cs304
Software Engineering

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Southern University of Science and Technology

Slides adapted from cs427 (UIUC) and cs409 (SUSTech)

Administrative Info

- **Project Progress Report Uploaded:**
  - **due on 26 April 2021, 12.01am**
  - You need to know how to run and read the results for the **3 static analysis tools thought in the lab last week**
    - The leader needs to go to GitHub discussion to put the selected time slot
    - Choose the time based on the registered lab time
- All lab exercise should be submitted before next lab to avoid accumulating too much assignments
  - Reverse engineering lab not many students have submitted
- **Ask question on GitHub discussion instead of Wechat:**
  - Wechat group is for posting announcement

UI Design

User Interface Design

- Important
- Hard
- Isn’t covered well by most software development processes

10 Rules of Good UI Design to Follow On Every Web Design Project

From: https://www.youtube.com/watch?v=RFv53AxxQAo

10 rules of Good UI Design

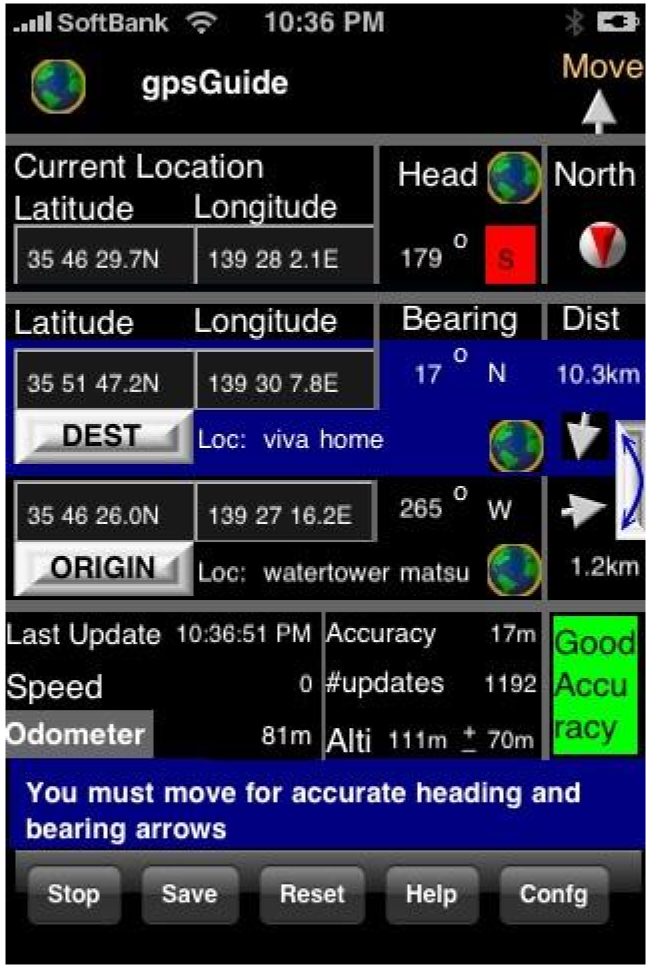
1. Make Everything the User Needs Readily Accessible
2. Be Consistent
3. Be Clear
4. Give Feedback
5. Use Recognition, Not Recall
6. Choose How People Will Interact First
7. Follow Design Standards
8. Elemental Hierarchy Matters
9. Keep Things Simple
10. Keep Your Users Free & In Control

https://www.elegantthemes.com/blog/resources/10-rules-of-good-ui-design-to-follow-on-every-web-design-project

Reading

- Joel Spolsky on Software
- Read nine “chapters” of the “book” on UI design for programmers at the link https://www.joelonsoftware.com/category/uibook/

UI Hall of Fame or Shame?



SoftBank 10:36 PM

gpsGuide Move

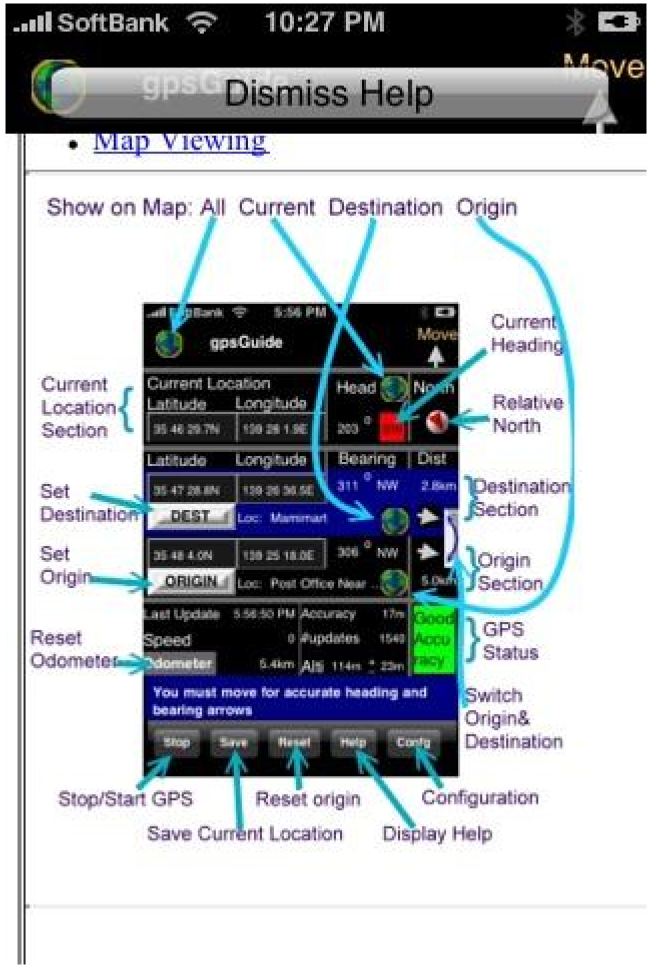
Current Location		Head	North
Latitude	Longitude		
35 46 29.7N	139 28 2.1E	179 o S	

Latitude	Longitude	Bearing		Dist
35 51 47.2N	139 30 7.8E	17 o	N	10.3km
DEST	Loc: viva home			
35 46 26.0N	139 27 16.2E	265 o	W	
ORIGIN	Loc: watertower matsu			1.2km

Last Update	10:36:51 PM	Accuracy	17m	Good Accu racy
Speed	0	#updates	1192	
Odometer	81m	Alti	111m ± 70m	

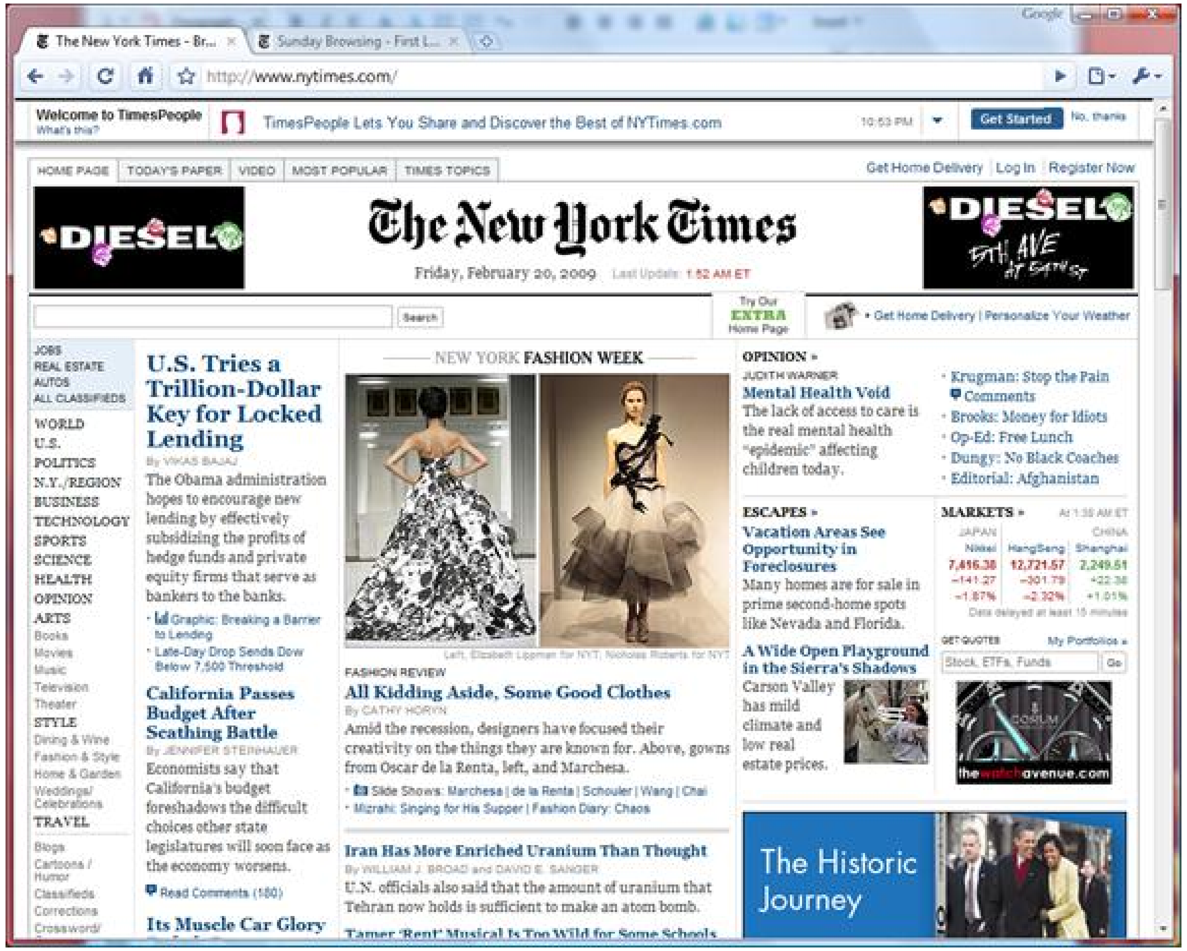
You must move for accurate heading and bearing arrows

Stop Save Reset Help Confg



Desktop vs. Mobile

Small Screen



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STYLE
Dining & Wine
Fashion & Style
Home & Garden
Weddings/ Celebrations
TRAVEL
Blogs
Cartoons / Humor
Classifieds
Corrections
Crossword/

U.S. Tries a Trillion-Dollar Key for Locked Lending

By VIKAS BAJAJ

The Obama administration hopes to encourage new lending by effectively subsidizing the profits of hedge funds and private equity firms that serve as bankers to the banks.

- Graphic: Breaking a Barrier to Lending
- Late-Day Drop Sends Dow Below 7,500 Threshold

California Passes Budget After Scathing Battle

By JENNIFER STEINHAUER

Economists say that California's budget foreshadows the difficult choices other state legislatures will soon face as the economy worsens.

Read Comments (180)

Its Muscle Car Glory

NEW YORK FASHION WEEK

Left, Elizabeth Lippman for NYT; Nicholas Roberts for NYT

FASHION REVIEW

All Kidding Aside, Some Good Clothes

By CATHY HORYN

Amid the recession, designers have focused their creativity on the things they are known for. Above, gowns from Oscar de la Renta, left, and Marchesa.

- Slide Shows: Marchesa | de la Renta | Schouler | Wang | Chai
- Mizrahi: Singing for His Supper | Fashion Diary: Chaos

Iran Has More Enriched Uranium Than Thought

By WILLIAM J. BROAD and DAVID E. SANGER

U.N. officials also said that the amount of uranium that Tehran now holds is sufficient to make an atom bomb.

Tamer 'Rent' Musical Is Too Wild for Some Schools

OPINION »

JUDITH WARNER

Mental Health Void

The lack of access to care is the real mental health "epidemic" affecting children today.

- Krugman: Stop the Pain
- Comments
- Brooks: Money for Idiots
- Op-Ed: Free Lunch
- Dungy: No Black Coaches
- Editorial: Afghanistan

ESCAPES »

Vacation Areas See Opportunity in Foreclosures

Many homes are for sale in prime second-home spots like Nevada and Florida.

A Wide Open Playground in the Sierra's Shadows

Carson Valley has mild climate and low real estate prices.

MARKETS » At 1:35 AM ET

JAPAN		CHINA
Nikkei	HangSeng	Shanghai
7,416.38	12,721.57	2,249.51
−141.27	−301.79	+22.38
−1.87%	−2.32%	+1.01%

Data delayed at least 15 minutes

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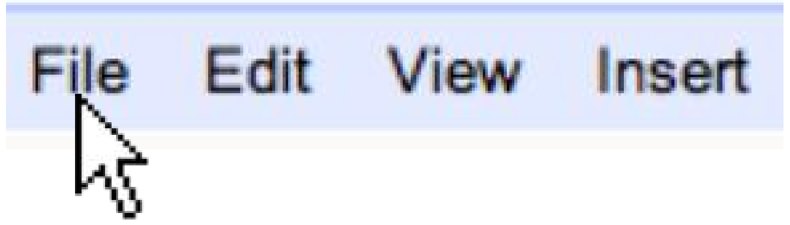
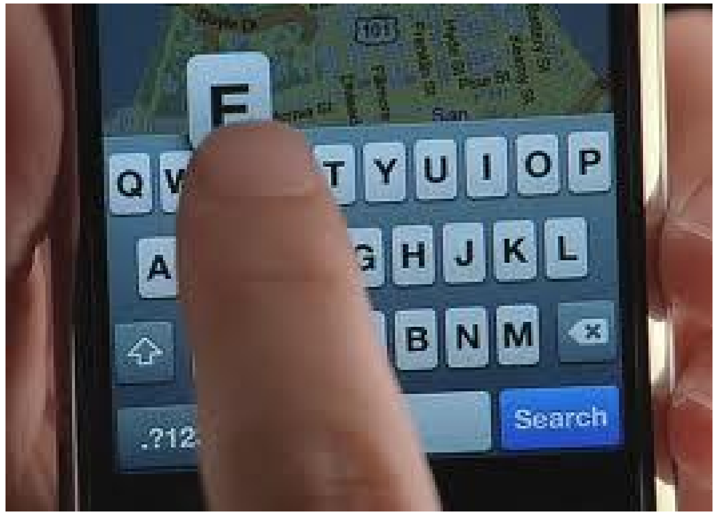
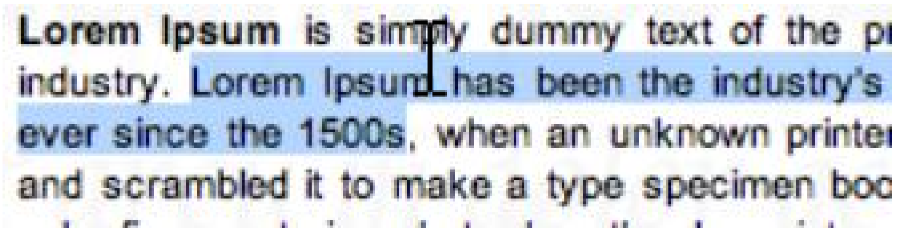
thewatchavenue.com

The Historic Journey

“Fat Finger”

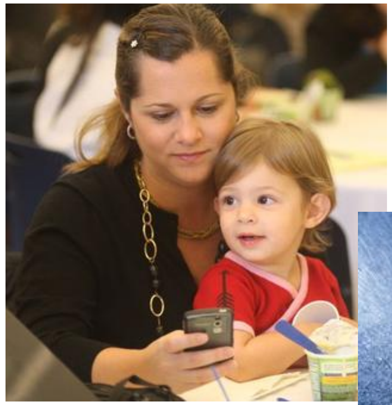





Lorem Ipsum is simply dummy text of the pı
industry. Lorem Ipsum has been the industry's
ever since the 1500s, when an unknown printeı
and scrambled it to make a type specimen boc

Text Input

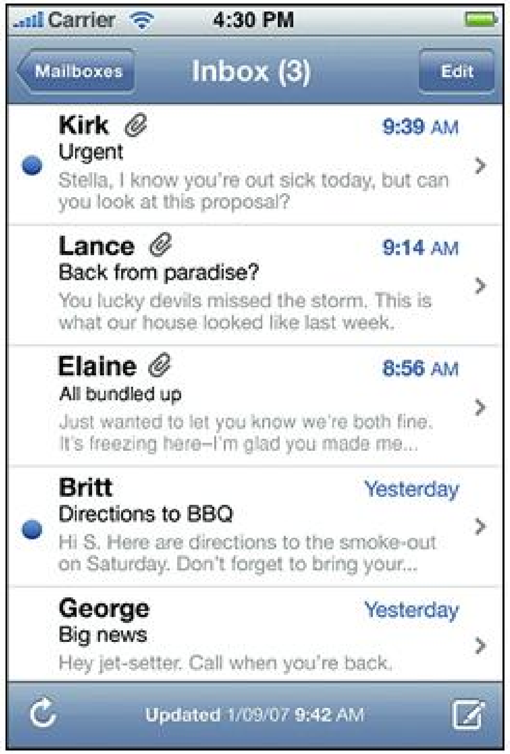
Context



Other Issues in Mobile

- Power & battery life
- Network latency, bandwidth, inconsistency
- CPU speed

Distinct Screens



Kirk 9:39 AM
Urgent
Stella, I know you're out sick today, but can you look at this proposal?

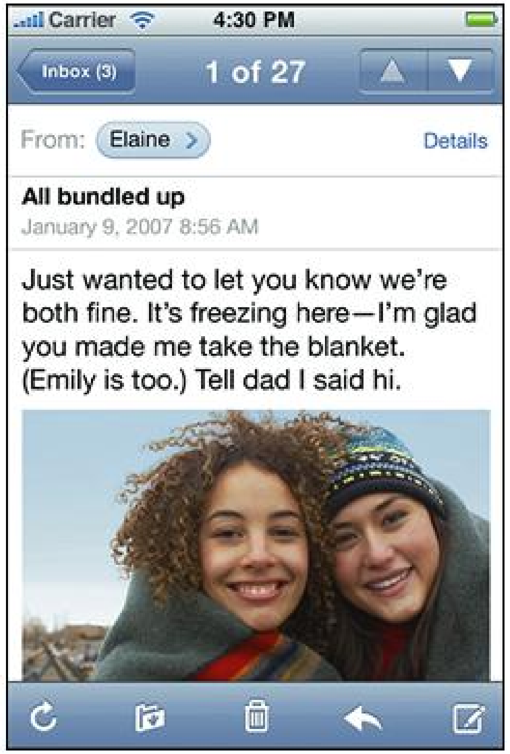
Lance 9:14 AM
Back from paradise?
You lucky devils missed the storm. This is what our house looked like last week.

Elaine 8:56 AM
All bundled up
Just wanted to let you know we're both fine. It's freezing here–I'm glad you made me...

Britt Yesterday
Directions to BBQ
Hi S. Here are directions to the smoke-out on Saturday. Don't forget to bring your...

George Yesterday
Big news
Hey jet-setter. Call when you're back.

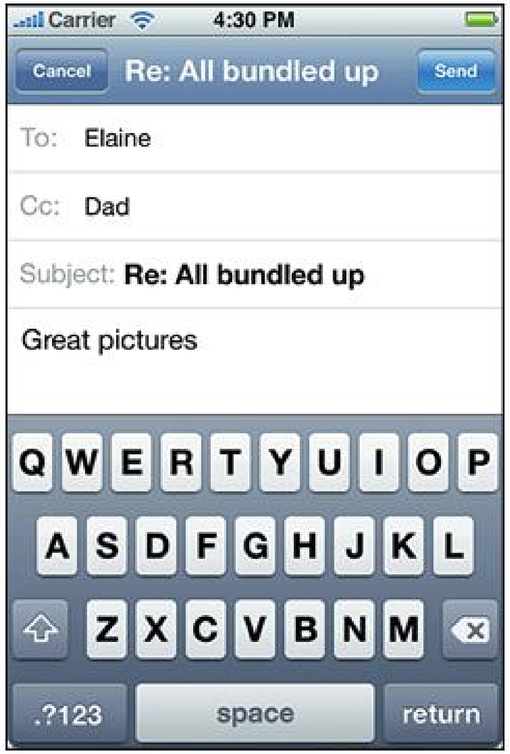
Updated 1/09/07 9:42 AM



From: Elaine

All bundled up
January 9, 2007 8:56 AM

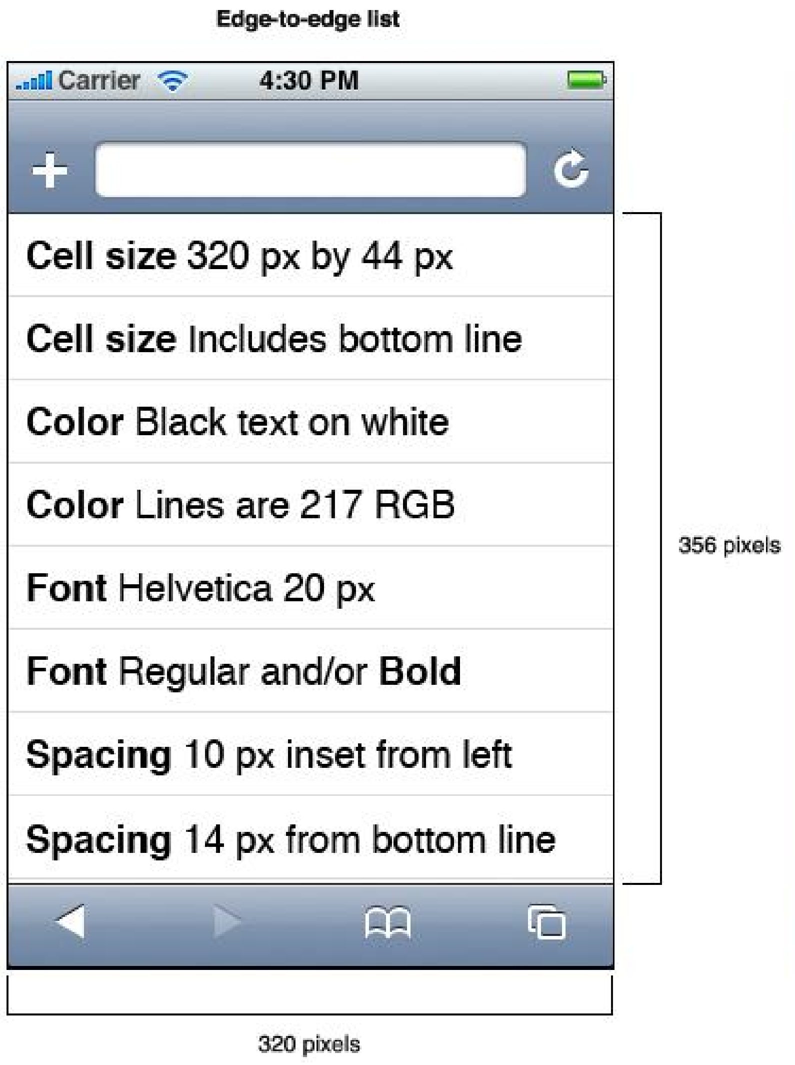
Just wanted to let you know we're both fine. It's freezing here—I'm glad you made me take the blanket. (Emily is too.) Tell dad I said hi.



To: Elaine
Cc: Dad
Subject: Re: All bundled up

Great pictures

Scrolling Lists



Cell size 320 px by 44 px

Cell size Includes bottom line

Color Black text on white

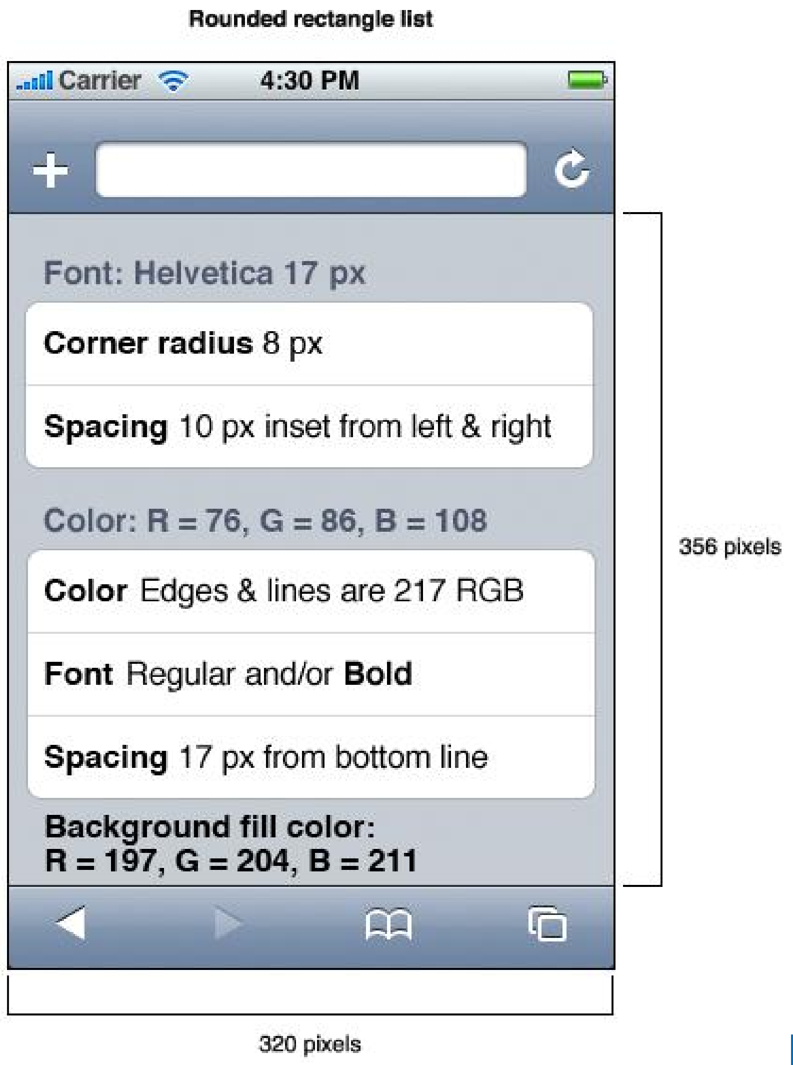
Color Lines are 217 RGB

Font Helvetica 20 px

Font Regular and/or Bold

Spacing 10 px inset from left

Spacing 14 px from bottom line



Font: Helvetica 17 px

Corner radius 8 px

Spacing 10 px inset from left & right

Color: R = 76, G = 86, B = 108

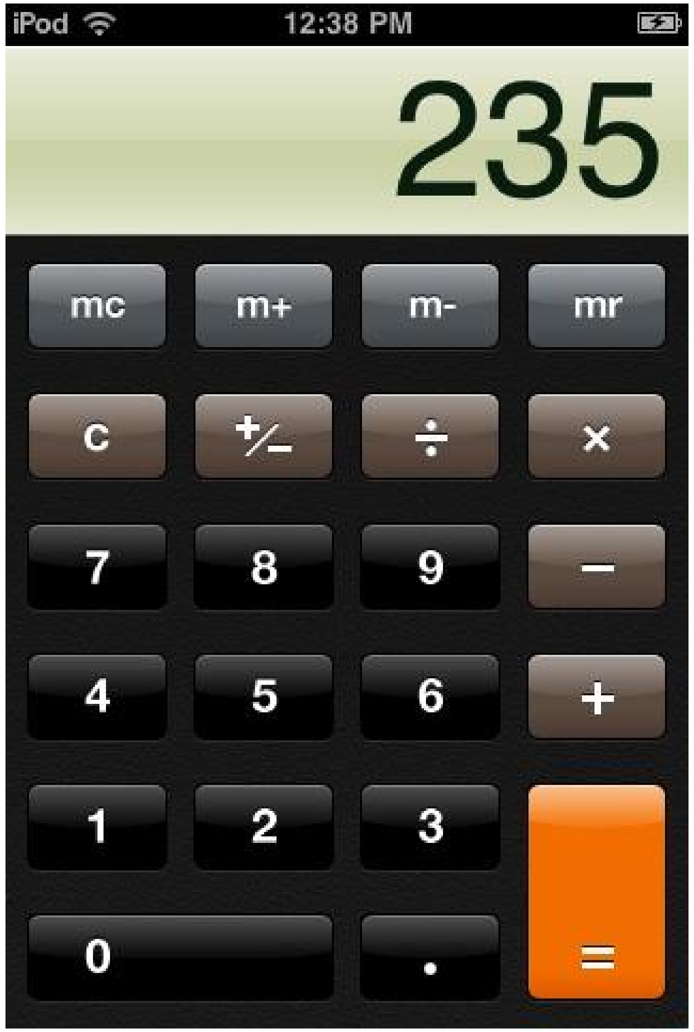
Color Edges & lines are 217 RGB

Font Regular and/or Bold

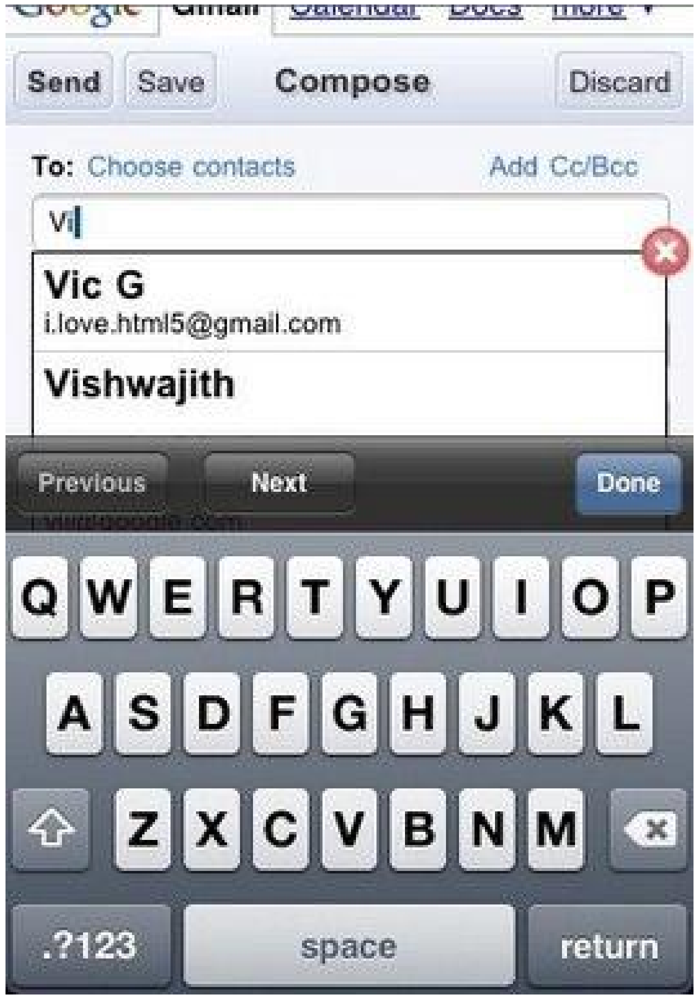
Spacing 17 px from bottom line

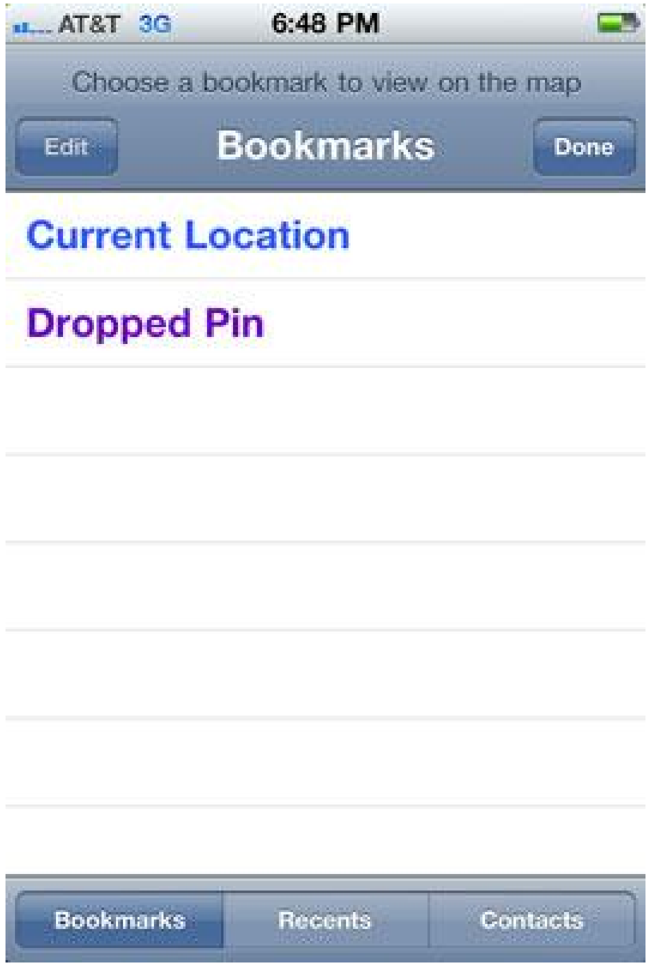
Background fill color:
R = 197, G = 204, B = 211

Finger-Sized Targets

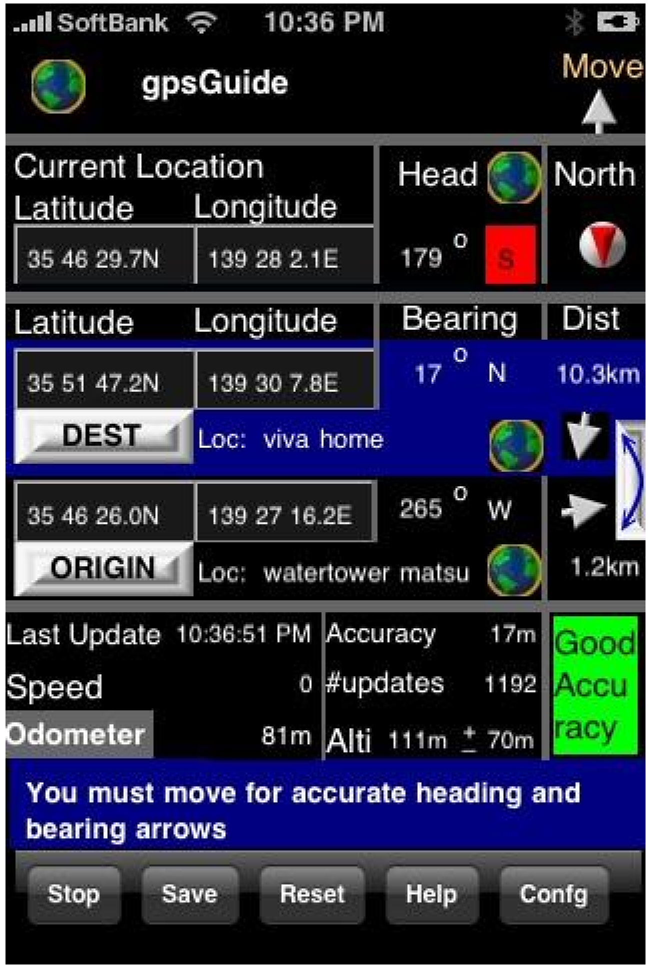


Minimize Text Input





Simplify, Simplify, Simplify!


SoftBank 10:36 PM

gpsGuide Move

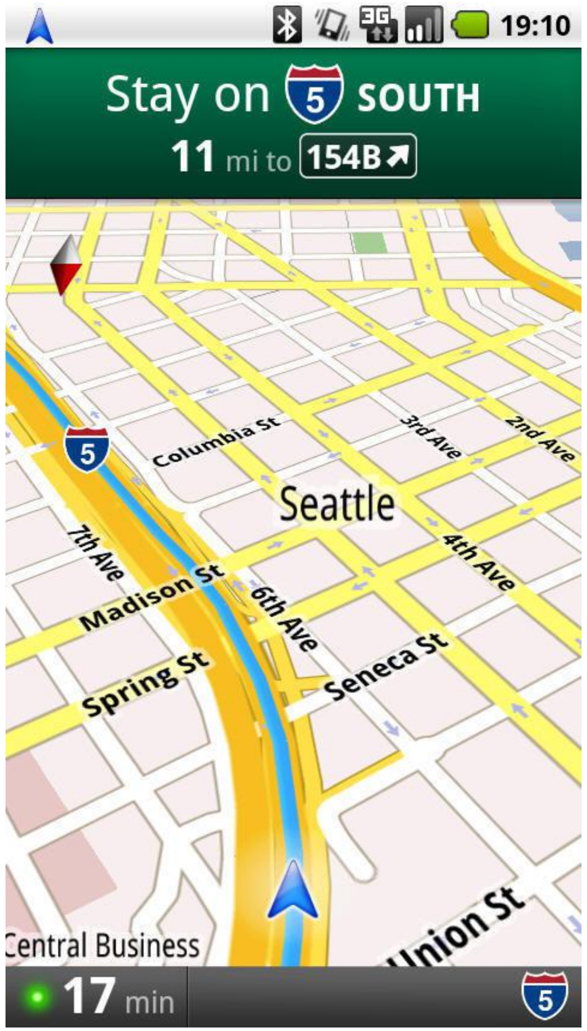
Current Location Latitude	Longitude	Head	North
35 46 29.7N	139 28 2.1E	179 o S	

Latitude	Longitude	Bearing	Dist
35 51 47.2N	139 30 7.8E	17 o N	10.3km
DEST	Loc: viva home		
35 46 26.0N	139 27 16.2E	265 o W	
ORIGIN	Loc: watertower matsu		1.2km

Last Update 10:36:51 PM Accuracy 17m Good Accuracy
Speed 0 #updates 1192
Odometer 81m Alti 111m ± 70m

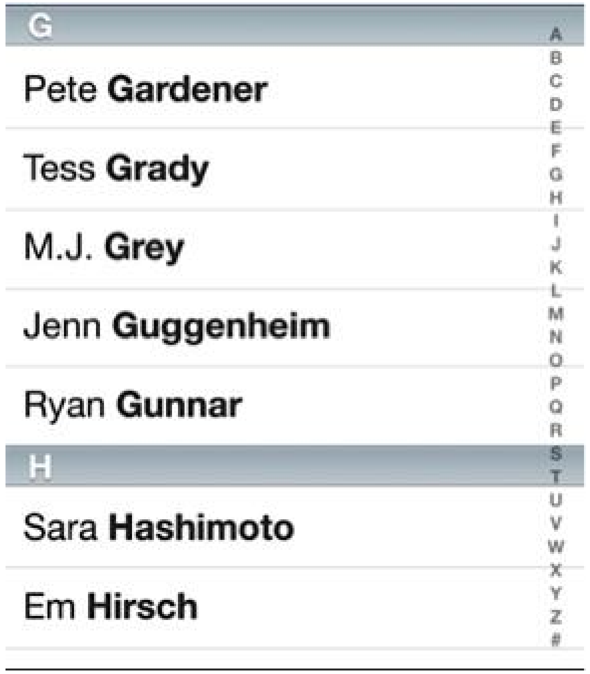
You must move for accurate heading and bearing arrows

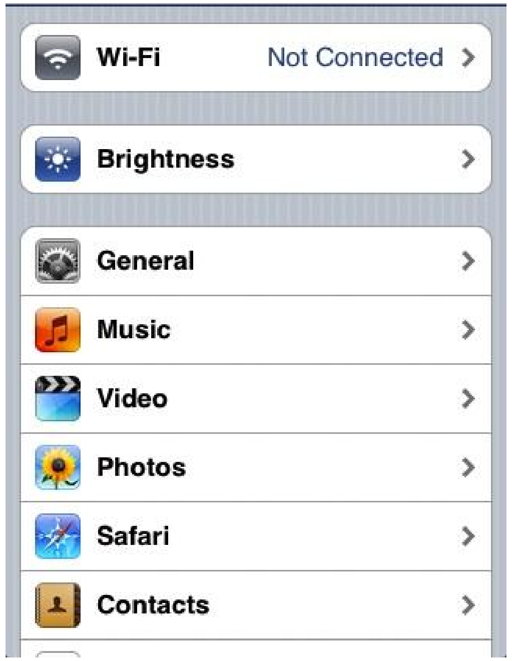
Stop Save Reset Help Confg

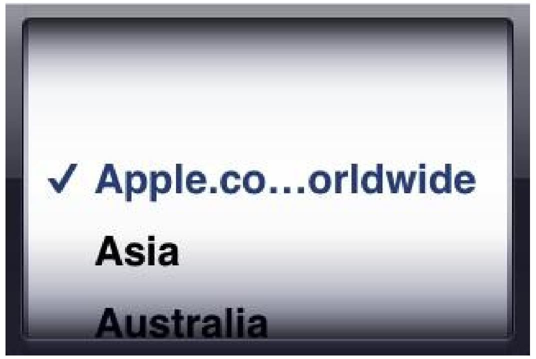


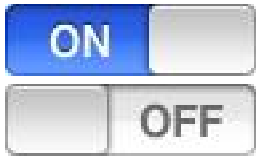
Slides from http://stellar.mit.edu/S/course/6/sp11/6.831/materials.html ©Rob Miller

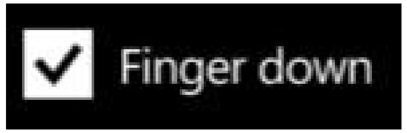
Mobile Widgets



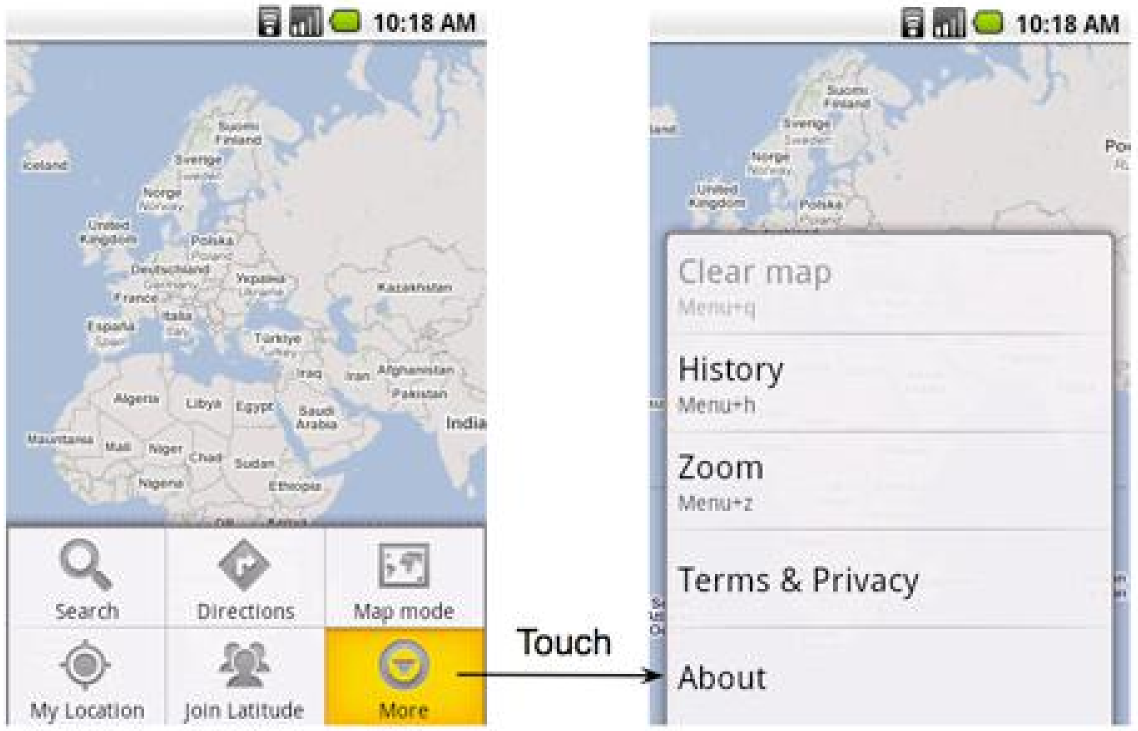






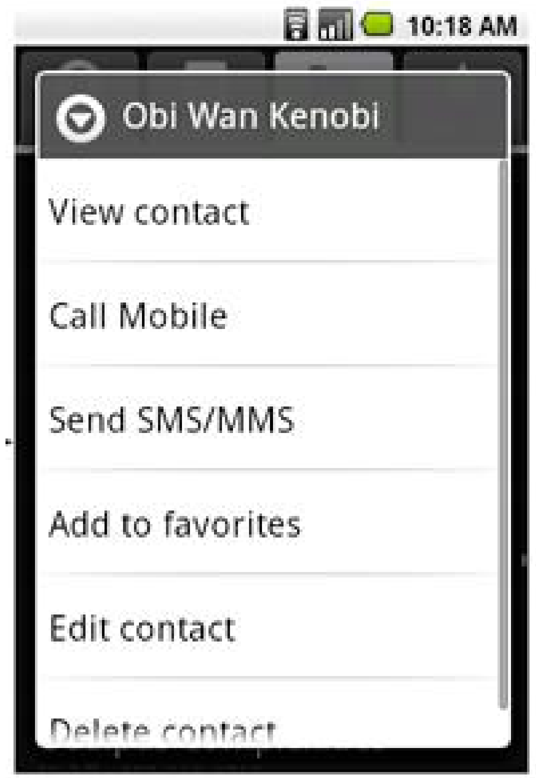


Many Kinds of Menus



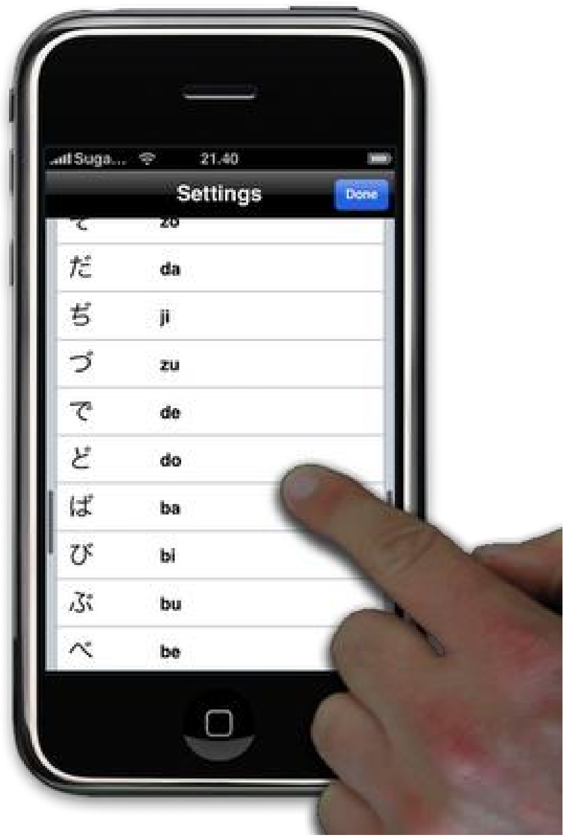
Options icon menu

Options expanded menu



Context Menu

Touch Gestures



Summary of Mobile UI Design

- Mobile UI design faces new challenges
  - Small screens
  - Fat fingers
  - Poor text entry
- Simplify
  - Follow design patterns
  - Use touch gestures where possible

Group Discussion

- Form a group with 2-3 students
- Each student identifies a mobile app that she/he feels to be the best in UI/usability
- Each student identifies a mobile app that she/he feels to be the worst in UI/usability
- Discuss in your group what UI designs make the mobile app best/worst
  - Share some commonalities in answers across students

Principle

- UI design is more like film-making than bridge-building
  - About communication
  - Requires understanding audience
  - Requires specialized skills
  - Requires iteration

Back to Joel: Golden Rules

- Let the user be in control
  - Ask the user whether he/she is sure about making this change
- Reduce the user’s memory load
  - Ask for saving passwords, saving preferences, etc.
- Be consistent
  - If you are using a shortcut in one program, keep it consistent in the other programs

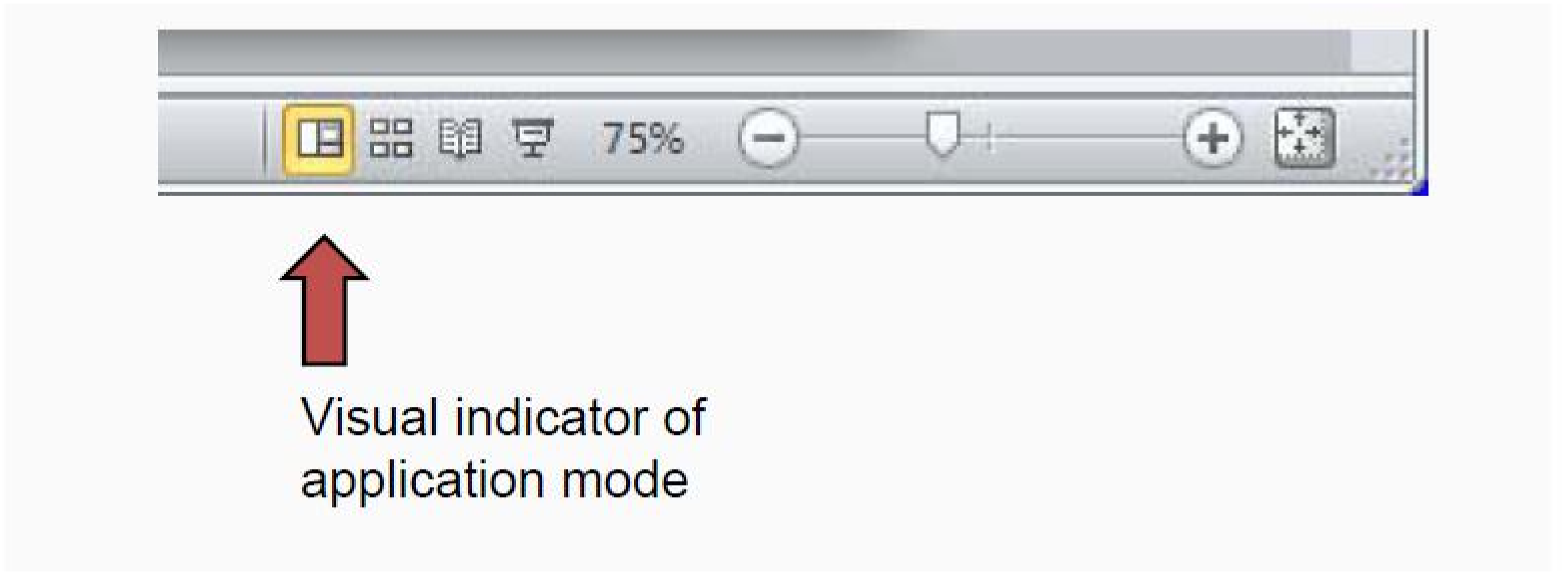
Let the User be in Control (1)

- Undo
- Macros
- Direct manipulation

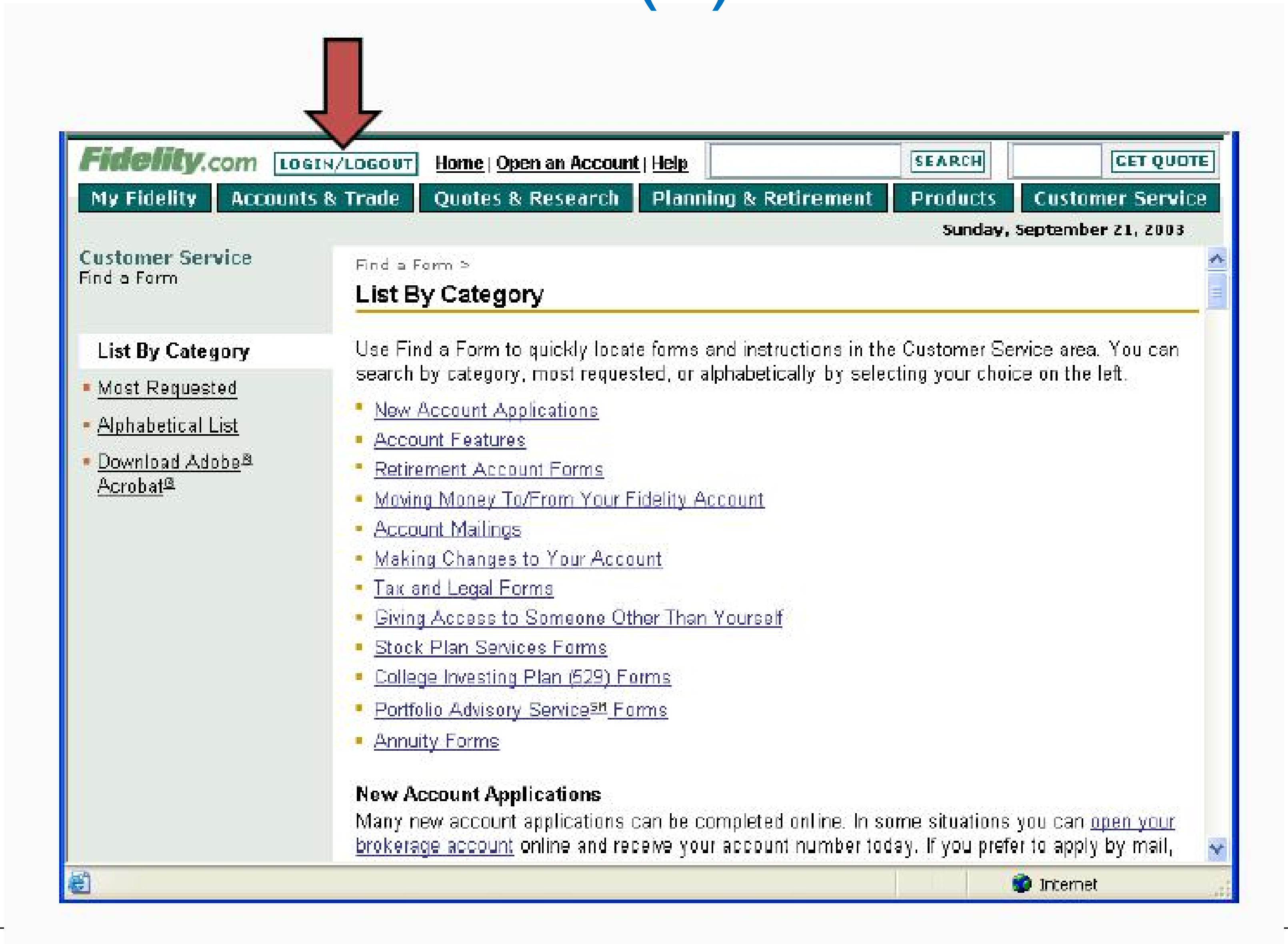
More info: http://www.cs.wm.edu/~kemper/cs435/slides/l18.pdf

Let the User be in Control (2)

- Modes
  - Use a new window instead of a new mode
  - Make modes visible (signed in/logged out)



Let the User be in Control (3)



Sunday, September 21, 2003

Customer Service
Find a Form

List By Category
- Most Requested
- Alphabetical List
- Download Adobe® Acrobat®

Find a Form >

List By Category

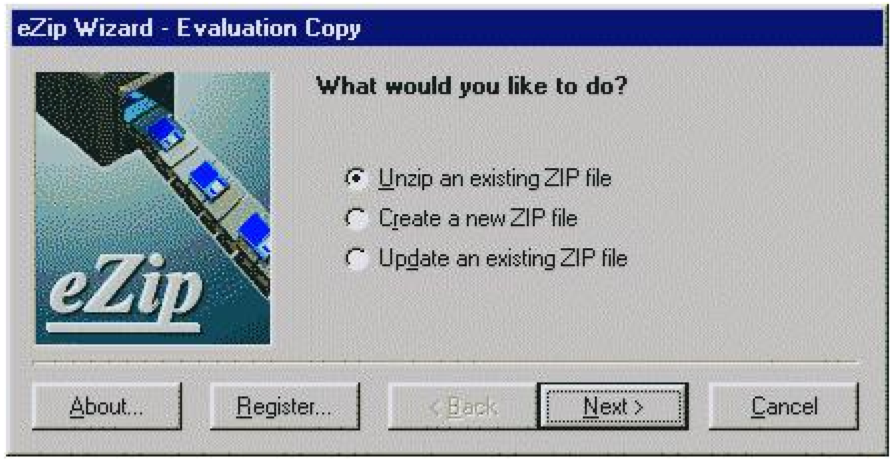
Use Find a Form to quickly locate forms and instructions in the Customer Service area. You can search by category, most requested, or alphabetically by selecting your choice on the left.

- New Account Applications
- Account Features
- Retirement Account Forms
- Moving Money To/From Your Fidelity Account
- Account Mailings
- Making Changes to Your Account
- Tax and Legal Forms
- Giving Access to Someone Other Than Yourself
- Stock Plan Services Forms
- College Investing Plan (529) Forms
- Portfolio Advisory Service℠ Forms
- Annuity Forms

New Account Applications

Many new account applications can be completed online. In some situations you can open your brokerage account online and receive your account number today. If you prefer to apply by mail,

Wizards


eZip Wizard - Evaluation Copy

What would you like to do?

[✓ Unzip an existing ZIP file]
Create a new ZIP file
Update an existing ZIP file

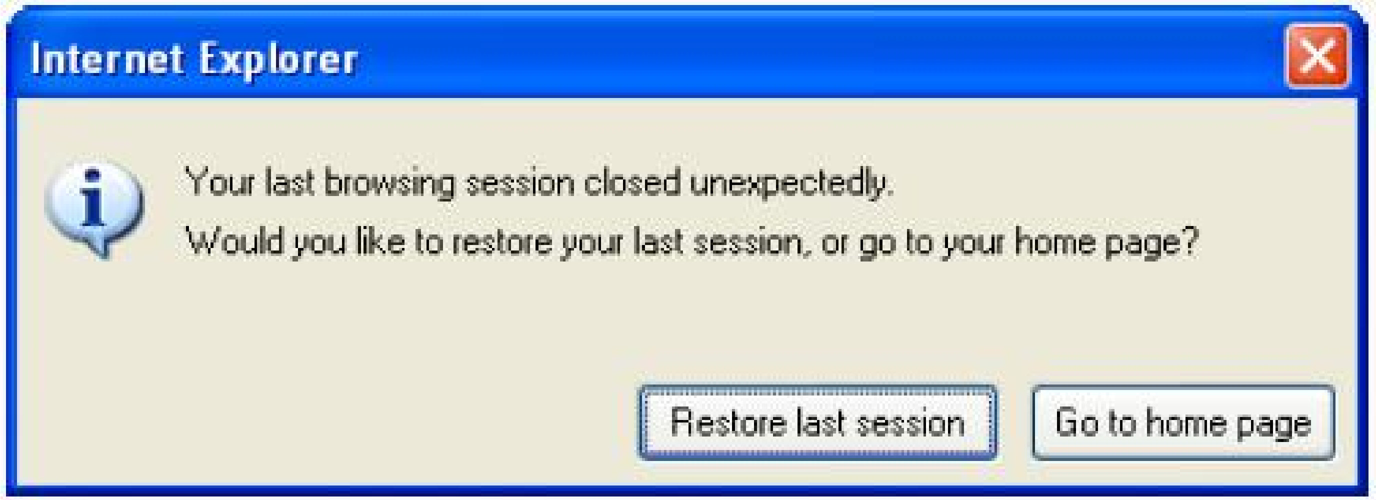
- No uncommon tasks for beginners
- Guide through steps with option to leave
- Different versions for different level of expertise

Reduce Memory Load (1)

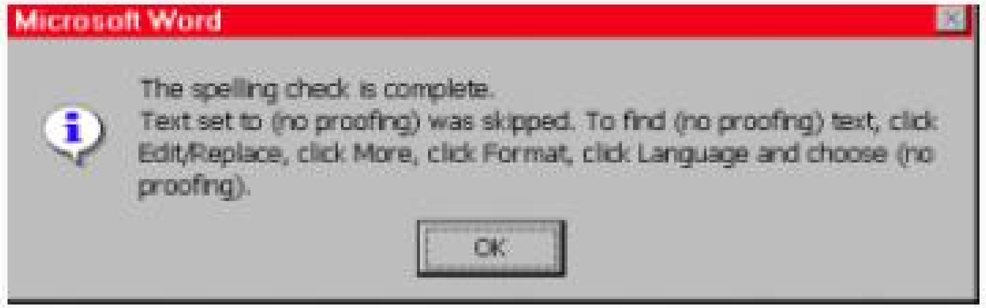
- □Reduce demand on short-term memory
- □Establish meaningful defaults
- □Define intuitive shortcuts
- □Use real-world metaphors
- □Speak user’s language
- □Let user recognize, not remember

TEENS REACT TO WINDOWS 95:
https://www.youtube.com/watch?v=8ucCxtgN6sc

Reduce Memory Load (2)


Internet Explorer

Your last browsing session closed unexpectedly.
Would you like to restore your last session, or go to your home page?


Microsoft Word

The spelling check is complete.
Text set to (no proofing) was skipped. To find (no proofing) text, click Edit/Replace, click More, click Format, click Language and choose (no proofing).

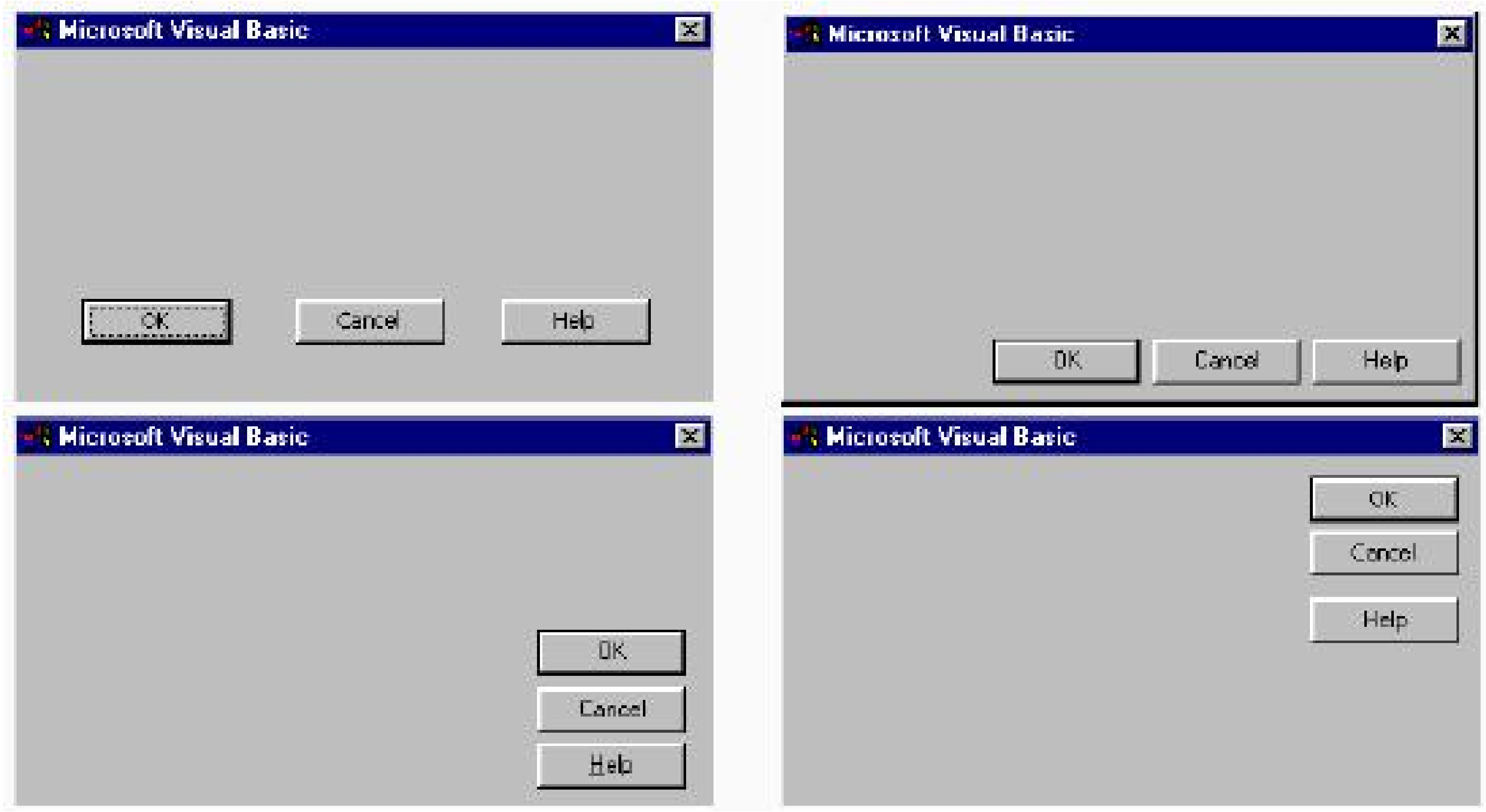
Common techniques

- ☐Menus with keyboard shortcuts
- ☐Dialog boxes
- ☐Tabs
- ☐Toolbar

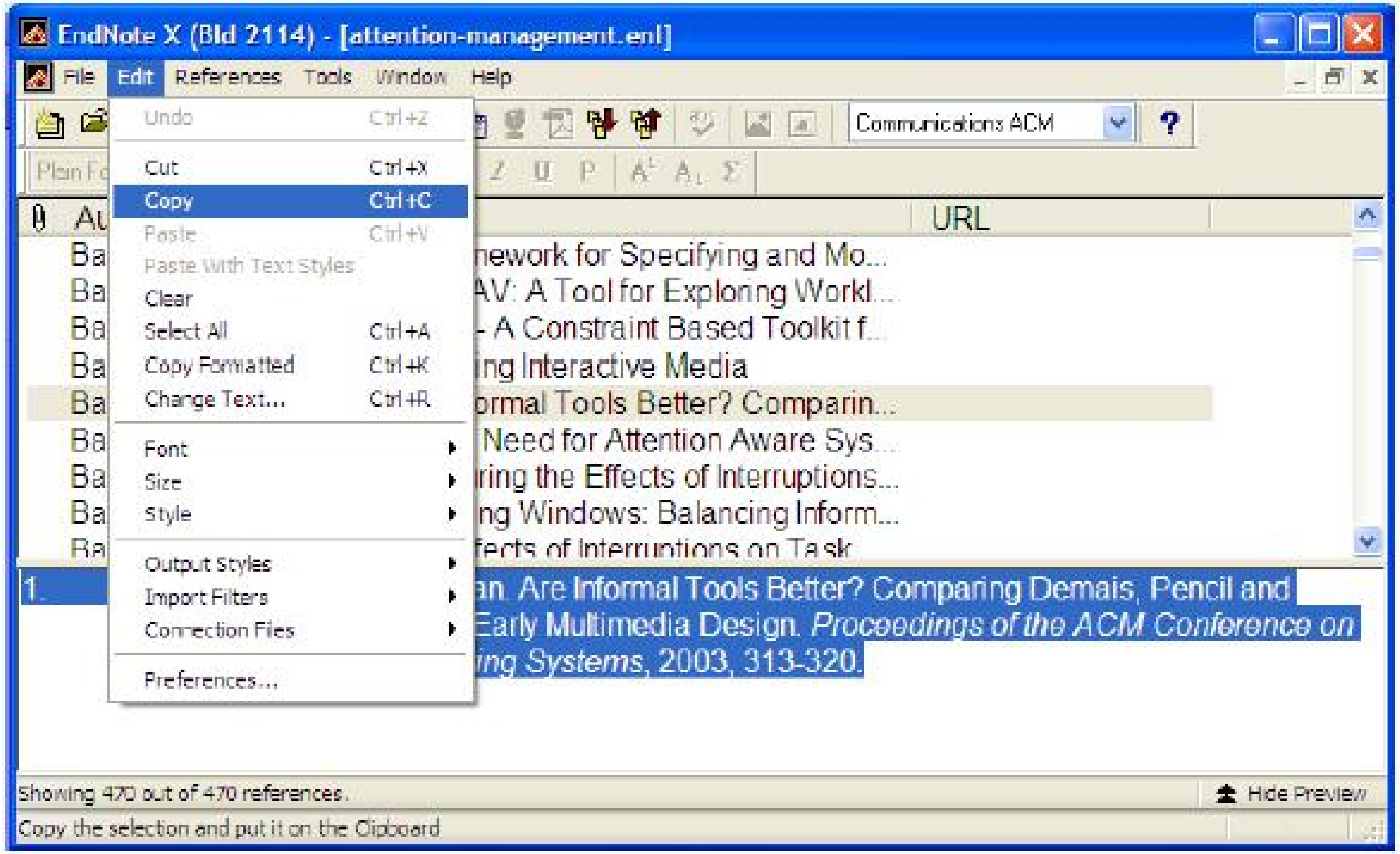
Be Consistent (1)

- Use visual interface standards
  - For operating system
  - For organization
  - For product or set of products
- Keep user from getting lost
- System will explain itself

Be Consistent (2)



Be Consistent (3)



EndNote X (Bld 2114) - [attention-management.enl]

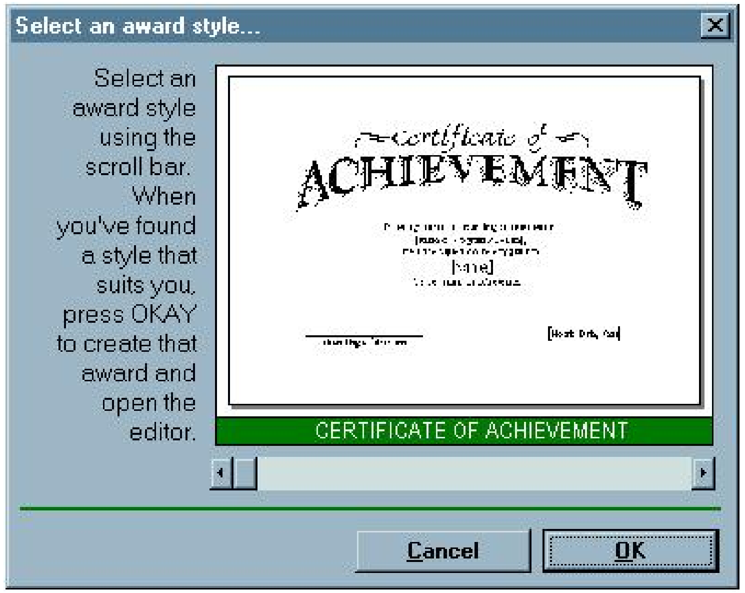
Ba nework for Specifying and Mo...
Ba AV: A Tool for Exploring Workl...
Ba - A Constraint Based Toolkit f...
Ba ing Interactive Media
Ba ormal Tools Better? Comparin...
Ba Need for Attention Aware Sys...
Ba ring the Effects of Interruptions...
Ba ng Windows: Balancing Inform...
Ba fects of Interruptions on Task

1. an. Are Informal Tools Better? Comparing Demais, Pencil and Early Multimedia Design. *Proceedings of the ACM Conference on ing Systems*, 2003, 313-320.

Showing 470 out of 470 references.

Copy the selection and put it on the Clipboard

Easier to navigate



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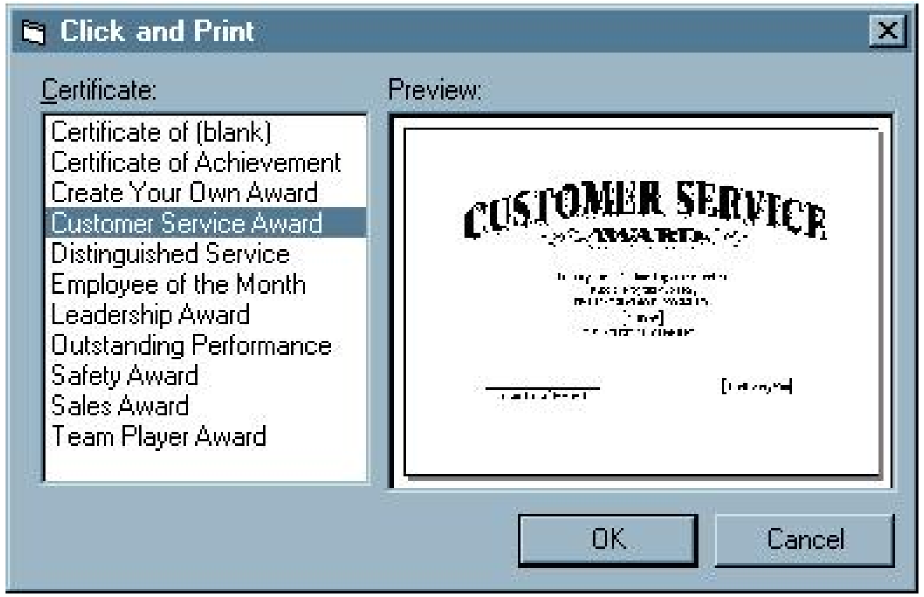
Certificate of ACHIEVEMENT

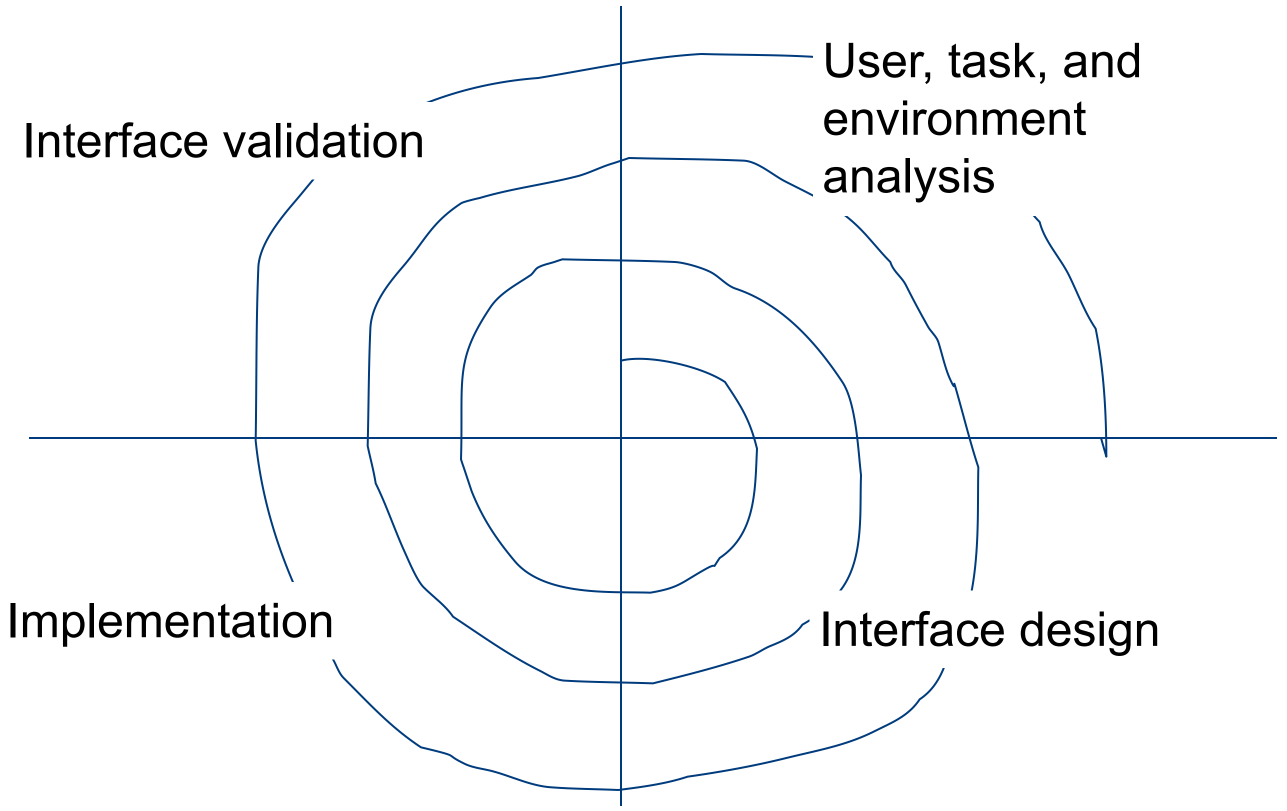
CERTIFICATE OF ACHIEVEMENT



Certificate of (blank)
Certificate of Achievement
Create Your Own Award
Customer Service Award
Distinguished Service
Employee of the Month
Leadership Award
Outstanding Performance
Safety Award
Sales Award
Team Player Award

CUSTOMER SERVICE AWARD

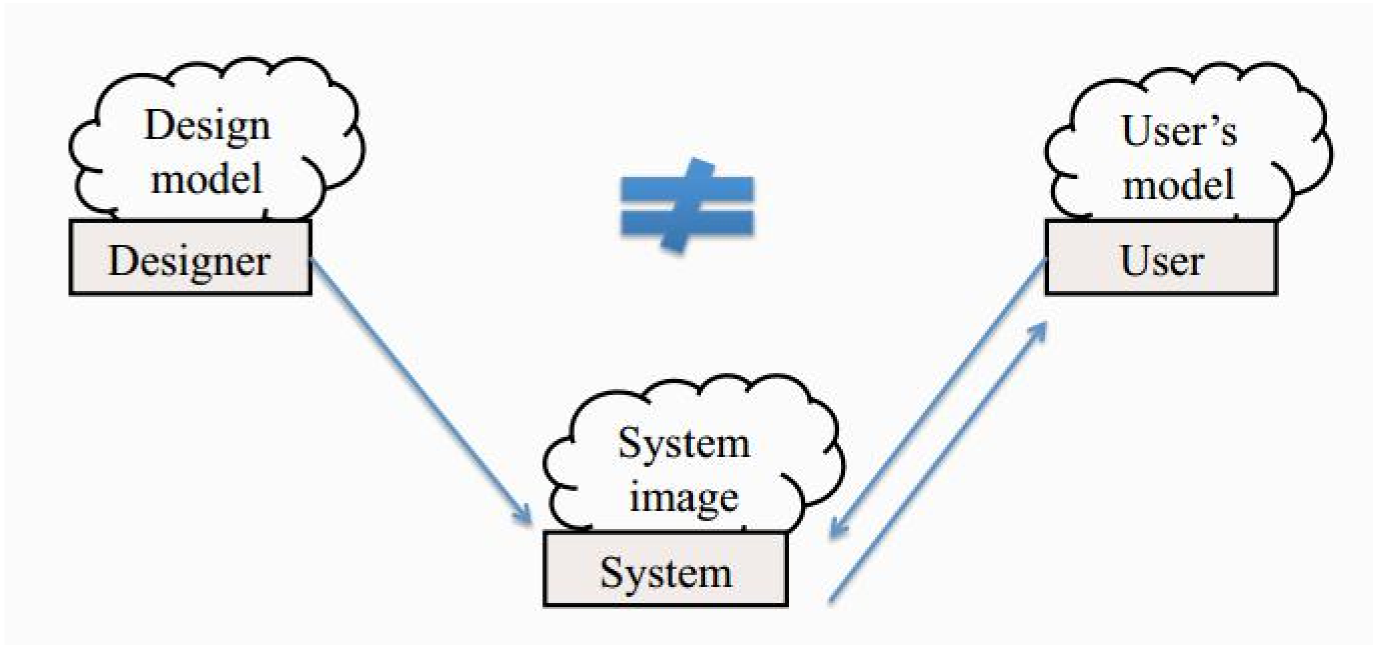
The UI Design Process



Models (1)

- Design model - what the designer thinks about the system
- User model - what the user thinks about the system
- System image - interface, manuals, training material, web site

Models (2)


Design model
Designer
≠
User's model
User
System image
System

Design in nutshell

Pressman says:

"The role of interface designer is to reconcile these differences and derive a consistent representation of the interface"

Early phases

- What are users like?
- What do they think the system should be like?
- What is a single, consistent model of the system that can satisfy all the users?

Later phases

Design

- What should system be like?
- How can we make the users understand it?
- For each aspect of the system, design the system image to match the desired user model

Validation

- Does user model match our goal?

Task Analysis and Modeling

- What tasks will a user of the system perform?

- High level - why people use the system
- Low level - tasks involved in using the system

Tasks and Use Cases

- Use cases are high-level tasks
  - Decompose high-level ones into low-level ones
  - Find ones that are missing
  - Simplify by generalizing
- UI design requires more detail than use case analysis usually provides

Tasks

- For each task:
  - Is it easy to start the task?
  - Is all the needed information easily accessible?
  - Is it easy to see what to do next?

User Interface Design

- UI communicates with the user
- Like any form of communication
  - Needs feedback and iteration
  - There are standard ways of making a UI
  - Great UIs are rare and require creativity

Stages of UX Design

From: https://www.youtube.com/watch?v=K44tP606seE

Low-level design

- Map task into actions that can be directly implemented by standard widgets
- Use consistent labels across tasks
- Use consistent widgets across tasks

E-mail

- Tasks
  - Read a message
  - Check to see if there is more mail
  - Reply to a new message
  - Send a message to a set of people
  - Stop half-way through writing a message and wait till tomorrow
  - Save a message

Design model

- Message
- Mailbox
- Incoming messages go to in-box
- Messages in out-box can be marked “ready to be sent”
- New messages created in out-box
- Can move messages from one mailbox to another

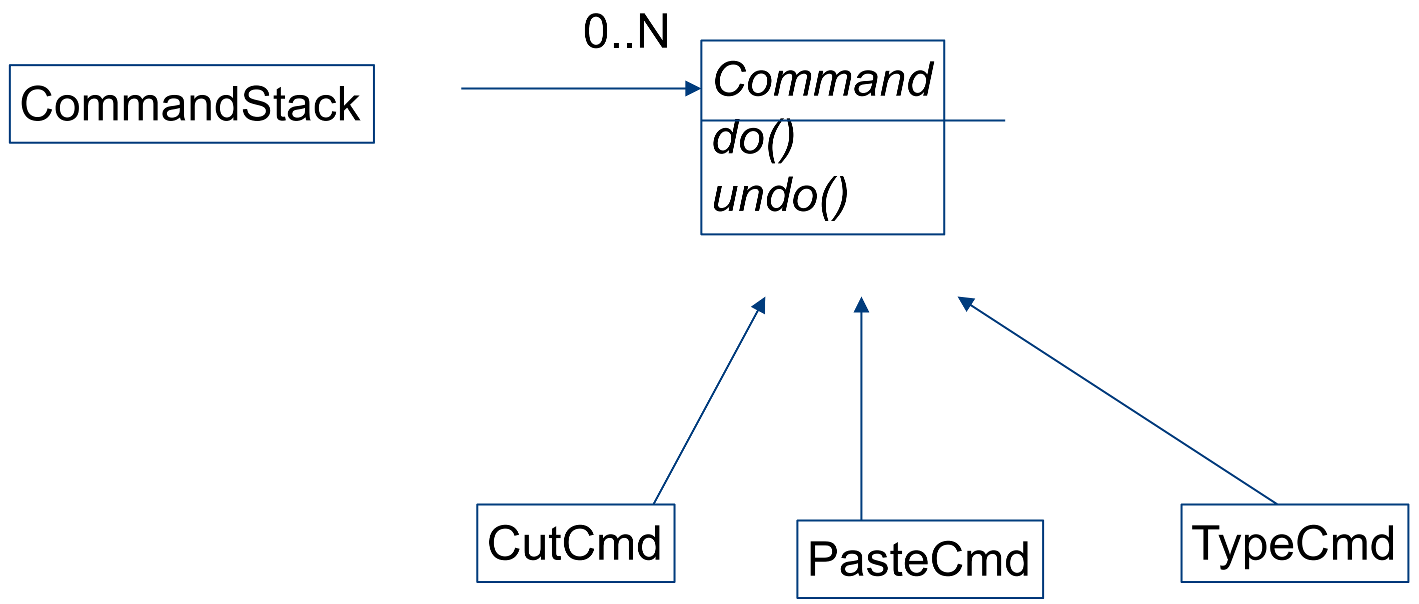
Object-oriented UI

- Objects represented by lists, icons
- Operations are on menus, buttons
- Perform operation on selected object
- Make a few operations that work on many kinds of objects
- Specify arguments by:
  - Dialog box
  - Multiple selection

Relate UI to design

- Window for domain object
  - Commands taken from operations on object
  - Direct manipulation interface
- Window for use case
  - Several windows on same domain object
  - Window might display state of use case
  - Window might display argument (dialog box)
  - Commands are steps in use case

Command design pattern

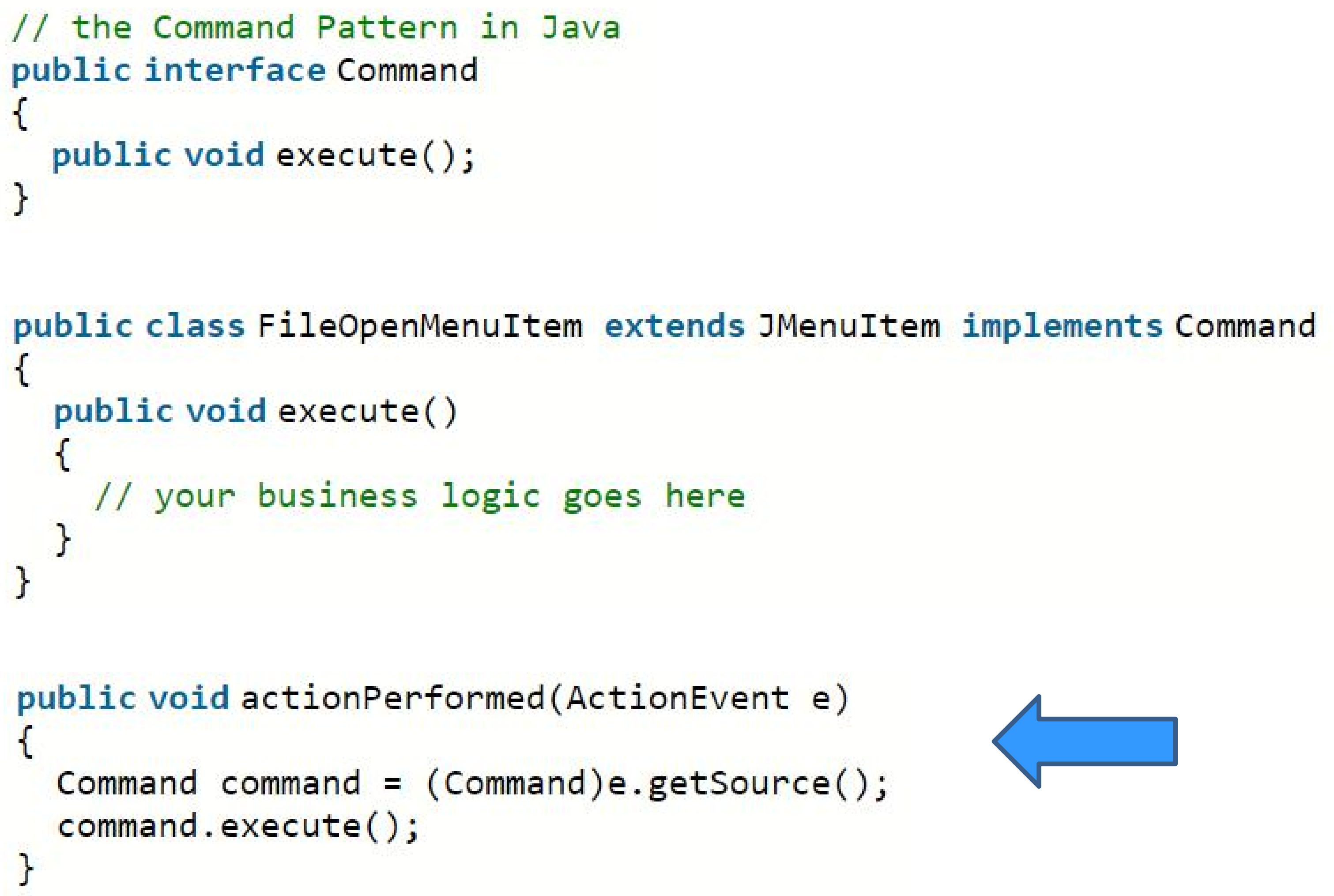


Example Code – Not Using Command Design Pattern

```
public void actionPerformed(ActionEvent e)
{
  Object o = e.getSource();
  if (o instanceof fileNewMenuItem)
      doFileNewAction();
  else if (o instanceof fileOpenMenuItem)
      doFileOpenAction();
  else if (o instanceof fileOpenRecentMenuItem)
      doFileOpenRecentAction();
  else if (o instanceof fileSaveMenuItem)
      doFileSaveAction();
  // and more ...
}
```

http://alvinalexander.com/java/java-command-design-pattern-in-java-examples

Example Code – Using Command Design Pattern



```java
// the Command Pattern in Java
public interface Command
{
  public void execute();
}


public class FileOpenMenuItem extends JMenuItem implements Command
{
  public void execute()
  {
    // your business logic goes here
  }
}


public void actionPerformed(ActionEvent e)
{
  Command command = (Command)e.getSource();
  command.execute();
}
```

http://alvinalexander.com/java/java-command-design-pattern-in-java-examples

Joel on Software

- “In most UI decisions, before you design anything from scratch, you absolutely have to look at what other popular programs are doing and emulate that as closely as possible.”
- “Users don't have the manual, and if they did, they wouldn't read it.”
- “In fact, users can't read anything, and if they could, they wouldn't want to.”

Response times

From *Usability Engineering* by Jakob Nielsen

- 0.1 sec - limit for “instantaneous”
- 1 sec - limit for “doesn’t interrupt flow”
  - Consider progress indicator
- 10 sec - limit for “keeping attention focused on dialog”
  - Consider making it a background task

Evaluating UI

- Must evaluate UI
  - To see how to improve it
  - To see whether it is good enough to be released

UI metrics

- Size of written specification
- Number of user tasks
- Number of actions per task
- Number of system states
- Number of help messages

UI evaluation with users

- Once system has users …
  - Surveys
  - Focus groups
  - Mailing list for support
  - Analyze help desk logs
  - Analyze access logs for web apps

https://www.youtube.com/watch?v=MI92QEqE-RQ

https://www.youtube.com/watch?v=ELYVpikRNEE

Early UI evaluation

- Have people use the system
  - Give them tasks
- Find out what is wrong with it
  - Surveys
  - Direct observation
    - Qualitative - did they seem to be having trouble?
    - Quantitative - measure time for tasks

Very early UI evaluation

- Evaluate paper prototypes
- Evaluation team
  - Person to talk to user
  - Person to record observations
  - Person to play computer
- UI made from paper, plastic (pop up menus), and colored ink

UI evaluation

- Be purposeful
  - Decide on purpose of evaluation
    - “Is this menu confusing?”
    - “Can someone start using the system without reading a manual?”
  - Choose tasks
  - Make goals and measure to see if goals are met

Size of evaluation

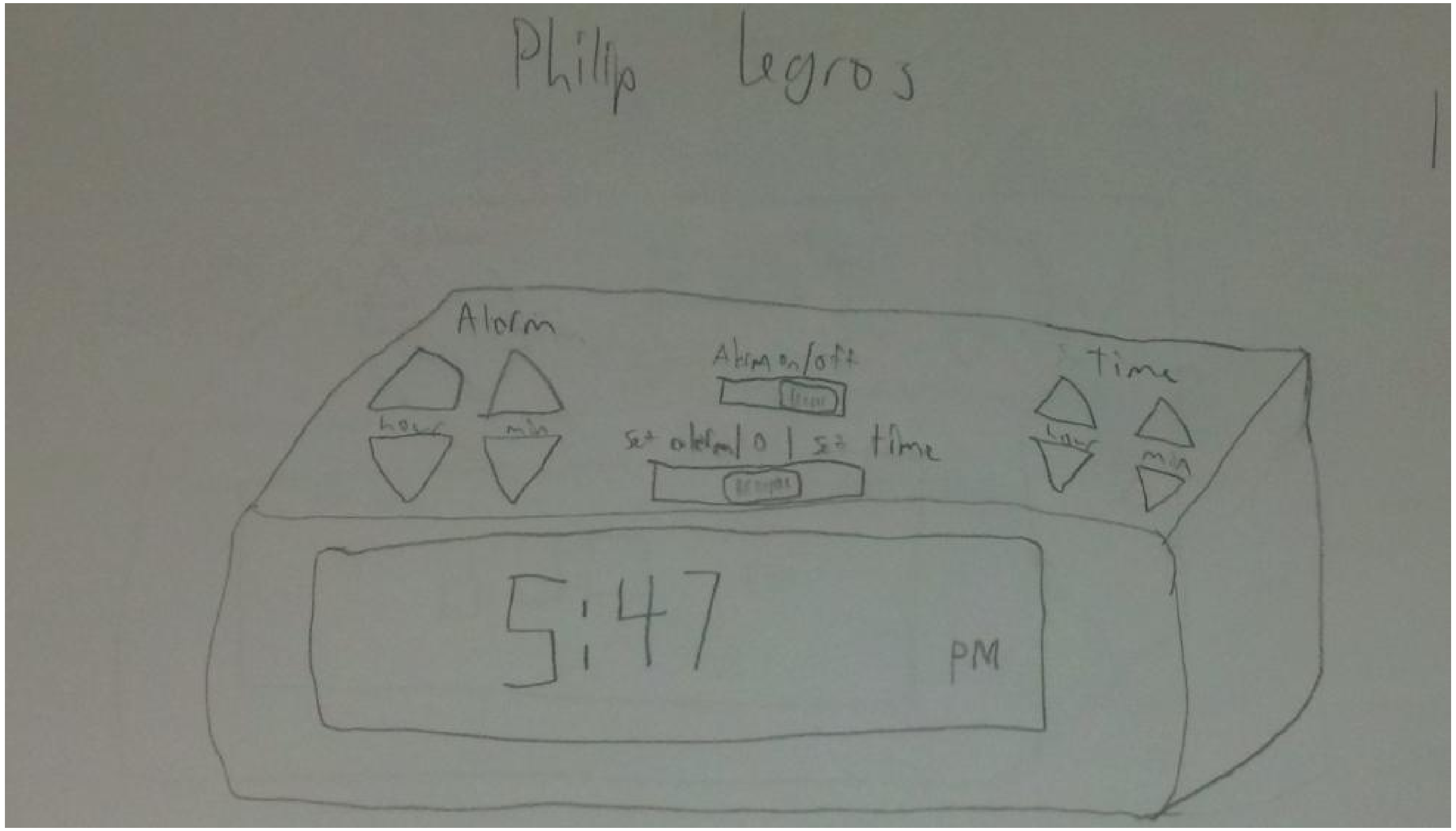
- Statistically valid sample maybe: 20-100
- Most common size: 5

- Purpose is to invent good UI
- Perform evaluations after every iteration

Alarm Clock Prototype - 1

1: Default Clock State

Alarm off, time set to 5:47PM.

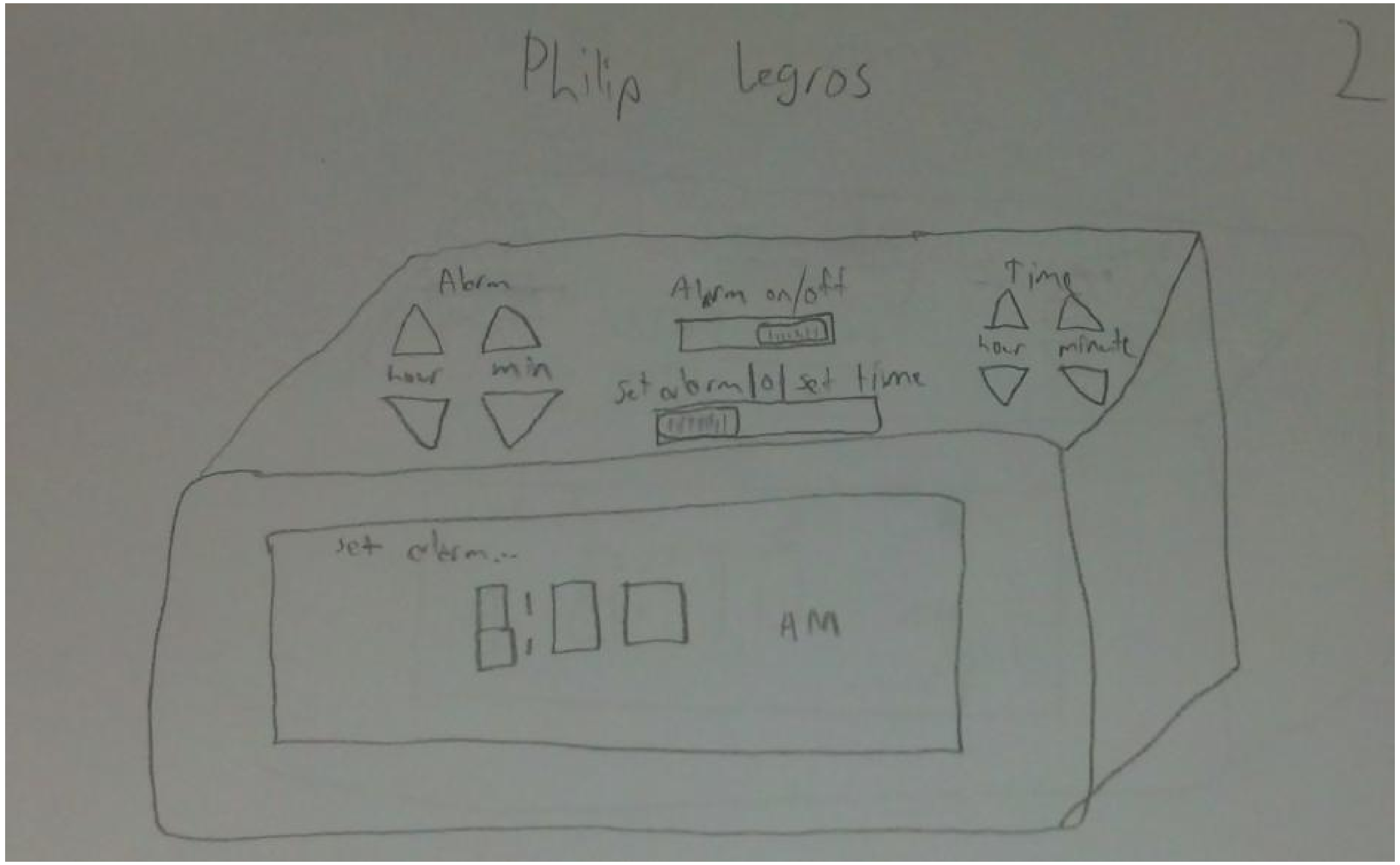


http://www.theforgeconceptual.com/alarm-clock-prototyping

Alarm Clock Prototype - 2

2: Set Alarm

User sets alarm to 8AM.

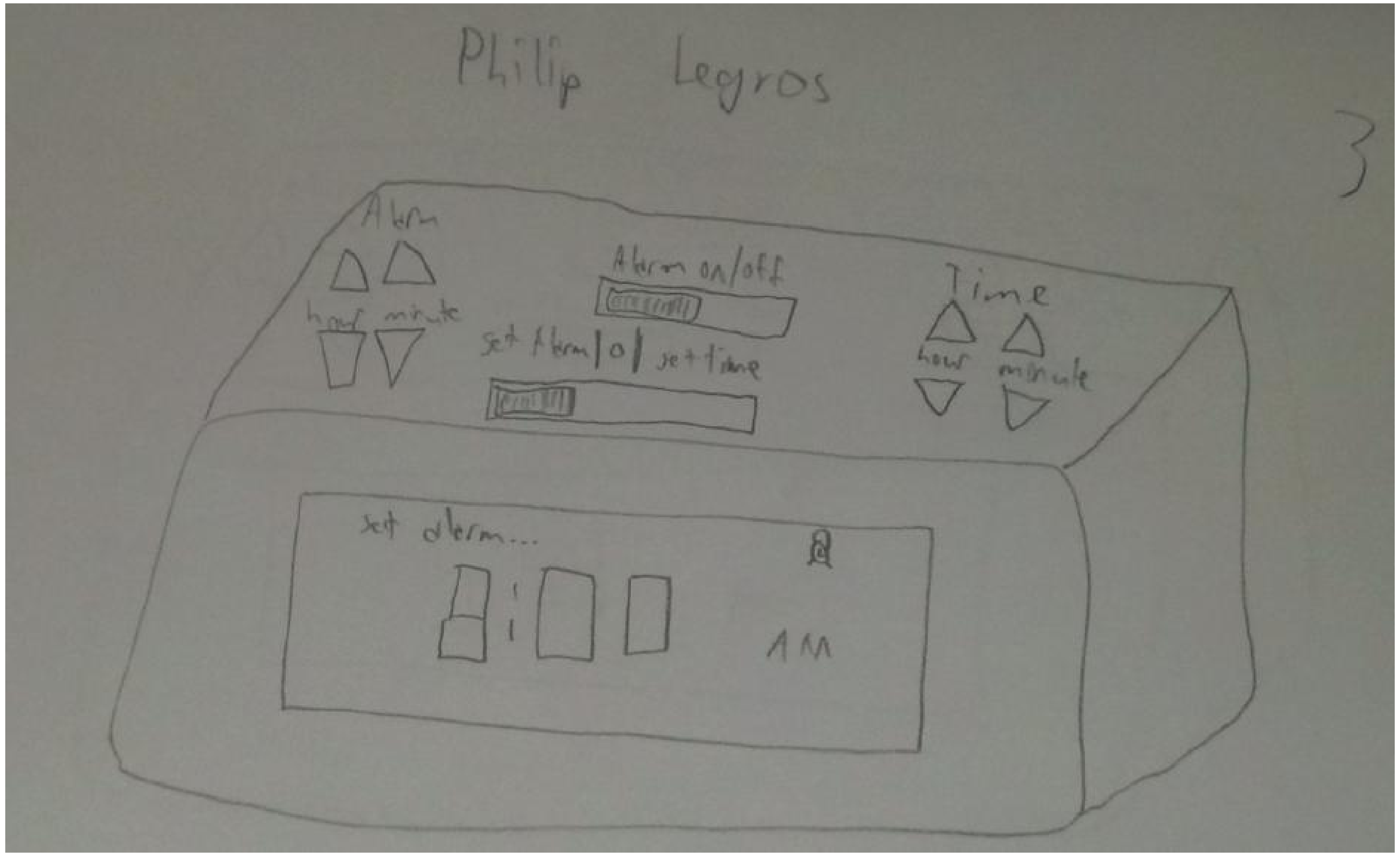


http://www.theforgeconceptual.com/alarm-clock-prototyping

Alarm Clock Prototype - 3

3: Activate Alarm

User turns on the alarm.

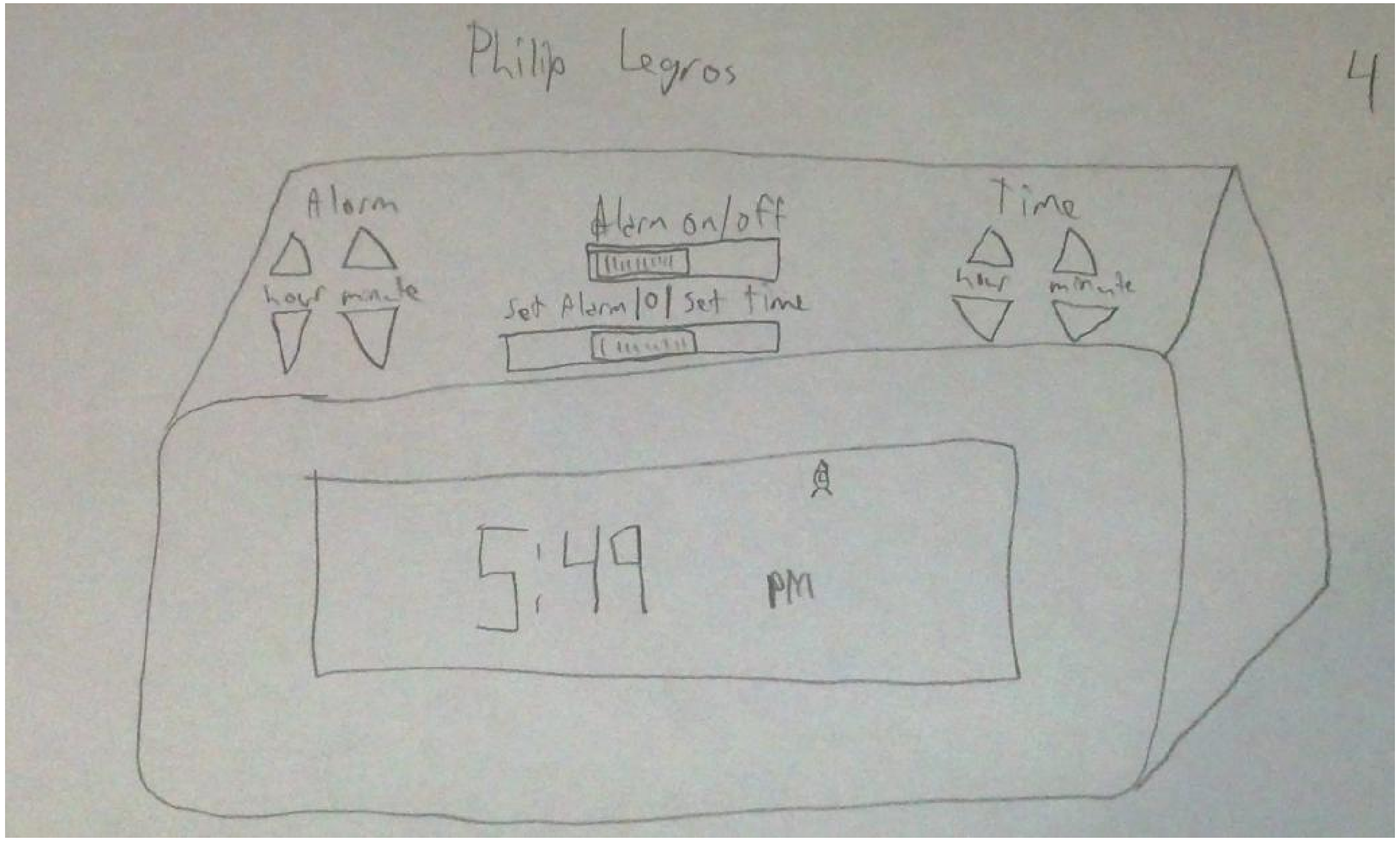


http://www.theforgeconceptual.com/alarm-clock-prototyping

Alarm Clock Prototype - 4

4: Return to Display

User returns to current time mode.



http://www.theforgeconceptual.com/alarm-clock-prototyping

Group Exercise: Paper Prototyping

- Get into group of 2 students
  - or 3 if you there are an odd number of students in the lecture
- **Make a low-fidelity UI prototype of an alarm clock smartphone app OR part of your own project (6 mins)**
  - Each of you should draw your own alarm clock at the same time; don't discuss it with your partner yet
- **Then simulate your prototype (4 mins)**, acting as the phone, while your partner acts as user. Use these tasks:
  - Is the alarm set to wake me up at 9am?
  - Suppose not; set the alarm to wake me up at 9am
  - Set the current time one hour backward for a daylight savings time switch
- Then switch roles, so that the other person acts as the phone simulating their own prototype on you

Microsoft Customer Experience Improvement Program (CEIP)

- Multiple channels for user feedback
  - Usability test, surveys, focus groups & other field studies
  - Limited customer base
- CEIP
  - Providing all customers with ability to contribute to the design and development of Microsoft products
  - Voluntary participation
  - Anonymous

CEIP data

- ☐ Usage
  - How software is used
  - Examples: general feature usage, commands on Ribbon, actions taken in wizards, etc.
- ☐ Reliability and performance
  - Whether software performs as expected
  - Examples: assertions for logical inconsistency, measuring execution speed, etc.
- ☐ Hardware/software configuration
  - Providing context for data interpretation
  - Example: long document loading time only on machines with low RAM or a particular processor speed?

Questions answered by usage data

- Command usage
  - How frequently is it used? *[Prominence on UI]*
  - How many people use it? *[Impact]*
  - What is the most frequent way of accessing it? *[Ease of access]*
  - Does this command occur as part of a clear workflow? *[Better support]*
- Feature usage
  - How many files contain a Table? *[Impact]*
  - How big is the average Table? *[Optimization choice]*
  - What are the most frequently used Table styles? *[Design choices]*
  - What other features are used in files containing Tables? *[interaction with other features]*

Design alternatives

- Novice users
  - Menus
  - Make it look like something else
  - Simple
- Expert users
  - Commands
  - Specialize to make users efficient
  - Powerful

Design alternatives

- ☐Standard IO vs. new IO
- ☐Existing metaphors/idioms vs. new metaphors/idioms
- ☐Narrow market vs. broad market

Implementation concerns

- Simplicity
- Safety
- Use standard libraries/toolkits
- Separate UI from application
    - Model-View-Controller (MVC)
    - Three-tier: presentation, application, data

1. Simplicity

- Tradeoff between number of features and simplicity
- Don't compromise usability for function
- A well-designed interface fades into the background
- Basic functions should be obvious
- Advanced functions can be hidden

Make controls obvious & intuitive

- Is the trash-can obvious and intuitive?
- Are tabbed dialog boxes obvious and intuitive?
- Is a mouse obvious and intuitive?

2. Safety

- Make actions predictable and reversible
- Each action does one thing
- Effects are visible
  - User should be able to tell whether operation has been performed
- Undo

3. Use standard libraries

- Don’t build your own!
  - If necessary, add to it, but try to use standard parts instead of building your own
- Provide familiar controls
- Provide consistency
- Reduce cost of implementation
- Library designers probably better UI designers than you are

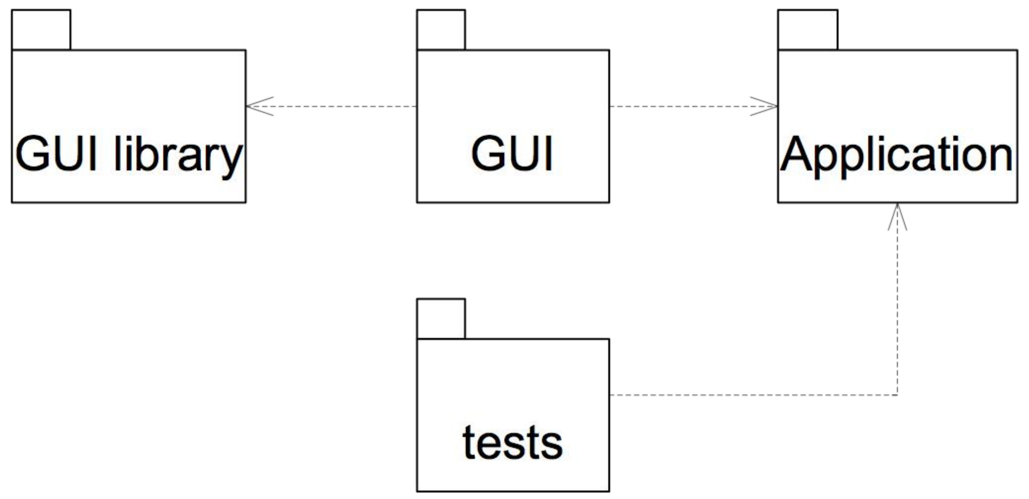
When to build your own

- ☐You are a platform provider or
- ☐You have special needs and a lot of money and

- ☐You are not in a hurry and
- ☐You know what you are doing

4. Separate UI and application

- UI and application change independently
- UI and application built by different people



UI in Web: ASP/JSP/Rails…

- Embed code in your HTML
  - VB code in ASP, Java code in JSP, Ruby code in Rails…
- Can call other code
- Need to decide on how much code goes in the web page, and how much goes outside

Separate UI from application

- HTML is UI
- Put as little code on web page as possible
- Web page has just enough code to call the actual application logic

Benefits

- Write automatic tests for application objects, not for UI
- People who write HTML don’t need to know how to program well
- Programmers don’t need to be good UI designers

Downside

- Application objects generate HTML
  - But you can make standard set of “adapters” and so don’t have to duplicate code
  - Lists, radio buttons, etc.
- Code tends to creep into web pages
  - Refactor
  - Review

Results

- Easier to test
  - Automatic tests for application objects
  - Test GUI manually or with automatic “smoke tests” or use something like Selenium
- Easier to change
  - Can change “business rule” independently of GUI
  - Can add web interface, speech interface, etc.

One issue: selecting colors

- Leave it to a graphic designer
- Use system colors (actually pull them from config)
- Use the company/university colors
- Use a color palette generator

Summary

- UI design is hard
  - Must understand users
  - Must understand problems
  - Must understand technology
  - Must understand how to evaluate
- UI design is important
  - UI is what the users see
  - UI can “make it or break it” for software