Sketching and Prototyping

SWE 632
Spring 2022

Administrivia

- HW2 due today
- HW3 due next week
- Midterm exam in 2 weeks (midterm review next week)
  - Covers all lectures & readings before exam
- 3 tech talks today

Iterative Model of User-Centered Design

Observation

(Re)Define the Problem

Understand User Needs

Test

Evaluate what
you have built

Idea Generation

Brainstorm
what to build

Prototype

Build

Iterative Model of User-Centered Design

Idea Generation

Brainstorm
what to build

Prototype

Build

Sketching & Storyboards

Based on slides by Bonnie John and Jennifer Mankoff

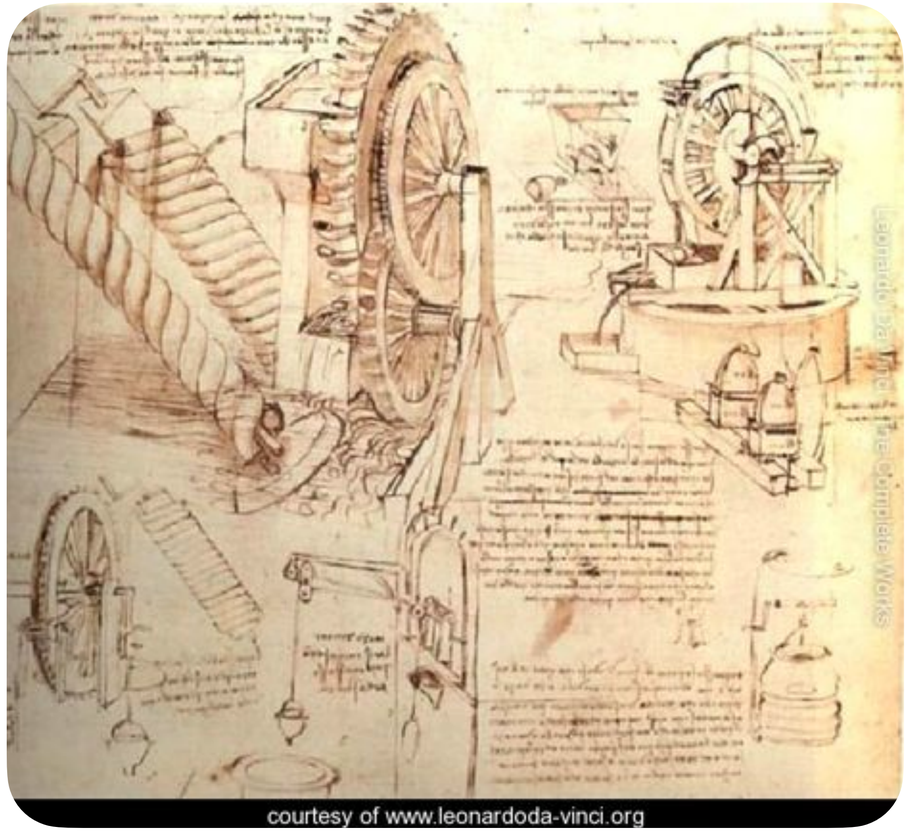
How do You Brainstorm?

What is a Sketch?

"A conversation between the sketcher or designer and the artifact"

Why Sketch?

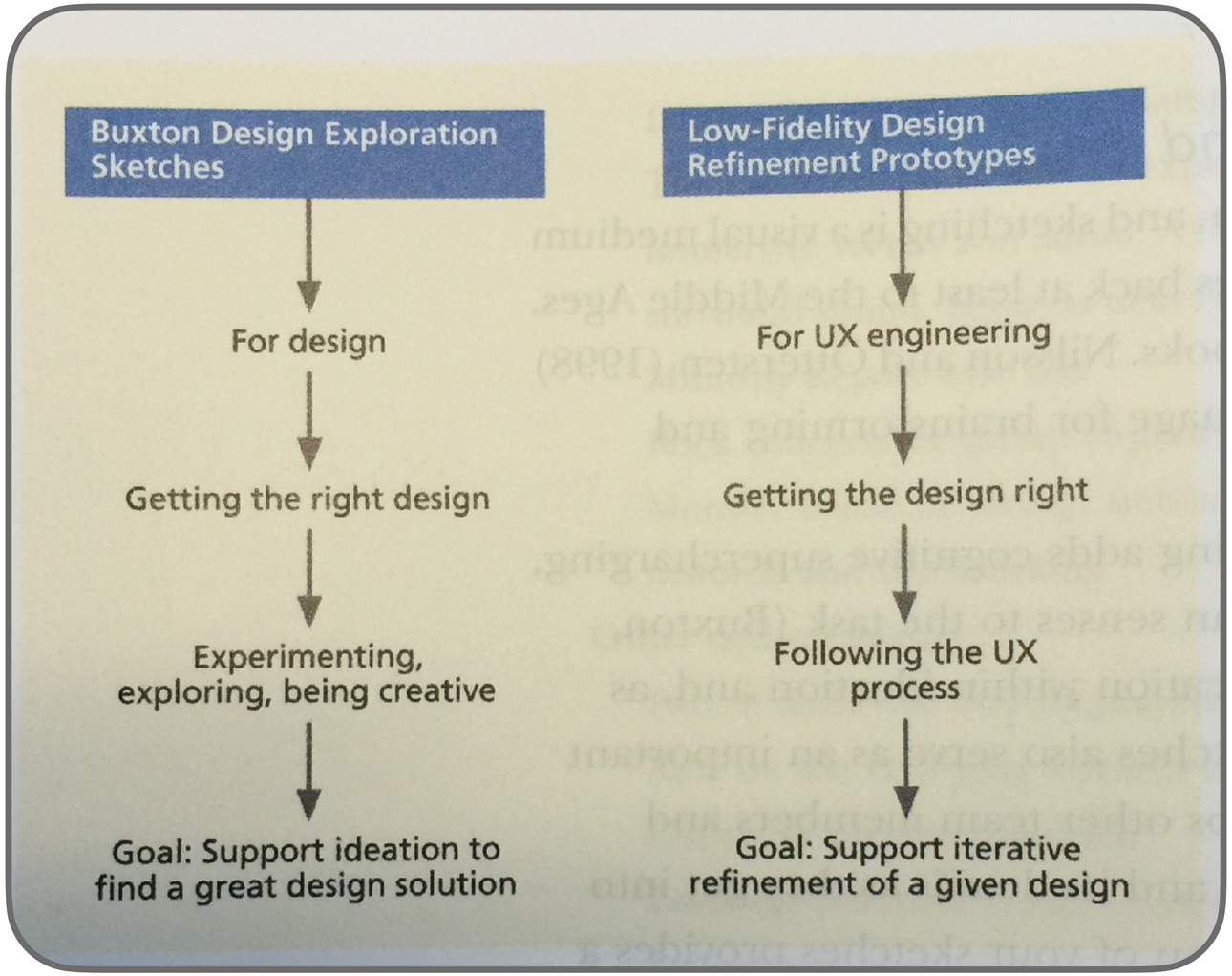
- Sketching offers ***visual*** medium for exploration, offering cognitive scaffolding to externalize cognition



Being Creative with Sketches

- How do you come up with a great idea?
  - Generate lots of ideas
  - Work through ideas through externalization in sketch
  - Critique the ideas
  - Refine them to make them better
- Sketching offers a low-cost medium for working with early ideas ***before*** committing to one
- Design is process of creation & ***exploration***

Sketching vs. Prototyping



Physical Sketches

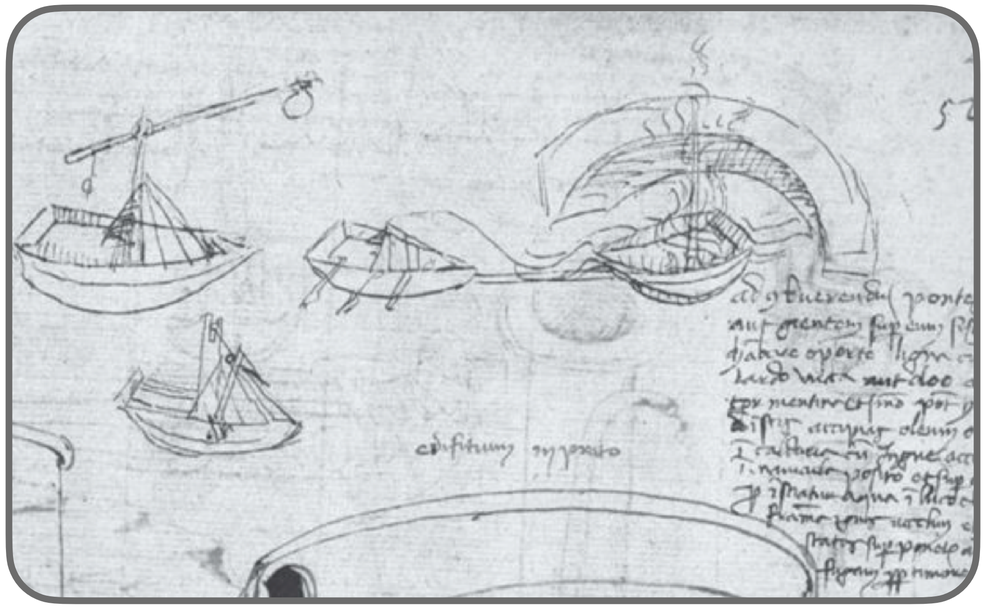
- Production tools for sketching:
  - whiteboards, blackboards, cork boards, flip chart easels
  - post it notes
  - duct tape, scotch tape, push pins, staples
  - marking pens, crayons, spray paint
  - scissors, hobby knives, foam core board
  - duct tape
  - bits of cloth, rubber

The Space Remembers

- Covering walls, whiteboards, etc. w/ materials is extremely useful
- Provides fast access for revisiting and remixing old ideas
- Facilitates group discussion of designs

Sketches are Sketchy

- Not mechanically correct and perfectly straight lines
- ***Freehand***, open gestures
- Strokes may miss connections
- Resolution & detail **low** enough to suggest is concept
- Deliberately ***ambiguous*** & abstract, leaving “holes” for imagination

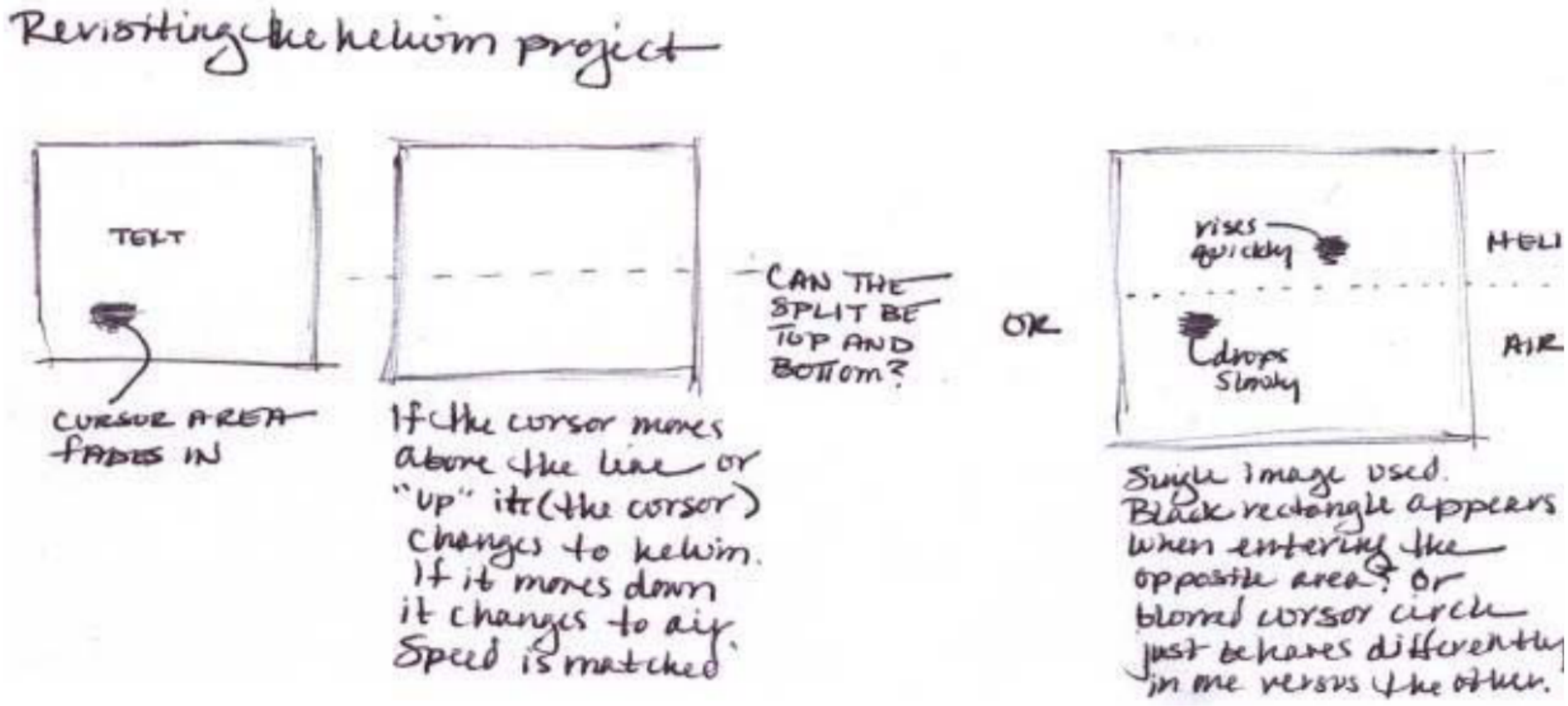


Rules for Sketching

- ***Everyone*** can sketch; you do not have to be artistic
- Most ideas conveyed more effectively with sketch than words.
- Sketches are ***quick*** and inexpensive to create; do not inhibit early exploration
- Sketches are ***disposable***; no investment in sketch itself
- Sketches are ***timely***; made in-the-moment, just-in-time
- Sketches are ***plentiful***; entertain large # of ideas w/ multiple sketches of each

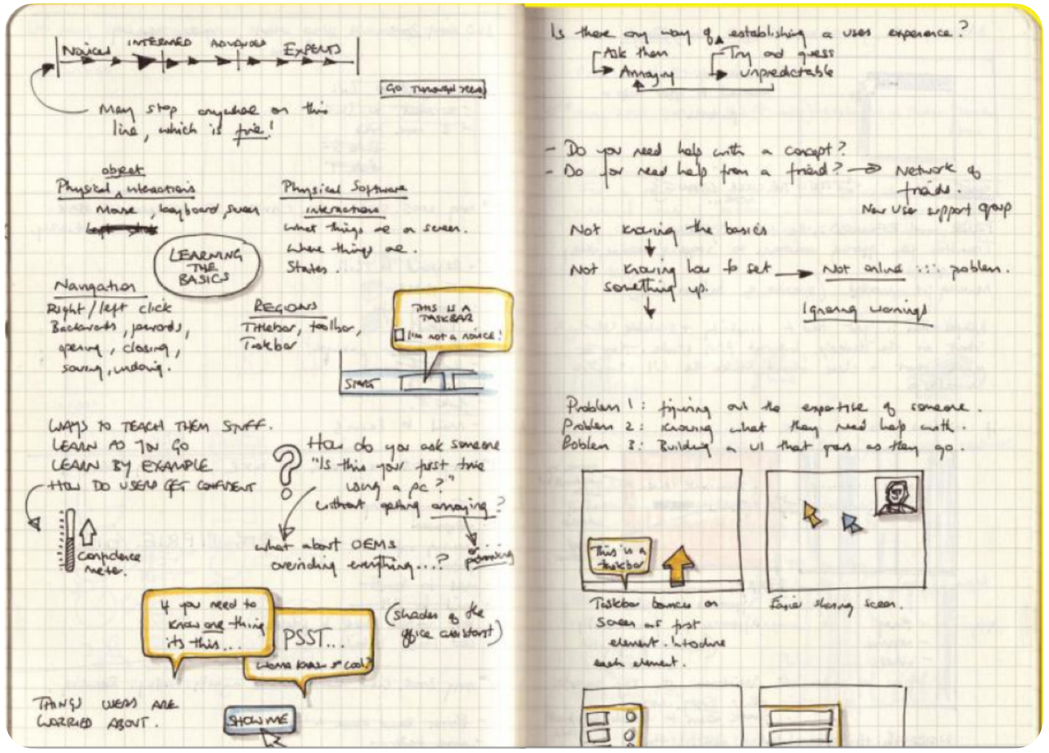
Sketches Include Annotations

- Annotations explain what is going on in each part of sketch & how

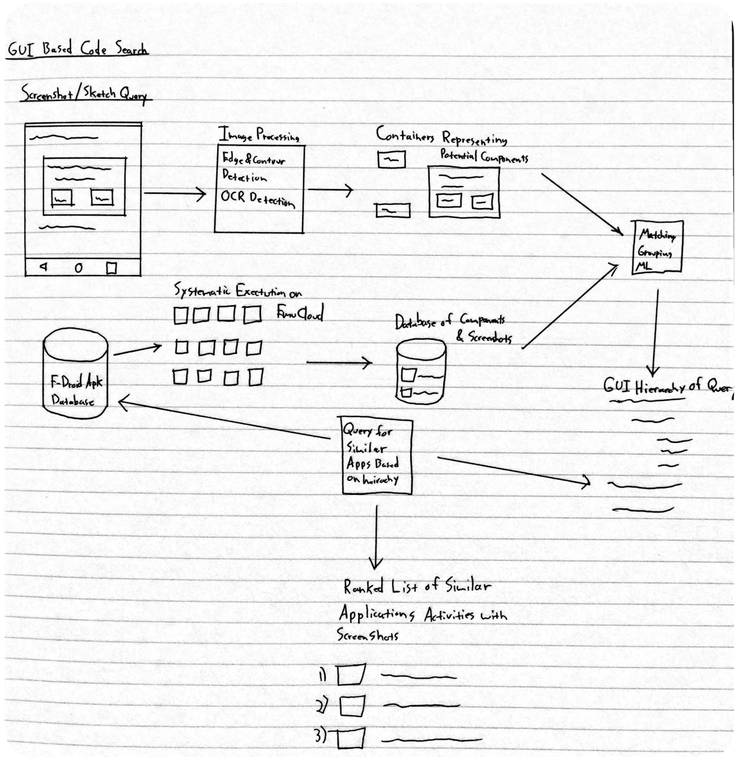


Myers et al. (2008). How Designers Design and Program Interactive Behaviors. VL/HCC 2008.

Sketches part of design exploration

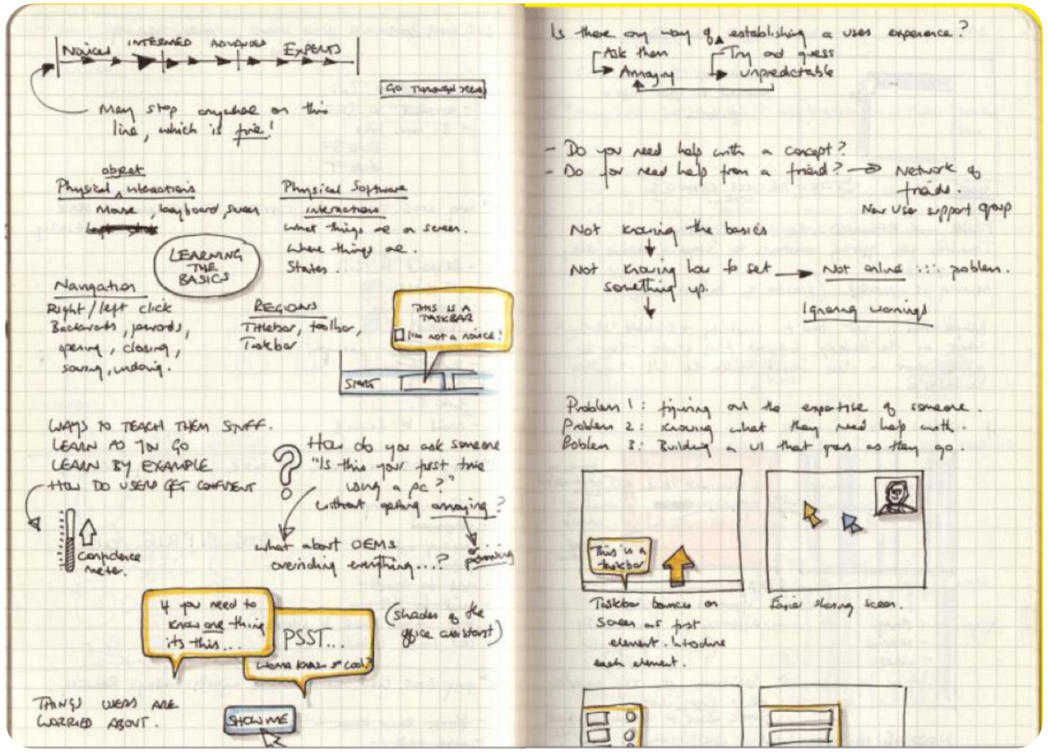


B. Buxton. Sketching User Experiences.



K. Moran, ReDraw Project Sketch

Sketches part of design exploration



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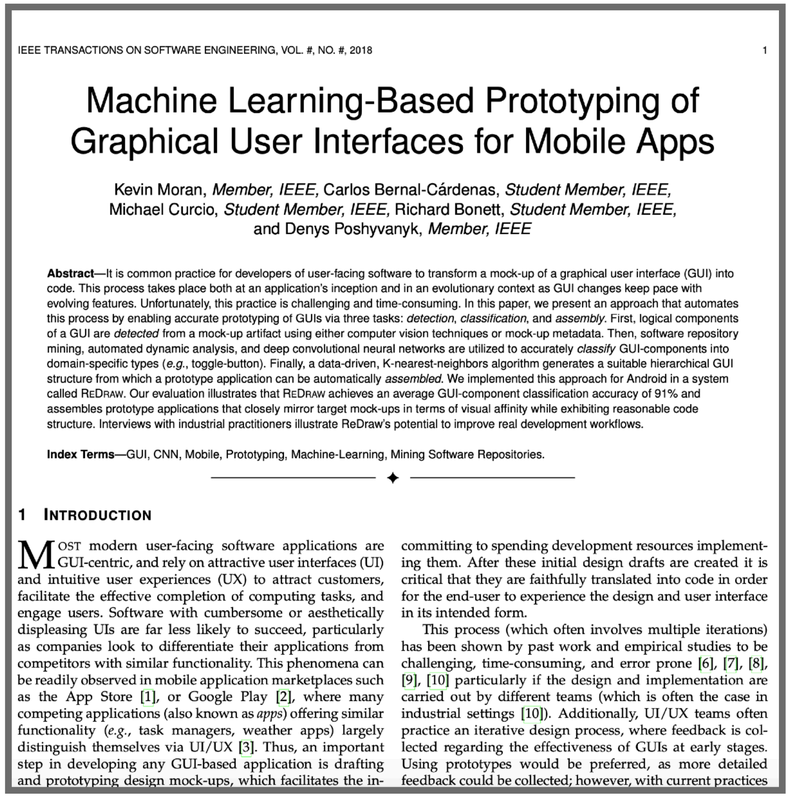


IEEE TRANSACTIONS ON SOFTWARE ENGINEERING, VOL. #, NO. #, 2018 1

Machine Learning-Based Prototyping of Graphical User Interfaces for Mobile Apps

Kevin Moran, *Member, IEEE*, Carlos Bernal-Cárdenas, *Student Member, IEEE*, Michael Curcio, *Student Member, IEEE*, Richard Bonett, *Student Member, IEEE*, and Denys Poshyvanyk, *Member, IEEE*

Abstract—It is common practice for developers of user-facing software to transform a mock-up of a graphical user interface (GUI) into code. This process takes place both at an application's inception and in an evolutionary context as GUI changes keep pace with evolving features. Unfortunately, this practice is challenging and time-consuming. In this paper, we present an approach that automates this process by enabling accurate prototyping of GUIs via three tasks: *detection*, *classification*, and *assembly*. First, logical components of a GUI are *detected* from a mock-up artifact using either computer vision techniques or mock-up metadata. Then, software repository mining, automated dynamic analysis, and deep convolutional neural networks are utilized to accurately *classify* GUI-components into domain-specific types (*e.g.*, toggle-button). Finally, a data-driven, K-nearest-neighbors algorithm generates a suitable hierarchical GUI structure from which a prototype application can be automatically *assembled*. We implemented this approach for Android in a system called REDRAW. Our evaluation illustrates that REDRAW achieves an average GUI-component classification accuracy of 91% and assembles prototype applications that closely mirror target mock-ups in terms of visual affinity while exhibiting reasonable code structure. Interviews with industrial practitioners illustrate ReDraw's potential to improve real development workflows.

Index Terms—GUI, CNN, Mobile, Prototyping, Machine-Learning, Mining Software Repositories.

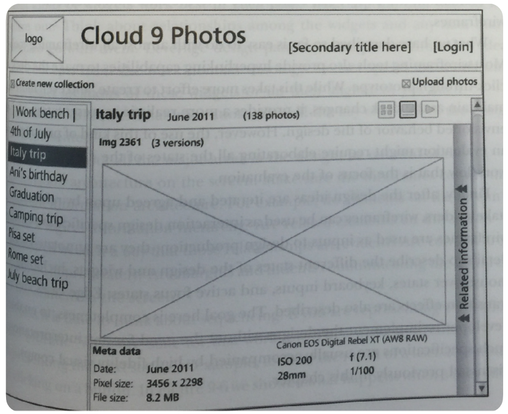
1 INTRODUCTION

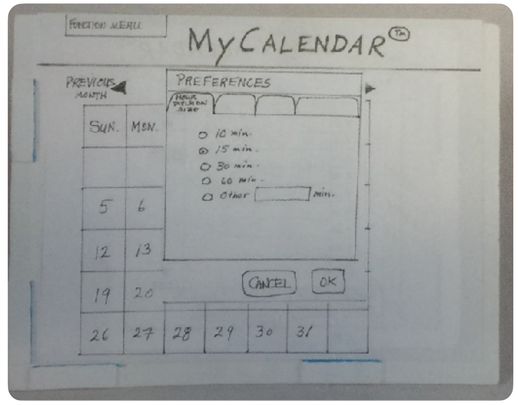
MOST modern user-facing software applications are GUI-centric, and rely on attractive user interfaces (UI) and intuitive user experiences (UX) to attract customers, facilitate the effective completion of computing tasks, and engage users. Software with cumbersome or aesthetically displeasing UIs are far less likely to succeed, particularly as companies look to differentiate their applications from competitors with similar functionality. This phenomena can be readily observed in mobile application marketplaces such as the App Store [1], or Google Play [2], where many competing applications (also known as *apps*) offering similar functionality (*e.g.*, task managers, weather apps) largely distinguish themselves via UI/UX [3]. Thus, an important step in developing any GUI-based application is drafting and prototyping design mock-ups, which facilitates the in-committing to spending development resources implementing them. After these initial design drafts are created it is critical that they are faithfully translated into code in order for the end-user to experience the design and user interface in its intended form.

This process (which often involves multiple iterations) has been shown by past work and empirical studies to be challenging, time-consuming, and error prone [6], [7], [8], [9], [10] particularly if the design and implementation are carried out by different teams (which is often the case in industrial settings [10]). Additionally, UI/UX teams often practice an iterative design process, where feedback is collected regarding the effectiveness of GUIs at early stages. Using prototypes would be preferred, as more detailed feedback could be collected; however, with current practices

K. Moran, ReDraw Project Sketch

Fidelity of Sketches & Mockups





Storyboard — Wireframe — Prototype

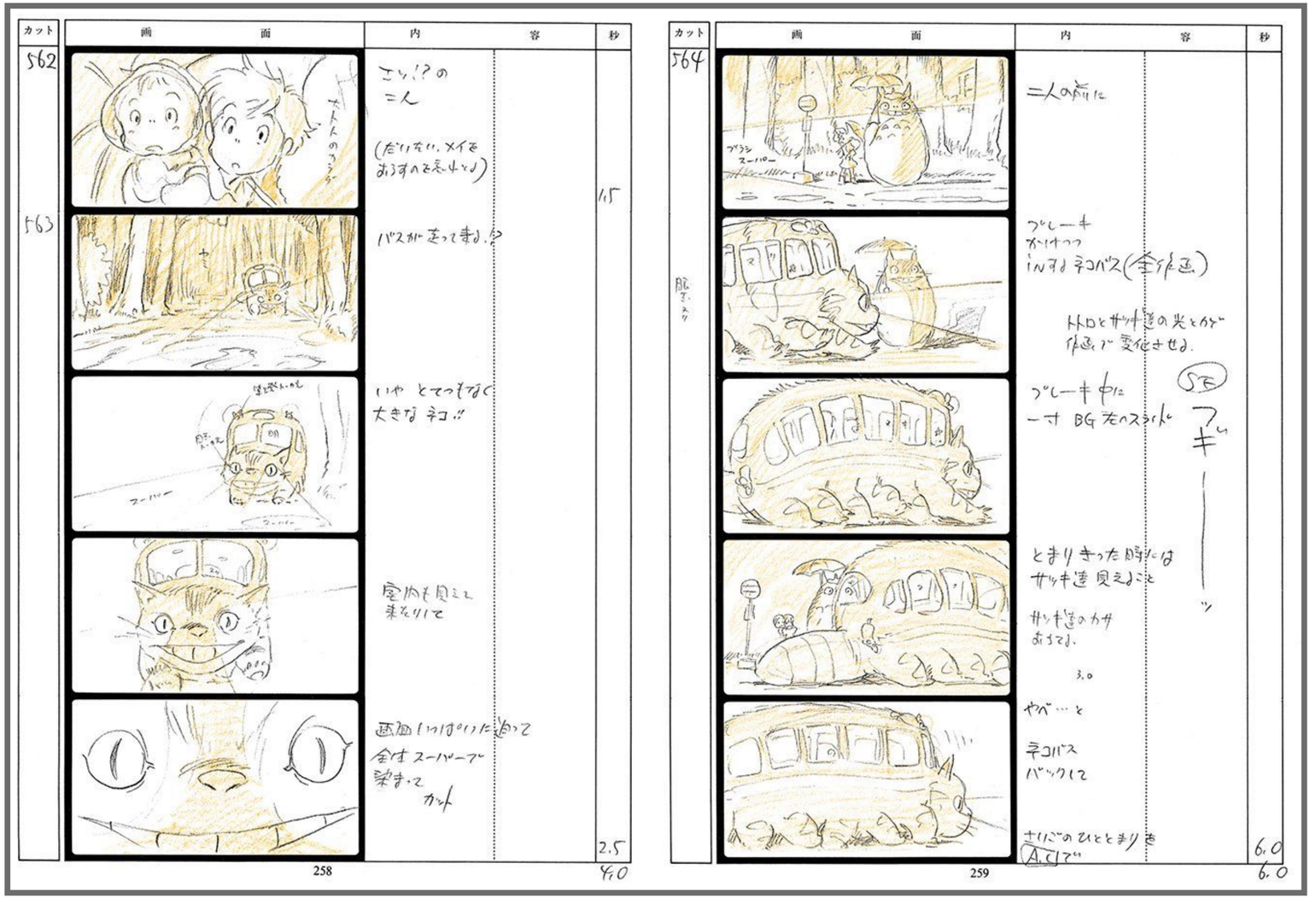
low ← Fidelity → high

(many details left unspecified)

(more polished & detailed)

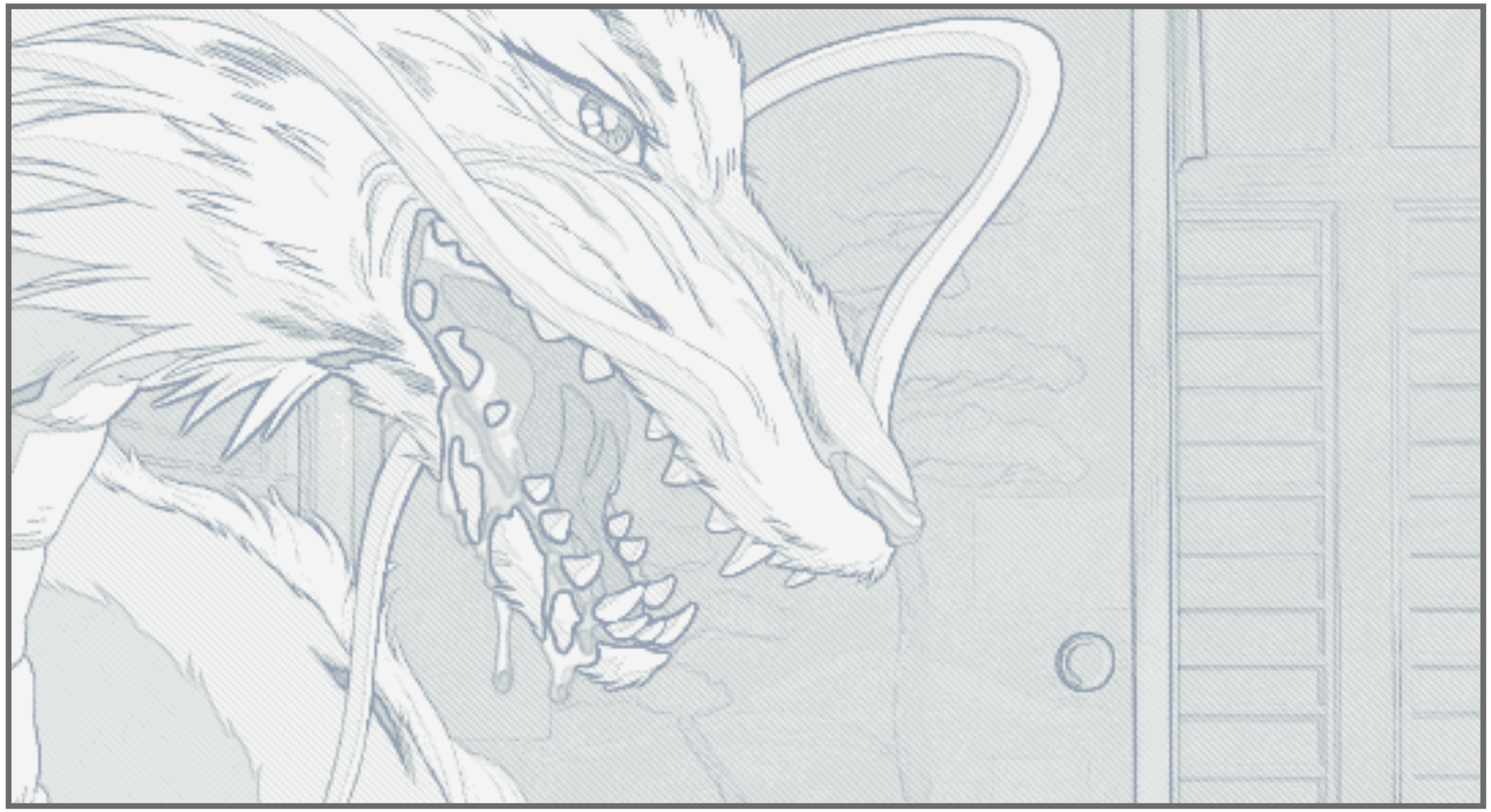
Storyboards

Classic StoryBoards



Storyboard from Studio Ghibli: *“My Neighbor Totoro”*

Classic Storyboards



Credit Studio Ghibli: *“Spirited Away”*

Storyboards for UI Design

- Sequence of visual “frames” illustrating ***interplay*** between user & envisioned system
- Explains how app fits into a larger ***context*** through a single scenario / story
- Bring design to ***life*** in graphical clips - freeze frame sketches of user interactions
- “Comic-book” style ***illustration*** of a scenario, with actors, screens, interaction, & dialog

Crafting a Storyboard

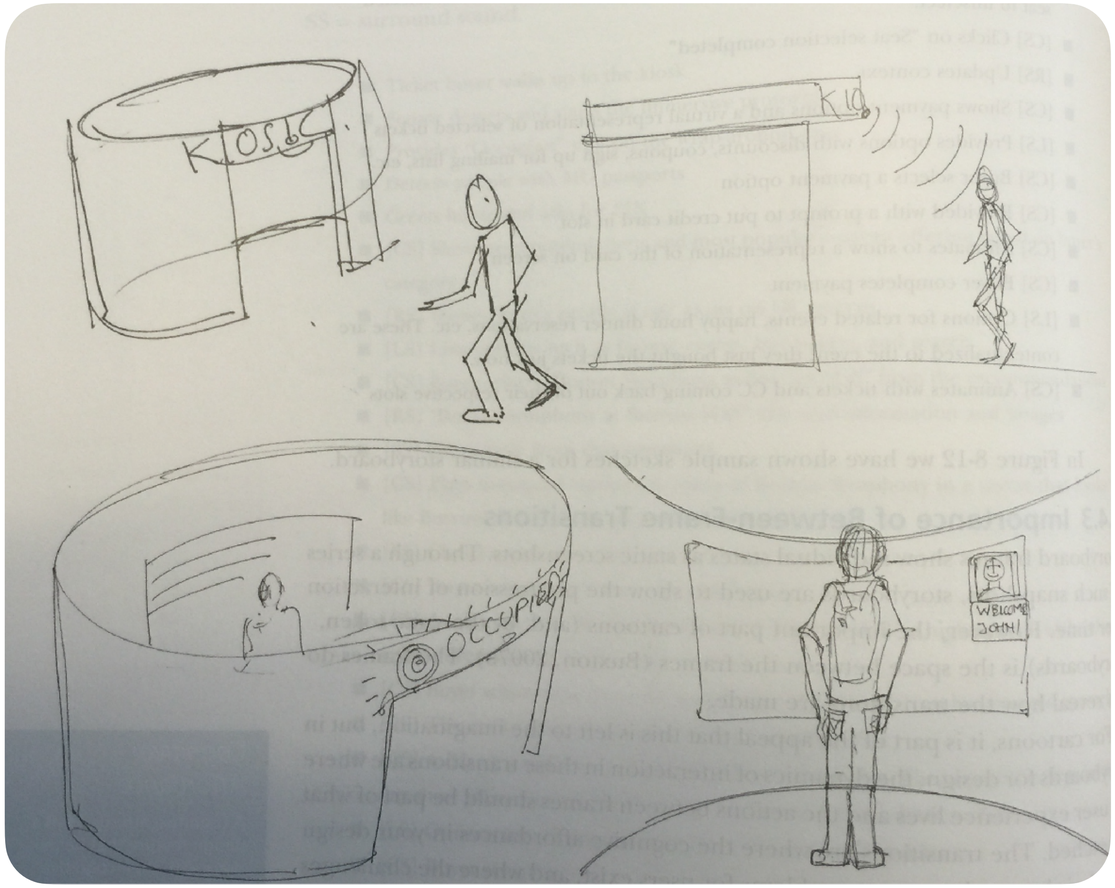
- Set the stage:
  - Who? What Where? Why? When?
- Show key interactions with application
- Show consequences of taking actions
- May also think about errors

Example Elements of a UI Storyboard

- Hand-sketched pictures annotated with a few words
- Sketch of user activity before or after interacting w/ system
- Sketches of devices & screens
- Connections with system (e.g., database connection)
- Physical user actions
- Cognitive user action in “thought balloons”

Example: Ticket Kiosk

Ticket buyer walks up to the kiosk



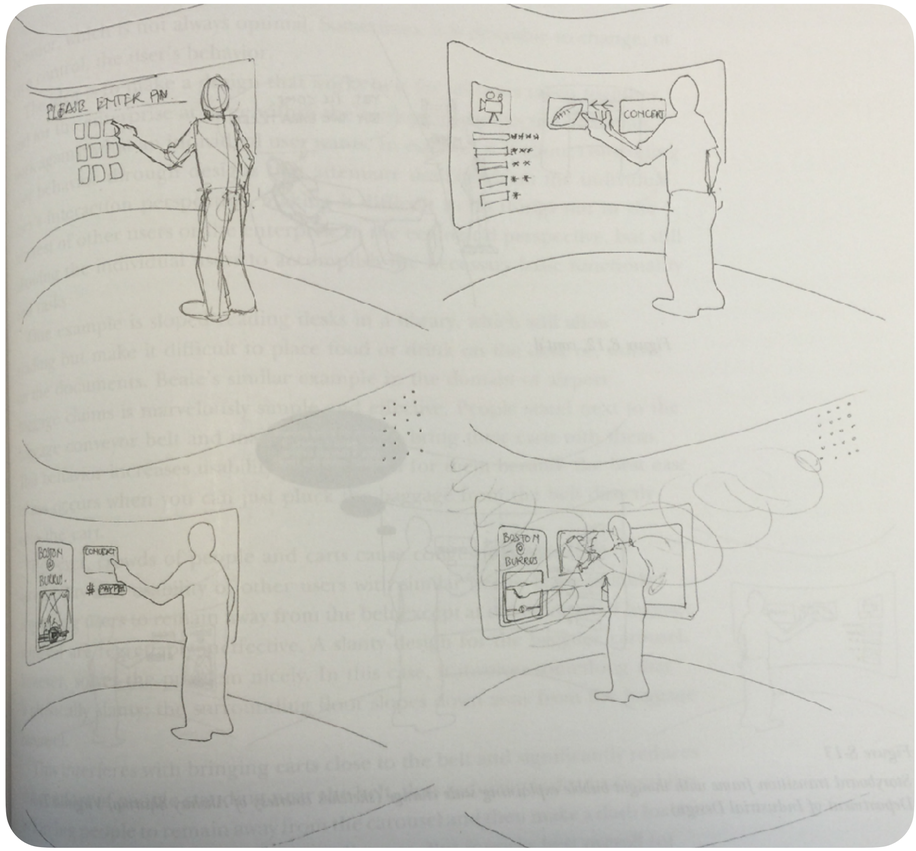
Sensor detects user & starts immersive process

Displays “Occupied” sign on wraparound case

Detects people with ID card

Example: Ticket Kiosk

Greets buyer and asks for PIN



Shows recommendations & most popular categories

Buyer selects “Boston symphony at Burruss Hall”

Plays music from symphony, shows date & time picker

Frame Transitions

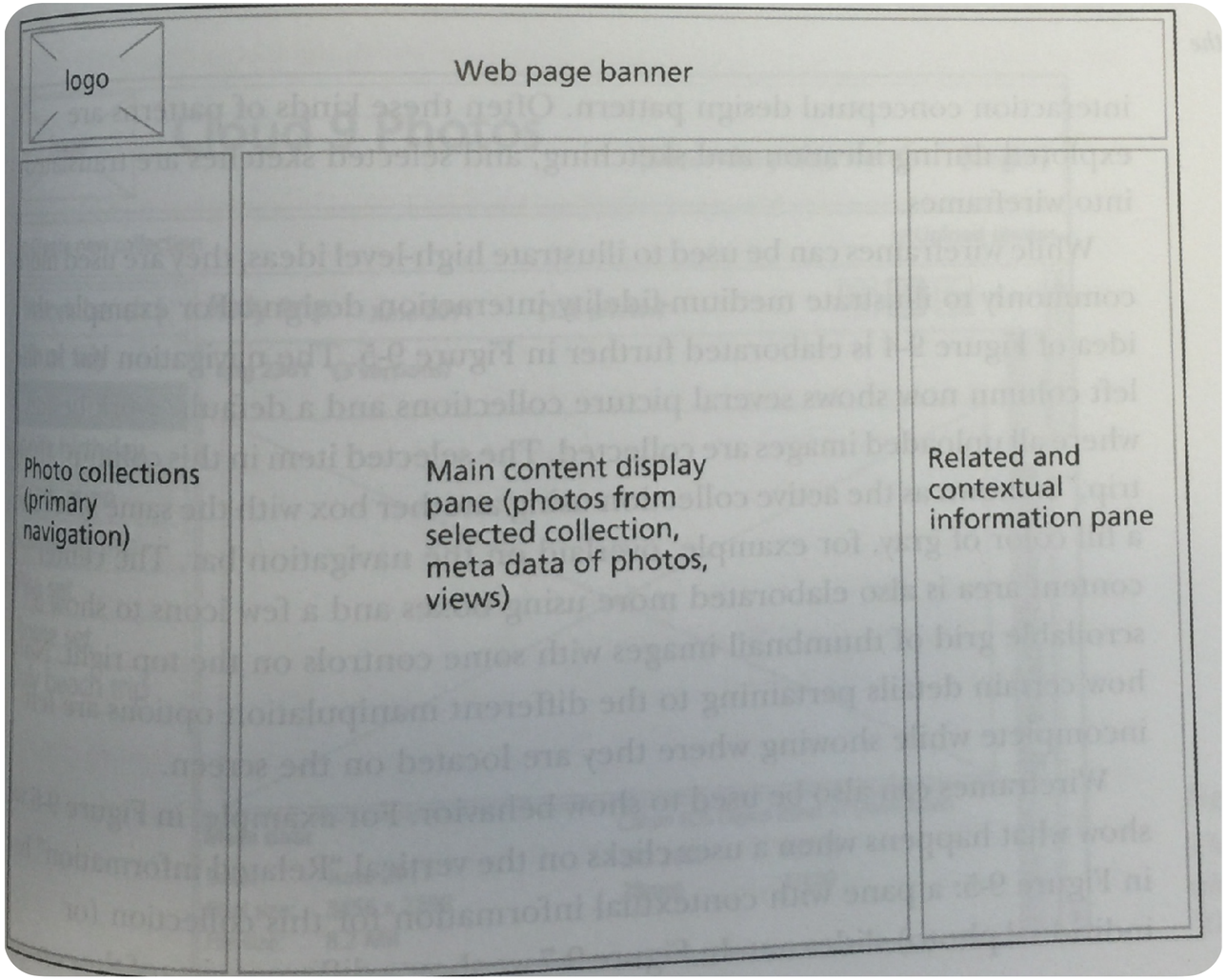
- Transitions between frames particularly important
- What users think, how users choose actions
- Many problems can occur here (e.g., gulfs of execution & evaluation) - we will talk more in a future class!
- Useful to think about how these work, can add thought bubbles to describe

Wireframes & Design Critiques

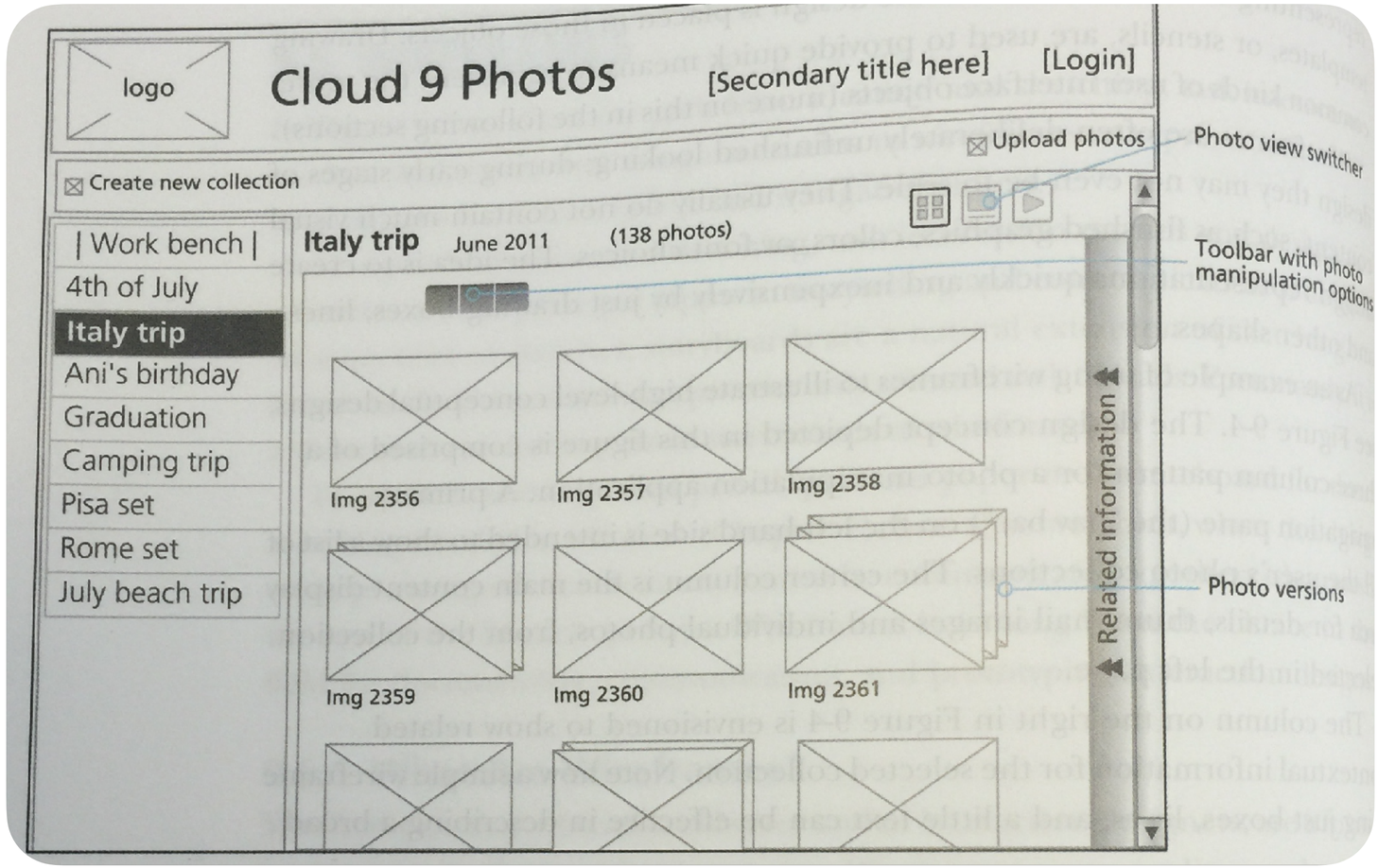
Wireframes

- Lines & outlines (“wireframes”) of boxes & other shapes
- Capturing emerging interaction designs
- Schematic designs to define screen content & visual flow
- Illustrate approximate visual layout, behavior, transitions emerging from task flows
- Deliberate unfinished: do not contain finished graphics, colors, or fonts

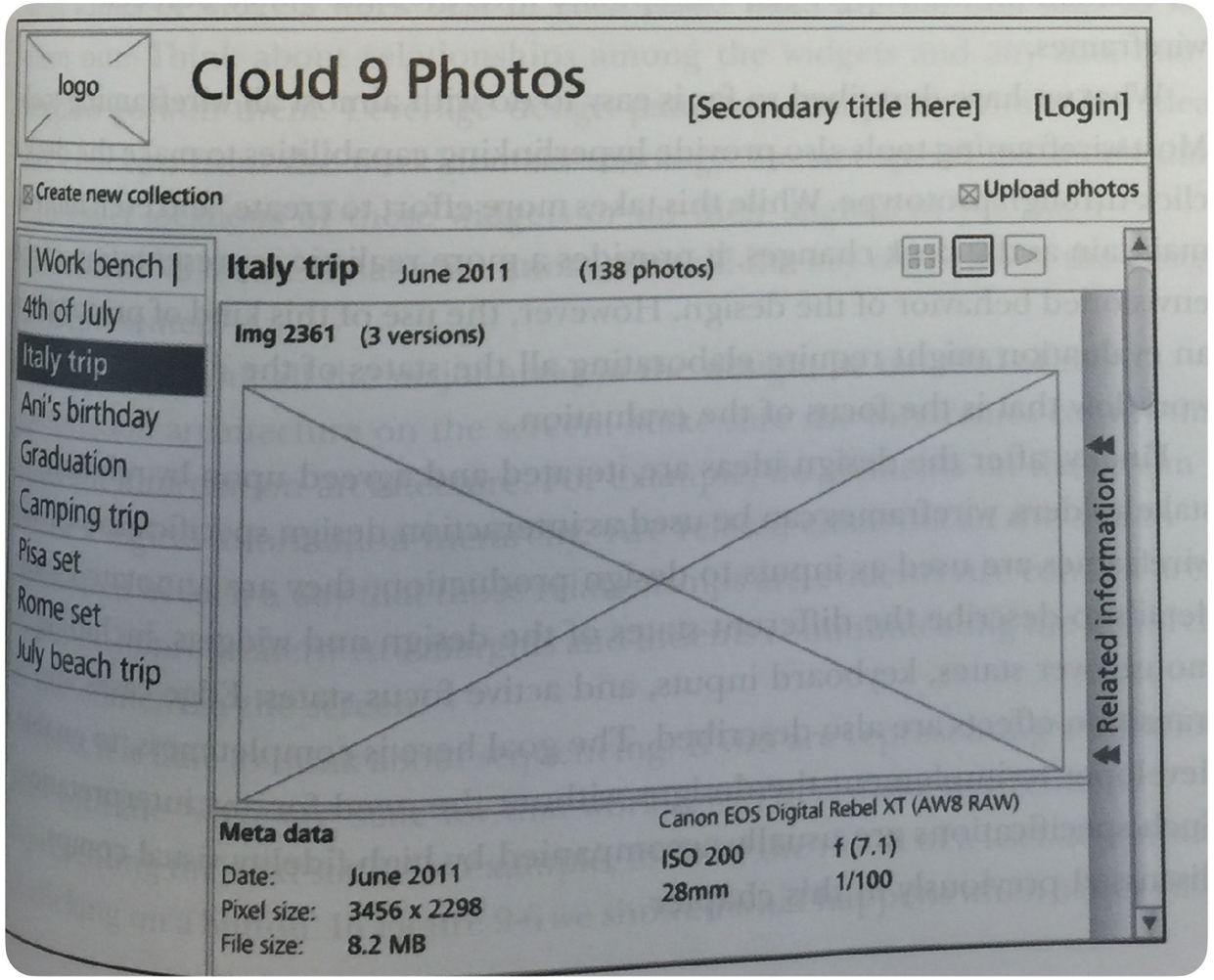
Example


logo
Web page banner
Photo collections (primary navigation)
Main content display pane (photos from selected collection, meta data of photos, views)
Related and contextual information pane

Example


logo
Cloud 9 Photos
[Secondary title here]
[Login]
Upload photos
Create new collection
Photo view switcher
| Work bench |
4th of July
Italy trip
Ani's birthday
Graduation
Camping trip
Pisa set
Rome set
July beach trip
Italy trip
June 2011
(138 photos)
Toolbar with photo manipulation options
Related information
Img 2356
Img 2357
Img 2358
Img 2359
Img 2360
Img 2361
Photo versions

Example


logo
Cloud 9 Photos
[Secondary title here]
[Login]
Create new collection
Upload photos
| Work bench |
4th of July
Italy trip
Ani's birthday
Graduation
Camping trip
Pisa set
Rome set
July beach trip
Italy trip
June 2011
(138 photos)
Img 2361
(3 versions)
Related information
Meta data
Date:
June 2011
Pixel size:
3456 x 2298
File size:
8.2 MB
Canon EOS Digital Rebel XT (AW8 RAW)
ISO 200
f (7.1)
28mm
1/100

Wireframes

- Can be used to step through a particular scenario
- Focus on key screens rather than every screen
- Tools can help
  - Can be made clickable
  - Can use stencils & templates; copy & edit similar screens

Creating a Wireframe - (1)

- What are the key interactions needed to support design?
- What widgets support these interactions?
- What are the best ways to lay them out?
- How do these relate to conceptual design & user’s mental model?

Creating a Wireframe - (2)

- What are all of the items: toolbars, scrollbars, windows, …?
- Are there too many widgets on the screen?
- What happens when data is larger than available space? Will entire page scroll, or individual panel?
- How much detail of items to show?

Design Critiques

- Stylized meeting for getting feedback on design sketches & prototypes
- Solicit feedback from peers
- History: studio art education

http://www.flickr.com/photos/pjchmiel/2972140234/

Designer: Frame the Discussion

- State ***explicitly***: What would you like comments on?
  - Overall idea?
  - Usability?
  - Specific interaction design?
  - Visual design?
- Take a **dispassionate** stance (this is hard!)
  - Show alternatives where possible

Critic: How to Avoid Deaf Ears

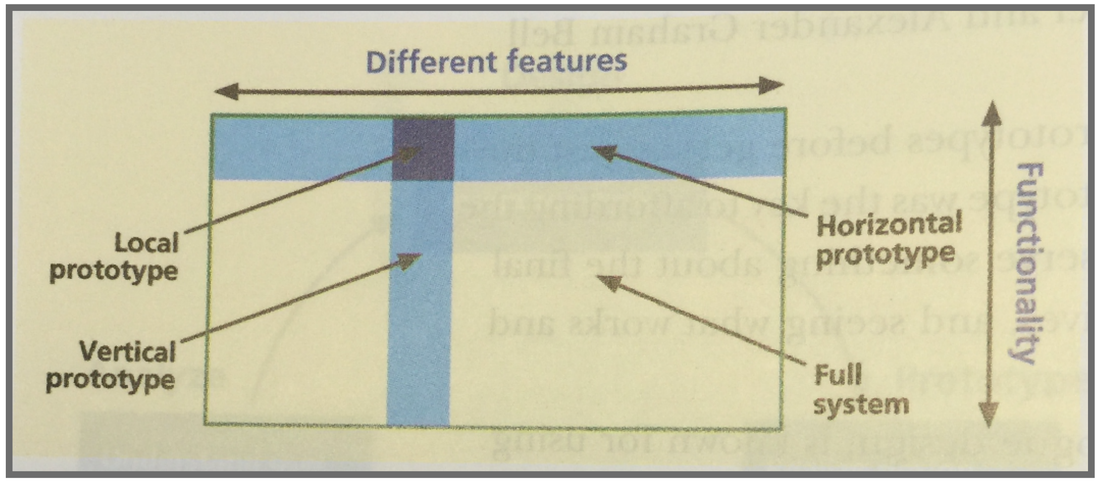
- Comments about the ***design***, not the designer
- Point out positive aspects - be ***specific***
  - Not: “I like this, but…”
  - “The layout effectively communicate the hierarchical nature of the data. However…”
- Ask for ***alternatives*** instead of offering solutions
  - Not: “You should really change X”
  - Instead “Have you considered alternatives for X?”

Prototyping

Prototyping

- How do you know your system design is right before you invest the time to build it?
- Answer: prototyping!
  - Evaluation performed ***before*** investing resources in building finished product
  - Early version of system constructed much ***faster*** & with less expense used to evaluate & ***refine*** design ideas

Types of Prototypes



- Which details do you leave out?
- **Horizontal**: *broad* in features, less depth
  - Explore overall concept of app, but not specific workflows
- **Vertical**: lots of *depth*, but only for a few features
  - Enables testing limited range of features w/ realistic user evals
- **T**: most of UI realized at low depth, few parts realized in depth
  - Combination of vertical & horizontal
- **Local**: focused prototype on ***specific*** interaction detail

Interactivity of Prototypes

- Scripted, click through prototypes
  - Prototype w/ ***clickable*** links to move between screens
  - Live action storyboard of screens
  - Simulates real ***task flow***, but w/ static content
- Fully-implemented prototypes
  - Usually ***expensive*** to implement actual system
  - But can build key piece of system first to evaluate

Wizard of Oz

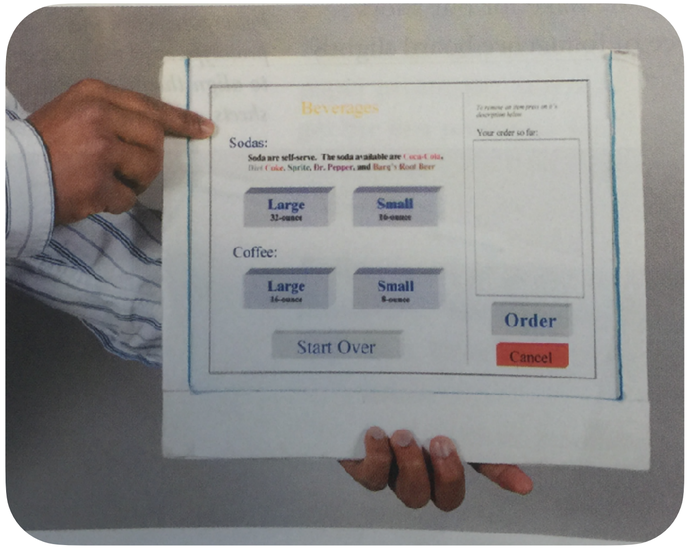
- Goal: ***simulate*** actual system w/ out building it
  - Want user to interact ***as if*** they were interacting w/ real system
  - Helps explore how users would interact w/ novel interaction if it were to exist
- Example: natural command line (Good et al 1984)
  - Users typed in commands to interact w/ computer
  - Commands intercepted by hidden human who interpreted commands & executed them

Paper Prototypes

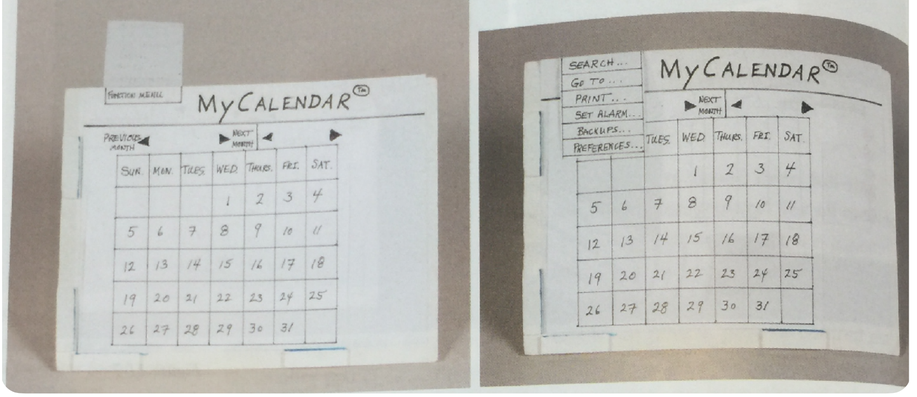
- ***Low fidelity*** prototype w/ paper mockups
- **Goal:** get feedback from users early w/ very low cost interactive prototype of envisioned interaction design

Paper Prototyping (1)

- Set a realistic deadline
- Gather set of paper prototyping materials
- Work ***fast*** & do not color within the lines
- Reuse existing sketches & mockups
- Make underlying paper mockups of key screens



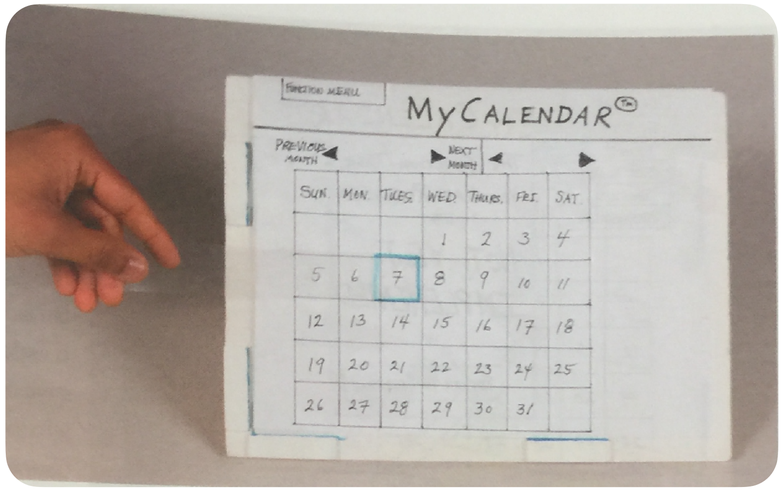
Paper Prototyping (2)



- Use ***paper cutouts*** & tape onto full-size transparencies as “interaction sheets” for moving parts, making modular by including only a small amount
- Do not write or mark on interaction sheets
- Be ***creative***
- ***Reuse*** at every level
- Cut corners wherever possible (trade accuracy against efficiency)
- Make a “this feature not implemented” message

Paper Prototyping (3)

- Include “***decoy***” user interface objects not needed for expected tasks
- Accommodate data value entry by users w/ blank transparencies
- ***Organize*** materials to manage complex task threads
- ***Pilot*** test thoroughly



In Class Activity

Group activity

- In groups of 2 or 3:
  - The venture capitalist from Lecture 3 who invested $5M in your new consumer product would like an update! They'd like to see how your app would work in one specific scenario, and how this would help better meet user needs.
  - Start with a specific set of user needs and develop a key scenario illustrating a benefit of your app.
  - Build a series of at least 5 wireframe “pages” supporting one scenario for the app.
- Deliverables
  - Few sentences describing the purpose of the app.
  - Few sentences describing the scenario for the app: what is the user's goal.
  - At least 5 wireframe pages describing what the app looks like at each step, with annotations below describing the user's goal.
  - Few sentences explaining why this design is better than current approach users might use.
- Due by 11pm today.

10 Minute Break