Prototyping &
UI Software

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Agenda

- Prototyping
  - Dimensions and terminology
  - Non-computer methods
  - Computer methods
- UI Software
  - Design tools
  - UI toolkits
  - GUI builder tools
- Poster session preview
- Exam preview
Your Project Group

DILBERT

THE TECHNOLOGY DEMO

THE SOFTWARE ISN'T 100% COMPLETE.

IF IT HAD A USER INTERFACE YOU WOULD SEE SOMETHING HERE... HERE... AND SOMETIMES HERE.

AND THEN YOU'D BE SAYING, "I GOTTA GET ME SOME OF THAT."

ANY QUESTIONS?

Design Artifacts

- How do we express early design ideas?
  - No software coding at this stage

- Key notions
  - Make it fast!!!
  - Allow lots of flexibility for radically different designs
  - Make it cheap
  - Promote valuable feedback

*** Facilitate iterative design and evaluation ***
Dilemma

- You can’t evaluate design until it’s built
  - But...
- After building, changes to the design are difficult

- Simulate the design, in low-cost manner

Prototyping Dimensions

- 1. Representation
  - How is the design depicted or represented?
  - Can be just textual description or can be visuals and diagrams

- 2. Scope
  - Is it just the interface (mock-up) or does it include some computational component?
Dimensions (contd)

- **3. Executability**
  - Can the prototype be “run”?
  - If coding, there will be periods when it can’t

- **4. Maturation**
  - What are the stages of the product as it comes along?

  Revolutionary - Throw out old one
  Evolutionary - Keep changing previous design

Terminology (1)

- **Early prototyping**

- **Late prototyping**
Terminology (2)

- **Low-fidelity prototype**
  
  Far from final form of system, such as paper, drawings, etc.

- **High-fidelity prototype**
  
  Close to final form of system, much more realistic to actual application

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Terminology

- **Horizontal prototype**
  
  Very broad, does or shows much of the interface, but does this in a shallow manner

- **Vertical prototype**
  
  Fewer features or aspects of the interface simulated, but done in great detail
Rapid Prototyping Methods

- Non-computer vs. computer-based

Typically earlier in process  
Typically later in process

Non-Computer Methods

- Goal: Want to express design ideas and get quick & cheap opinions on system

- Methods?
1. Design Description

- Can simply have a textual description of a system design
  - Obvious weakness is that it’s so far from eventual system
  - Doesn’t do a good job representing visual aspects of interface

2. Sketches, Mock-ups

- Paper-based “drawings” of interfaces
- Good for brainstorming
- Focuses people on high-level design notions
- Not so good for illustrating flow and the details
- Quick and cheap -> helpful feedback
Physical Mock-Ups

- Wooden blocks and labels - device control

(Three versions of a hand-held controller)

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Physical Mock-Up

- Styrofoam and Buttons

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Spring 2004 CS 4750 project "Golf Caddy" by:
Chris Hamilton
Linda Kang
Luigi Montanez
Ben Tomassetti
3. Storyboard

• What is it?

Some slides taken from lecture by Khai Truong

Storyboarding

• Pencil and paper simulation or walkthrough of system look and functionality
  – Use sequence of diagrams/drawings
  – Show key snap shots
  – Quick & easy
Uses / background

- Very similar in nature to:
  - Comic art / cartoons

- Used in:
  - Movie / multimedia design
  - Product / software development

Example

Sketches solve two problems with use of more fully-developed prototypes

User reluctance to suggest changes to what might look like a finished product
User focus too much on details (graphic design, etc) of UI rather than big picture
Elements of storyboard

- Graphical depiction of scenarios

- 5 visual elements
  - Number of frames/panes
  - Use of words
  - Level of detail
  - Inclusion of people
  - Time passage

How is it done?

- **Novice designers’ process**
  - Individual brainstorming about ideas
  - May do some quick initial sketches
  - Team meeting to discuss ideas / drawings
  - Decision on what to draw
  - Spend next ~8 hours together drawing
    - Co-location allows quick feedback
    - Can also glance at what others are drawing for inspiration
How is it done?

- **Expert designers’ process**
  - Get assignment
  - Individual brainstorming about ideas
    - Determine the story
    - Includes a lot of sketches using pencil + paper
    - A very iterative process through a lot of initial drafts
  - Team meeting to discuss ideas / drawings
    - Share copies of drawings
    - Discuss what stories should be told
  - Repeat
  - Generate more polished art for presentation
  - Develop

Experts’ advice on storyboarding

- Keep it short: 1 interaction/activity per storyboard
- More is not always better. Why?
  - May lose focus of story
  - May lose reader’s attention

- Biggest challenge? Experts say:
  - Must be able to succinctly tell story
Keep the drawing short

• Drawing more is not always needed...

Use taglines / captions

• Keep it short
Inclusion of actors and objects helps to create empathy

- "The first thing users will want to know is why do I even care about this application?"

- Can show how the user interacts with the system and how the system affects the user

When to show time passing

- Time passing is implicit
- Only needed when gross changes or minute changes need to be explicit
- Readers bring own expectations of how much time passes into the storyboard
Some advice

- Figure out your story
- Identify main points in the story
- Draw 3-5 frames/panes (to match the main points)
- Keep it simple...
- Add taglines / text to enhance understanding
- Pilot storyboards & iterate

4. Scenarios (aka Use Cases)

- Hypothetical or fictional situations of use
  - Typically involving some person, event, situation and environment
  - Provide context of operation
  - Often in narrative form, but can also be sketches or even videos
Scenario Utility

- Engaging and interesting
- Allows designer to look at problem from another person’s point of view
- Facilitates feedback and opinions
- Can be very futuristic and creative
- Can involve social and interpersonal aspects of the task

5. Other Techniques

- Tutorials & Manuals
  - Maybe write them out ahead of time to flesh out functionality
  - Forces designer to be explicit about decisions
  - Putting it on paper is valuable
Computer-Supported Methods

• Simulate more of system functionality
  – Usually just some features or aspects
  – Can focus on more of details
  – Typically engaging
  – Can lead to “stale” design, can focus user (or customer) too much on the details of the interface, too early in the design process
  – Danger: Users are more reluctant to suggest changes once they see more realistic prototype

Prototyping Tools

• 1. Draw/Paint programs
  – Draw each screen, good for look

  Thin, horizontal prototype PhotoShop, Corel Draw,...
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Prototyping Tools

- 2. Scripted simulations/slide shows
  - Put storyboard-like views down with (animated) transitions between them
  - Can give user very specific script to follow
  - Often called chauffeured prototyping

- Examples: PowerPoint, Hypercard, Macromedia Director, HTML

Powerpoint Transition Controls

Mouse click actions:
- Next slide
- Previous slide
- First slide
- Last slide
- Last slide viewed
- End show
- Custom show
- URL
- File
Scripting Example

But Beware!

DILBERT

By Scott Adams

AS YOU CAN CLEARLY SEE IN SLIDE 397...

GAAAAH!

"POWERPOINT POISONING."
Apple Hypercard

- Once a very popular prototyping tool for simulating UI
- Allows control of simple card transitions
- More complex behaviors

```plaintext
on mouseUp
    play "boing"
    wait for 3 seconds
    visual effect wipe left very fast to black
    click at 150,100
    type "goodbye"
end mouseUp
```

Macromedia Director

- Combines various media with script written in Lingo language
- Concerned with place and time
  - Objects positioned in space on “stage”
  - Objects positioned in time on “score”
- Easy to transition between screens
- Can export as executable or as Web Shockwave file
Prototyping Tools

- 3. Interface Builders
  - Tools for laying out windows, controls, etc. of interface
    - Have build and test modes that are good for exhibiting look and feel
    - Generate code to which back-end functionality can be added through programming
  - Examples: Visual Basic, Delphi, UIMX, ...
True Programming

- Less useful for rapid prototyping, but can save re-coding time down the road
- More constrained in look and feel
- Constrained to traditional interaction styles and methods
  - Hard to think outside the box

- More to come in a few minutes...
Other Prototyping Tools

• Denim

http://guir.berkeley.edu

Audio Interface (Telephony) Builder Tools

• SUEDE - Flow-chart for speech interface
  – Landay et al, UC Berkeley (now U Washington)
• Used for wizard-of-Oz studies
• Could be used to drive real system
• guir.berkeley.edu/projects/suede/index.shtml
Prototyping Technique

- **Wizard of Oz** - Person simulates and controls system from “behind the scenes”
  - Use mock interface and interact with users
  - Good for simulating system that would be difficult to build

Can be either computer-based or not
Wizard of Oz

- **Method:**
  - Behavior should be algorithmic
  - Good for voice recognition systems

- **Advantages:**
  - Allows designer to immerse oneself in situation
  - See how people respond, how specify tasks

Prototyping Tools

- **Good features**
  - Easy to develop & modify screens
  - Supports type of interface you are developing
  - Supports variety I/O devices
  - Easy to link screens and modify links
  - Allows calling external procedures & program
  - Allows importing text, graphics, other media
  - Easy to learn and use
  - Good support from vendor
Prototyping

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Prototyping Summary

- Tradeoffs of simplicity, manageability
- Veracity
- Interactiveness
- Up-front costs vs. down the road costs

- Key: Don’t let the prototyping environment drive or constrain your creativity!!
UI Software & Programming

- OK, let’s return to what we were talking about earlier
- The final level up...building the actual application
User Interface Software

- What support is provided for building graphical user interfaces?
  - UI toolkits
  - GUI builder tools

- Let’s examine some background...

GUI System Architecture

What does it look like?
Layered Architecture

Window System

- Allocates and manages
  - Regions of display to application programs, keeps programs out of each other's way
  - Input devices (keyboard, mouse) to application, routes input events

- Called by application program to
  - Create/delete windows (ie, allocate resource)
  - Operate on windows (move, resize, bring to top, hide, give name, clear)
  - Enable input devices
  - Get input from user via interaction devices
Key Windowing Concepts

- Server/client
- Window manager ≠ window system
- Virtual display/input device abstraction
- Window hierarchy
- Event notification: queue vs. callback
- User actions
- Input focus
- Consequences of server actions (redraw)

Client-Server Window System

(After Fig 10.2, Dix, Finlay, Abowd and Beale)
Client- Server

- "Policy-free" server, not seen by user
- A *Window manager* client gives the "look and feel", not the *window system* (server)
- Multiple clients, each seen by user on terminal
- Linux/Unix WMs built on the X Window System include
  - LVWM - Open Look Virtual Window Manager
  - FVWM - Feeble Virtual Window Manager
  - MWM - Motif Window Manager
  - AfterStep
  - GWM - Generic Window Manager

Window Hierarchy
Event Notification

- Event types
  - User actions - mouse movements/button clicks, keyboarding, enter or leave window
  - Server actions, such as making window visible - client may need to redraw window

- Event queue – program examines the queue, calls an action routines, determined by event type and screen object under cursor

- Callback – the window system notifier is told which action routine to call for each type of event for each object on screen

Input Focus

- To which client do events go?
- Not always where the cursor is located
- Dynamic dragging outside of window
- Type into one window while "mouse" in another
Separation of Concerns

- Application
  - Core functionality
  - Operations
  - Data

- Interface
  - Interface components
  - Graphics
  - I/O

Should these be separated architecturally and in code?

Why or why not?

How Does a Toolkit Work?

- What exactly does it provide?
- How is it organized?
Toolkit Workings

- User takes actions, interacts with interface
- Those actions must be delivered to application in meaningful ways
- Application takes appropriate actions, perhaps updating display

Seeheim Model

Conversational model

Dominant model for long time
Object Model

- UI is collection of interactor objects (often called widgets)
- User directly manipulates them
- Objects responsible for transmitting user actions to application in meaningful ways

Model-View-Controller (MVC)

- Developed for Smalltalk (Alan Kay)
- A refined object model: \( V+C = UI \)
- Used in JAVA’s Swing UI widget library

State and behavior of Model

Create and update a View of the model

Control/manage user interaction with the model
MVC Example - a Push Button

- Model - a boolean - on or off
- View - a drawing - in each possible state
- Controller - tell model to change state, and view to change view
  - Note - most buttons have more complex behavior than this


MVC Flexibility

- Clear separation of concerns makes changes easy
  - Want a different button appearance? Change the view, nothing else.
  - Want mouse_over rather than mouse_down to change state?
Locus of Control

- "Traditional" software
  - Control is in system, query user when input needed

- Event-driven software
  - Control is with user (wait for action)
  - Code reacts to user actions
  - More difficult to write code this way, harder to modularize, etc.

Classical Event-Driven Program
UI Toolkit

- What application programmer typically programs with
- Combination of interface objects and management behaviors
- Usually object-oriented now
- Library of software components and routines that programmer puts together
  - X Windows: X Toolkit & Motif
  - Macintosh: Mac Toolbox, MacApp
  - Windows: Windows Developers’ Toolkit
  - Java: Swing

Classical Approach to Input Event Dispatching – Not so Good

Entry Point

Events

Event Queue

Operating System

Application program polls the event queue

Examine events, call processing module

Process event type 1

Process event type 2

Process event type 3
Classical Event-Driven Program

- Initialize display & system
- Repeat
  - Wait for and get next user action
  - Decipher action
  - Take appropriate action
  - Update display
- Until Done

Callback Routine – Way to go

- Software procedure, part of application
- Invoked when particular action occurs to UI component, such as pressing a PushButton
- Procedure is invoked with event parameters
Window Approach to Input Event Dispatching - Good

Events → Event Queue → Examine events, call processing module → Callback to process event type 1
                      → Callback to process event type 2
                      → Callback to process event type 3

Window Manager Notifier → Application program callbacks invoked by window manager

Widgets are Source of Events

- Widgets are typically structured as objects
- JAVA’s Swing uses MVC model
  - Each widget has three parts
Windows Widgets

- Buttons (several types)

- Scroll bars and sliders

- Pulldown menus

More Windows Widgets

- Palettes

- Dialog boxes

- Windows and many more...
Example – X & Motif

- Object-oriented hierarchy of UI interactors called widgets
  - Associate callback routines in your code with them

- Interface is built up by putting child widgets “onto” parent widgets

Widget

Graphical user interface interactor object
Widget Hierarchy

- Widgets organized into inheritance hierarchy

```
Primitive
  /|
 / |\
 Text Label Button Scroll Bar
```

Push Button, Drawn Button, Toggle Button

Widget

- Visual appearance
- Set of tailorable attributes

```c
PushButton {
  Color Background;
  int MarginLeft;
  int MarginRight;
  int BorderWidth;
  Pixmap ArmPixmap;
  Boolean FillOnArm;
  CallbackList ActivateCallback;
}
```

- Interactive behavior
Widget Use

- Set up widget attributes
- Create widget object (as child of parent widget)
- Define callback or event procedure for widget

Callbacks associated with objects and events
Multiple Callbacks per Object

- Example - button object with 5 callbacks
  - Mouse enter - (1) highlight
  - Mouse button down - (2) additional highlighting
  - Mouse leave while button down - (3) remove highlight
  - Mouse button up - (4) remove highlight, (5) perform action

Widget and Callback

```c
n = 0;
xmstr = XmStringCreate("Color", XmSTRING_DEFAULT_CHARSET);
XtSetArg(args[n], XmNlabelString, xmstr); n++;
XtSetArg(args[n], XmNbackground, red); n++;
colorbut = XtCreateManagedWidget("colorbutton",
  xmPushButtonWidgetClass, focusrowcol, args, n);
XtAddCallback(colorbut, XmNactivateCallback,
colorChangeCB, id);

void
colorChangeCB(Widget w, XtPointer userdata, XtPointer evdata)
{
  // Actions
}
```
Main Program Event Loop

```c
void CheckXEvents()
{
    XEvent xev;

    while (XtAppPending(_context)) {
        XtAppNextEvent(_context, &xev);
        XtDispatchEvent(&xev);
    }
}
```

OO Systems

- Java’s GUI programming done with AWT and Swing
- More distributed model (separate threads)
- Primary action here is dispatching events to objects (widgets) as messages
- Delegation important
  - Can make particular objects responsible for event handling
Example - Java AWT

```java
public void mouseReleased(MouseEvent e) {
    System.out.println("Changing color");
    if (bHighlight)
        frame.setHighlight(highlight);
    else
        frame.setHighlight(normal);
    bHighlight = !bHighlight;
}
```
Java Output

Get What You Ask For
Higher Level Tools

- Provide assistance or some automation in developing UIs
- Four types
  - Language - high-level programming language
  - Application framework - for specific application domain
  - Model-based systems - driven by UML or DB Schema
  - Interactive GUI Builders - by far the most prevalent and accessible

GUI Builder Tools

- Why build graphical (visual) interface with textual commands?
- Why not show what you want it to look like?

Tool Methods

- Work area (interface being built)
- Drag and drop interactors/widgets onto work area
- Specify position, color, look, etc.
- Often provide Build/Test modes

Example: dtbuilder (Motif)
Example: Visual Basic

Widgets in VB Toolbox
Connecting Code to Widgets

Making Menus
Interested in This?

- Take CS 6456, Principles of UI Software
- Should have a good programming background

MidTerm Exam

- Next Tuesday
- Short answer style questions
  - Know your definitions, terms, concepts
  - Material from lecture & book
Poster Session

- Thursday during class
- Buy a poster board (bookstore)
- Display your design ideas
  - Lots of pictures
  - Explanatory text
- Get some good feedback

Upcoming

- Mid-term Exam
- Poster Session
- Dialog styles