User-Centered Design

Software development

waterfall model (1970s)

Requirements analysis

Design

Implementation

Testing

Spiral model (Boehm, 1998)
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
1: Understanding the users and analyzing their needs

Identify the users

Who are they?
- eg. kids, elderly 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?

Process

1. Data collection
2. Data analysis: interpretation, modeling & specification of user needs, requirements
Recherche methods

Qualitative or quantitative

*Can be subjective:* we cannot completely 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

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

- Success 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 responses from many people

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

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Undecided</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>The cashier was courteous</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>The cashier was professional in appearance</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>I was given a receipt at the end of my transaction</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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**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**


**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

**design an interview**

**Goal:**
- Facts or opinions?
- Details or generalities?
- Real stories 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.

**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

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**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 for things. She much prefers to shop online. Her kids enjoy board games for fun and education. To unwind she enjoys dining out with friends, the occasional yoga class and needspend.

**Web & Technology**

<table>
<thead>
<tr>
<th>Interests</th>
<th>Favourite Brands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activities: Dining out, reading, needlepoint, yoga, doing crafts with her children. General Interests: Decorating, cooking and baking, children's educational issues.</td>
<td>All brands, specifically Fisher Price, Callow, ABC, Totnas, Road and kids' adults board games.</td>
</tr>
</tbody>
</table>

**Motivations**

- 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.

**Goals**

- To purchase a toy or game my child/children will enjoy.
- I want to keep my child/children 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 new toy events.

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**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

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?*

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**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.

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**conceptual model vs. mental model**

**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

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

Metaphor

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

Metaphors and negative transfers

Metaphors and negative transfers

The calculator

Steps in the design process

Conceptual design
The concept: *conceptual 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

- Describe the interaction in easy-to-read segments
- Define the key elements in a coherent order
- Decide which details to show

Storyboards

- Note how each scene in this storyboard is annotated

Alfred Hitchcock’s storyboards (Musée des Lettres et manuscrits, Paris)
Possible storyboard structure

this type focuses on a complete interaction

Possible storyboard structure

this type focuses on detailed interaction sequences
from the book "Sketching User Experiences: The Workbook"

Possible storyboard structure

Participatory design

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

(we can show more interaction details with video prototyping)
Participatory design

Detailed design

- Define the interaction, e.g., with navigation diagrams and state machines
- Define the « look-and-feel »

Prototype is used to ...
- Explore different design alternatives
- Ensure its usability 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

Prototypes

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

What is a prototype?
**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)

**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

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Prototyping & design evolution

Early design
- Brainstorm different representations
- Choose a representation
- Rough out interface style
- Task centered walkthrough and redesign
- Fine tune interface, screen design
- Heuristic evaluation and redesign
- Usability testing and redesign
- Limited field testing
- Alpha/Beta tests

Late design
- Sketches & low fidelity paper prototypes
- Medium fidelity prototypes
- High fidelity prototypes
- Working systems

From sketches to prototypes

From Sketching the User Experience, Bill Buxton