Outline

Overview

Software Engineering

Usability Engineering

Explaining Design

Implementation Support
  Windowing systems
  Application architectures
  Multi-threading
Outline

Overview

Software Engineering

Usability Engineering

Explaining Design

Implementation Support
  Windowing systems
  Application architectures
  Multi-threading
Focus on Implementation

- HCI in the software process: **Usability Engineering** and **Design Rationale**
- Programming interfaces: **Implementation Support**
Outline

Overview

Software Engineering

Usability Engineering

Explaining Design

Implementation Support
  Windowing systems
  Application architectures
  Multi-threading
HCI in Software Engineering

- waterfall model with feedback
HCI in Software Engineering

▶ traditional process models require modification...

.waterfall model with feedback
HCI in Software Engineering

- traditional process models require modification...
- user participation
  - during design
  - during evaluation

Waterfall model with feedback
HCI in Software Engineering

- traditional process models require modification...
- user participation
  - during design
  - during evaluation
- usability evaluation

waterfall model with feedback
HCI in Software Engineering

- traditional process models require modification...
- user participation
  - during design
  - during evaluation
- usability evaluation
- should design interface early, not as a bolt-on!
- → UI in process

**waterfall model** with feedback
Lauesen and Harning (2001) describe a process called *Virtual Windows* which connects tasks, data models and UI design.
HCI-oriented processes

- Lauesen and Harning (2001) describe a process called *Virtual Windows* which connects tasks, data models and UI design.
Outline

Overview

Software Engineering

Usability Engineering

Explaining Design

Implementation Support
  Windowing systems
  Application architectures
  Multi-threading
Ultimate usability test: measure user experience
Ultimate usability test: measure user experience

Usability measures made explicit as requirements

Usability specification:
  - usability attribute/principle
  - measuring concept
  - measuring method
  - now level/ worst case/ planned level/ best case

Cf. ISO 9241 metrics in Lecture 10
Usability Engineering

- Ultimate usability test: measure user experience
- Usability measures made explicit as requirements
- Usability specification:
  - usability attribute/principle
  - measuring concept
  - measuring method
  - now level/ worst case/ planned level/ best case
- Cf. ISO 9241 metrics in Lecture 10
- Problems:
  - usability spec requires level of detail that may not be possible early in design
  - satisfying a usability specification does not necessarily satisfy usability
<table>
<thead>
<tr>
<th>Attribute: Backward recoverability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Measuring concept:</strong> Undo an erroneous programming sequence</td>
</tr>
<tr>
<td><strong>Measuring method:</strong> Number of explicit user actions to undo current program</td>
</tr>
<tr>
<td><strong>Now level:</strong> No current product allows such an undo</td>
</tr>
<tr>
<td><strong>Worst case:</strong> As many actions as it takes to program-in mistake</td>
</tr>
<tr>
<td><strong>Planned level:</strong> A maximum of two explicit user actions</td>
</tr>
<tr>
<td><strong>Best case:</strong> One explicit cancel action</td>
</tr>
</tbody>
</table>
Outline

Overview

Software Engineering

Usability Engineering

Explaining Design

Implementation Support
  Windowing systems
  Application architectures
  Multi-threading
Design Rationale

- **Design rationale** is information that explains why a computer system is the way it is.

- **Benefits of design rationale**
  - communication throughout life cycle
  - reuse of design knowledge across products
  - enforces design discipline
  - presents arguments for design trade-offs
  - organizes potentially large design space
  - capturing contextual information

- **Types of DR:**
  - **Process-oriented** preserves order of deliberation and decision-making
  - **Structure-oriented** emphasizes post hoc structuring of considered design alternatives

- **Examples:**
  - Issue-based information system (IBIS)
  - Design space analysis
  - Psychological design rationale
Issue-based Information System

- Process-oriented; main elements are:
  - *issues*: hierarchical structure with root
  - *positions*: potential resolutions
  - *arguments*: modify relationship between above
Design Space Analysis

- Structure-oriented: **QOC hierarchy**
  - *questions*: major issues of a design
  - *options*: alternative answers
  - *criteria*: means to assess options
Supports the **task-artefact** cycle in which user tasks are affected by the systems they use.
Psychological Design Rationale

- Supports the **task-artefact** cycle in which user tasks are affected by the systems they use
- Consequences of design for users made explicit
- Method:
  - designers identify tasks system will support
  - scenarios are suggested to test task
  - users are observed on system
Psychological Design Rationale

- Supports the task-arteffect cycle in which user tasks are affected by the systems they use
- Consequences of design for users made explicit
- Method:
  - designers identify tasks system will support
  - scenarios are suggested to test task
  - users are observed on system
- Psychological claims of system made explicit
- Negative aspects used to improve next iteration
Outline

Overview

Software Engineering

Usability Engineering

Explaining Design

Implementation Support
  Windowing systems
  Application architectures
  Multi-threading
How does HCI affect the programmer?
Advances in coding have elevated programming
  - hardware specific $\Rightarrow$ interaction-technique specific
Programming the Interface

- How does HCI affect the programmer?
- Advances in coding have elevated programming
  - hardware specific $\Rightarrow$ interaction-technique specific
- Layers of development tools
  - windowing systems
  - interaction toolkits
  - user interface management systems (UIMS)
Programming the Interface

- How does HCI affect the programmer?
- Advances in coding have elevated programming
  - hardware specific $\iff$ interaction-technique specific
- Layers of development tools
  - windowing systems
  - interaction toolkits
  - user interface management systems (UIMS)
- Application architectures
  - Model-View-Controller (MVC)
  - Presentation-Abstraction-Control (PAC)
Programming the Interface

- How does HCI affect the programmer?
- Advances in coding have elevated programming
  - hardware specific $\Rightarrow$ interaction-technique specific
- Layers of development tools
  - windowing systems
  - interaction toolkits
  - user interface management systems (UIMS)
- Application architectures
  - Model-View-Controller (MVC)
  - Presentation-Abstraction-Control (PAC)
- Body of programming techniques
  - concurrency management
Windowing systems

- Role: mediate between devices and applications
  - “multiplex” I/O devices to allow multiple applications
  - *device independence* on top of *imaging model*
Windowing systems

- Role: mediate between devices and applications
  - “multiplex” I/O devices to allow multiple applications
  - *device independence* on top of *imaging model*
- Three possible software architectures:
  - each application manages all processes
    - everyone worries about synchronization
    - reduces portability of applications
  - management role within kernel of operating system
    - applications tied to operating system
  - management role as separate application
    - maximum portability
    - client-server, e.g. *X Windows*
Application architecture: read-eval

```
repeat
    read-event(myevent)
    case myevent.type
        type_1:
            do type_1 processing
        type_2:
            do type_2 processing
        ...
        type_n:
            do type_n processing
    end case
end repeat
```
void main(String[] args) {
    Menu menu = new Menu();
    menu.setOption("Save");
    menu.setOption("Quit");
    menu.setAction("Save", mySave)
    menu.setAction("Quit", myQuit)
    ...
}

int mySave(Event e) {
    // save the current file
}

int myQuit(Event e) {
    // close down
}
MVC: Model-View-Controller

- MVC highly influential design pattern used in Smalltalk (1980)
Coutaz (1987) introduced PAC, a generalisation of MVC:
Graphical specification

- Trend in dialogue control:
  - internal control (e.g. read-eval loop)
  - external control (e.g. UIMS)
  - presentation control (e.g. **graphical specification**)

- Issues: focus on one window, hard to "see" paths through system
- Examples: Visual Basic, Flash, DreamWeaver, NetBeans Interface Builder
Graphical specification

- Trend in dialogue control:
  - internal control (e.g. read-eval loop)
  - external control (e.g. UIMS)
  - presentation control (e.g. graphical specification)

- coder draws components
- sets actions with script or links to program
- Issues: focus on one window, hard to “see” paths through system
- Examples: Visual Basic, Flash, DreamWeaver, NetBeans Interface Builder
Multi-threading in practice

Multithreaded GUI toolkits seem to be one of the Failed Dreams [of Computer Science].

Graham Hamilton, Sun VP

http://weblogs.java.net/blog/kgh/archive/2004/10/

- Multi-threading desirable; yet nearly all GUI toolkits use **single-threaded subsystem**, e.g. an event dispatch thread as in Swing. Why?
Multi-threading in practice

Multithreaded GUI toolkits seem to be one of the Failed Dreams [of Computer Science].

Graham Hamilton, Sun VP

http://weblogs.java.net/blog/kgh/archive/2004/10/

- Multi-threading desirable; yet nearly all GUI toolkits use `single-threaded subsystem`, e.g. an `event dispatch thread` as in Swing. Why?
- GUI components (visual, e.g. `JTable` and data, e.g. `TreeModel`) accessed only from event thread.
- A few exceptions, e.g:
  - adding and removing listeners
  - `SwingUtilities.isEventDispatchThread` to check if current thread is event thread
Example Event Listener

```java
import javax.swing.*;  import java.awt.event.*;
import java.awt.Color;  import java.util.Random;

public class ColorButton extends JFrame {
    // A button with a listener to change its color
    public static void main(String[] args) {
        new ColorButton();
    }
    final Random random = new Random();
    final JButton button = new JButton("Change Color");
    ColorButton() {
        button.addActionListener(new ActionListener() {
            public void actionPerformed(ActionEvent e) {
                button.setBackground(new Color(random.nextInt()));
            }
        });
        add(button); pack(); setVisible(true);
    }
    setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
}
```
Flow of Events

- Simple event listener processes events like this:

  mouse click → action event → action listener → set color

- To use a view and data model (MVC), this:

  mouse click → action event → action listener → update table model
  ↓
  update table view → table listener → table changed event

- fireXxx methods used to indicate model change
- control stays in event thread
Advanced GUI architectures

- Update presentation from GUI thread:
  - `SwingUtilities.invokeLater`, schedules a task for execution in the event thread (callable anywhere)
  - `SwingUtilities.invokeLaterAndWait`, schedules task in event thread and blocks (call from non-GUI thread)

- To keep GUI responsive, handle long-running tasks:
  - dispatch separate non-GUI threads to do work (e.g. using thread pool Executor)

- Need “thread-hopping”:
  - non-GUI thread queues GUI events to signal progress, completion
  - GUI thread handles cancellation event to kill non-GUI thread

- Managing data models:
  - *shared data model*: synchronisation needed
  - *thread-safe data models*: fine-grained concurrency; versioning
  - *split data model*: presentation-domain and application-domain models
References

Joëlle Coutaz.
PAC, on object oriented model for dialog design.

Soren Lauesen and Morten Borup Harning.
Virtual windows: Linking user tasks, datamodels, and interface design.

See also:
- Dix et al, Chapters 6 and 8.
- Java Swing programming resources at http://java.sun.com/docs/books/tutorial/uiswing/