What we expect

- A set of requirements
  contract style • 5–10 pages

- A set of use cases
  Pressman style • 20–40 pages

- A GUI design
  covering most of the use cases

- Architectural models and data models
  covering most of the use cases

- An executable prototype
  covering 5–95% of the use cases (negotiable)

All numbers are negotiable depending on project

Dec 3 (draft)
Dec 10 (final)

December
January
February
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February

User Interface Design and Usability

Software Engineering
Rahul Premraj + Andreas Zeller • Saarland University

Credits: Robert Miller, MIT
Mary Czerwinski, MSR

What is good design?

http://www.ingenfeld.de/
Don't go to the right?

http://www.baddesigns.com/examples.html

What do these symbols mean?

Real example from a (expensive) car (as in the picture, no idea which model)—the icons on the buttons placed on the car’s dashboard are unclear. I have highlighted the vague ones in red.

How much is the gas?

It is not obvious which label belongs to which field.
Interface

- The point of interaction or communication between a computer and any other entity, such as a printer or human operator.
- The layout of an application’s graphic or textual controls in conjunction with the way the application responds to user activity: an interface whose icons were hard to remember.
What is Design?

Design is not just what it looks like and feels like. Design is how it works.

Super cool chopstick - the front end doesn't touch the table.
What is Design?

Design is not just what it looks like and feels like. Design is how it works.

Apple isn’t perfect. Some examples of problems with Apple products – faulty CDs, discolored handrests, smoking connectors, and exploding batteries.

It is easy to overdo design and make the product utterly useless.

User is centric to design. Every decision should be made keeping the user in mind.
User-Centric Design

• Cost saving!
• Competitive market - user expectations.
• Political demands
• Is Help always helpful?

Human Capabilities

• Memory
• Attention
• Visual Perception
• Learning
• Color
• Language + Communication
• Ergonomics

Memory

• Associations are built by repetition.
• Scaffold model (more likely to remember items that have many associations).
• Recognition is easier than recall.
• Working memory has small capacity.
• Long-term memory has large capacity.
Attention

- Attention is a resource – gets divided amongst tasks.
- Automatic well-learnt processes not need much attention.
- Important to get (for you as a designer).

Visual Perception

- We excel at pattern recognition.
- We automatically try to organize visual displays and look for cues.
- Motion, grouping, contrast, color can make different parts of a display more or less salient.

Learning

- Learning is improved by organization.
- Consistency and mnemonics improve learning.
- Targeted feedback facilitates learning.
- Learning occurs across people and organizations.
Learning

- Incrementally presented information accelerates learning.
- Some users like to explore systems to learn; others will not.
- Workers focus on accomplishing tasks, not learning software.

Color

- Red-green color blindness (protanopia & deuteranopia)
  - 8% of males
  - 0.4% of females
- Blue-yellow color blindness (tritanopia)
  - Far more rare
- Guideline: don’t depend solely on color distinctions
  - use redundant signals: brightness, location, shape

Protanopia = absence of red receptors
Deuteranopia = absence of green receptors
Tritanopia = absence of blue receptors

Traffic lights are readable even for color-blind people (due to location of lights). Also notice the blueish tint in the “green” light.
Example of an Ishihara color test plate.

[Note 1] The numeral "74" should be clearly visible to viewers with normal color vision. Viewers with dichromacy or anomalous trichromacy may read it as "21", and viewers with achromatopsia may not see numbers. [Wikipedia]
Where does UCD fit into the development process?

Traditional Waterfall Model

Traditional Waterfall Model with Feedback
Waterfall Model Poor for UI Design

- UI design is risky.
  - So we are likely to get it wrong.
- Users are not involved in validation until acceptance testing.
  - So we won’t find out until the end.
- UI flaws often cause changes in requirements and design.
  - So we have to throw away carefully written and tested code.

Iterative Design

- Every iteration corresponds to a release
  - Evaluation (complaints) feeds back into next version’s design
- Using your paying customers to evaluate your usability
  - They won’t like it
  - They won’t buy version 2

Iterative design is the current best-practice process for developing user interfaces. It’s a specialization of the spiral model described by Boehm for general software engineering.
Spiral Model

- Early iterations use cheap prototypes (paper prototyping).
- Later iterations have richer implementations.
- More iterations generally means better UI.
- Only mature iterations are seen by the world.

Paper Prototyping
Paper Prototyping

Benefits

- Fast way to mock up an interface - no coding required.
- Finds a variety of problems with the interface.
- Allows an interface to be refined based on user feedback before implementation begins.
- A multidisciplinary team can participate.
- Encourages creativity from the product team and users alike.
Disadvantage

- Doesn't produce any code.
- Does not find all classes of problems with an interface.
- Can affect the way users interact with the interface.
- Users might think it is unprofessional. (ch. 13)
- Has stronger benefits in some situations than in others.

UI Analysis & Design

- Iterative Design using a Spiral Model.
- Early focus on users and tasks.
  - User analysis: who the users are.
  - Task analysis: what they need to do?
  - Involve users as evaluators, consultants and sometimes designers.
- Constant Evaluation

Know Your User

- Novice
- Knowledgeable, intermittent user
- Knowledgeable, frequent user
- Age, gender, ethnicity
- Physical abilities
- Domain experience
- Application experience
- Work environment
- Communication patterns

For 2nd pt., imagine you need to test how to draw a curved line on Adobe Photoshop. Paper prototyping is not the best way!

Based on Rob Miller: "UI Design and Implementation – User-Centered Design"
Know Your User

- Techniques
  - Questionnaires
  - Interviews
  - Observations

- Obstacles
  - Artificial barriers between developers and users.
  - Some users are expensive to talk to.

Example: Self-Service Grocery Checkout

- Who are the users?
  - Grocery shoppers
  - Wide age range
  - Possibly no computer experience
  - No training
  - Knowledge of products, but not management
  - Shoppers help each other.
    - Mostly women with small children.
    - Store assistants to help users.

Task Analysis

- Identify the individual tasks to be solved.
- Each task is a goal.
- Start with the big goal and then, decompose hierarchically.
  - Overall goal: Shoppers want to purchase groceries.
  - Tasks:
    - Register groceries into the system.
    - Pay

Let’s look at an example. Suppose we’ve been charged with designing a system that will allow grocery shopper to ring up and pay for their purchases themselves.

The next step is figuring out what tasks are involved in the problem. A task should be expressed as a goal: what needs to be done, not how.
Essential Parts of Task Analysis

1. What must be done?
   - Goal

2. What must be done before to make it possible?
   - Preconditions
     - Tasks on which this task depends
     - Information that must be known to the user

3. What steps are involved in doing the task?
   - Subtasks (may be decomposed recursively)

Example: Self-Service Grocery Checkout

- Goal
  - Enter groceries into register
- Preconditions
  - All groceries that you want are in the cart
- Subtasks
  - Enter pre-packaged items
  - Bag loose items, weigh and register them.

Dangers of Task Analysis

- Duplicating a bad existing procedure in software.
- Example: Flipping through a book
- Failing to capture good aspects of existing procedure
- Ask users why they do what they do, not just what they do

Suppose we did a task analysis by observing users interacting with paper manuals. We’d see a lot of page flipping: “Find page N” might be an important subtask. We might naively conclude from this that an online manual should provide really good mechanisms for paging & scrolling, and that we should pour development effort into making those mechanisms as fast as possible. But page flipping is an artifact of physical books! It would pay off much more to have fast and effective searching and hyperlinking in an online manual. That’s why it’s important to focus on why users do what they do, not just what they do.
Improve Task Analysis

- Questions to ask
  - Why do you do this? (goal)
  - How do you do it? (subtasks)
- Look for weaknesses in current situation
  - Goal failures, wasted time, user irritation
- Contextual inquiry
- Participatory design

User Design Principles

Observe users doing real work, challenge assumptions and probe surprises

Usability Principles

Nielson’s 10 Principles of UI Design

- Shneiderman’s 8 Golden Rules
- Tog’s 16 Principles
Nielson’s Principles

1. Match the real world
2. Consistency and Standards
3. Help and Documentation
4. User Control and Freedom
5. Visibility of System Status
6. Flexibility and Efficiency
7. Error Prevention
8. Recognition, not Recall
9. Error Reporting, Diagnosis, Recovery
10. Aesthetic and Minimalist Design

Match the Real World

THE PROBLEM IS YOUR MODEM CAN’T INTERFACE WITH YOUR ISP BECAUSE YOUR RJ11 CABLE NEEDS UPGRADING

WILL IT COST MUCH?

THAT DEPENDS ON WHETHER YOU JUST SAID “YOU NEED A LONGER PHONE CORD”

Examples
- Desktop
- Trashcan

Dangers of metaphors
- Often hard for designers to find
- Deceptive
- Constraining
- Breaking the metaphor

Use of a metaphor doesn’t excuse other bad design decisions
Direct Manipulation

- User interacts with visual representation of data objects
  - Continuous visual representation
  - Physical actions or labeled button presses
  - Rapid, incremental, reversible, immediately visible effects
- Examples
  - Files and folders on a desktop
  - Scrollbar
  - Dragging to resize a rectangle
  - Selecting text
- Visual representation and physical interaction are important

Affordances

of direct manipulation

- Perceived and actual properties of a thing that determine how the thing could be used
  - *Chair* is for sitting
  - *Knob* is for turning
  - *Button* is for pushing
  - *Listbox* is for selection
  - *Scrollbar* is for continuous scrolling or panning
- Perceived vs. actual

Natural Mapping

- Physical arrangement of controls should match arrangement of function
- Best mapping is direct, but natural mappings don’t have to be direct
  - Light switches
  - Stove burners
  - Turn signals
  - Audio mixer
Feedback / Responsiveness

• Actions should have immediate, visible effects
  • Push buttons
  • Scrollbars
  • Drag & drop

• Kinds of feedback
  • Visual
  • Audio
  • Haptic (conveyed by sense of touch)

Consistency and Standards

Mac, Windows, Gnome, and KDE guidelines

Help and Documentation

Help should be (a) searchable, (b) context-sensitive, (c) task sensitive, (d) concrete, (e) short
User Control and Freedom

- Provide Undo
- Long operations should be allowed to be paused/suspended
- All dialogs should have a cancel button

Visibility of System Status

- Change cursor to indicate action
- Use highlights to show selected objects
- Use status bar to show progress

Flexibility and Efficiency

- Recently-used history is one very useful kind of shortcut, like this
- Recently-used files menu
Error Prevention

One way to prevent errors is to allow users to select rather than type. Misspellings then become impossible.

Recognition, not Recall

Use menus, not command languages
Use combo boxes, not textboxes
Use generic commands
All needed information must be visible

Error Reporting, Diagnosis, Recovery

A good error message should (1) be precise; (2) speak the user’s language, avoiding technical terms and details unless explicitly requested; (3) give constructive help; and (4) be polite.
Aesthetic and Minimalist Design

Principle 1
Focus on the user and their tasks, not the technology.

Some other important principles
Principle 2
Consider function first, presentation later.

Principle 3
Conform to users’ view of the task.

Principle 4
Don’t complicate the users’ task.
Principle 5
Promote Learning

“As we start a new school year, Mr. Smith, I just want you to know that I’m an Abstract-Sequential learner and trust that you’ll conduct yourself accordingly.”

Principle 6
Deliver information, not just data.

Principle 7
Try it out on users, then fix it!
Usability Tests

• Time $T$ to move your hand to a target of size $S$ at distance $D$ away is:

$$T = a + b \log \left( \frac{2D}{S} \right)$$

• Depends only on index of difficulty $\log(2D/S)$

Fitt’s Law

Implications of Fitt’s Law

• Targets at screen edge are easy to hit
  • Mac menubar beats Windows menubar
  • Unclickable margins are foolish
• Hierarchical menus are hard to hit
  • Gimp/GTK: instantly closes menu
  • Windows: .5 s timeout destroys causality
  • Mac does it right: triangular zone

http://en.wikipedia.org/wiki/Fitts'_law
No formulae, just understand the law and its implications.

The following heatmap from one of our eyetracking studies shows how users looked at this homepage. Their task was to find the current population of the United States.
Design decisions involve tradeoffs among different attributes.

Usability is only one aspect of s/w development.

This and the following are poor examples of GUI design. In this slide, there is basically so many options, full of text, non-descriptive icons.

Too many tabs???
In Microsoft Assistant Killed in Denver, it was reported that Microsoft program managers demonstrated a technique to kill the assistant to a crowd attending a development conference.

On MS-word, there are so many possible effects on the same text. Note that options such as Strikethrough and Double strikethrough can be opted together for the same text. Similarly subscript and superscript.
Puzzle

“503 polite people say hello first”

The poor secretary, confronted with this message, simply typed “mismatch” – without success :-(

Type “Mismatch”
Summary

Spiral Model

Usability Principles

Nielson's 10 Principles
Of UI Design

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• Tog's 16 Principles