Introduction to Software Engineering

8. User Interface Design
Roadmap

- Interface design models
- Design principles
- GUI characteristics
- Usability Testing
Literature

Sources

Recommended reading
> Mary Beth Rosson, John M. Carroll, *Usability Engineering*, 2002
> Alan Cooper, *The Inmates are running the Asylum*, SAMS, 1999.
> *The Interface Hall of Shame*, http://homepage.mac.com/bradster/iarchitect/shame.htm
Roadmap

- Interface design models
- Design principles
- GUI characteristics
- Usability Testing
The UI design process

> UI design is an *iterative process* involving close liaisons between users and designers.

> The 3 core activities in this process are:
  
  — *User analysis*. Understand what the users will do with the system;
  
  — *System prototyping*. Develop a series of prototypes for experiment;
  
  — *Interface evaluation*. Experiment with these prototypes with users.
The design process

- Analyse and understand user activities
- Produce paper-based design prototype
  - Design prototype
  - Produce dynamic design prototype
  - Executable prototype
- Evaluate design with end-users
  - Evaluate design with end-users
  - Implement final user interface
Four different models occur in HCI design:

1. The design model expresses the software design.

2. The user model describes the profile of the end users. (i.e., novices vs. experts, cultural background, etc.)

3. The user’s model is the end users’ perception of the system.

4. The system image is the external manifestation of the system (look and feel + documentation etc.)
UI Models

Implementation Model

... Manifest Models ...

Mental Model

Worse  Manifest Models  Better

Alan Cooper, *About Face*, 1995
Roadmap

- Interface design models
- **Design principles**
- GUI characteristics
- Usability Testing
## User Interface Design Principles

<table>
<thead>
<tr>
<th>Principle</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>User familiarity</strong></td>
<td>Use terms and concepts <em>familiar</em> to the user.</td>
</tr>
<tr>
<td><strong>Consistency</strong></td>
<td>Comparable operations should be activated in the <em>same way</em>. Commands and menus should have the same format, etc.</td>
</tr>
<tr>
<td><strong>Minimal surprise</strong></td>
<td>If a command operates in a known way, the user should be able to <em>predict</em> the operation of comparable commands.</td>
</tr>
<tr>
<td><strong>Feedback</strong></td>
<td>Provide the user with visual and auditory feedback, maintaining <em>two-way communication</em>.</td>
</tr>
<tr>
<td><strong>Principle</strong></td>
<td><strong>Description</strong></td>
</tr>
<tr>
<td>-------------------</td>
<td>--------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Memory load</td>
<td>Reduce the amount of information that must be remembered between actions. <em>Minimize</em> the memory load.</td>
</tr>
<tr>
<td>Efficiency</td>
<td>Seek efficiency in dialogue, motion and thought. <em>Minimize keystrokes and mouse movements.</em></td>
</tr>
<tr>
<td>Recoverability</td>
<td>Allow users to <em>recover from their errors</em>. Include undo facilities, confirmation of destructive actions, 'soft' deletes, etc.</td>
</tr>
<tr>
<td>User guidance</td>
<td>Incorporate some form of <em>context-sensitive user guidance</em> and assistance.</td>
</tr>
</tbody>
</table>
Roadmap

- Interface design models
- Design principles
- GUI characteristics
- Usability Testing
## GUI Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Windows</strong></td>
<td>Multiple windows allow <em>different information to be displayed simultaneously</em> on the user’s screen.</td>
</tr>
<tr>
<td><strong>Icons</strong></td>
<td>Usually icons represent <em>files</em> (including folders and applications), but they may also stand for <em>processes</em> (e.g., printer drivers).</td>
</tr>
<tr>
<td><strong>Menus</strong></td>
<td>Menus bundle and organize <em>commands</em> (eliminating the need for a command language).</td>
</tr>
<tr>
<td><strong>Pointing</strong></td>
<td>A pointing device such as a mouse is used for <em>command choices</em> from a menu or indicating items of interest in a window.</td>
</tr>
<tr>
<td><strong>Graphics</strong></td>
<td>Graphical elements can be <em>commands</em> on the same display.</td>
</tr>
</tbody>
</table>
**Advantages**

> They are easy to learn and use.
  
  — Users without experience can learn to use the system quickly.

> The user may switch attention between tasks and applications.

> Fast, full-screen interaction is possible with immediate access to the entire screen

**Problems**

> A GUI is not automatically a good interface
  
  — Many software systems are never used due to poor UI design
  
  — A poorly designed UI can cause a user to make catastrophic errors
Direct Manipulation

**Advantages**

> Users *feel in control* and are less likely to be intimidated by the system
> User *learning time* is relatively short
> Users get *immediate feedback* on their actions
> mistakes can be quickly detected and corrected

**Problems**

> Finding the right user *metaphor* may be difficult
> It can be *hard to navigate* efficiently in a large information space.
> It can be *complex to program* and demanding to execute
Menu Systems

**Advantages**
> Users don’t need to remember command names
> Typing effort is minimal
> User errors are trapped by the interface
> Context-dependent help can be provided (based on the current menu selection)

**Problems**
> Actions involving *logical conjunction* (and) or disjunction (or) are awkward to represent
> If there are many choices, some *menu structuring* facility must be used
> *Experienced users find menus slower* than command language
Menu Structuring

**Scrolling menus**
- The menu can be scrolled to reveal additional choices
- Not practical if there is a very large number of choices

**Hierarchical menus**
- Selecting a menu item causes the menu to be replaced by a sub-menu

**Walking menus**
- A menu selection causes another menu to be revealed

**Associated control panels**
- When a menu item is selected, a control panel pops-up with further options
Command Interfaces

With a command language, the user types commands to give instructions to the system

> May be implemented using cheap terminals
> Easy to process using compiler techniques
> Commands of arbitrary complexity can be created by command combination
> Concise interfaces requiring minimal typing can be created
Command Interfaces

**Advantages**
> Allow experienced users to *interact quickly* with the system
> Commands can be *scripted* (!)

**Problems**
> Users have to *learn and remember* a command language
> Not suitable for *occasional* or inexperienced users
> An *error detection* and recovery system is required
> *Typing ability* is required (!)
**Analogue vs. Digital Presentation**

*Digital presentation*
- *Compact* — takes up little screen space
- *Precise values* can be communicated

*Analogue presentation*
- Easier to get an 'at a glance' *impression* of a value
- Possible to show *relative values*
- Easier to see *exceptional* data values

<table>
<thead>
<tr>
<th>Pressure</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>100</td>
<td>25</td>
</tr>
<tr>
<td>200</td>
<td>50</td>
</tr>
<tr>
<td>300</td>
<td>75</td>
</tr>
<tr>
<td>400</td>
<td>100</td>
</tr>
</tbody>
</table>
Colour Use Guidelines

Colour can help the user understand complex information structures.

> Don’t use (only) colour to communicate meaning!
  —Open to misinterpretation (colour-blindness, cultural differences ...)
  —Design for monochrome then add colour

> Use colour coding to support user tasks
  —highlight exceptional events
  —allow users to control colour coding

> Use colour change to show status change

> Don't use too many colours
  —Avoid colour pairings which clash

> Use colour coding consistently
Roadmap

> Interface design models
> Design principles
> GUI characteristics
> **Usability Testing**
Usability Testing

> Observe a group of test subjects performing a pre-defined scenario

— Which test subjects?
— How many test subjects?
— Which scenarios?
— What to observe?
Some evaluation of a user interface design should be carried out to assess its *usability*.

Full scale evaluation is very *expensive* and *impractical* for most systems.

Ideally, an interface should be evaluated against a *usability specification*. However, it is rare for such specifications to be produced.
Simple evaluation techniques

- *Questionnaires* for user feedback.
- *Video recording* of system use and subsequent tape evaluation.
- *Instrumentation* of code to collect information about facility use and user errors.
- The provision of code in the software to collect *on-line user feedback.*
Hints

> Establish concrete goals — what do you want to achieve?
   — What criteria will you use to establish “success”?
   — What data will you collect?
   — Choose representative test tasks.

> Carry out a pilot test first.

> Test users should truly represent the intended users.

> Use experienced experimenters. (Get trained!)
   — Make the test subjects feel comfortable.
   — Don’t bias the results.
## Usability Attributes

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learnability</td>
<td>How long does it take a new user to become <em>productive</em> with the system?</td>
</tr>
<tr>
<td>Speed of operation</td>
<td>How well does the system <em>response</em> match the user’s work <em>practice</em>?</td>
</tr>
<tr>
<td>Robustness</td>
<td>How <em>tolerant</em> is the system of user error?</td>
</tr>
<tr>
<td>Recoverability</td>
<td>How good is the system at <em>recovering</em> from user errors?</td>
</tr>
<tr>
<td>Adaptability</td>
<td>How closely is the system tied to a <em>single model</em> of work?</td>
</tr>
</tbody>
</table>
Why you only need to test with 5 users

http://www.useit.com/alertbox/20000319.html

Usability laboratories (!)
Roadmap

- Interface design models
- Design principles
- GUI characteristics
- Usability Testing
- Summary
Key points

> The user interface design process involves *user analysis*, *system prototyping* and *prototype evaluation*.

> *User interface design principles* should help guide the design of user interfaces.

> *Interaction styles* include direct manipulation, menu systems form fill-in, command languages and natural language.

> *Graphical displays* should be used to present trends and approximate values. *Digital displays* when precision is required.

> *Colour* should be used *sparingly and consistently*.

> The goals of *UI evaluation* are to *obtain feedback* on how to improve the interface design and to assess if the interface meets its *usability requirements*. 
What you should know!

> What models are important to keep in mind in UI design?
> What is the principle of minimal surprise?
> What problems arise in designing a good direct manipulation interface?
> What are the trade-offs between menu systems and command languages?
> How can you use colour to improve a UI?
> In what way can a help system be context sensitive?
Can you answer the following questions?

> Why is it important to offer “keyboard short-cuts” for equivalent mouse actions?

> How would you present the current load on the system? Over time?

> What is the worst UI you ever used? Which design principles did it violate?

> What’s the worst web site you’ve used recently? How would you fix it?

> What’s good or bad about the MS-Word help system?
You are free:
▪ to copy, distribute, display, and perform the work
▪ to make derivative works
▪ to make commercial use of the work

Under the following conditions:

**Attribution.** You must attribute the work in the manner specified by the author or licensor.

**Share Alike.** If you alter, transform, or build upon this work, you may distribute the resulting work only under a license identical to this one.

▪ For any reuse or distribution, you must make clear to others the license terms of this work.
▪ Any of these conditions can be waived if you get permission from the copyright holder.

Your fair use and other rights are in no way affected by the above.

http://creativecommons.org/licenses/by-sa/3.0/