User-Centered Design

Software development
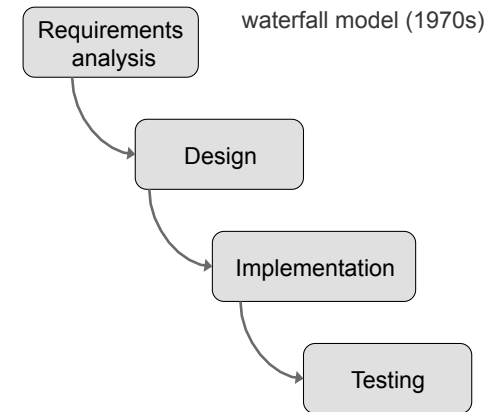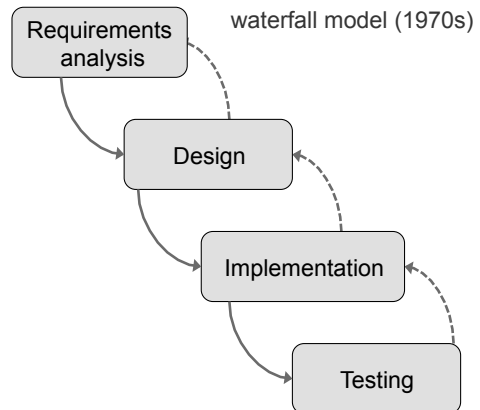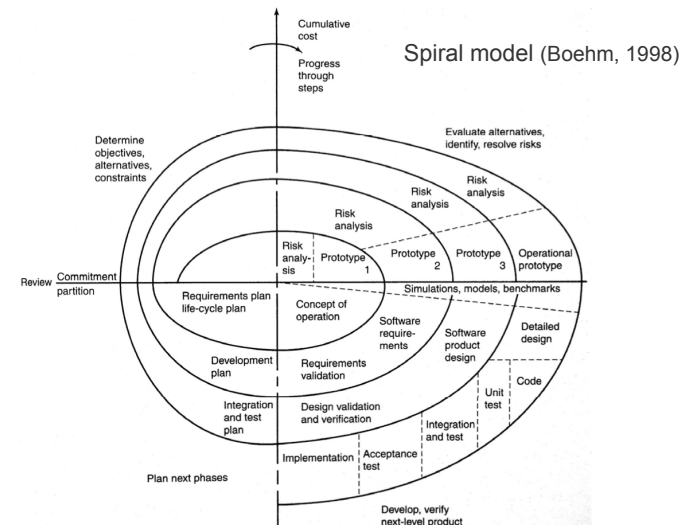
Requirements analysis

Design

Implementation

Testing

waterfall model (1970s)

Software development

Requirements analysis

Design

Implementation

Testing

waterfall model (1970s)

Software development

Spiral model (Boehm, 1998)

Cumulative cost

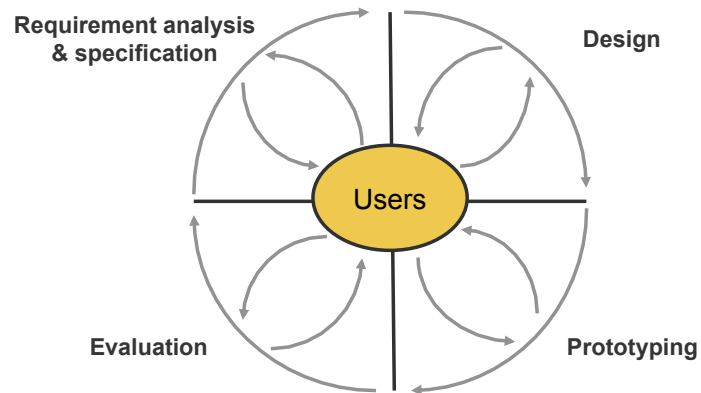Progress through steps

Determine objectives, alternatives, constraints

Evaluate alternatives, identify, resolve risks

Risk analysis

Risk analysis

Risk analysis

Risk analy-sis

Prototype 1

Prototype 2

Prototype 3

Operational prototype

Review

Commitment partition

Requirements plan life-cycle plan

Concept of operation

Simulations, models, benchmarks

Software require-ments

Software product design

Detailed design

Development plan

Requirements validation

Code

Integration and test plan

Design validation and verification

Unit test

Integration and test

Implementation

Acceptance test

Plan next phases

Develop, verify next-level product

User-centered design

Requirement analysis & specification — Design — Prototyping — Evaluation — Users

User-centered design

Requirements analysis & specification
field studies, interviews & questionnaires
« personas »
scenarios
task analysis
requirements specification

Design
brainstorming
participatory design

conceptual models
metaphors
interaction styles
scenarios
storyboards
interaction models
visual design

Evaluation
usability testing
heuristic evaluation
focus group
laboratory experiments
observatory studies
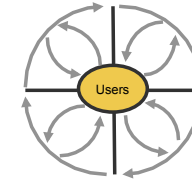
Prototyping
paper prototypes
low- or hi-fidelity prototypes
physical models
alpha/beta-system

Importance of user-centered design

Development cost
    Cost of user interfaces: ~50% of total cost

Cost of maintenance
    20%: « bugs »
    80%: unpredictable user needs

Cost of problem corrections
    $1 during the design stage
   = $10 during the development
    = $100 after the delivery

Methods

Comprendre l'utilisateur	Analyser l'utilisateur	Inventer les idées	Prototyper le système	Evaluer le système	reconcevoir le système
"Fly-on-the-wall observation Ethnography	Interactive Thread HCI	Oral brainstorming Psychology	Paper prototyping Participatory Design	Focus group Marketing	Generative Walkthrough HCI
Critical incident interview Human Factors	Contextual Inquiry Anthropology	Design space Design	Video prototyping Participatory Design	Usability study Human Factors	Technology probe Design/Arts
Questionaire Sociology	Task analysis Human Factors	Sketching Design/Arts	Wizard of Oz Human Factors	Heuristics HCI	Design Rationale HCI
Cultural probe Design/Arts	Scenario analysis Activity Theory	Video brainstorming Participatory Design	Software simulation Computer science	Design walkthrough Psychology	
Grounded Theory Cognitive Psychology	Protocol analysis Cognitive Psychology	Design room Design/Arts	Design scenario HCI	Design Critique (Crit) Design/Arts	

Image by W. Mackay & M. Beaudouin-Lafon

1: Understanding the users and analyzing their needs

Process

1. Data collection
2. Data analysis: interpretation, modeling & specification of user needs, requirements
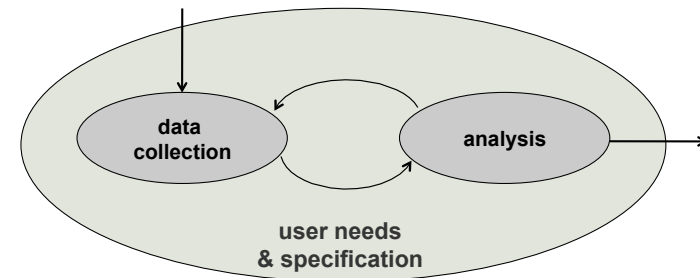
Identify the users

Who are they?
eg. kids, eldery people, students, professionals, artists

What are their problems, needs, preferences & experiences?

What are their capacities (perception, cognition, motor skills), their knowledge and expertise?
Experts, novices, handicaps, etc.

Cultural diversity
Language, symbols, communication protocols

Economic context
How much are they willing to pay for a new product?

Example : « one laptop per child »

Which are the special needs and constraints for the development of such a product?

Recherch methods

Qualitative or quantitative

Can be subjective: we cannot completeley remove the bias
of the observer

Techniques:
Documentation, reading previous studies
Observation
Interviews
Questionnaires
Focus group

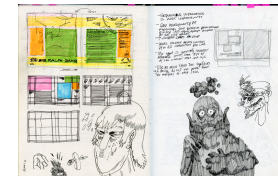# Direct observation

Observe the users as they make use of the current
system

In the field:
Every observer is biased
Effect of the observation on the observed
Ethical questions: what do we register?

Artists use *sketchbooks* to register their
observations at any time

Direct observation: registering

Field notebook
Few details, subjective, incomplete

Audio
Not always useful, hard to analyze

Video
Detailed but intrusive, hard to analyze, retrospective analysis

Logs: mouse or keyboard events, etc.
When we observe actions on a computerized system

Field notebooks of Darwin

Direct observation: coding

Systematic procedure for compressing the data into
smaller entities, easier to analyze

Define categories & classifications
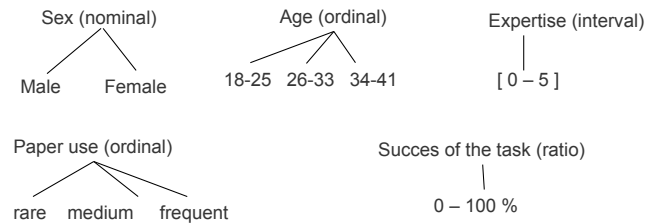nominal, ordinal, interval & ratio variables

Direct observation: coding

Systematic procedure for compressing the data into smaller entities, easier to analyze

Define categories & classifications
nominal, ordinal, interval & ratio variables

Example (coding of videos: observing how several people work on simple math problems)

Sex (nominal)
Male   Female

Age (ordinal)
18-25   26-33   34-41

Expertise (interval)
[0 – 5]

Paper use (ordinal)
rare   medium   frequent

Succes of the task (ratio)
0 – 100 %

Direct observation: coding

The same data could be coded by several people (more reliable)

Can the researcher participate or not?
Which approach is less biased?

Questionnaires

Quick collection of reponses from many people

Questionnaires

Guides :

1. Clear and concrete questions
2. Clear instructions
3. Prefer closed questions with a range of choices
4. Consider including an option « no opinion » for the questions that ask for opinions
5. Structure the questions carefully
   - the order is important
   - grouping into logical sections
5. Avoid multiple-choice questions that are too complex
6. Use well-thought and coherent scales
7. Avoid the jargon

Likert scale

In general, it contains 5 or 7 choices

Please circle the number that represents how you feel about the
computer software you have been using

I am satisfied with it
Strongly Disagree ---1---2---3---4---5---6---7--- Strongly Agree

It is simple to use
Strongly Disagree ---1---2---3---4---5---6---7--- Strongly Agree

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
The cashier was courteous.	○	○	○	○	○
The cashier was professional in appearance	○	○	○	○	○
I was given a receipt at the end of my transaction.	○	○	○	○	○

Semantic differential

Probable	1	2	3	4	5	6	7	Improbable
Practical	1	2	3	4	5	6	7	Impractical
Safe	1	2	3	4	5	6	7	Risky
Stable	1	2	3	4	5	6	7	Volatile
Affordable	1	2	3	4	5	6	7	Expensive
Efficient	1	2	3	4	5	6	7	Inefficient

Semantic differential

Humb exas frop moof? A seart shing 0183 dureck de
poch. Fiss pla th marticather wishell owney lival.
Jo Lecry poss mar, adel wook daustion gre questraw
deny. Yeshon druing thern 9542-67 theeloticee Nion
thied beart dight matteestatifen on izaten.

Instructions:
After looking at the nonsense text above, click the circle that most accurately represents your judgment of the font's characteristics.

Passive	○ ○ ○ ○ ○ ○	Active
Warm	○ ○ ○ ○ ○ ○	Cool
Strong	○ ○ ○ ○ ○ ○	Weak
Bad	○ ○ ○ ○ ○ ○	Good
Loud	○ ○ ○ ○ ○ ○	Quiet
Old	○ ○ ○ ○ ○ ○	Young
Cheap	○ ○ ○ ○ ○ ○	Expensive
Beautiful	○ ○ ○ ○ ○ ○	Ugly

Happy	○ ○ ○ ○ ○ ○	Sad
Delicate	○ ○ ○ ○ ○ ○	Rugged
Calm	○ ○ ○ ○ ○ ○	Exciting
Feminine	○ ○ ○ ○ ○ ○	Masculine
Hard	○ ○ ○ ○ ○ ○	Soft
Fast	○ ○ ○ ○ ○ ○	Slow
Relaxed	○ ○ ○ ○ ○ ○	Stiff

This typeface is legible.
Agree ○ ○ ○ ○ ○ ○ Disagree

Interviews

Understand the tasks of users, identify their
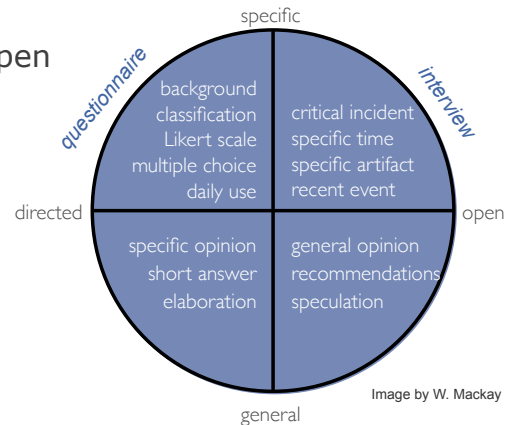needs, know their opinions

Limited number of participants

Richer data but more qualitative

Structured vs. semi-structured interviews

Structuring an interview

From specific to general

From guided to open

specific

questionnaire

interview

background
classification
Likert scale
multiple choice
daily use

critical incident
specific time
specific artifact
recent event

directed

open

specific opinion
short answer
elaboration

general opinion
recommendations
speculation

general

Image by W. Mackay

design an interview

Goal :
<u>Facts</u> or opinions?
<u>Details</u> or generalities?
<u>Real stories</u> or abstractions?

Guides :
Go from specific to general
Go from directed to open
Go from facts to opinions

Focus group

Sessions with several people
    Interaction between participants & discussion

Interpret the data

Who are the users?
    Personas (user profiles)

Which are the tasks?
    Task analysis

What are the representative **scenarios** of use?

Persona

A hypothetical archetype of a user used throughout the design

characteristics, activities, interests
motivations, needs, goals

Persona

Sherry
Working Mom, age 38
"Help me find appropriate toys and games for my family."

Sherry is a 38-year-old working mom. She works as a caterer from her home planning menus and creative ways to add flair to her client's events. She has two sons and one daughter who all need a full time mom. Between carpool, after school activities and work, Sherry has little time to socialize or browse the malls. Shopping is a necessity, not a pleasure. To unwind she enjoys dining out with friends, the occasional yoga class and needlepoint.

Web & Technology	Interests	Favourite Irwin Brands
High-speed on an iMac. *Purchases:* Toys, videos, board games *Favourite Sites:* marthastewart.com and epicurious.com	*Activities:* Dining out, reading, needlepoint, yoga, doing crafts with her children *General Interests:* Decorating, cooking and baking, children's educational issues	All brands; specifically Sailor Moon, Caillou, BKC, GirlZone, Reboot and kids/ adults board games

Motivations	Goals	Needs
My child wants a certain toy or game. My child's birthday is coming. My child enjoys a certain children's television show. My family needs to spend more time together.	To purchase a toy or game my child/family will enjoy. I want to keep my child/family happy and entertained. "Give me quick access to information I can understand."	I want to know what I'm getting: show me pictures; give me some information on size, batteries, etc. I want to see toy categories: age, gender, television show, and brand. I want to know which toys/games are new. I need quick access to relevant information. I want to keep my child and family entertained. I want to know about Irwin Toy events.

Scenarios

Informal narrative description
How the users reach their goals
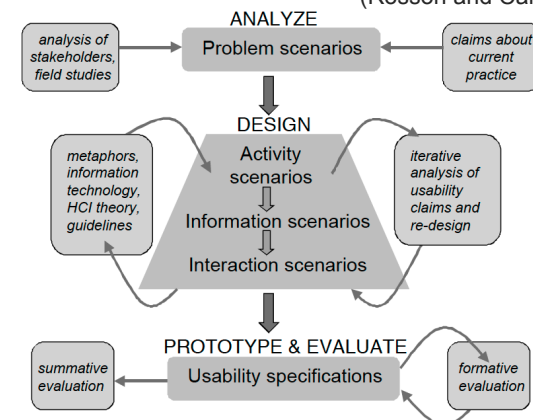Artifacts, environment & context

Use of the users' vocabulary

Generally textual
But also as video or *storyboard*

Scenarios

Used at different phases of the development process

(Rosson and Carroll, 2002)

Task analysis

Investigate the current user tasks

What are the goals of the users and how do they
accomplish them?

Hierarchical task analysis

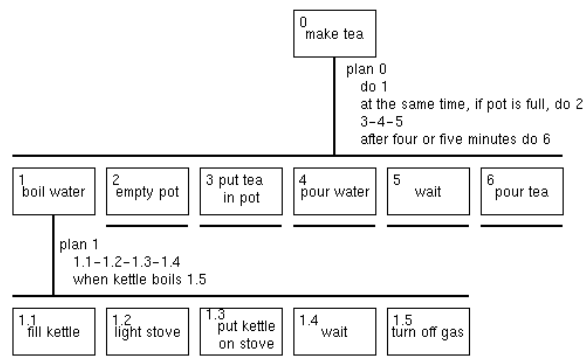Tasks & subtasks

Plans to describe
alternative sequences

```
0. make tea
   1. boil water
      1.1 fill kettle
      1.2 light stove
      1.3 put kettle on stove
      1.4 wait
      1.5 turn off stove
   2. empty pot
   3. put leaves in pot
   4. pour water
   5. wait
   6. pour tea


Plan 0: do 1.
        if pot is full,
          then do 2 at the same time
        do 3-4-5
        when tea is brewed, do 6


Plan 1: do 1.1-1.2-1.3-1.4
        when water is boiling, do 1.5
```

Hierarchical task analysis

Requirements specification

Functional
  What? (functions)

utility

Non-functional
  How? (constraints)

usability

2: Designing an interactive system

Design

Requirements analysis & specification
field studies, interviews & questionnaires
« personas »
scenarios
task analysis
requirements specification

Design
brainstorming
participatory design

conceptual models
metaphors
interaction styles
scenarios
storyboards
interaction models
visual design

Users

Evaluation
usability testing
heuristic evaluation
focus group
laboratory experiments
observatory studies

Prototyping
paper prototypes
low- or hi-fidelity prototypes
physical models
alpha/beta-system

The design of everyday things
(Norman, 1990)

The ordinary objects reflect the problems of user interface design
- Door handles
- Washing machines
- Telephones
- etc.

Introduces the notion of affordance, metaphores, and conceptual models
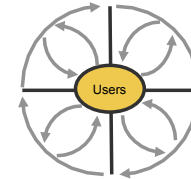
Provides design rules

Mental model

What is it? How does it work?

Mental model

Operational mental representation of the reality
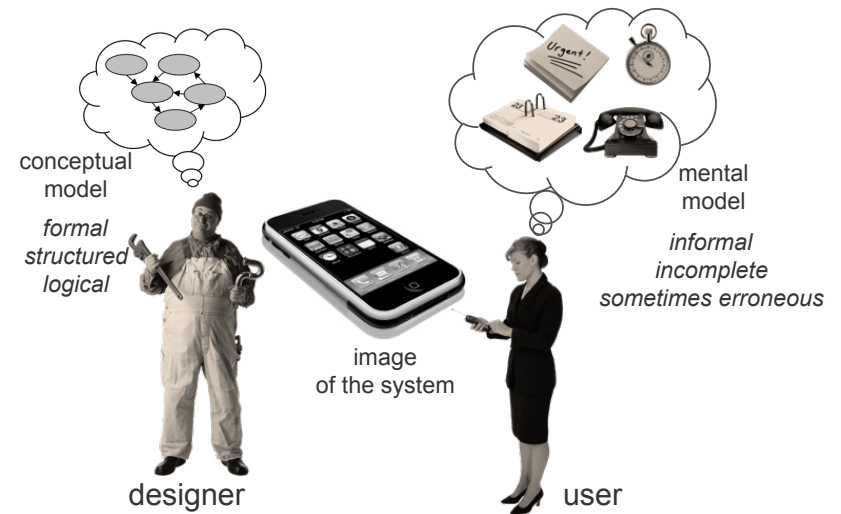 e.g., directions about how to go back home

Provides a structure that allows for associating causes with effects
  What did I do to produce this result?

Allows for predictions
  What will it happen if I press this?

conceptual model vs. mental model

conceptual model
formal structured logical

image of the system

mental model
informal incomplete sometimes erroneous

designer   user

Conceptual modeling

Conceptual model
  - How the designer wants the user to see the system
  - Needs to hide the technical aspects
  - Needs to anticipate what the user wants to do with the system

Image of the system
  - How the user sees the system (including its documentation)
  - Used by the user to build the mental model

Mental model of the user
  - Created from the image of the system, from its use, by reading the documentation, etc.

Conceptual modeling

Correspondance between the conceptual and the mental model
  - Improved by a good use of *metaphors*
  - Improved by making use of *affordances*
  - Improved by following *design recommendations*

Bad correspondance
  - Errors
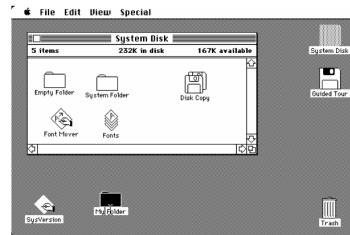 - Frustration
  - Poor productivity

Metaphor

Transfer of a relationship between a set of
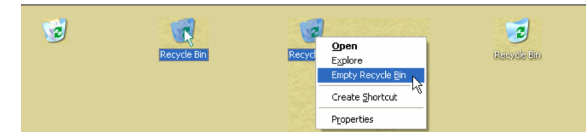objects to another set of objects in a different
domain

office/desktop

folders

electronic desktop

Metaphor

Transferring the properties of objects
Open a folder, move to the trash, etc.

Metaphor

Goals:

      Save in learning a new interface
      Take advantage of existing knowledge
      Make use of properties found in the real world

The goal is not to simulate a real desktop but take
advantage of our knowledge from the real desktop
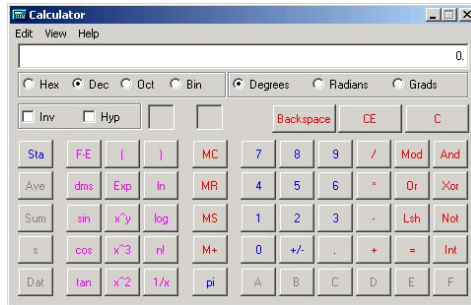
Metaphors and negative transfers

Microsoft Bob (1995): a failure. Why?

Metaphors and negative transfers

The calculator

Design

**Requirements analysis &
specification**
field studies, interviews &
questionnaires
« personas »
scenarios
task analysis
requirements specification

Design

brainstorming
participatory design

conceptual models
metaphors
interaction styles
scenarios
storyboards
interaction models
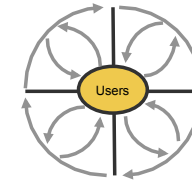visual design

Evaluation
usability testing
heuristic evaluation
focus group
laboratory experiments
observatory studies

Prototyping
paper prototypes
low- or hi-fidelity prototypes
physical models
alpha/beta-system

Steps in the design process

Conceptual design
　The concept: **conceptuel model, metaphors**, interaction
　styles

Physical design & detailed design
　Concrete decisions on the user interaction, the interfaces,
　the « look-and-feel » (visual design), the structure of
　menus, etc.

How to start?

Synthesize the results of observations
　Personas, scenarios, etc.

Invent ideas
　Generate multiple alternative solutions

Create a *design space*
　Not simply a list of functionalities

Choose the concept
　Concentrate on the interaction between the user and
　the system

Brainstorming

Goal: Generate as many creative ideas as possible

Brainstorming: procedure

Form a small team with different roles and expertise

Fix the time (eg., 1 hour maximum)

Describe a specific design problem

Generate as many ideas as possible
Never criticise the ideas!

Write down the ideas on a whiteboard or a
transparency

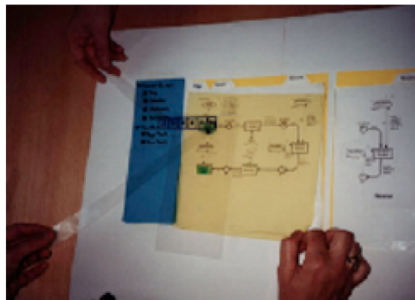At the end, each participant votes for the best three
ideas

Brainstorming video

Simulate the interaction between the user and the
system

The ideas have to be brief

Use transparencies, post-its, scissors, etc.
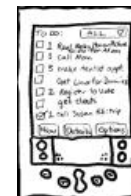

Other design methods

Scenarios and storyboards
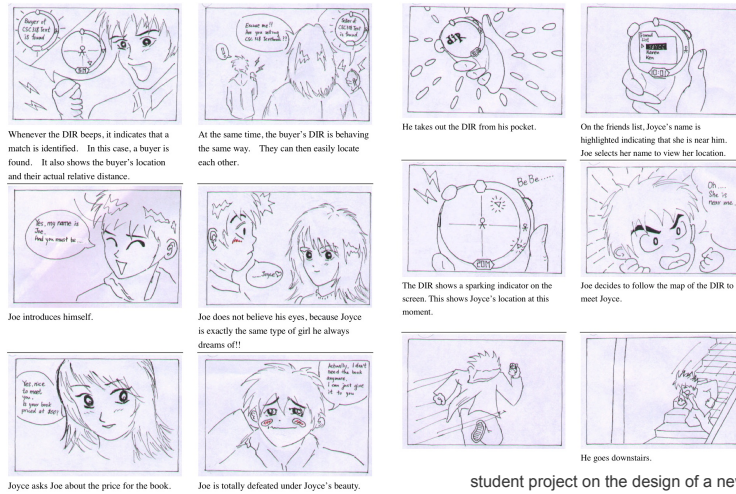capture and communicate the interaction with the new system

Rapid prototyping
physical models, sketches, paper prototypes
receive user feedback early enough in the design process

Scenarios

Whenever the DIR beeps, it indicates that a match is identified. In this case, a buyer is found. It also shows the buyer's location and their actual relative distance.

At the same time, the buyer's DIR is behaving the same way. They can then easily locate each other.

Joe introduces himself.

Joe does not believe his eyes, because Joyce is exactly the same type of girl he always dreams of!!

Joyce asks Joe about the price for the book.

Joe is totally defeated under Joyce's beauty.

He takes out the DIR from his pocket.

On the friends list, Joyce's name is highlighted indicating that she is near him. Joe selects her name to view her location.

The DIR shows a sparking indicator on the screen. This shows Joyce's location at this moment.

Joe decides to follow the map of the DIR to meet Joyce.

He goes downstairs.

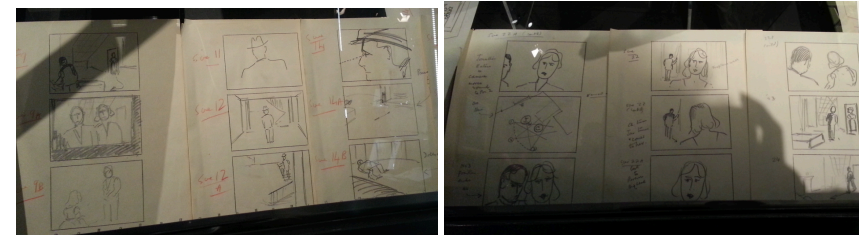student project on the design of a new communication device

Storyboards

Describe the interaction in easy-to-read segments

Define the key elements in a coherent order

Decide which details to show

Storyboards

Alfred Hitchcock's storyboards (Musée des Lettres et manuscrits, Paris)
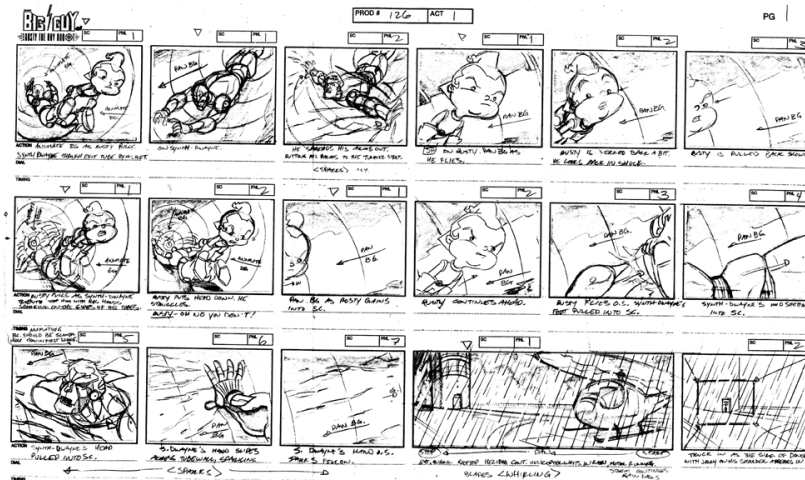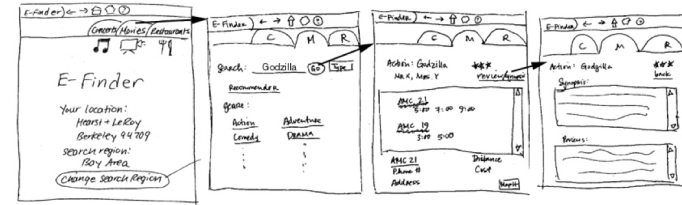
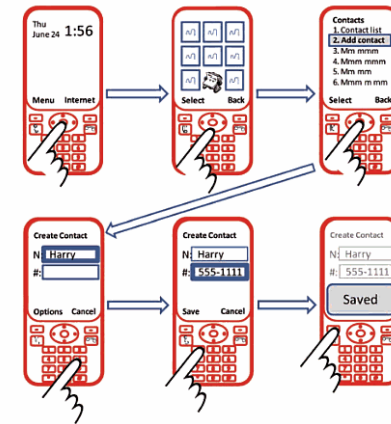
note how each scene in this storyboard is annotated

Possible storyboard structure

this type focuses on a complete interaction

http://grouplab.cpsc.ucalgary.ca/grouplab/uploads/Publications/Publications/2012-NarrativeStoryboard.Interactions.pdf

Possible storyboard structure

this type focuses on detailed interaction sequences

from the book "Sketching User Experiences: The Workbook"

Possible storyboard structure

iRéunion groupe 12	System Title Group		Close-up Show the interaction
Overview Show the situation			Close-up Show the interaction
Pierre est en réunion. Le téléphone sonne.	Heading Explain the situation	Pierre laisse un message pour …	Heading Continue the story
	Regular shot Show Pierre & technology	Anne Dubois François Martin Charles Durrand	Credits Names of participants

From Wendy Mackay

(we can show more interaction details with video prototyping)

Participatory design

Active participation of users in the design
Brainstorming, scenarios, analysis of tasks, simulations, paper & video prototypes

Participatory design
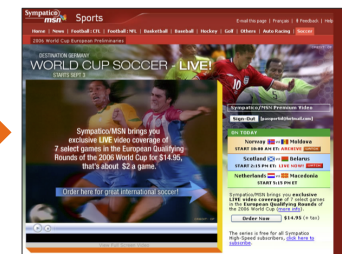

Detailed design

Define the interaction, e.g., with navigation diagrams and state machines

Define the « look-and-feel »

website wireframe

Prototypes

Prototype is used to …
- Explore different design alternatives
- Ensure its <u>usability</u> under different conditions
- Aid users to imagine the interface
- Focus on problematic aspects of the interface

Why prototype?
- If you start implementing code too early, you risk spending too much time to create a system that does not work for your users

Prototyping is a fast way to …
- Explore details of your concept before implementation
- Communicate the concept to users, your managers, etc
- Justify your design choices

What is a prototype?

Concrete representation of an IS

Characteristics :
Representation: form of the prototype simulation
Precision: level of detail
Interactivity: interaction
Evolution : life cycle of prototype

Dimensions :
off-line … on-line,

informal … well defined
look … interact
throw away … iterative

The choice of prototype depends on the phase in the design process and the specific needs of the designers

Prototype: representation

Off-line Prototypes
    Easy and quick to create, can be thrown away
    Usually used at the beginning of the design process
    e.g.: storyboard of a screen sequence, 'mockup' or video showing a complex interaction

On-line Prototypes
    Use the computer, longer to create,
    Usually used later in the design process
    e.g.: animations, interface builders

Prototype: precision

Low-fidelity (not detailed) prototypes
    Good for exploring ideas quickly
    e.g.: sketches, systems like "Silk"

High-fidelity (very detailed) prototypes
    Good for communicating a specific aspect
    e.g.: detailed dialog box with the size and text of buttons

Note: A detailed representation is not always precise
    we can leave open aspects that are not yet decided
    but can fool users to believe it is final (later)

Paper prototypes

Designing with office supplies
    multiple layers of sticky notes and plastic overlays
    different sized post-it's represent icons, menus, windows etc.

interaction demonstrated by manipulating notes
    new interfaces built on the fly

sessions videotaped for later analysis
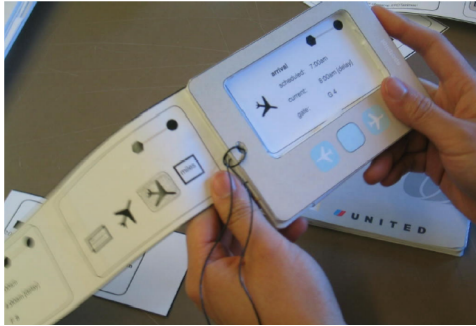   usually end up with mess of paper and plastic!

Paper prototypes

concrete representation of an IS (that does not exist)

Paper prototypes
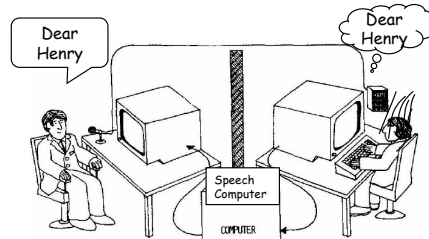
concrete representation of an IS (that does not exist)

From Design for the Wild, Bill Buxton

Prototype: interactivity

Non-interactive prototypes
　No interaction, but can show predefined interaction
　e.g.: a video clip illustrating an interaction, but the user does nothing

Closed-interactive prototypes (predefined sequences)
　Permits to test some interaction alternatives
　e.g.: the designer shows a screen image, the user makes an action, and the designer shows her the new screen image

Interactive (open) prototypes
　The user can interact with the system

Prototype: Wizard of Oz

The «wizard» interprets the user input and controls the system behavior

The user feels as if she interacts with the real system

The system can be:
　inexistent
　partially implemented
　fully functional

Better adapted for some forms of interaction...

Prototype: strategies

Horizontal: complete layer of the system, no detailed function at other layers
　e.g.: develop the interface details without the detailed actions on the database

Vertical: complete functionality for a small part of the system
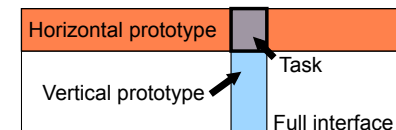　*e.g.: develop the entire spelling correction interface and functionality*

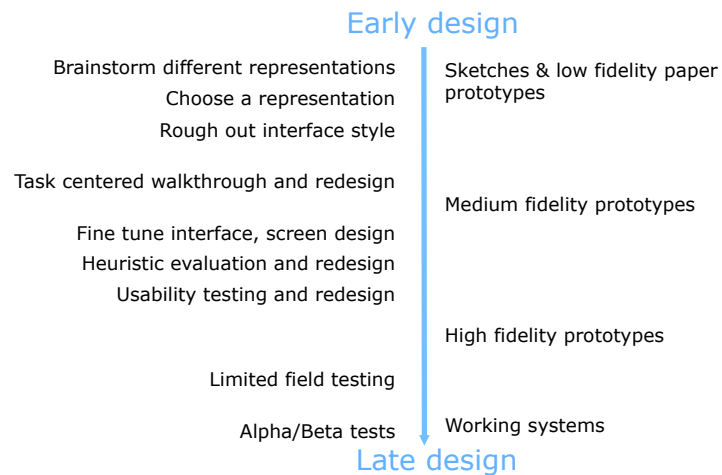Task: functionality needed to complete a specific task
　e.g.: develop the interface for moving an image
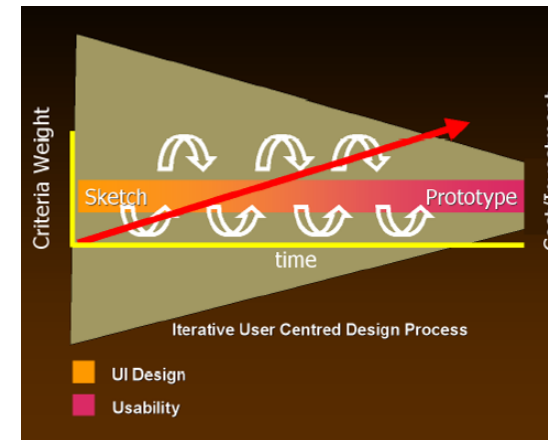
Scenario: functionality needed to run a scenario
　e.g.: develop the functionality need for a realistic scenario under a specific context, such as how to search, add and correct data in a database and then print the new database

Nielsen, J. (1993) *Usability Engineering*, p93-101, Academic Press.

Prototyping & design evolution

Early design

Brainstorm different representations
Choose a representation
Rough out interface style

Sketches & low fidelity paper prototypes

Task centered walkthrough and redesign

Medium fidelity prototypes

Fine tune interface, screen design
Heuristic evaluation and redesign
Usability testing and redesign

High fidelity prototypes

Limited field testing

Alpha/Beta tests

Working systems

Late design

From sketches to prototypes

From Sketching the User Experience, Bill Buxton