what the participant would be asked to do;
  - the length of time needed for the study;
  - the compensation that would be offered for participating;
  - participants' right to withdraw from the study at any time;
  - a promise that the person's identity would not be disclosed; and
  - an agreement that the data collected would be confidential and would be available to only the evaluators
- Then they were asked to explore the iPad
- Next they were asked to perform randomly assigned specified tasks

Examples of the tasks

App or website	Task
iBook	Download a free copy of *Alice's Adventures in Wonderland* and read through the first few pages.
Craigslist	Find some free mulch for your garden.
eBay	You want to buy a new iPad on eBay. Find one that you could buy from a reputable seller.
Time Magazine	Browse through the magazine and find the best pictures of the week.
Epicurious	You want to make an apple pie for tonight. Find a recipe and see what you need to buy in order to prepare it.
Kayak	You are planning a trip to Death Valley in May this year. Find a hotel located in the park or close to the park.

Table 14.1 Examples of some of the tests used in the iPad evaluation (adapted from Budiu and Nielsen, 2010).

Source: Copyright Nielsen Norman Group, from report available at http://www.nngroup.com/reports/.

Example of the equipment

Figure 14.6 The setup used in the Chicago usability testing sessions

Source: Copyright Nielsen Norman Group, from report available at http://www.nngroup.com/reports/.

Problems and actions

- Problems detected:
  - Accessing the Web was difficult
  - Lack of affordance and feedback
  - Getting lost
  - Knowing where to tap
- Actions by evaluators:
  - Reported to developers
  - Made available to public on nngroup.com
- Accessibility for all users important

Experiments

- Test hypothesis
- Predict the relationship between two or more variables.
- Independent variable is manipulated by the researcher.
- Dependent variable influenced by the independent variable.
- Typical experimental designs have one or two independent variables.
- Validated statistically & replicable.

Experimental designs

- Different participants - single group of participants is allocated randomly to the experimental conditions.
- Same participants - all participants appear in both conditions.
- Matched participants - participants are matched in pairs, e.g., based on expertise, gender, etc.

Different, same, matched participant design

Design	Advantages	Disadvantages
Different	No order effects	Many subjects & individual differences a problem
Same	Few individuals, no individual differences	Counter-balancing needed because of ordering effects
Matched	Same as different participants but individual differences reduced	Cannot be sure of perfect matching on all differences

Field studies

- Field studies are done in natural settings.
- “In the wild” is a term for prototypes being used freely in natural settings.
- Aim to understand what users do naturally and how technology impacts them.
- Field studies are used in product design to:
  - identify opportunities for new technology;
  - determine design requirements;
  - decide how best to introduce new technology;
  - evaluate technology in use.

Technology for context-aware field data collection

Figure 14.7 An example of a context-aware experience sampling tool running on a mobile device

Source: From Cogdill, K. (1999) "MedlinePlus Interface Evaluation: Final Report". Reproduced by permission of Prof. Keith Cogdill.

An in the wild study: UbiFit Garden

Figure 14.8 UbiFit Garden's glanceable display: (a) at the beginning of the week (small butterflies indicate recent goal attainments; the absence of flowers means no activity this week); (b) a garden with workout variety; (c) the display on a mobile phone (the large butterfly indicates this week's goal was met)

Source: From Consolvo, S., McDonald, D.W., Toscos, T. *et al* (2008) "Activity sensing in the wild: a field trial of UbiFit garden". In: *Proceedings of CHI 2008*, ACM Press, New York, p. 1799.

Data collection & analysis

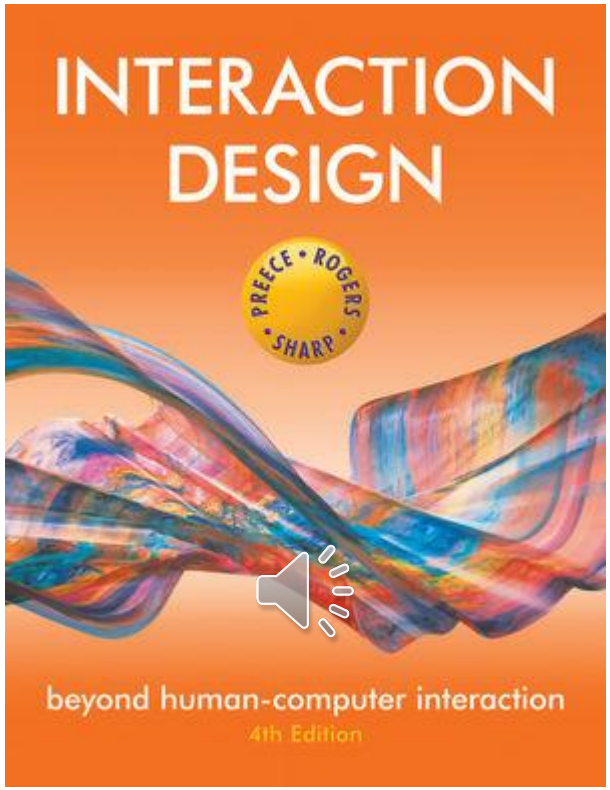
- Observation & interviews
  - Notes, pictures, recordings
  - Video
  - Logging

Data presentation

- The aim is to show how the products are being appropriated and integrated into their surroundings.
- Typical presentation forms include:
  - Vignettes,
  - Excerpts,
  - Critical incidents,
  - Patterns, and narratives.

Key points

- Usability testing takes place in controlled usability labs or temporary labs.
- Usability testing focuses on performance measures, eg. how long and how many errors are made when completing a set of predefined tasks. Indirect observation (video and keystroke logging), user satisfaction questionnaires and interviews are also collected.
- Affordable, remote testing systems are more portable than usability labs. Many also contain mobile eye-tracking and other devices.
- Experiments test a hypothesis by manipulating certain variables while keeping others constant.
- The experimenter controls independent variable(s) in order to measure dependent variable(s).
- Field studies are evaluation studies that are carried out in natural settings to discover how people interact with technology in the real world.
- Field studies that involve the deployment of prototypes or technologies in natural settings may also be referred to as ‘in the wild’.
- Sometimes the findings of a field study are unexpected, especially for in the wild studies in which explore how novel technologies are used by participants in their own homes, places of work, or outside.



Chapter 15
Evaluation: Inspections, Analytics & Models

Aims:

- Describe the key concepts associated with inspection methods.
- Explain how to do heuristic evaluation and walkthroughs.

- Explain the role of analytics in evaluation.
- Describe how to use Fitts' Law – a predictive model.

Inspections

- Several kinds.
- Experts use their knowledge of users & technology to review software usability.
- Expert critiques can be formal or informal.
- Heuristic evaluation is a review guided by a set of heuristics.
- Walkthroughs involve stepping through a pre-planned scenario noting potential problems.

Heuristic evaluation

- Developed by Jacob Nielsen in the early 1990s.
- Based on heuristics distilled from an empirical analysis of 249 usability problems.
- These heuristics have been revised for current technology by Nielsen and others for:
  - mobile devices,
  - wearables,
  - virtual worlds, etc.
- Design guidelines form a basis for developing heuristics.

Revised version (2014) of Nielsen's original heuristics

- Visibility of system status.
- Match between system and real world.
- User control and freedom.
- Consistency and standards.
- Error prevention.
- Recognition rather than recall.
- Flexibility and efficiency of use.
- Aesthetic and minimalist design.
- Help users recognize, diagnose, recover from errors.
- Help and documentation.

No. of evaluators & problems

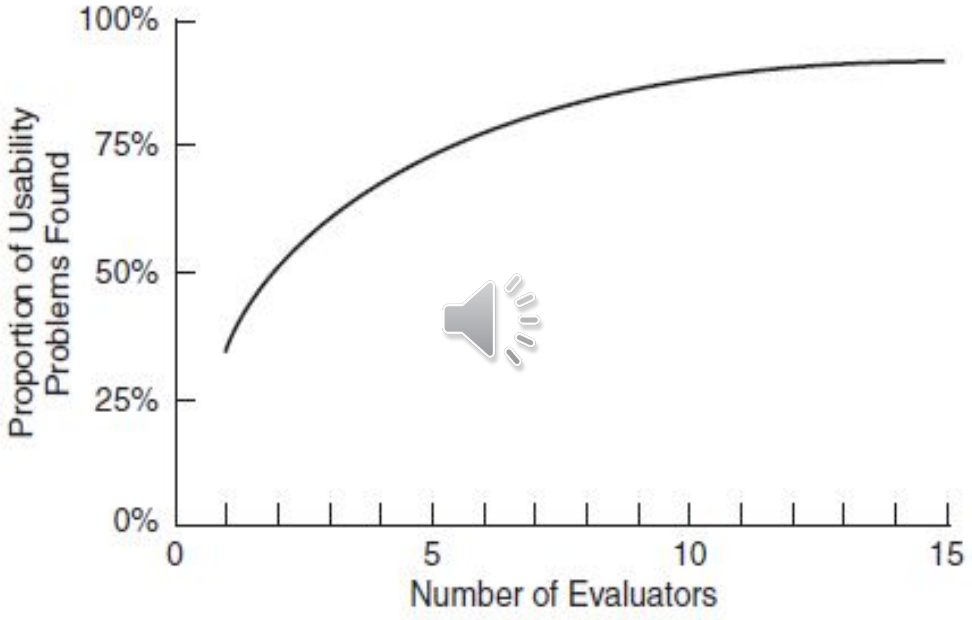


Figure 15.1 Curve showing the proportion of usability problems in an interface found by heuristic evaluation using various numbers of evaluators. The curve represents the average of six case studies of heuristic evaluation

Source: Usability Inspection Methods, J. Nielson & R.L. Mack ©1994. Reproduced with permission of John Wiley & Sons Inc.

Number of evaluators

- Nielsen suggests that on average 5 evaluators identify 75-80% of usability problems.
- Cockton and Woolrych (2001) point out that the number of users needed to find 75-80% of usability problems depends on the context and nature of the problems.

Heuristics for websites focus on key criteria (Budd, 2007)

- Clarity
  - Make system clear, concise, and meaningful as possible.
- Minimize unnecessary complexity & cognitive load
  - Make system as simple as possible to accomplish the task.
- Provide users with context
  - Interface should provide users with a sense of context in time and space.
- Promote positive & pleasurable user experience
  - Users should be treated with respect, and design should be aesthetically pleasing and promote a pleasurable and rewarding experience.

3 stages for doing heuristic evaluation

- Briefing session to tell experts what to do.
- Evaluation period of 1-2 hours in which:
  - Each expert works separately;
  - Take one pass to get a feel for the product;
  - Take a second pass to focus on specific features.
- Debriefing session in which experts work together to prioritize problems.

Advantages and problems

- Few ethical & practical issues to consider because users not involved.
- Can be difficult & expensive to find experts.
- Best experts have knowledge of application domain & users.
- Biggest problems:
  - Important problems may get missed;
  - Many trivial problems are often identified;
  - Experts have biases.

Cognitive walkthroughs

- Focus on ease of learning.
- Designer presents an aspect of the design & usage scenarios.
- Expert is told the assumptions about user population, context of use, task details.
- One or more experts walk through the design prototype with the scenario.
- Experts are guided by 3 questions.

The 3 questions

- Will the correct action be sufficiently evident to the user?
- Will the user notice that the correct action is available?
- Will the user associate and interpret the response from the action correctly?

As the experts work through the scenario they note problems.

Pluralistic walkthrough

- Variation on the cognitive walkthrough theme.
- Performed by a carefully managed team.
- The panel of experts begins by working separately.
- Then there is managed discussion that leads to agreed decisions.
- The approach lends itself well to participatory design.
- Also other adaptations of basic cognitive walkthroughs.

Predictive models

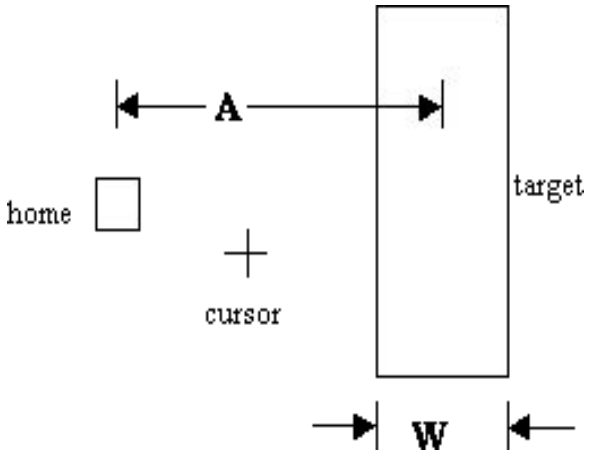
- Provide a way of evaluating products or designs without directly involving users.
- Less expensive than user testing.

- Usefulness limited to systems with predictable tasks - e.g., telephone answering systems, mobiles, cell and smart phones.
- Based on expert error-free behavior.

Fitts' Law (Fitts, 1954)

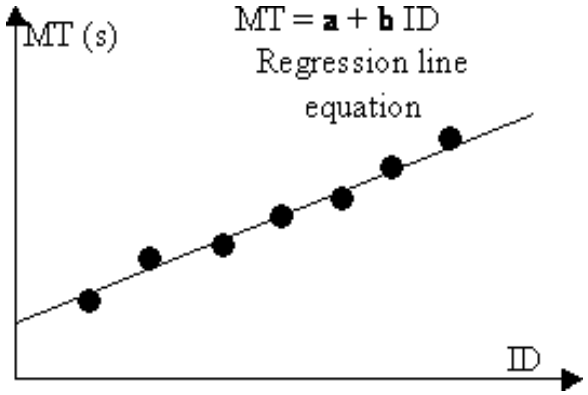
- Fitts' Law predicts that the time to point at an object using a device is a function of the distance from the target object & the object's size.
- The further away and the smaller the object, the longer the time to locate it and point to it.
- Fitts' Law is useful for evaluating systems for which the time to locate an object is important, e.g., a cell and smart phones, a handheld and mobile devices.

Fitts' Law (MacKenzie Formulation)



$$MT = a + b\log_2(\frac{A}{W} + 1)$$

$$ID = \log_2(\frac{A}{W} + 1)$$



MT: Movement Time – Time it takes to move cursor from home to target

ID: Index of Difficulty – Metric of tasks difficulty expressed as a measure of human performance in bits per section.

b: measured constant – approximately 200ms/bit.

Key points

- Inspections can be used to evaluate requirements, mockups, functional prototypes, or systems.
- User testing & heuristic evaluation may reveal different usability problems.
- Design guidelines can be used to develop heuristics
- Walkthroughs are focused so are suitable for evaluating small parts of a product.
- Analytics involves collecting data about users activity on a website or product
- Fitts' Law can be used to predict expert, error-free performance for clearly defined tasks with limited key presses, eg. data entry and smart phone use.