Designing for Humans

Human limits and capabilities

Human Performance Model

“People performing in systems have in common that they are each somebody, doing something, someplace” (Bailey, 1996)

The Human

The most complex of the three elements

The Activity

Example: use a pointing device to
- select an icon
- write your name

The Context

Examples:
- physical context, such as noise
- social context, such as crowds or isolation
Human Performance

- Limits and differences (next slide)

Types of Limits

- Sensory limits
  - thresholds
  - deficiencies
- Responder limits
- Cognitive processing limits
  - reaction time (next slide)
  - speed
  - accuracy
  - estimating
  - multitasking

Reaction Time

<table>
<thead>
<tr>
<th></th>
<th>Typical time delays (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensory receptor</td>
<td>1-38</td>
</tr>
<tr>
<td>Neural transmission to brain</td>
<td>2-100</td>
</tr>
<tr>
<td>Cognitive-processing delays (brain)</td>
<td>70-300</td>
</tr>
<tr>
<td>Neural transmission to muscles</td>
<td>10-20</td>
</tr>
<tr>
<td>Muscle latency and activation time</td>
<td>30-70</td>
</tr>
<tr>
<td>Total:</td>
<td>113-528</td>
</tr>
</tbody>
</table>

Inherent Speed Limits

Note: wpm = words/minute (1 word = 5 char)

Sensing

Senses:
- Sight
- Hearing
- Taste
- Smell
- Touch
- Kinesthetic
- Cutaneous
- Temperature
- Vestibular
**Sensory Limits ("Intensity")**

<table>
<thead>
<tr>
<th>Sense</th>
<th>Detection Threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sight</td>
<td>Candle flame seen 30 miles on a dark clear night</td>
</tr>
<tr>
<td>Hearing</td>
<td>Tick of a watch under quiet conditions at 20 feet</td>
</tr>
<tr>
<td>Taste</td>
<td>Teaspoon of sugar in 2 gallons of water</td>
</tr>
<tr>
<td>Smell</td>
<td>Drop of perfume diffused into a three-room apartment</td>
</tr>
<tr>
<td>Touch</td>
<td>Wing of a bee falling on your neck from a distance of 1 cm</td>
</tr>
</tbody>
</table>

**Vision Frequency Limits**

[Diagram showing the visible spectrum with wavelengths in nanometers]

**Visual-Cognitive Interaction**

“The Stroop Effect” (Stroop, 1935)

Say the words (or colours) in each list as quickly as possible.
Record the speed and accuracy of responses.
Are the results the same for each list?

**Stroop Effect in HCl**

Is there Stroop interference when entering a phone number, such as 1-800-HELLO, on a telephone keypad?

```
  1  2  3  4  5
  6  7  8  9  *
```

**Stereogram Example (Just for fun)**

[Image of a stereogram]

**Stereogram Example "shown"**

[Image of a stereogram shown]
One of the most widely used auditory illusions is Shepard's (1964) demonstration of pitch circularity, which has come to be known as the "Shepard Scale" demonstration. The demonstration uses a cyclic set of complex tones, each composed of 10 partials separated by octave intervals. The tones are cosinusoidally filtered to produce the sound level distributions shown in Figure 1 (next slide) and the frequencies of the partials are shifted upward in steps corresponding to a musical semitone (~6%). The result is an "ever-increasing" scale, which is a sort of auditory analog to the ever-ascending staircase visual illusion (Figure 2, next slide).

Remember Miller’s “magic number 7 +/-2”?
Here’s a quick experiment:
- I’ll say a sequence of numbers
- You write the sequence after I say it
- We’ll repeat this 10 times
- Sequence will begin with 4 numbers and will increase to 13 numbers
- Mark your neighbour’s sheet (right/wrong)
Worksheet

Enter Sequence Below

Mark 1 = correct
0 = wrong

A 7 4 9 2
B 3 0 5 8 2
C 9 3 7 1 4 6
D 3 6 5 0 7 2 4
E 2 1 9 7 8 5 4 3
F 3 7 5 6 2 5 4 0 0
G 3 5 2 7 0 8 9 3 2 5
H 0 8 7 3 9 1 2 3 5 1 6
I 3 5 2 4 9 0 5 8 2 0 4
J 7 5 3 9 1 8 4 5 1 3 4 3 0

Sequences

Kinesthetic sense

- Probably 3rd most important, next to vision and audition
- To control our actions, we need to know the position of body parts both before and after movements
- Kinesthetic sense provides information on the position of limbs, how far they have moved, etc.

Results

Memory Limit Experiment

Correct Responses

Sequence Length

Kinesthetic sense

Responding

Fitts' Law

Serial task
(aka reciprocal tapping task)
(from Fitts, 1954)
Discrete task

Task Difficulty

- Fitts proposed the following "Index of Difficulty" for target selection tasks:

\[ ID = \log_2 \left( \frac{A}{W} + 1 \right) \]

- Where
  - \( A \) is the amplitude of movement
  - \( W \) is the width of the target

Movement Time

- Fitts proposed that the movement time (MT) to select a target is linearly related to ID:

\[ MT (s) \sim ID (bits) \]

- Slope is in bits per second (bps)

Throughput

- Slope of the ID-MT relationship is a performance measure

- Depends on...
  - Human Activity
  - Context

E.g., mouse vs. trackball

Throughput in HCI

- Mouse
  \[ 0 \text{ bps} \]
- Trackball
  \[ 1 \text{ bps} \]
- Joystick
  \[ 2 \text{ bps} \]
- Touchpad
  \[ 3 \text{ bps} \]
- Controlling for, or understanding, other effects is extremely difficult (e.g., learning, individual differences, apparatus, procedures)

References

Overview

The following is the Table of Contents from the trail "Creating a GUI with JFC/Swing" in the "The Java Tutorial"

URL: http://java.sun.com/docs/books/tutorial/uiswing/TOC.html

Sections pertinent to 3461 are highlighted

If you haven’t already read these, please do

User Interfaces that Swing: A Quick Start Guide

Overview of the Swing API
Your First Swing Program
Example Two: SwingApplication
Example Three: CelsiusConverter
Example Four: LunarPhases
Example Five: VoteDialog
Layout Management
Threads and Swing
Summary
Questions and Exercises: User Interfaces That Swing

Getting Started with Swing

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Compiling and Running Swing Programs
Compiling and Running Swing Programs (Java 2 Platform)
Compiling and Running Swing Programs (JDK 1.1)
Running Swing Applets
A Quick Tour of a Swing Application's Code

Swing Features and Concepts

Swing Components and the Containment Hierarchy
Layout Management
Event Handling
Painting
Threads and Swing
More Swing Features and Concepts
The Anatomy of a Swing-Based Program

Using Swing Components

A Visual Index to the Swing Components
The JComponent Class
Using Top-Level Containers
How to Make Frames (Main Windows)
How to Make Dialogs
How to Make Applets
Using Intermediate Swing Containers
How to Use Panels
How to Use Scroll Panes
How to Use Split Panes
How to Use Tabbed Panels
How to Use Tool Bars
How to Use Internal Frames
Using Swing Components (2)
- How to Use Layered Panes
- How to Use Root Panes
- Using Atomic Components
  - How to Use Buttons, Check Boxes, and Radio Buttons
  - How to Use Color Choosers
  - How to Use Combo Boxes
  - How to Use File Choosers
  - How to Use Labels
  - How to Use Lists
  - How to Use Menus
  - How to Monitor Progress
  - How to Use Sliders
  - How to Use Tables

Using Swing Components (3)
- Using Text Components
  - An Example of Using Each Text Component
  - General Rules for Using Text Components
- How to Use Fields
  - How to Use Formatted Text Fields
  - Concepts: About Editor Panes and Text Panes
- Summary of Text
- How to Use Tool Tips
- How to Use Trees
- Solving Common Component Problems

Using Other Swing Features
- How to Use Actions
- How to Support Assistive Technologies
- How to Use Borders
- How to Use Icons
- How to Set the Look and Feel
- How to Use Threads
- How to Use Swing Timers
- Solving Common Problems Using Other Swing Features

Laying Out Components Within a Container
- Using Layout Managers
  - General Rules for Using Layout Managers
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  - How to Use BoxLayout
  - How to Use SpringLayout
  - How to Use CardLayout
  - How to Use FlowLayout
  - How to Use GridBagLayout
  - How to Use GridBagLayout: Specifying Constraints
  - How to Use GridBagLayout: The Example Explained
- Creating a Custom Layout Manager
- Doing Without a Layout Manager (Absolute Positioning)
- Solving Common Layout Problems

Writing Event Listeners
- Some Simple Event-Handling Examples
- General Information about Writing Event Listeners
- Listeners Supported by Swing Components
- Implementing Listeners for Commonly Handled Events
  - How to Write an Action Listener
  - How to Write a Caret Listener
  - How to Write a Change Listener
  - How to Write a Component Listener
  - How to Write a Container Listener
  - How to Write a Document Listener
  - How to Write a Focus Listener
  - How to Write an Internal Frame Listener
  - How to Write an Item Listener
  - How to Write a Key Listener

Writing Event Listeners (2)
- How to Write a List Data Listener
- How to Write a List Selection Listener
- How to Write a Mouse Listener
- How to Write a Mouse-Motion Listener
- How to Write a Table Model Listener
- How to Write a Tree Expansion Listener
- How to Write a Tree Model Listener
- How to Write a Tree-Selection Listener
- How to Write a Tree-Will-Expand Listener
- How to Write an Undoable Edit Listener
- How to Write a Window Listener
- Summary of Listener API
- Solving Common Event-Handling Problems
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  Painting Shapes
  Working with Text
Using Images
  Loading Images
  Displaying Images
Performing Animation
  Creating an Animation Loop with Timer
  Moving an Image Across the Screen
  Displaying a Sequence of Images
  Improving the Appearance and Performance of Image Animation
  Solving Common Graphics Problems

Converting to Swing

Why to Convert
How to Convert
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  Swing Replacements for AWT Components
  General Conversion Tips
  Component-Specific Conversion Tips
  Some Conversion Examples
  Solving Common Conversion Problems