Human-Computer Interaction

CS 449 | 649 – F26

Week 7: Oct 26 – Oct 30 🎃

UX Prototyping:

Sketches, flows, wireframes, paper prototypes

Models & Design principles for interaction

Evaluating low-fidelity prototypes

* Updated Oct 26 2026

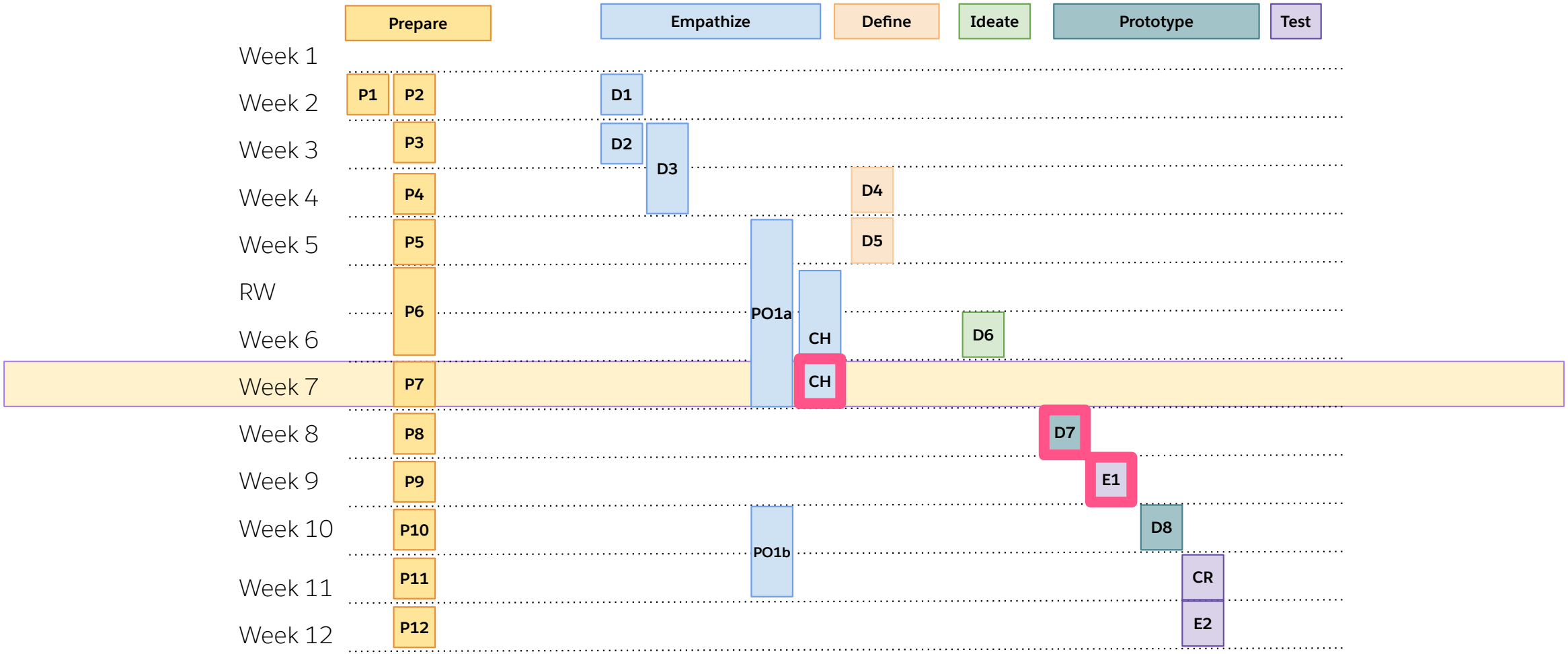
UNIVERSITY OF WATERLOO | DAVID R. CHERITON SCHOOL OF COMPUTER SCIENCE

WATERLOOHCI

Week 6 Recap

Stories, scenarios, use cases, storyboards … Design arguments … Creative process

Project Deliverables Build on Each Other



Week 7 To-Dos

✅ Complete design notebook entry for D6:
Create Design Ideas

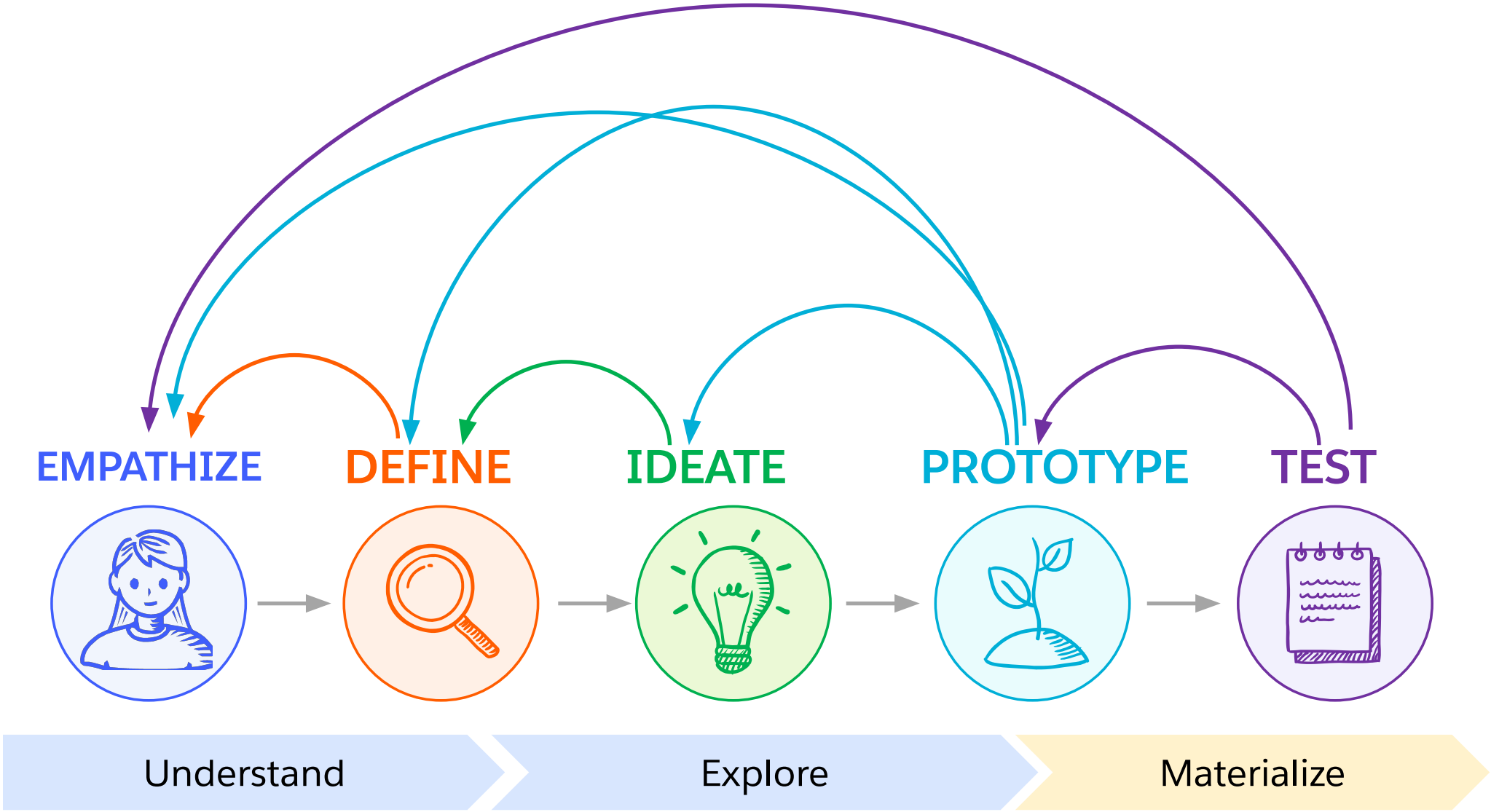
✅ P7: Prepare your CH2 Challenge Report Presentation

✅ Conduct final 1 - 2x PO1a Interviews

✅ Make progress on CH1: your Challenge Report (due Week 8)

UX Prototyping

Sketches → Flows + Wireframes → Paper Prototypes → (Functional / Graphic) Mock-ups → Product


EMPATHIZE
DEFINE
IDEATE
PROTOTYPE
TEST
Understand
Explore
Materialize

Ideate → Prototype

Ideate means challenge assumptions and generate ideas:

... Brainstorming
... Modelling
... Sketching

Prototype means start to create solutions:

... Mockups
... Interactive prototypes
... Design specifications

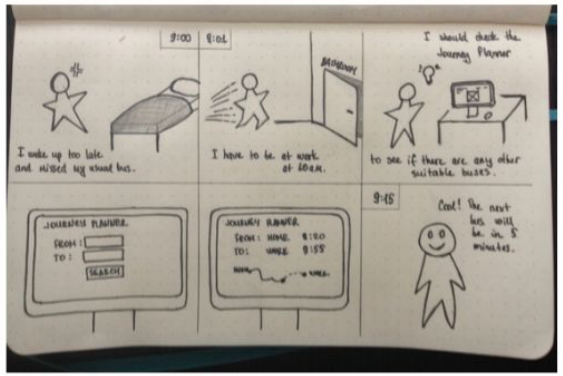
📖 Rikke Friis Dam: The 5 Stages in the Design Thinking Process (2025)

Ideating towards a holistic design

User stories / Storyboard

- description of a feature from an end-user perspective

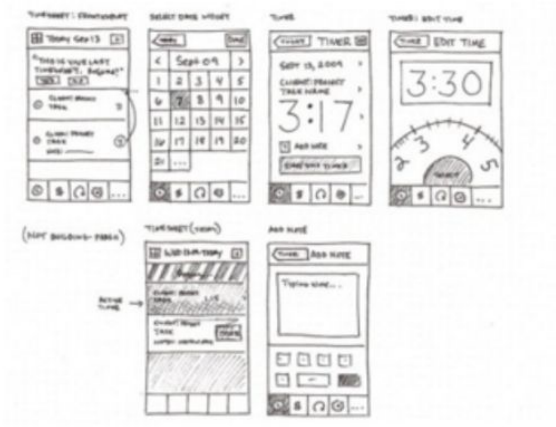
As a user / <persona> ,
I want / need <action>
so that I can <user goal>.



https://digitalflask.com/blog/ux-storyboarding-introduction/

Sketches

- illustration of how the basic concept works

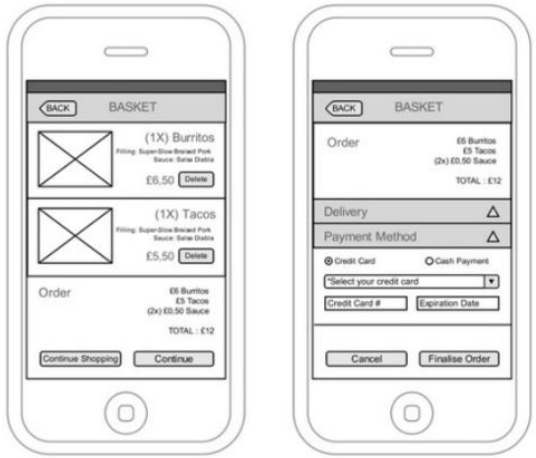


The idea translated into user interface form.

http://uxmovement.com/wireframes/why-its-important-to-sketch-before-you-wireframe/

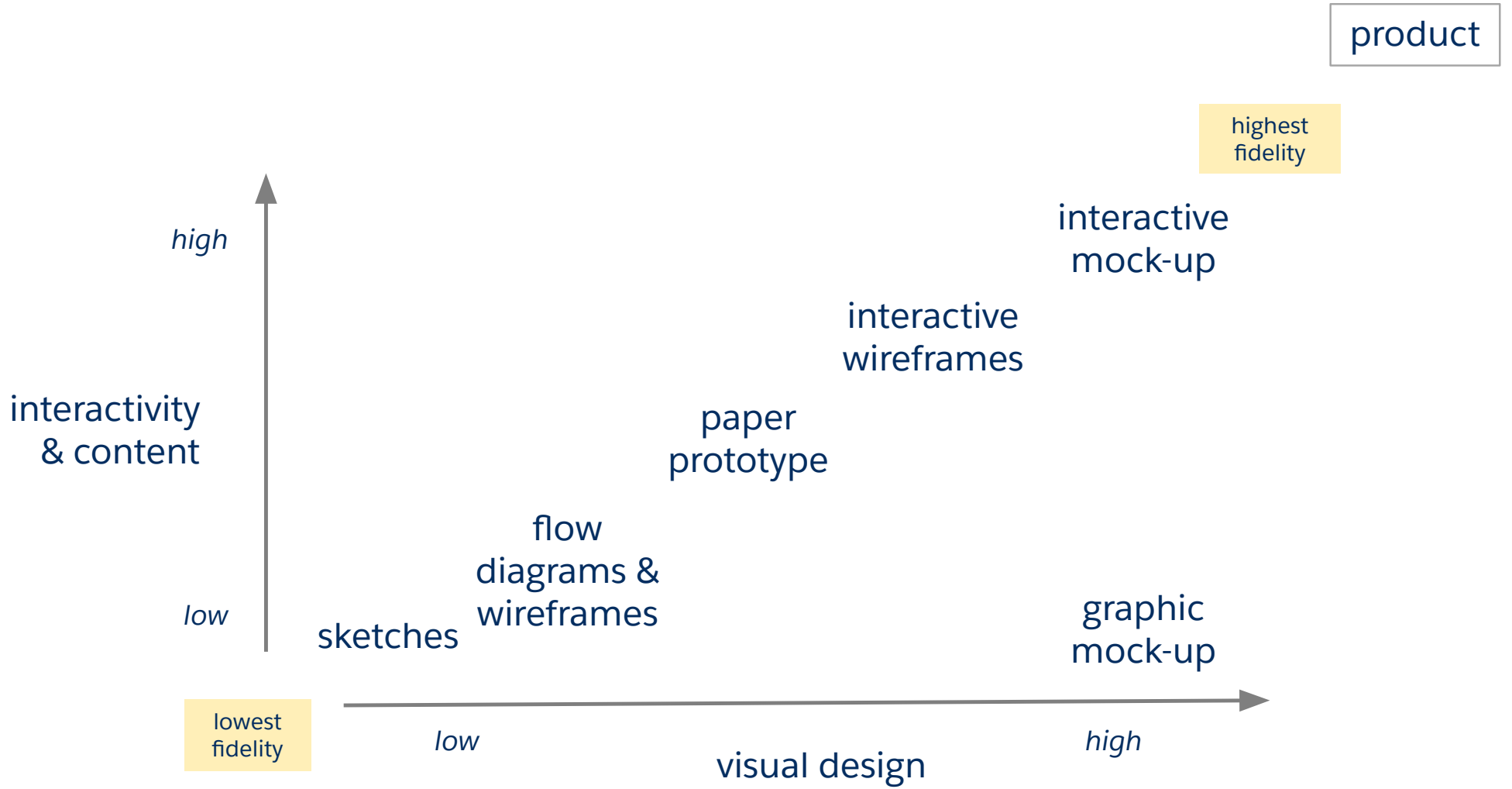
Wireframes

- static representation of the UI layout and user flow



https://www.behance.net/gallery/13421913/Wireframes-Restaurant-App

Prototype Fidelity



📖 Kyle Murphy: The 5 Dimensions of Prototype Fidelity (2019)

UX Prototyping

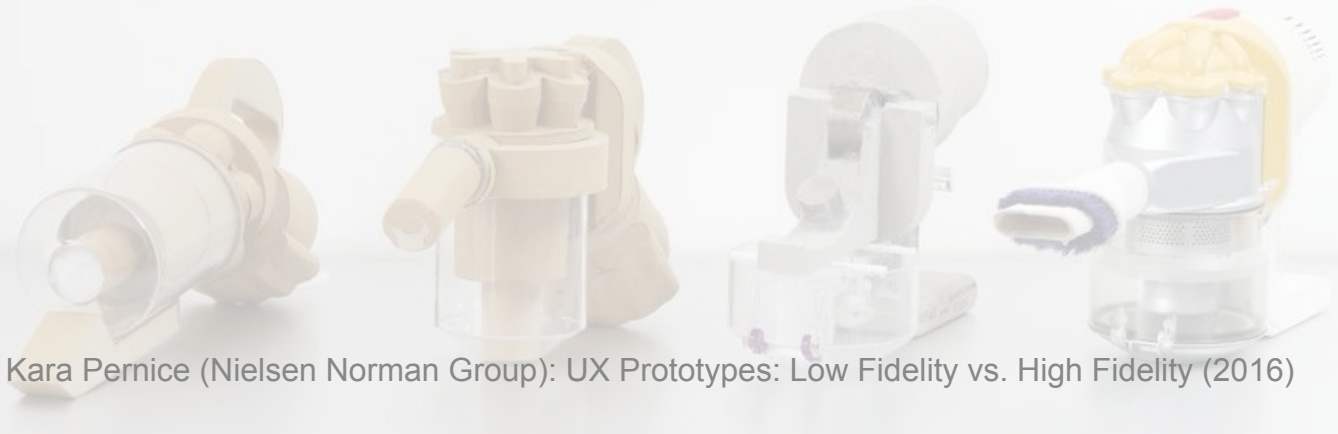
A prototype is a representation of a candidate solution or idea for demonstrating or testing

- … a **solution hypothesis** for a specific design problem
- … an experimental model of an idea

Prototypes have different levels of fidelity

- … how detailed, how functional, and how much it looks like the final thing
- … prototype fidelity should match the fidelity of the solution or idea

UX prototyping process should be **much faster** than implementation



📖 Kara Pernice (Nielsen Norman Group): UX Prototypes: Low Fidelity vs. High Fidelity (2016)

IDEO Prototype of Nasal Surgical Tool

Non-functional prototype made quickly using found objects to demonstrate an idea for general tool shape



non-functional prototype



product

📖 D.Collective: When You Show a Half-Baked Idea to an Important Client (2017)

Prototype of Nintendo Wii U

Functional prototype made using existing hardware to demonstrate and test a solution for a new kind of controller



functional prototype



product

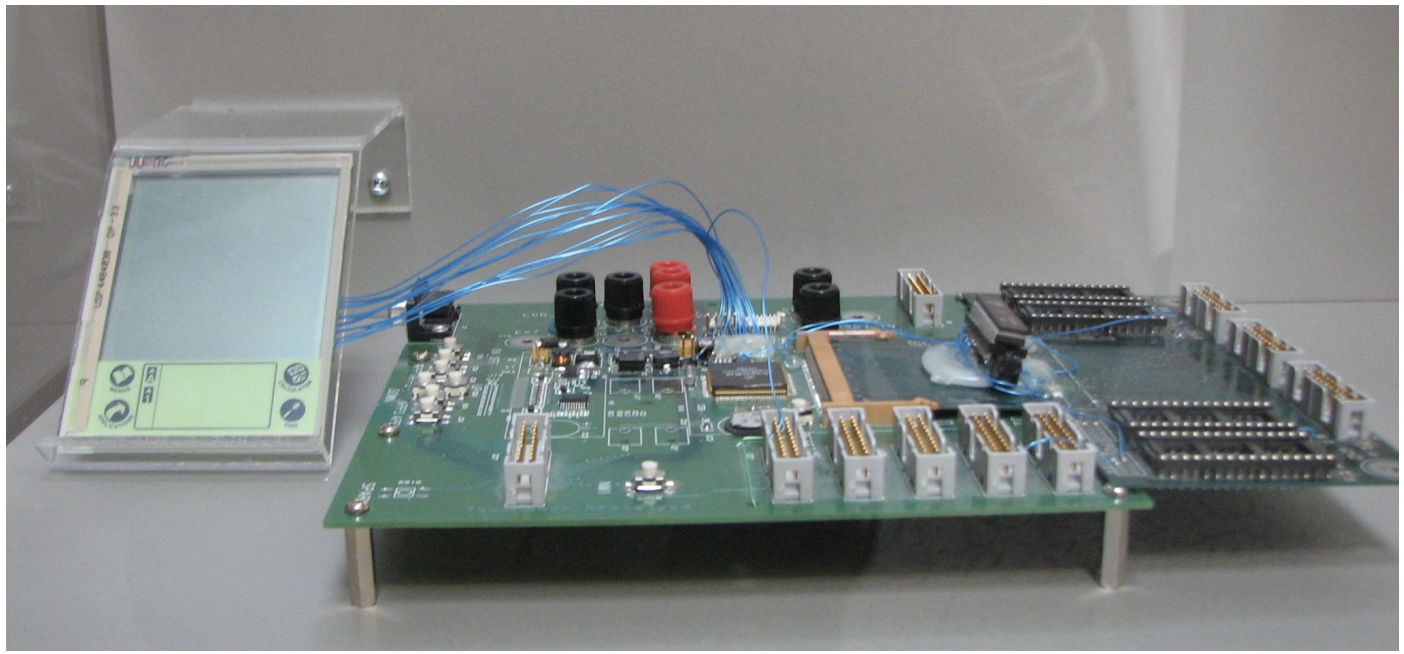
📖 Jackson Chung: 10 Early and Rarely Seen Prototypes of Now Famous Gadgets (2014)

Prototypes of Palm Pilot PDA

Non-functional prototype for form factor and informal field tests
Functional prototype for interaction and hardware development



non-functional prototype



functional prototype



product

📖 Alberto Savoia: The Palm Pilot Story (2019)

	Low Fidelity	High Fidelity
Interactivity		
Clickable Links & Menus	**No:** Targets do not work.	**Yes:** Many or all are clickable.
Automatic Response to User's Actions	**No:** Screens are presented to the user in real time by a person playing "the computer."	**Yes:** Links in the prototype are made to work via a prototyping tool (e.g., Figma).
Visuals		
Realistic Visual Hierarchy, Priority of Screen elements, and screen size	**No:** Only some or none of the visual attributes of the final live system are captured (e.g., a black-and-white sketch or wireframe, schematic representation of images and graphics, single sheet of paper for several screenfuls of information). Spacing and element prioritization may or may not be preserved.	**Yes:** Graphics, spacing, and layout look like a live system would look (even if the prototype is presented on paper).
Content		
Navigation & Hierarchy	**No:** The prototype includes only a summary of the content or a stand-in for product images.	**Yes:** The prototype includes all the content that would appear in the final design (e.g., full articles, product-description text and images).

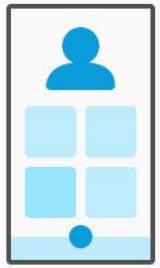
📖 Kara Pernice (Nielsen Norman Group) : UX Prototypes: Low Fidelity vs. High Fidelity (2016)

Ideate → Prototype

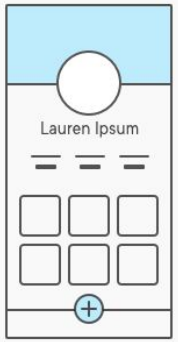
1. **Thumbnail**
page level



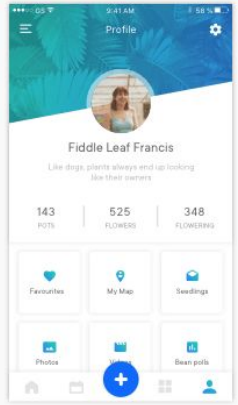
2. **Blockframe**
layout level



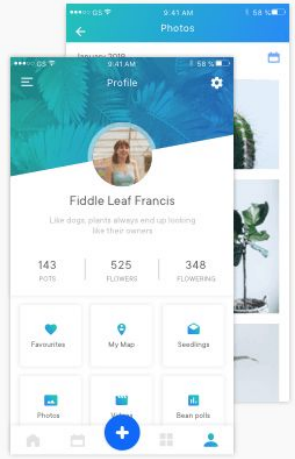
3. **Wireframe**
component level



4. **Interface**
styles level



5. **Prototype**
interactions level





Faster iterations



Slower iterations

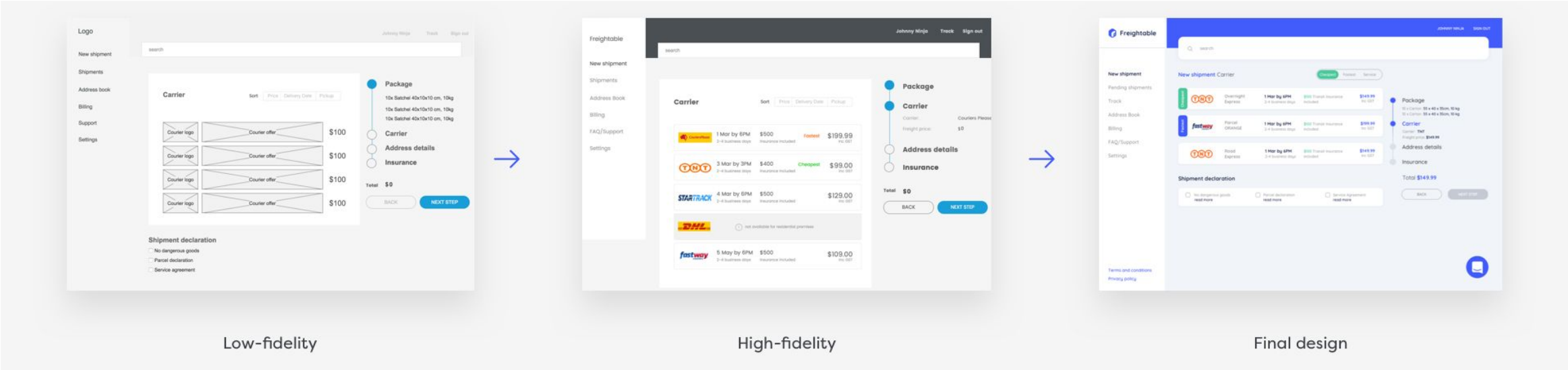
📖 Alexander Handley: User flow is the new wireframe (2018)

Interface Prototype Fidelity

Interface content: How detailed? … gibberish text vs. placeholder vs. real

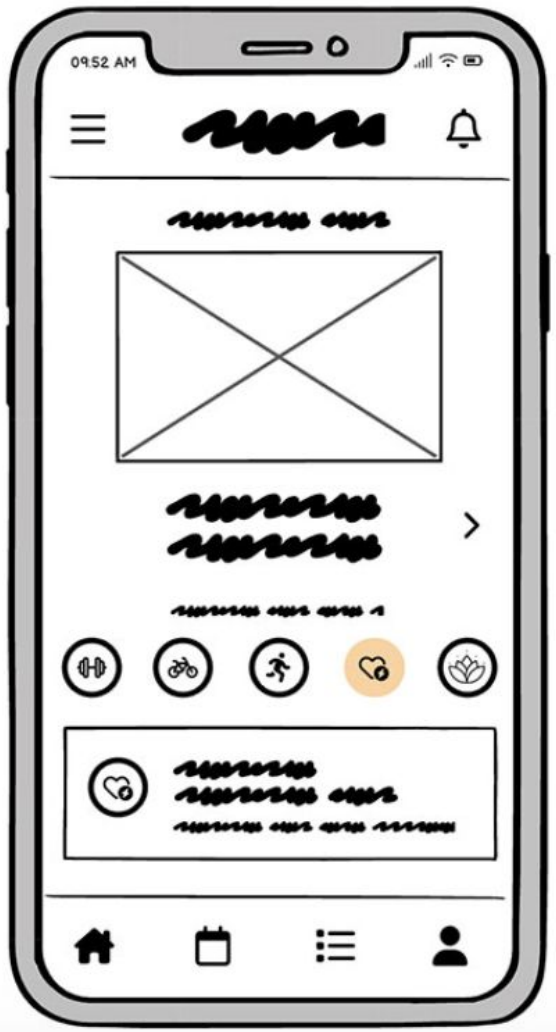
Level of interactivity: How functional? **…** static drawing vs. simulated vs. fully functioning

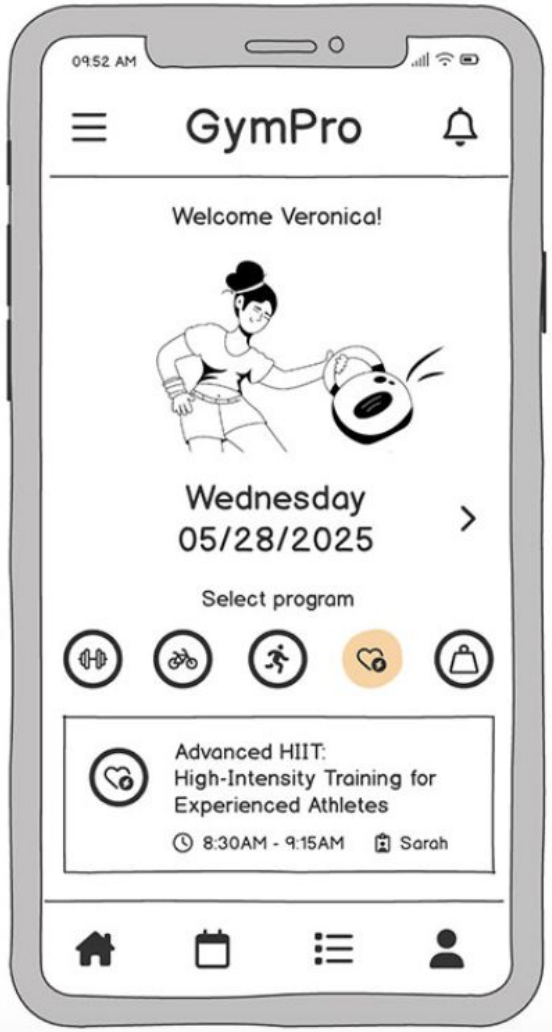
Visual design: **…** hand drawn vs. simple structure vs. graphic design

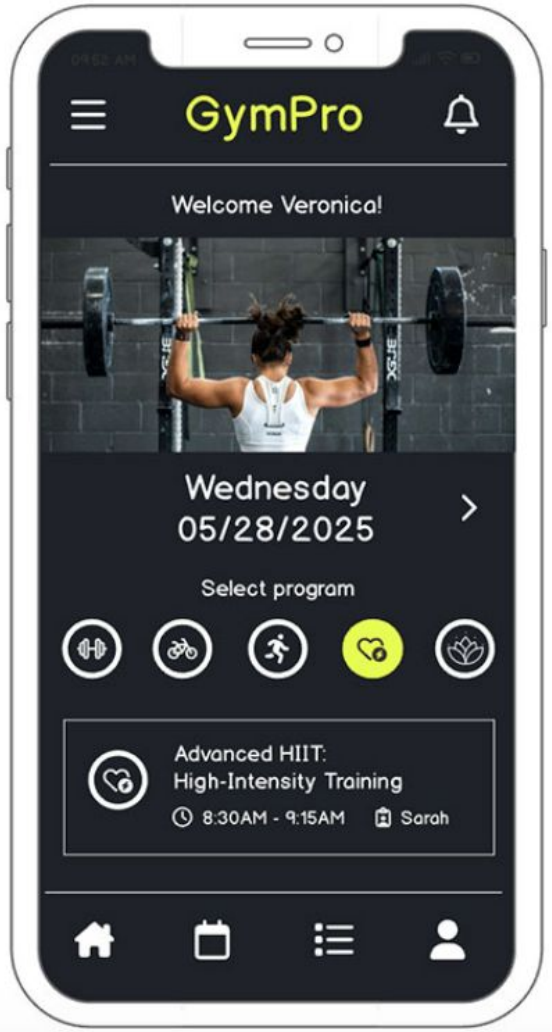


📖 Kyle Murphy: The 5 Dimensions of Prototype Fidelity (2019)

Interface Prototype Fidelity





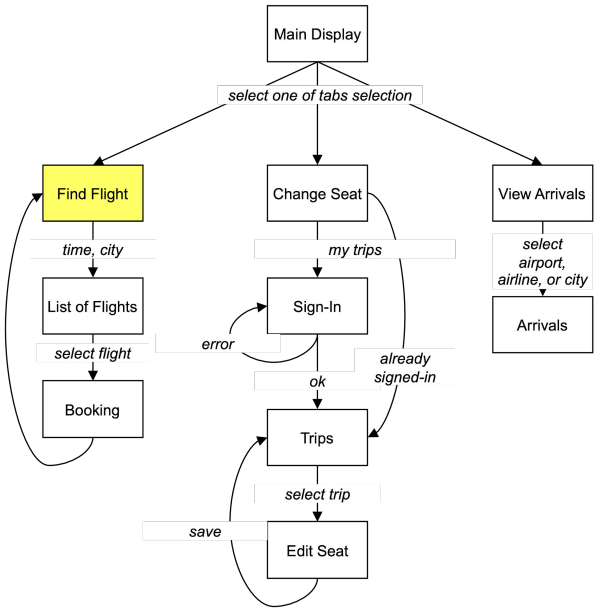


Breadth vs. Depth

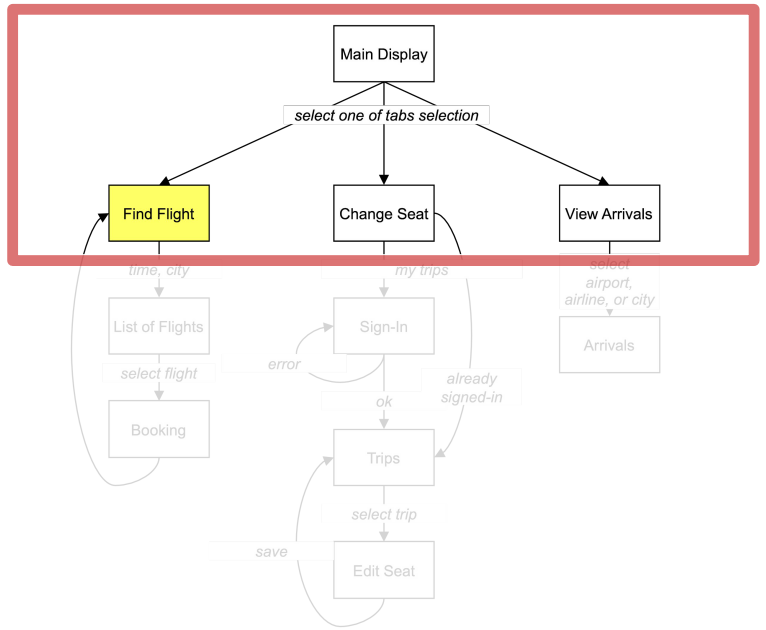
Breadth: how many features are prototyped … e.g., prototype first screen for each main nav item, but no more

Depth: how much of a feature is prototyped … e.g., full flow of one main nav item only

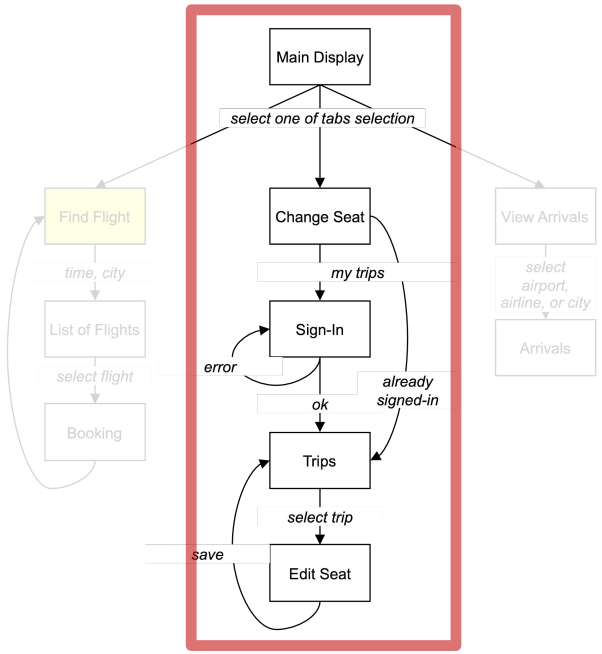
app structure



broad prototype scope



deep prototype scope



📖 Kyle Murphy: The 5 Dimensions of Prototype Fidelity (2019)

On Drawing

Why should you draw?

Author Manuscript

Author Manuscript

Author Manuscript

HHS Public Access

Author manuscript

Nat Rev Psychol. Author manuscript; available in PMC 2024 September 05.

Published in final edited form as:

Nat Rev Psychol. 2023 September ; 2(9): 556–568. doi:10.1038/s44159-023-00212-w.

Drawing as a versatile cognitive tool

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[2]Department of Psychology, Stanford University, Stanford, CA, USA.

[3]Department of Psychology, University of Chicago, Chicago, IL, USA.

[4]Department of Psychology, Goldsmiths, University of London, London, UK.

[5]Department of Psychology, Centre for Neuroscience Studies, Queen's University, Kingston, Ontario, Canada.

Abstract

Drawing is a cognitive tool that makes the invisible contents of mental life visible. Humans use this tool to produce a remarkable variety of pictures, from realistic portraits to schematic diagrams. Despite this variety and the prevalence of drawn images, the psychological mechanisms that enable drawings to be so versatile have yet to be fully explored. In this Review, we synthesize contemporary work in multiple areas of psychology, computer science and neuroscience that examines the cognitive processes involved in drawing production and comprehension. This body of findings suggests that the balance of contributions from perception, memory and social inference during drawing production varies depending on the situation, resulting in some drawings that are more realistic and other drawings that are more abstract. We also consider the use of drawings as a research tool for investigating various aspects of cognition, as well as the role that drawing has in facilitating learning and communication. Taken together, information about how drawings are used in different contexts illuminates the central role of visually grounded abstractions in human thought and behaviour.

Quarterly Journal of Experimental Psychology
Volume 69, Issue 9, September 2016, Pages 1752-1776
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https://doi.org/10.1080/17470218.2015.1094494

Article

The drawing effect: Evidence for reliable and robust memory benefits in free recall

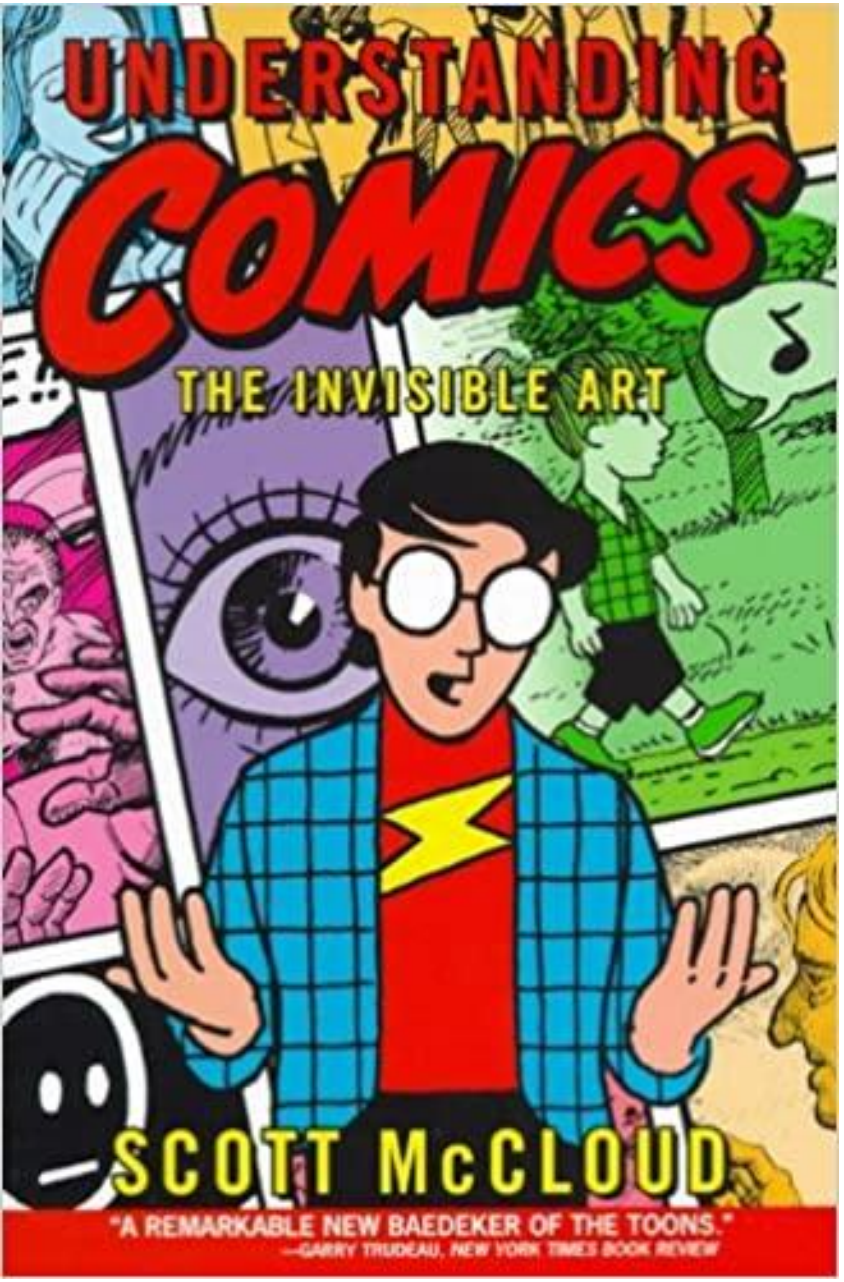
Jeffrey D. Wammes, Melissa E. Meade, and Myra A. Fernandes

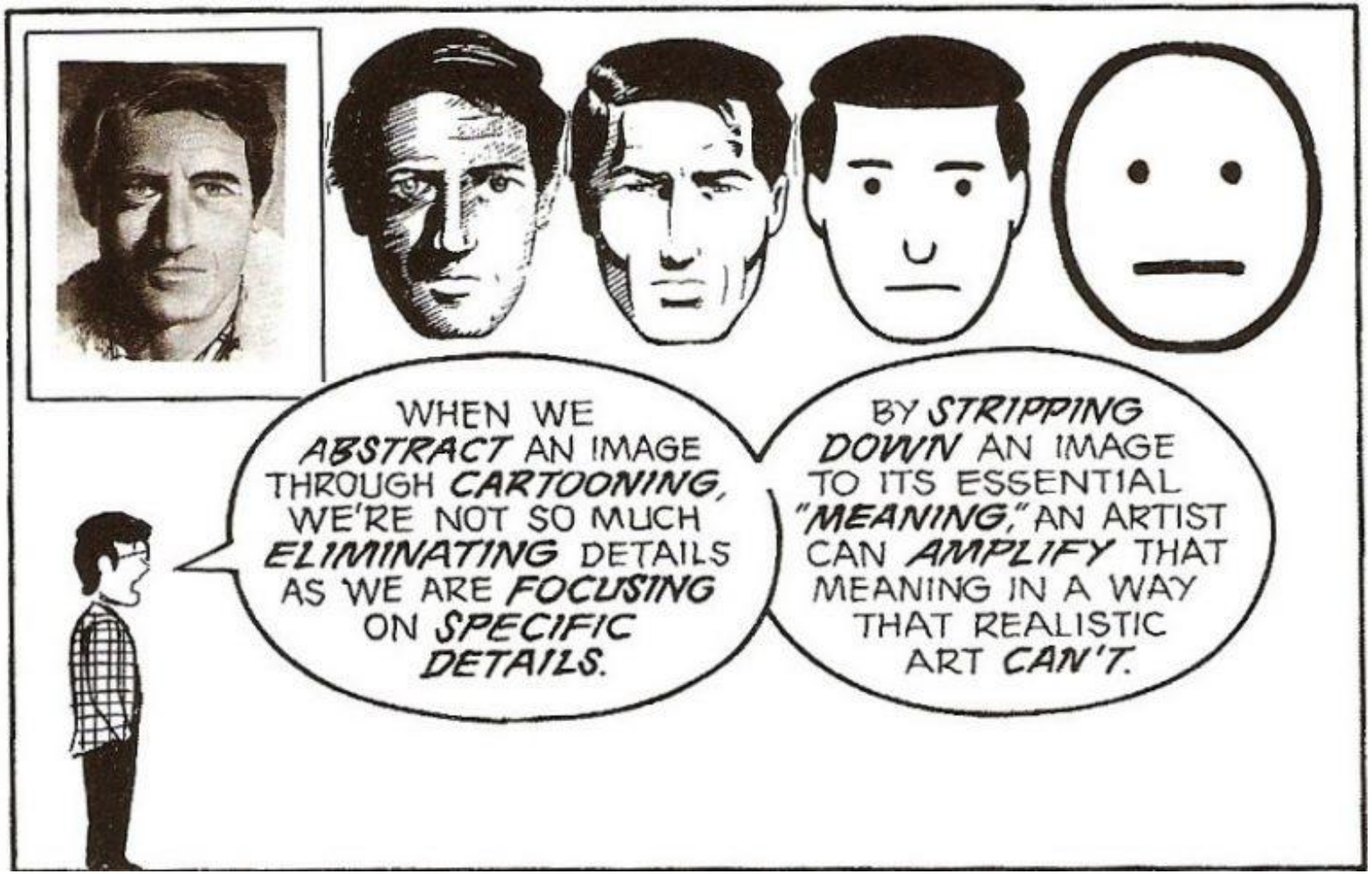
Abstract

In 7 free-recall experiments, the benefit of creating drawings of to-be-remembered information relative to writing was examined as a mnemonic strategy. In Experiments 1 and 2, participants were presented with a list of words and were asked to either draw or write out each. Drawn words were better recalled than written. Experiments 3–5 showed that the memory boost provided by drawing could not be explained by elaborative encoding (deep level of processing, LoP), visual imagery, or picture superiority, respectively. In Experiment 6, we explored potential limitations of the drawing effect, by reducing encoding time and increasing list length. Drawing, relative to writing, still benefited memory despite these constraints. In Experiment 7, the drawing effect was significant even when encoding trial types were compared in pure lists between participants, inconsistent with a distinctiveness account. Together these experiments indicate that drawing enhances memory relative to writing, across settings, instructions, and alternate encoding strategies, both within- and between-participants, and that a deep LoP, visual imagery, or picture superiority, alone or collectively, are not sufficient to explain the observed effect. We propose that drawing improves memory by encouraging a seamless integration of semantic, visual, and motor aspects of a memory trace.

Keywords

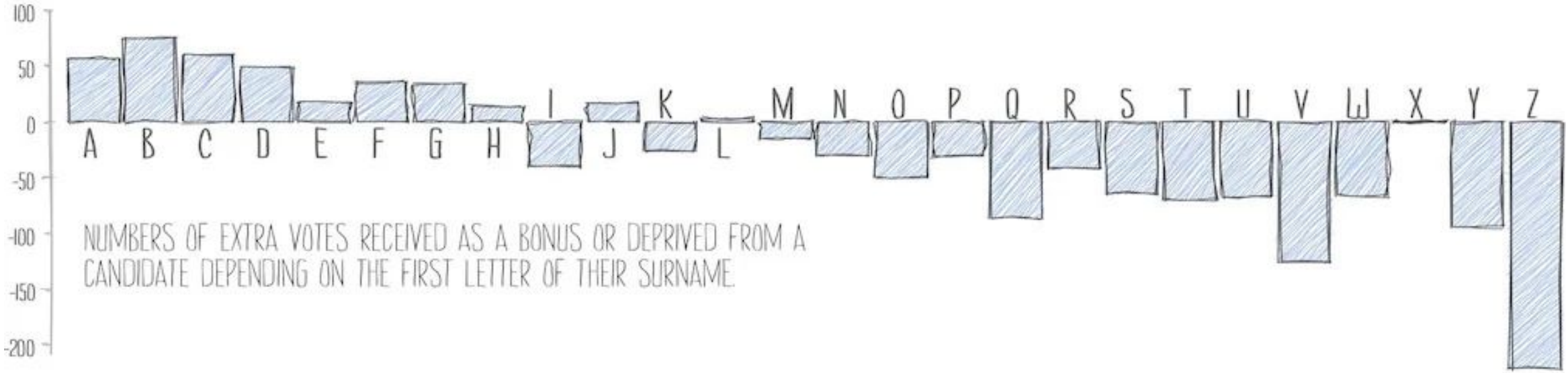
Subject-performed tasks, Memory, Drawing, Imagery, Levels of processing

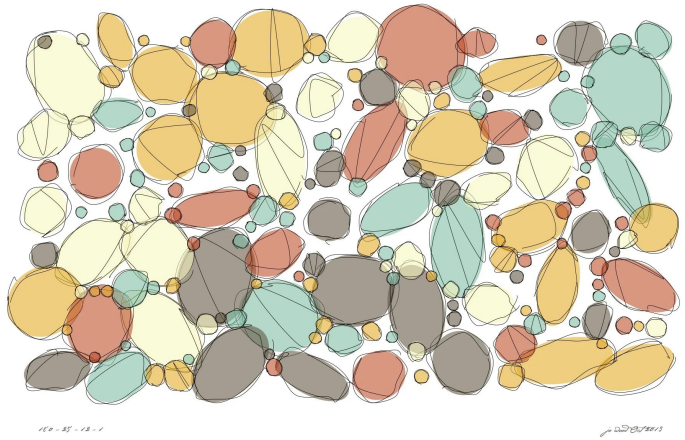


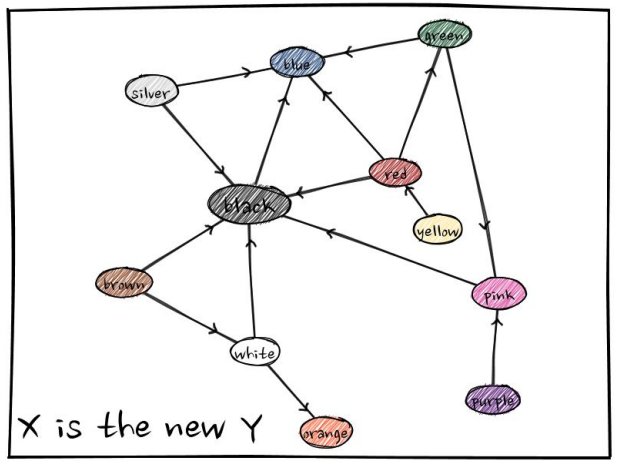


📖 Scott McCloud: *Understanding Comics: The Invisible Art* (1993)

Drawing Charts / Maps / Graphs









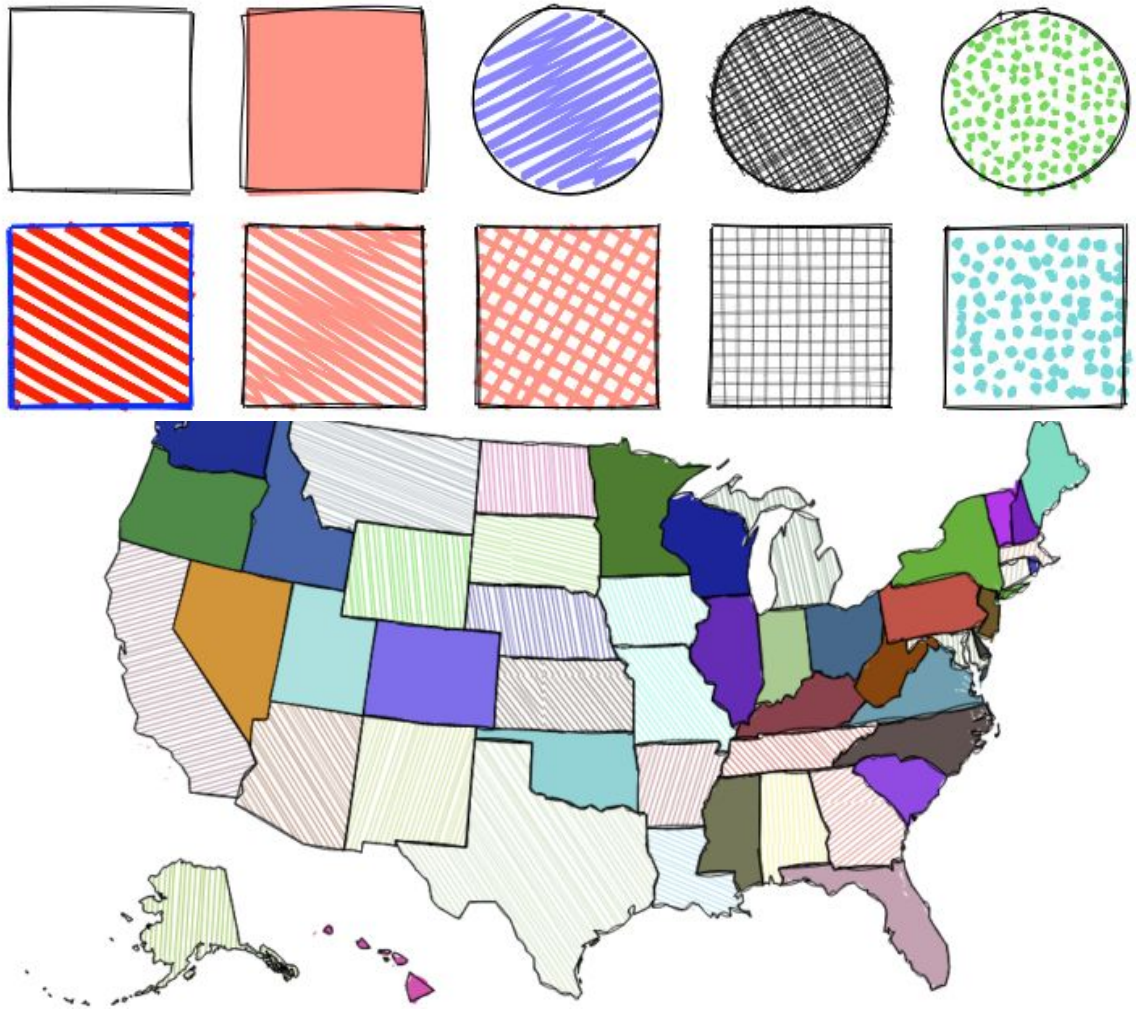
handy library for processing: 🌐https://www.gicentre.net/handy

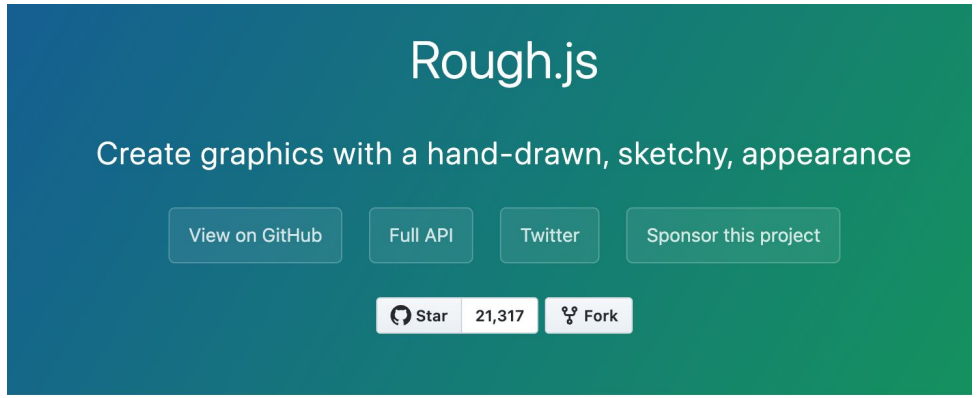
Drawing Charts / Maps / Graphs



handy library for processing: 🌐https://www.gicentre.net/handy

Drawing Charts / Maps / Graphs with Rough.js





Rough.js

Rough.js is a small (<9kB gzipped) graphics library that lets you draw in a *sketchy*, *hand-drawn-like*, style. The library defines primitives to draw lines, curves, arcs, polygons, circles, and ellipses. It also supports drawing SVG paths.

Rough.js works with both Canvas and SVG.

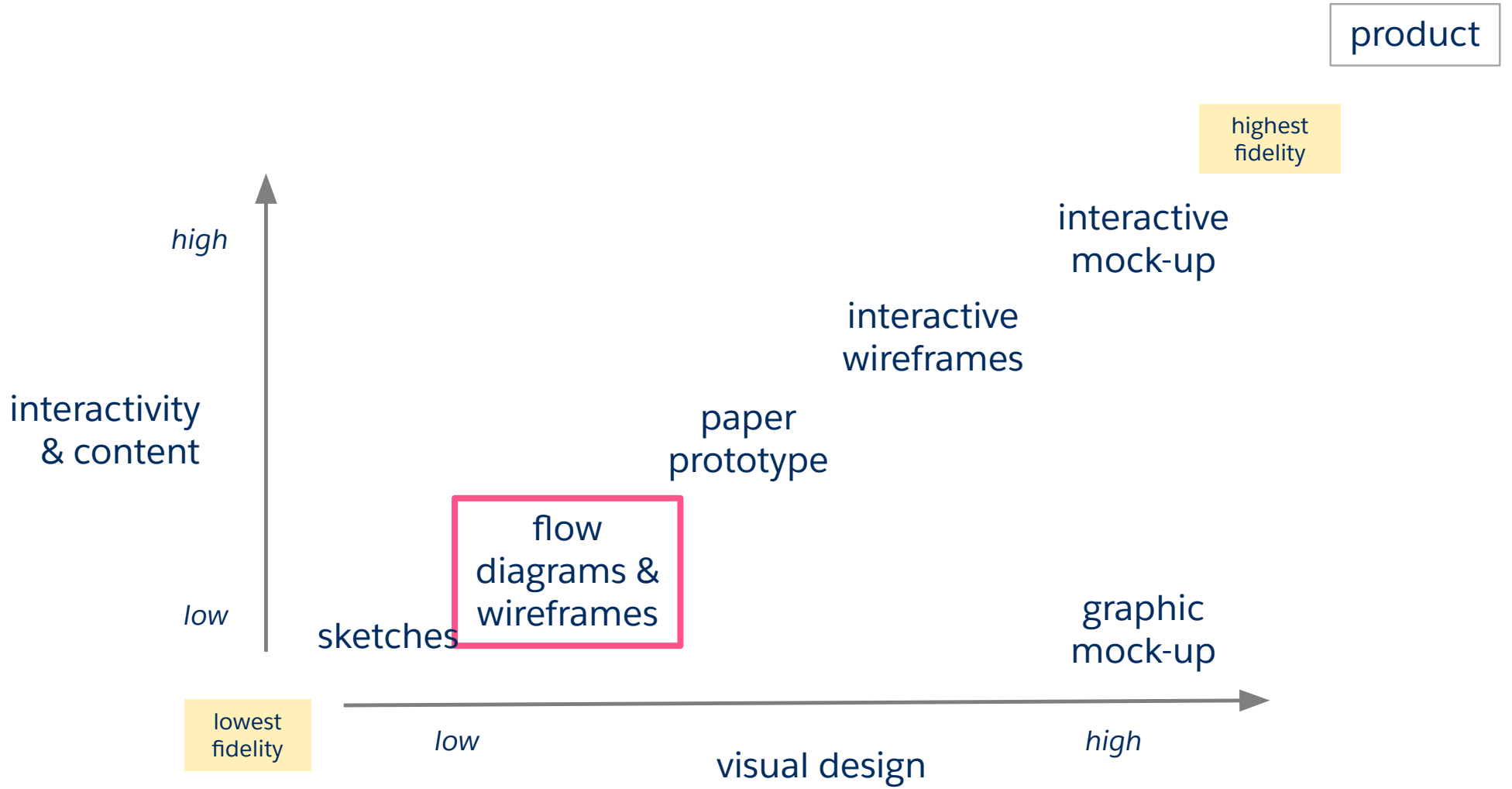


https://roughjs.com/

Flows

... a.k.a. { user | interaction | activity | UI | navigation | task | wire } flow

Prototype Fidelity



📖 Kyle Murphy: The 5 Dimensions of Prototype Fidelity (2019)

Flow Diagrams

The path a person follows through an interface to reach a goal

... a.k.a. { UX | user | interaction | activity | UI | navigation | task | wire } flow

... "**flow**" sometimes replaced with "**sequence**"

Main components:

... **Steps**: what pages/screens/panels a person sees

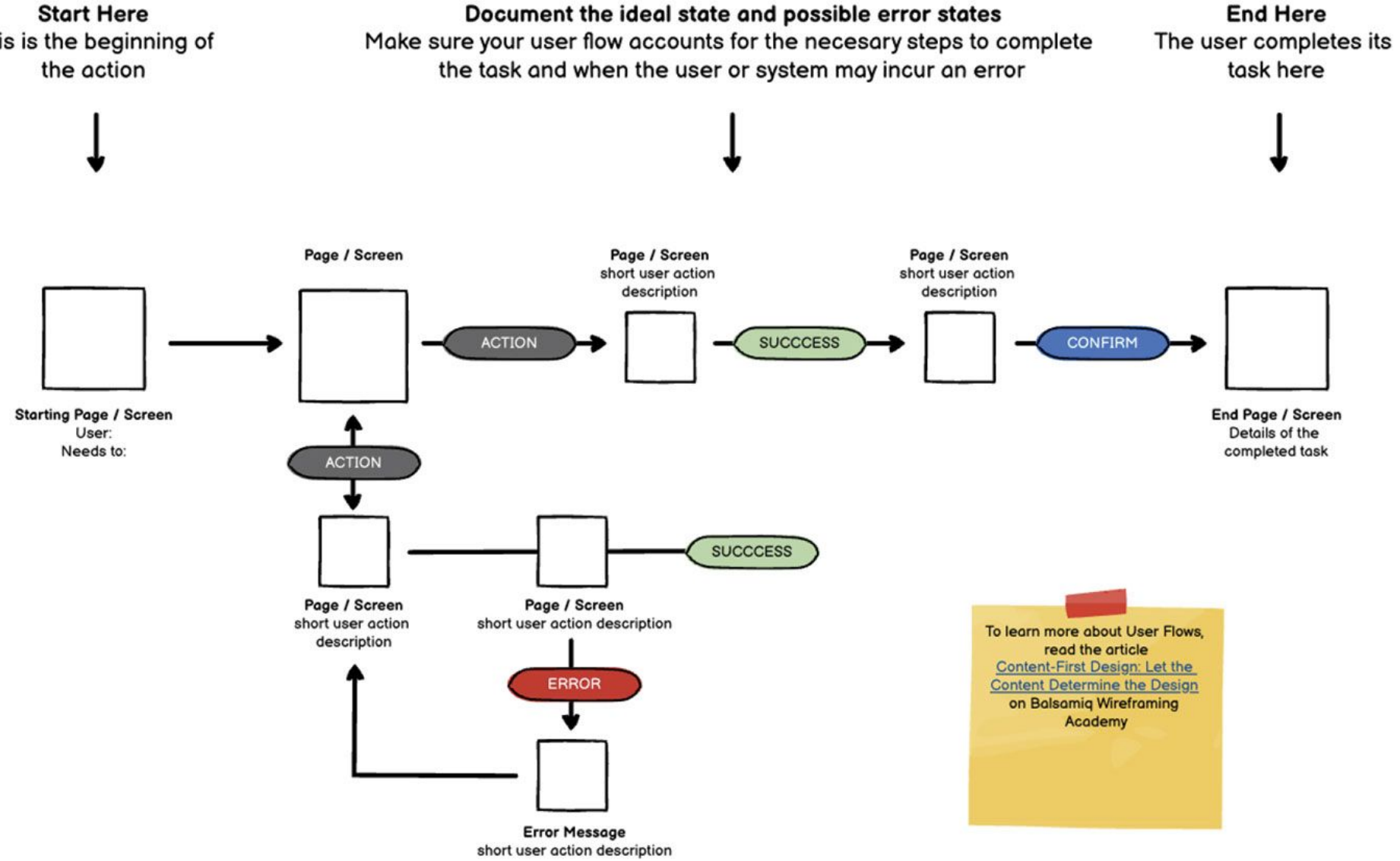
... **Actions**: what they do to move between steps

... **Decisions** :where an action/state can lead to different outcomes

Drawn as a diagram because writing a flow as a paragraph like a scenario is hard to reference

📖 Page Laubheimer (Nielsen Norman Group): Wireflows: A UX Deliverable for Workflows and Apps (2016)

Flow Diagram Example



📖 Mike Angeles: Wireflows: A beginner's guide to clearer UI design (2025)

A Visual Vocabulary for Flows

A standard set of graphical symbols and notation to describe information architecture and interaction design

Qualities of a good UI design visual vocabulary ...

- ... **Whiteboard-compatible**: quick enough to be done by hand
- ... **Tool-independent**: does not require specialized software
- ... **Small and self-contained**: not require specialized knowledge or interest

UML or full flow charts tend to be too formal, too "high ceremony"

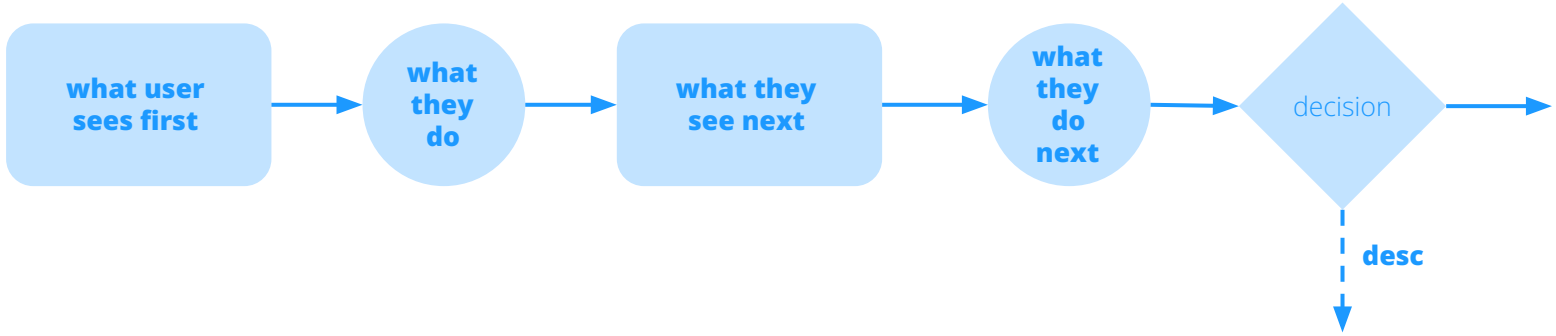
📖 Jesse James Garrett: A visual vocabulary for describing information architecture and interaction design (2002)

Flowchart Style Flow Diagram

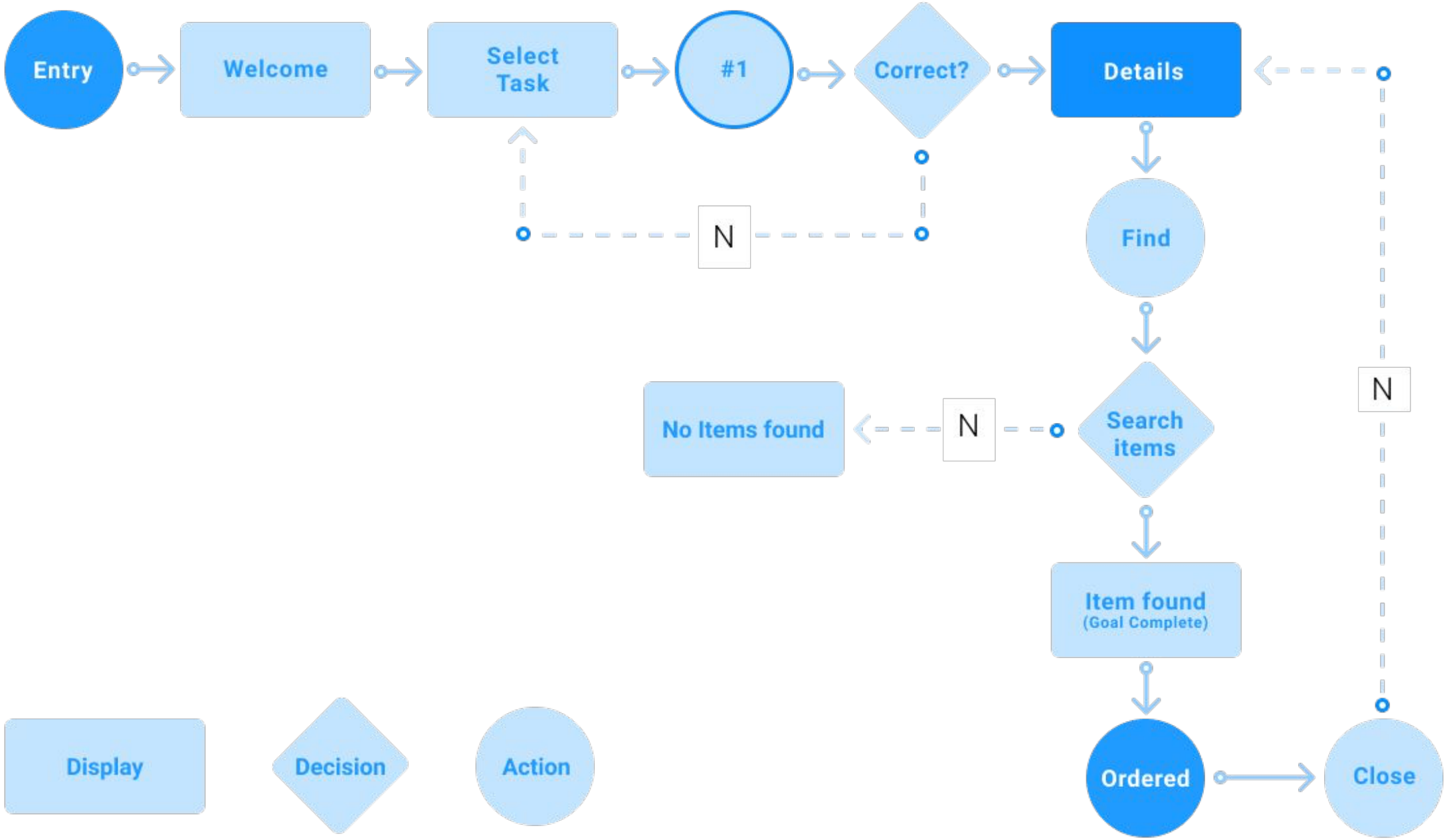
Use a subset of flowchart symbols to represent steps, actions, decisions.
Example vocabulary:

- … **rectangle** for step
- … **circle** and arrow for a person's action
- … **diamond** and arrows for decision
- … **dashed arrow** for secondary path

Most explicit, diagrams require more space, can take longer to diagram



📖 Camren Browne: What are User Flows in User Experience (UX) Design? (2024)



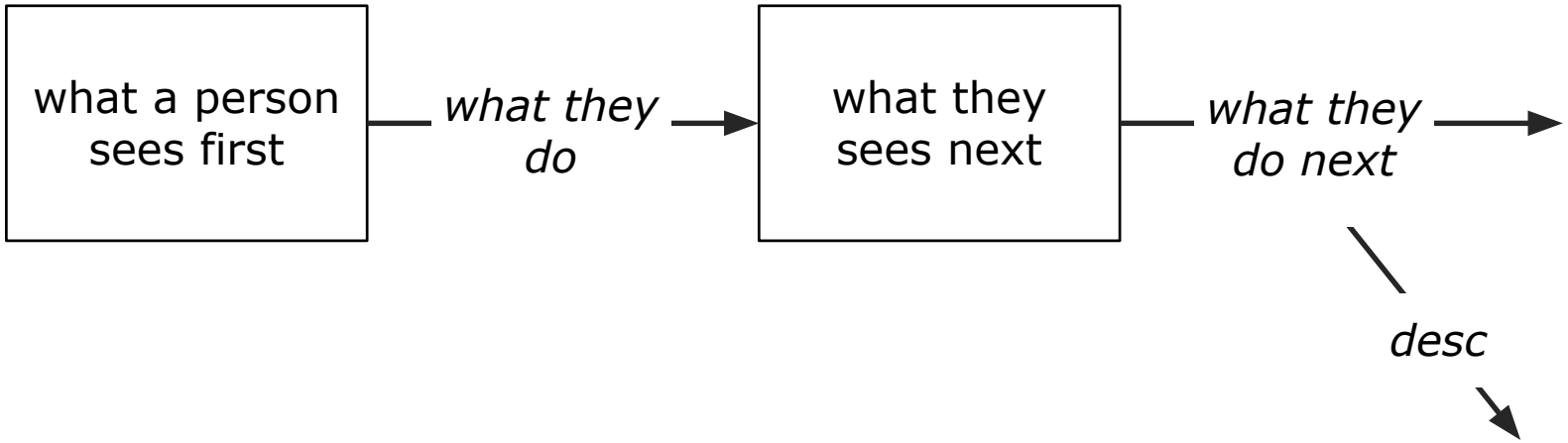
📖 Camren Browne: What are User Flows in User Experience (UX) Design? (2024)

Boxes and Arrows Style Flow Diagram

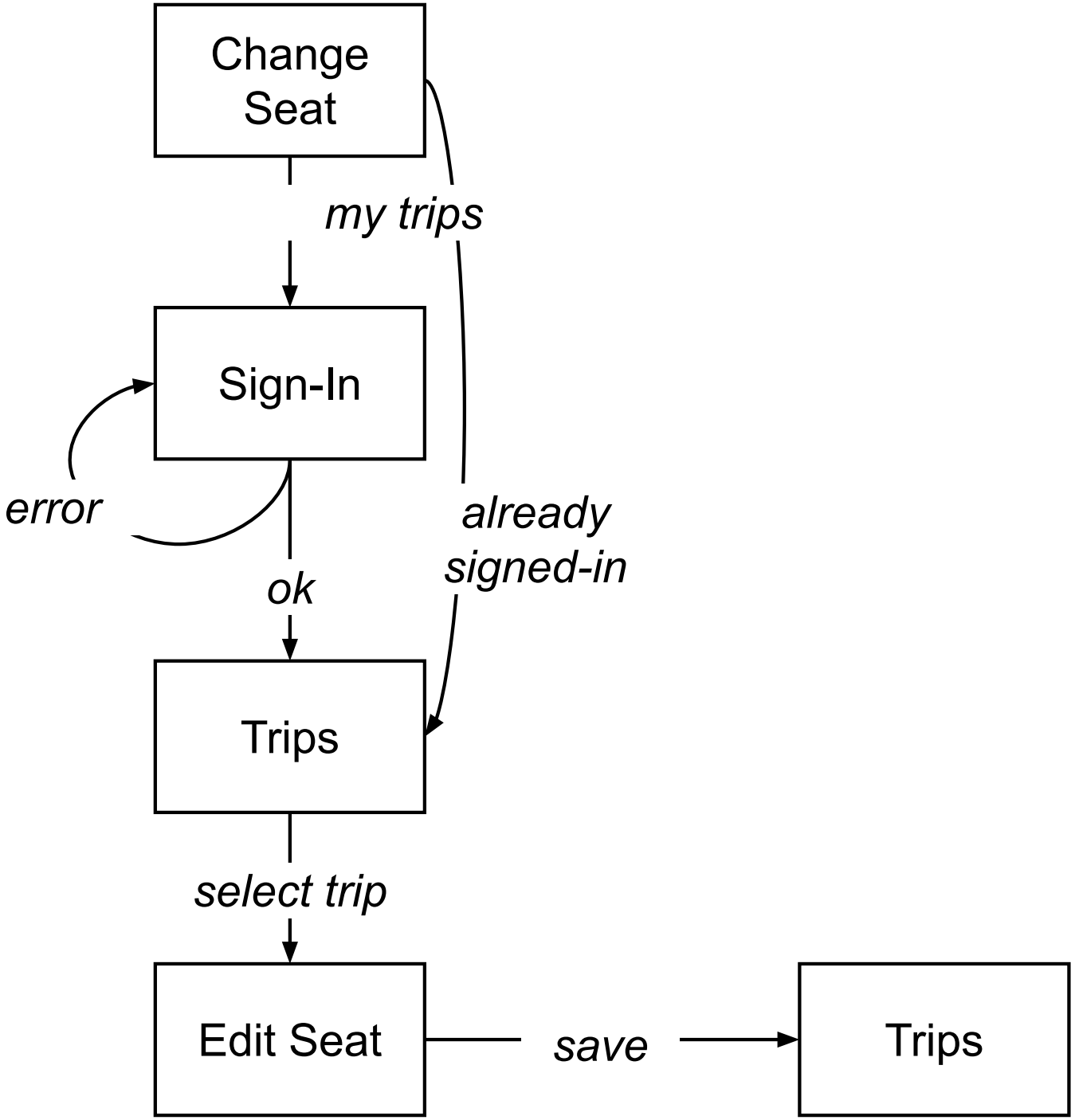
A tailored kind of flowchart style originally created for web pages

... **rectangle** for step
... **arrow** with label for a person's action
... **multiple arrows** with label for decision

Focus on simplicity and compact use of space, can be easy to diagram



📖 Camren Browne: What are User Flows in User Experience (UX) Design? (2024)


Change Seat
my trips
Sign-In
error
already signed-in
ok
Trips
select trip
Edit Seat
save
Trips

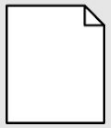
Visual Vocabulary Quick Reference

page



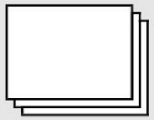
Pages are the fundamental unit of presentation on the Web, not (necessarily) a unit of implementation -- one page in your diagram may correspond to multiple HTML files (as in a frameset interface) or multiple units of code (as in a server-side include or database-driven implementation).

file



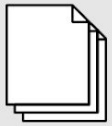
Files are parcels of data without navigational properties. They are delivered to the user for use outside a Web browser environment (such as audio or video files, stand-alone documents like PDFs, or executables).

page stack



A page stack indicates a group of functionally identical pages whose navigational properties are immaterial to the macrostructure of the site.

file stack



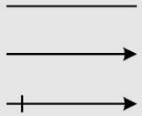
A file stack represents a group of files that receive identical navigational treatment and can be classified as a single entity (such as a collection of downloadable games or a library of PDF instruction manuals).

continuation



Continuation points allow us to separate our diagrams into easily digestible sections, we use continuation points to bridge the gaps between sections. A single continuation point may list one or more sources or destinations as needed. The choice of orientation is a matter of the architect's aesthetic judgment.

connectors



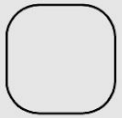
Relationships between elements are depicted with simple lines. Connectors use arrows to convey directionality, indicating how the user will move through the system. We use a crossbar on the opposite end of the arrow to prohibit upstream movement.

conditonal connectors



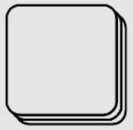
A conditional connector is used when a path may or may not be presented to the user depending upon whether one or more conditions are met. Conditional connectors use arrows to convey directionality, indicating how the user will move through the system. We use a crossbar on the opposite end of the arrow to prohibit upstream movement.

area



An area is used to identify a group of pages that share one or more common attributes (such as appearing in a pop-up window, or having some unique design treatment). Use labels to identify these attributes or (as with connectors), refer to notes elsewhere in the document if you have a lot to say.

iterative area



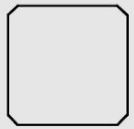
Iterative areas are used to represent architectures that involve repeating the same basic structure as it is applied to a number of functionally identical information elements. For example, you may have a product catalog in which each product has a number of pages associated with it.

conditional area



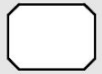
A conditional area is used when one or more conditions applies to a group of pages. Conditional areas are applied most commonly in situations involving access permissions, such as when a valid login or encrypted (SSL) connection is required. Conditional areas are associated with a result generated in the event that the condition(s) are not fulfilled.

flow area



A flow area encloses a sequence of steps (like a login procedure, for instance) that will appear repeatedly in different contexts throughout the design, analogous to a programming procedure. Flow areas require the use of two special types of continuation points: entry points and exit points.

flow reference



A flow reference serves as a sort of "placeholder" for a flow in every context in which it is repeated. Both the flow area and flow reference elements have the same basic shape, a rectangle with the corners clipped off.

concurrent set



A concurrent set is used in cases where a user action generates multiple, simultaneous results (such as spawning a pop-up window at the same time a page is loaded in the main window, or displaying a page while a file is being downloaded). Upstream elements connect to the curved side; downstream elements connect to the flat side.

decision point



A decision point is used to model when one user action may generate one of a number of results, and the system must make a decision about which result is to be presented. Note that arrows must be used in conjunction with decision points to clarify whether associated elements are upstream or downstream from the decision point.

conditional branch



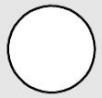
A conditional branch is when the system (*not based on user action*) must select one path among a number of mutually exclusive options to be presented to the user. Upstream elements connect to one point of the triangle; downstream elements connect to the opposite side.

conditonal selector



Conditional selectors function much like the conditional branch, with one important difference: with the selector, the various downstream paths are not mutually exclusive. Any number of the paths that fulfill the condition(s) may be presented to the user (e.g. search results.)

cluster



A cluster is used when a system can present more than one path based upon certain conditions. The cluster can appear downstream from either a conditional branch or a conditional selector. For example if the attribute being evaluated has value x, the user sees a path to page B; but if the attribute has value y, the user sees paths to both page C and page D.

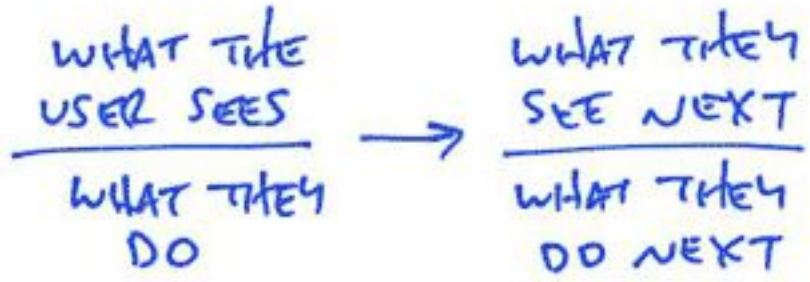
http://www.jjg.net/ia/visvocab/

📖 Jesse James Garrett (2016)

Ryan Singer's Shorthand Style for Flow Diagrams

Drawing diagrams can be time-consuming and hard to update

Simple shorthand for flows that's mostly text:



Each step has two pieces of information

- ... what a person sees (above the bar)
- ... what an action does (below the bar)
- ... also ways to show choices and decisions

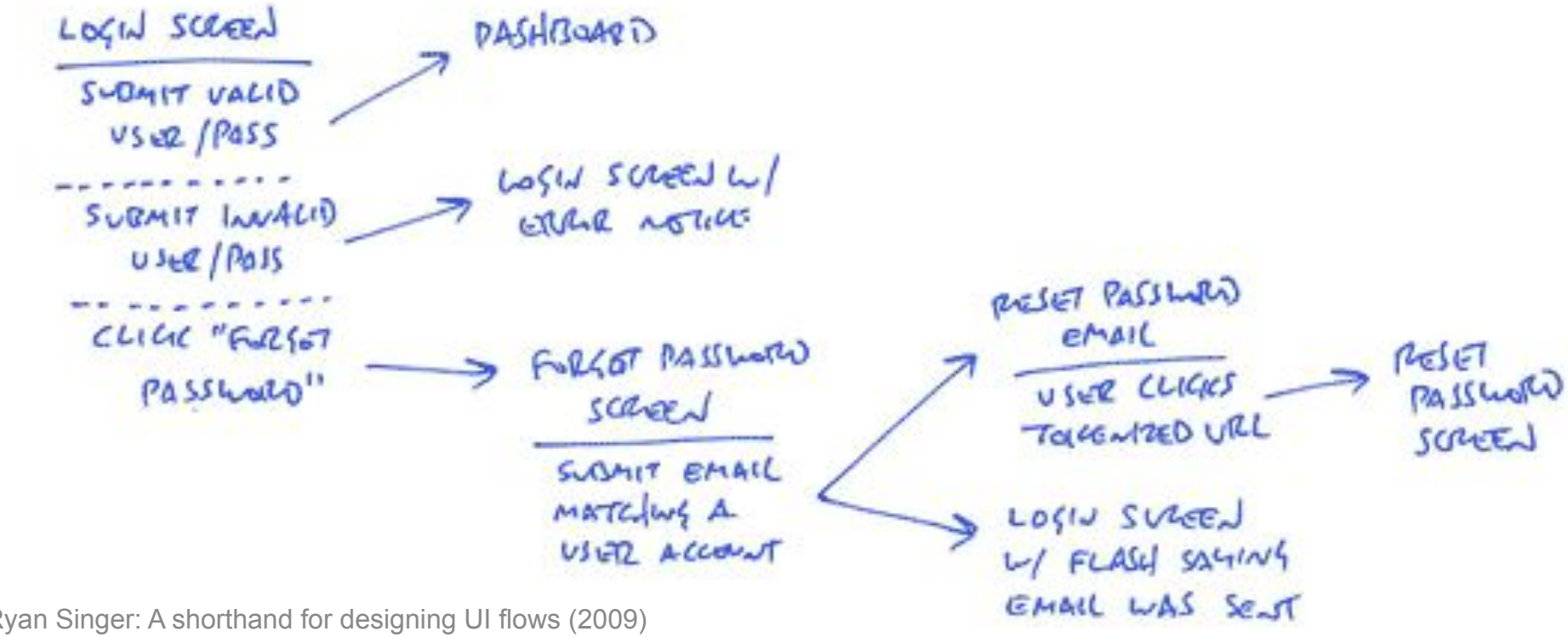
📖 Ryan Singer: A shorthand for designing UI flows (2009)

Example of Singer's Shorthand Style for Flow Diagrams

Additional notation:

... dashed line separates alternate actions

... more than one arrow indicates alternative paths

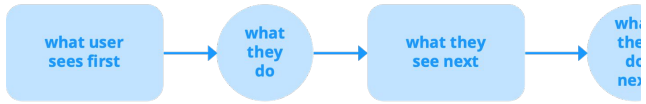


📖 Ryan Singer: A shorthand for designing UI flows (2009)

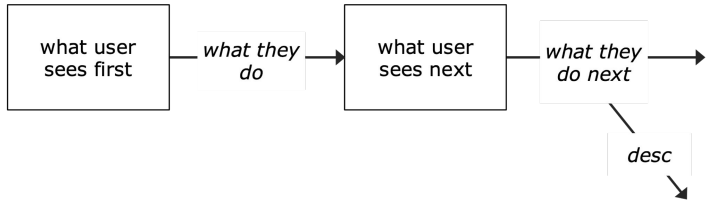
Which Diagram Style Should You Use?

For this course, it's your choice ... choose one, modify if necessary, and use it consistently through project

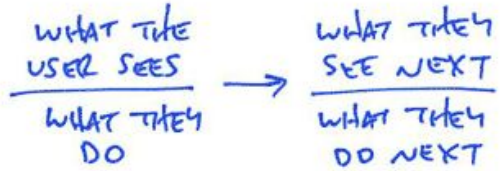
Flowchart Style



Boxes and Arrows



Singer's Shorthand



Flow Suggestions

A typical flow has 5 – 10 main steps

... less than 5 might suggest to little detail or too simple goal

... more than 10 might suggest a poor design or multiple goals

Focus on a primary sequence of steps to a main goal

... ok to sketch alternative flows in same diagram if closely related

Use 1 to 5 words to describe steps, actions, decisions

... some steps may be obvious to describe, e.g. "Main Screen"

... others may need interface details, e.g. "Map showing store locations"

Focus on ideation, use drawing method that's fast and easy to iterate

... can be hand drawn, but then harder to iterate and share

... tools like Figma and Miro are relatively fast and easy to iterate and share

Flows are about UX

Flows capture how interfaces change from the point of view of who's using it ... each flow is focused on a specific goal

The purpose of a UX flow is not the flow of the ...

❌ underlying technology ...
❌ development methodology ...
❌ person implementing the design

Flows vs.

Flows describe how someone will use your application

... ideation stage to find solution for goals, needs, and problems
... early design tool

Flows describe application usage at the interface level

... the granularity is always what screens/pages/panels do they see and what actions do they do to move between screens/pages/panels

Hierarchical Task Analysis

HTA is a model of what people do now

... empathy stage to understand current goals, needs, and problems
... a data synthesis tool

HTA models a task at multiple levels of abstraction

... the granularity depends on your research questions and results

Flows vs.

Flows describe how someone will use your application

... ideation stage to find solution for goals, needs, and problems
... an early design tool

Flows describe steps through an interface to reach a goal

... the task steps describe which screens/pages/panels are used

Storyboards

A storyboard envisions how an application can fit into someone's life

... ideation stage to convey the their environment and their emotions
... a motivational vision tool

A storyboard portrays this person and their steps to reach a goal

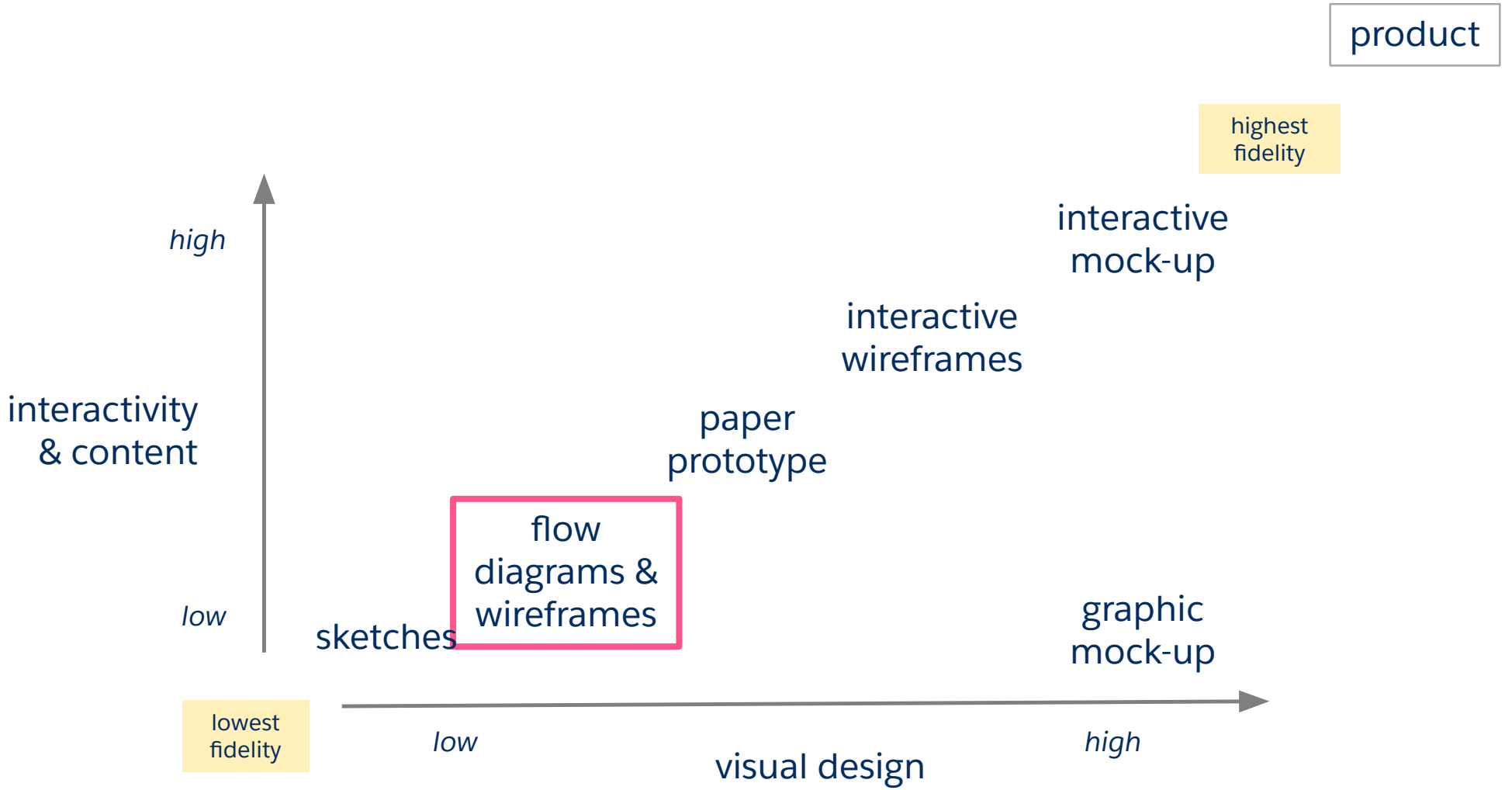
... the task steps are high level and some of the interface is included

HINT: You can user your storyboards to kick start ideas about your flows!

Wireframes

Static representation of high level layout, content, and controls in an interface

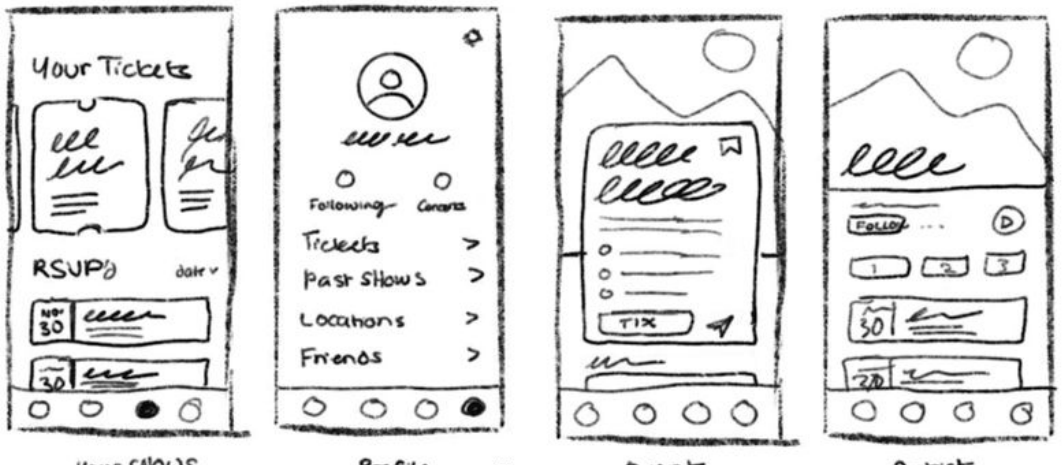
Prototype Fidelity

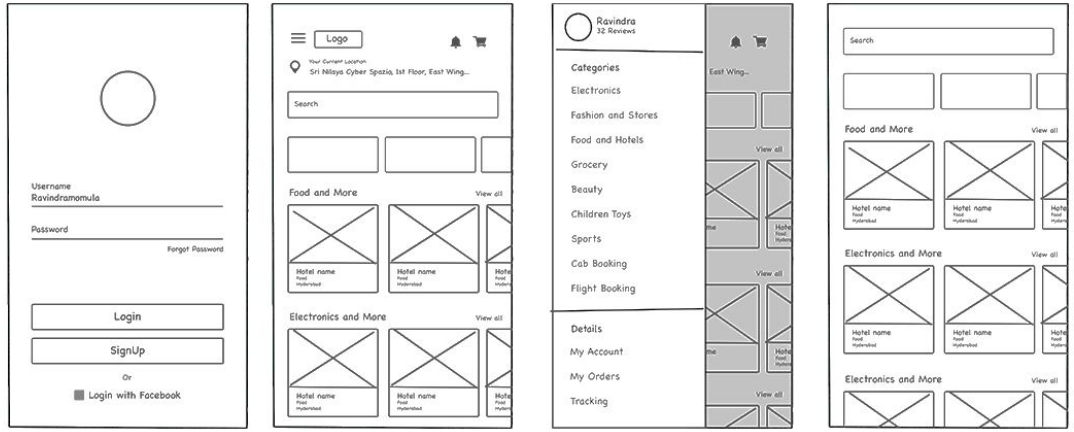


📖 Kyle Murphy: The 5 Dimensions of Prototype Fidelity (2019)

Wireframes

Static representation of high level layout, content, and controls in an interface … can be a screen, a page, a panel in a screen, etc.





📖 sketch.com: 10 Wireframe examples for mobile apps and websites (2026)

Wireframes are “Sketches”

Illustration of the essential elements without visual design

… Fast and simple

… Doesn’t have to look good

… Focus on brainstorming and communication





📖 Jason Fried: Sketching with a Sharpie (2007)

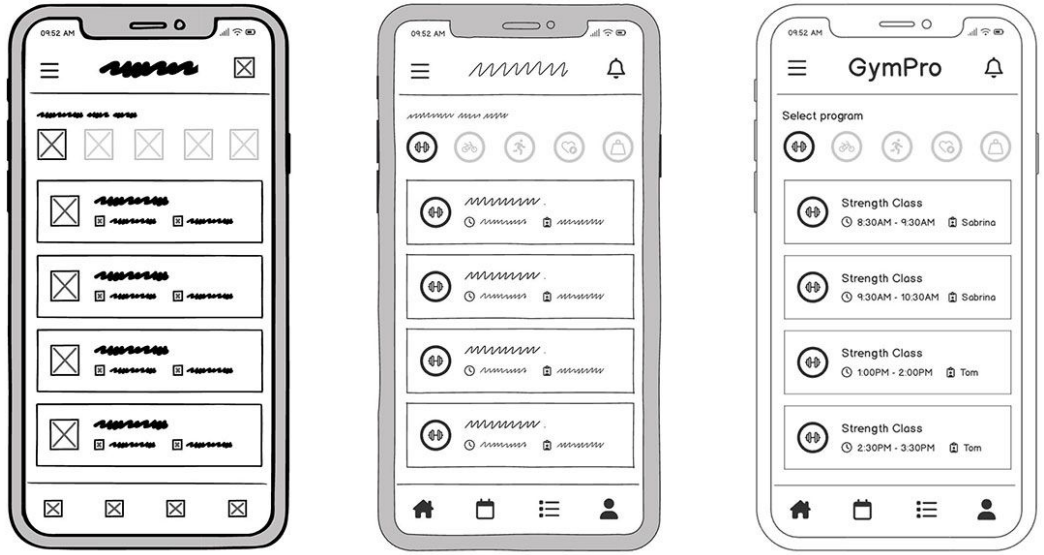
Wireframe Fidelity

Low-fidelity wireframes focus on layout and functionality without getting distracted by visuals.

- ... Basic shapes
- ... Grayscale colors
- ... Placeholder text

High-fidelity wireframes are more detailed and closer to the final design

- ... Real content,
- ... Precise spacing
- ... Early visual styling to show how the interface will actually look and work.



📖 Nick Babich: How to create mobile app wireframes (in just 8 steps) (2025)

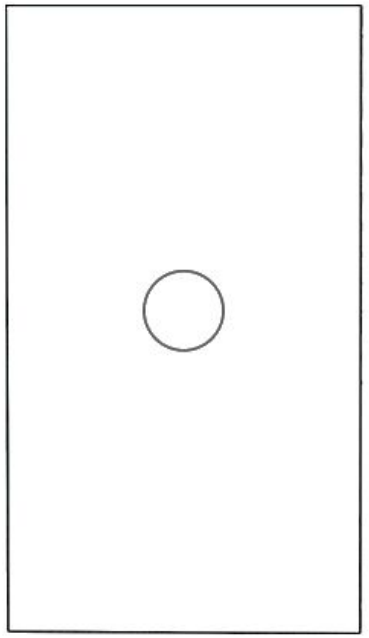
Guidelines for Wireframe Sketching

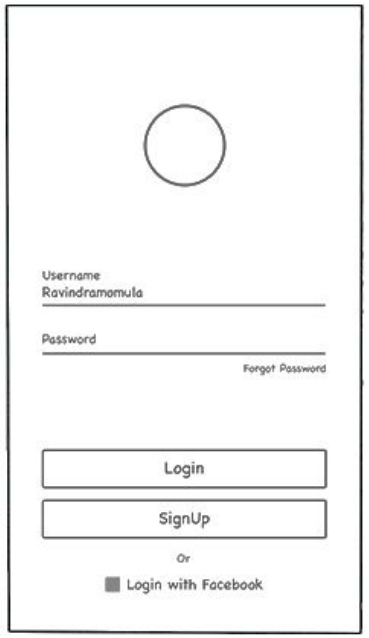
The visual vocabulary for wireframes should be fast to draw and keep the focus on interface structure and interaction, not graphic design

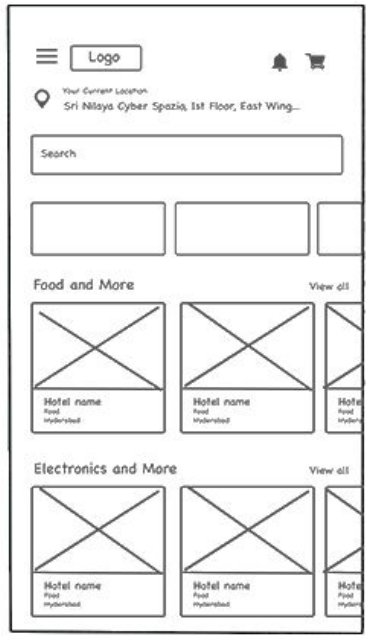
Suggestions

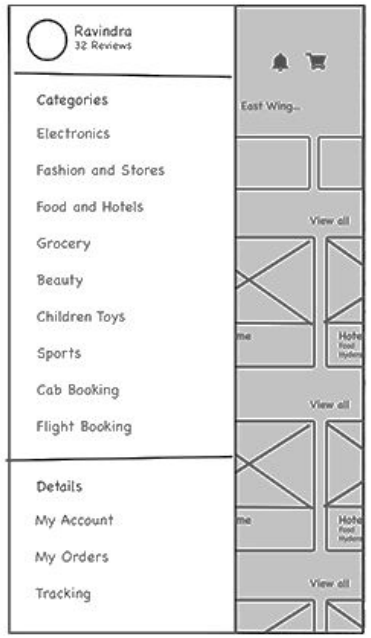
- … Stick to black, white, and shades of grey
- … Use a generic font like Arial or Verdana
- … Simple geometry like bounding boxes to convey structure
- … Use words and representative drawing for important elements
- … Use layout to indicate importance of content and UI controls

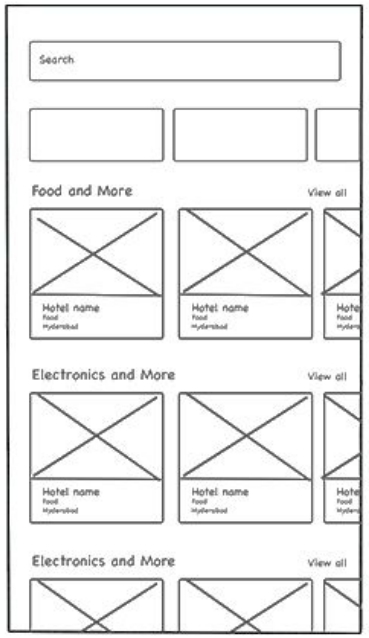

Popular
Recommended
HOME
Search
Upcoming
Genre
ROCK
BLUES
SEARCH
Your Tickets
RSVP'd
YOUR SHOWS
Following
Tickets
Past Shows
Locations
Friends
Profile
TIX
Event
Artist
Top For You
Similar
HOME
Search...
SEARCH POP UP
Yours
Past Shows
TICKETS
Filter
NEWS
RSVP
RSVPs
Profile

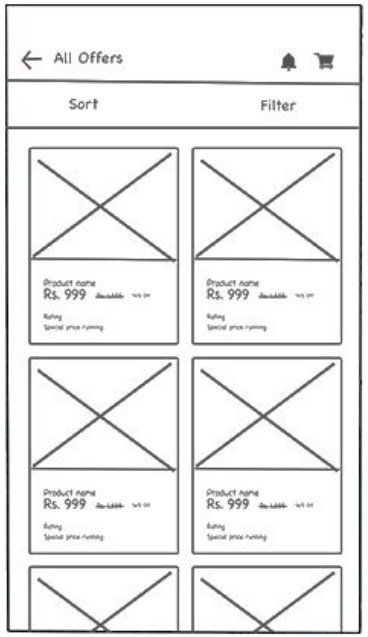


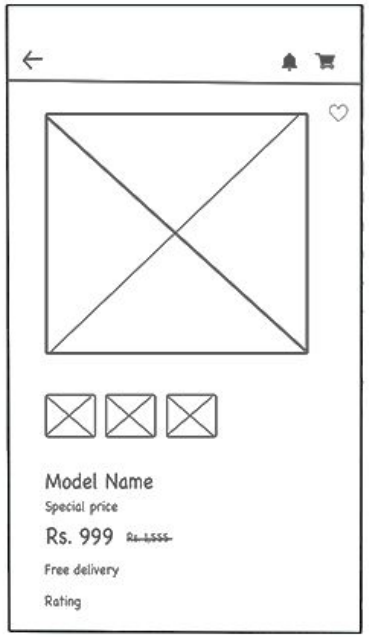

Username
Ravindramamula
Password
Forgot Password
Login
SignUp
Or
Login with Facebook

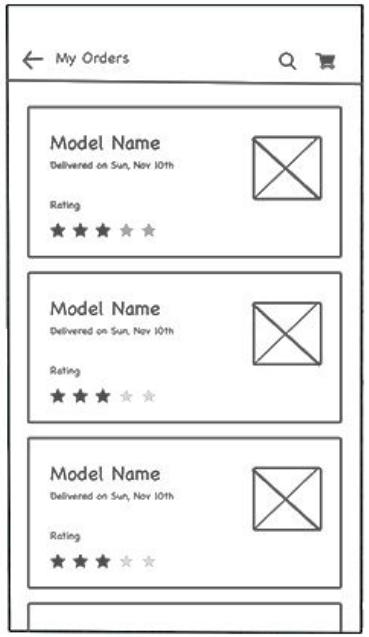

Logo
Your Current Location
Sri Nilaya Cyber Spazia, Ist Floor, East Wing...
Search
Food and More
View all
Hotel name
Food
Hyderabad
Electronics and More
View all
Hotel name
Food
Hyderabad

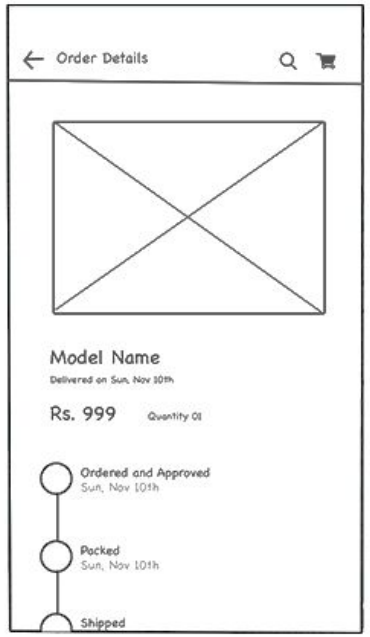

Ravindra
32 Reviews
Categories
Electronics
Fashion and Stores
Food and Hotels
Grocery
Beauty
Children Toys
Sports
Cab Booking
Flight Booking
Details
My Account
My Orders
Tracking
East Wing...
View all
View all
View all


Search
Food and More
View all
Hotel name
Food
Hyderabad
Electronics and More
View all
Hotel name
Food
Hyderabad
Electronics and More
View all


All Offers
Sort
Filter
Product name
Rs. 999
Rating
Special price running


Model Name
Special price
Rs. 999
Free delivery
Rating


My Orders
Model Name
Delivered on Sun, Nov 10th
Rating
Model Name
Delivered on Sun, Nov 10th
Rating
Model Name
Delivered on Sun, Nov 10th
Rating


Order Details
Model Name
Delivered on Sun, Nov 10th
Rs. 999
Quantity 01
Ordered and Approved
Sun, Nov 10th
Packed
Sun, Nov 10th
Shipped

But Interaction Takes Place in Time and Space

We need ways to ideate and design what an interface looks like and how it changes based on actions

Temporal:

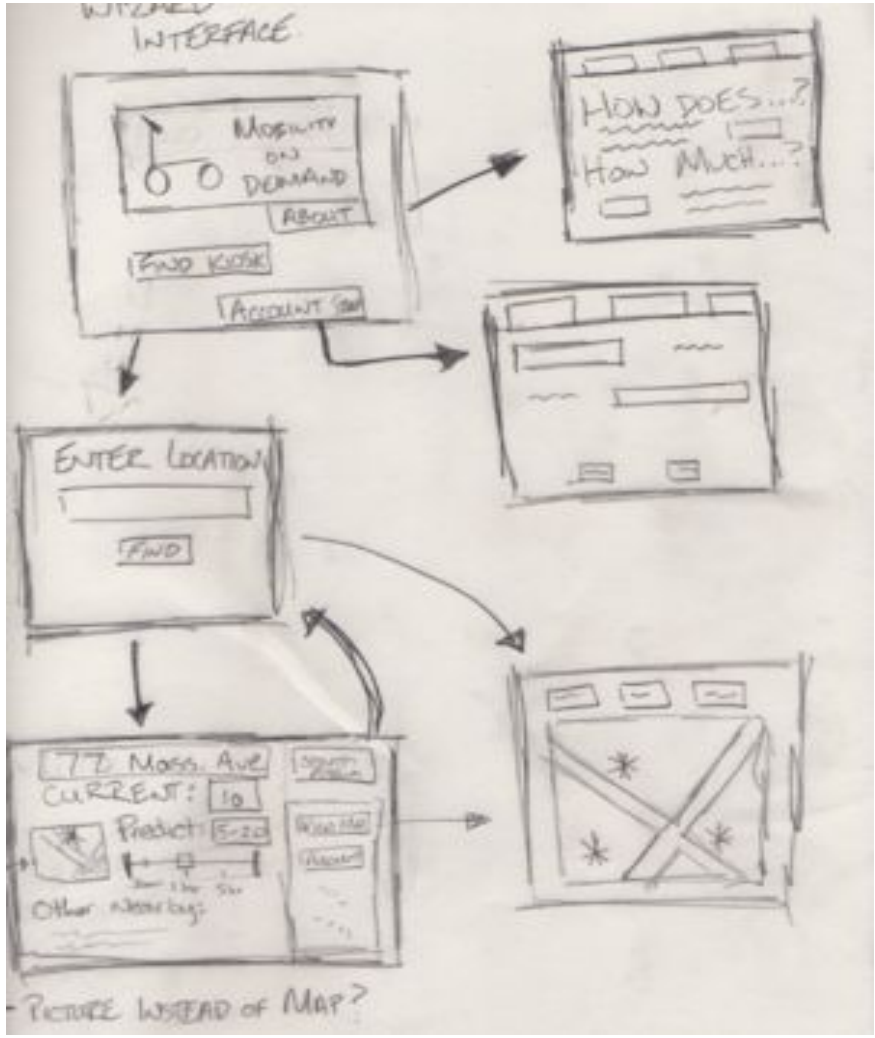
... when components appear or change in an interface

... the "flow" from one interface to another

Spatial:

... where components appear in an interface

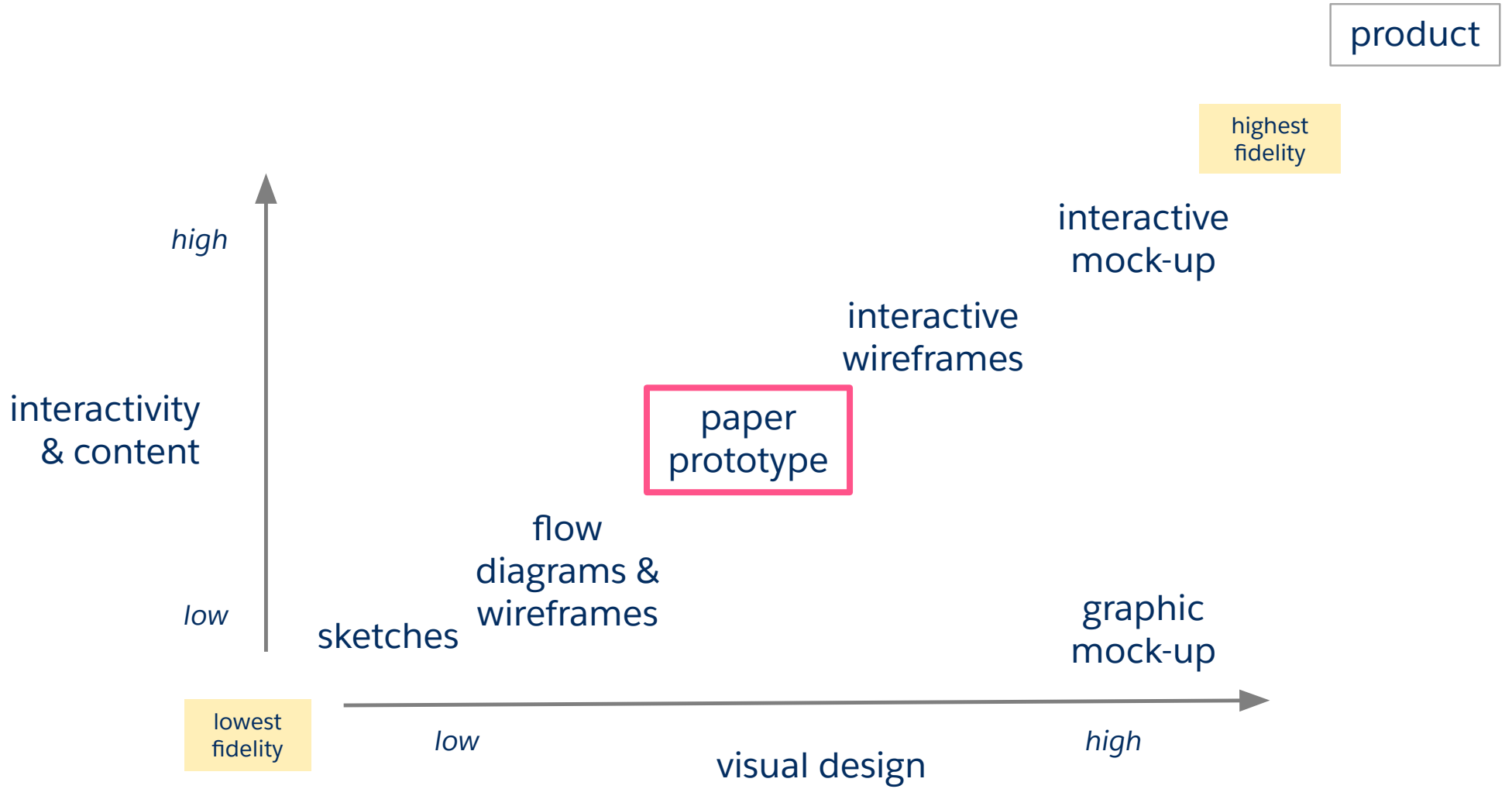
... the "layout" of an interface



Paper Prototypes

A low-fidelity prototype created from interface sketches, made interactive using a "human computer”

Prototype Fidelity



📖 Kyle Murphy: The 5 Dimensions of Prototype Fidelity (2019)

Paper Prototype

A low-fidelity prototype created from drawn sketches of the interface on paper which are made interactive using a "human computer"

Benefits:

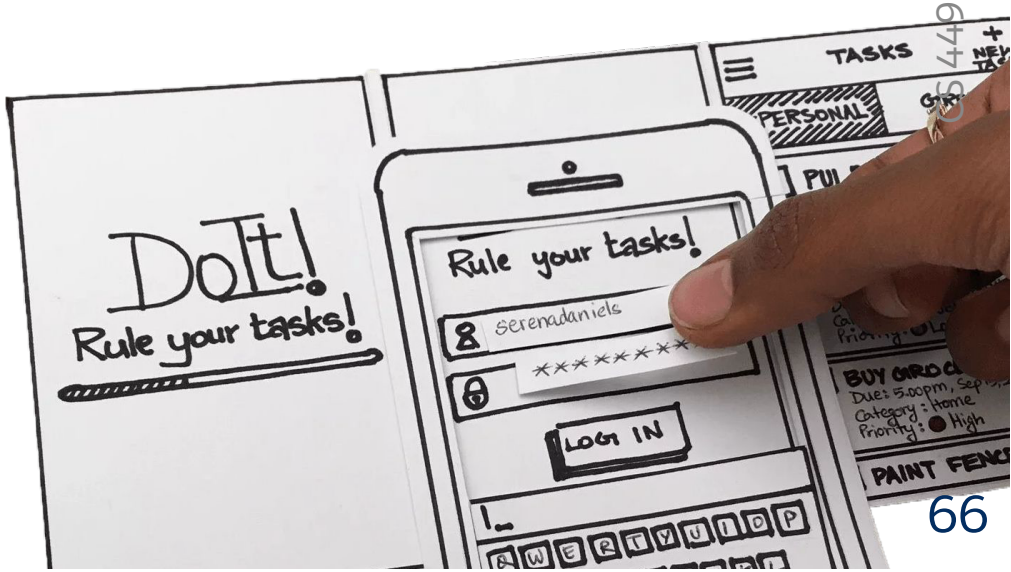
... fast to iterate, inexpensive and easy to do

... helps study participants focus on big picture, not aesthetic details

Drawbacks:

... lacks realism, hard to capture complex interactions

... testing must be in-person



📖 Kyle Murphy: The 5 Dimensions of Prototype Fidelity (2019)

Creating Paper Prototypes

Gather tools

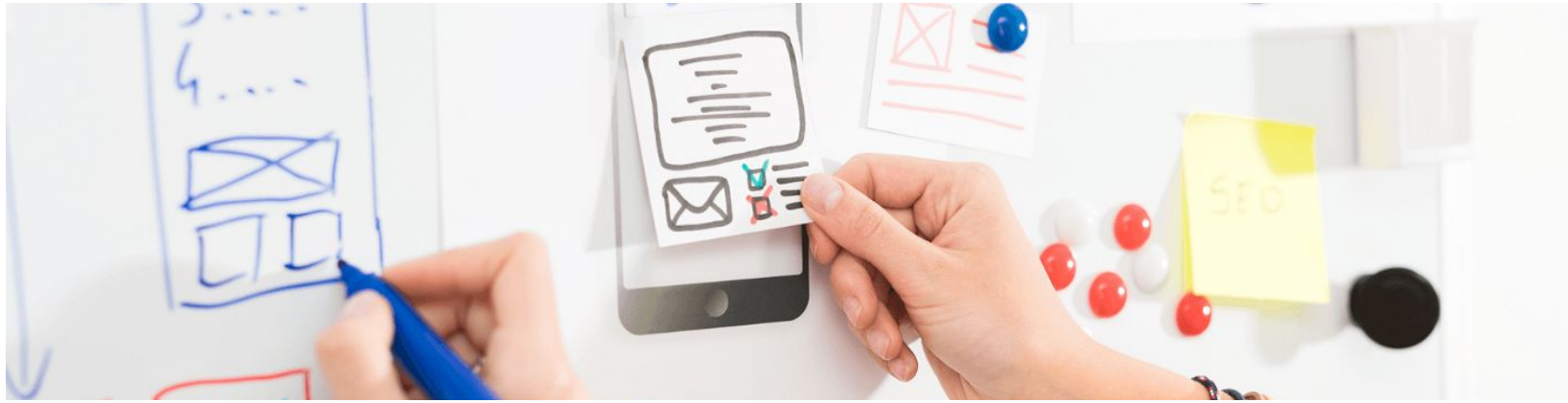
... paper, marker, scissors, transparent tape, post-it notes, highlighter

Print device templates so your sketches are a standard size

... doesn't have to be size of real device, focus on aspect ratio

Sketch each screen on a printed template

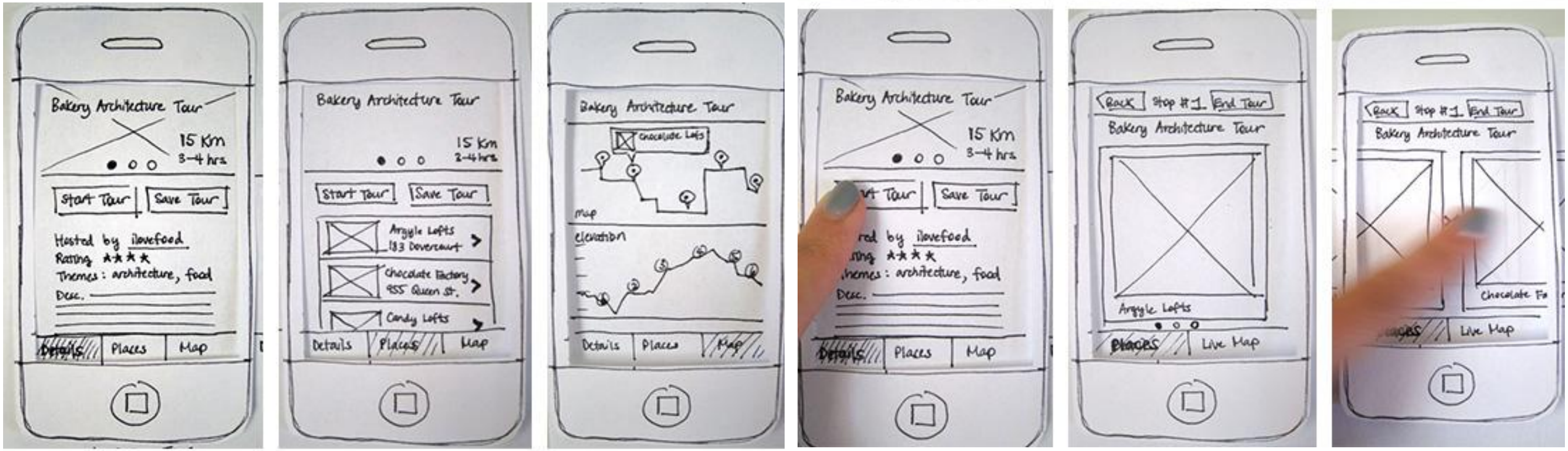
... for overlays like menus, panels, and dialogs, draw only this part on post-it or small piece of paper so it can be removed or attached



📖 Justinmind.com: Complete guide to paper prototyping (2024)

Paper Prototyping Style

Should look like a sketch
Approximate the intended layout, but keep it simple
Use a consistent style (a button should always look like a button)



Representing Widgets and More Complex Interactions

People testing your paper prototype can write in boxes, cross out checkboxes, etc. ...

Put dropdown items and menu items on sticky notes ...

Highlight selected items with transparency film with rectangle ...

Drag-and-drop can be shown by their actions ...

Scrolling panes can be simulated with cut-out window in paper ...

Fold paper and unfold for expandable content ...

"Under construction" screen when they pick options outside prototype ...

"Loading screen" to give human computer time to prepare interface change...

📖 Jakob Nielsen (Nielsen Norman Group): Paper Prototyping: Getting User Data Before You Code (2003)

Paper Prototype Interaction with Human "Computer"

1. Draw interface screens and components on paper
   ... important to use clear device frame with consistent size
   (print out templates)

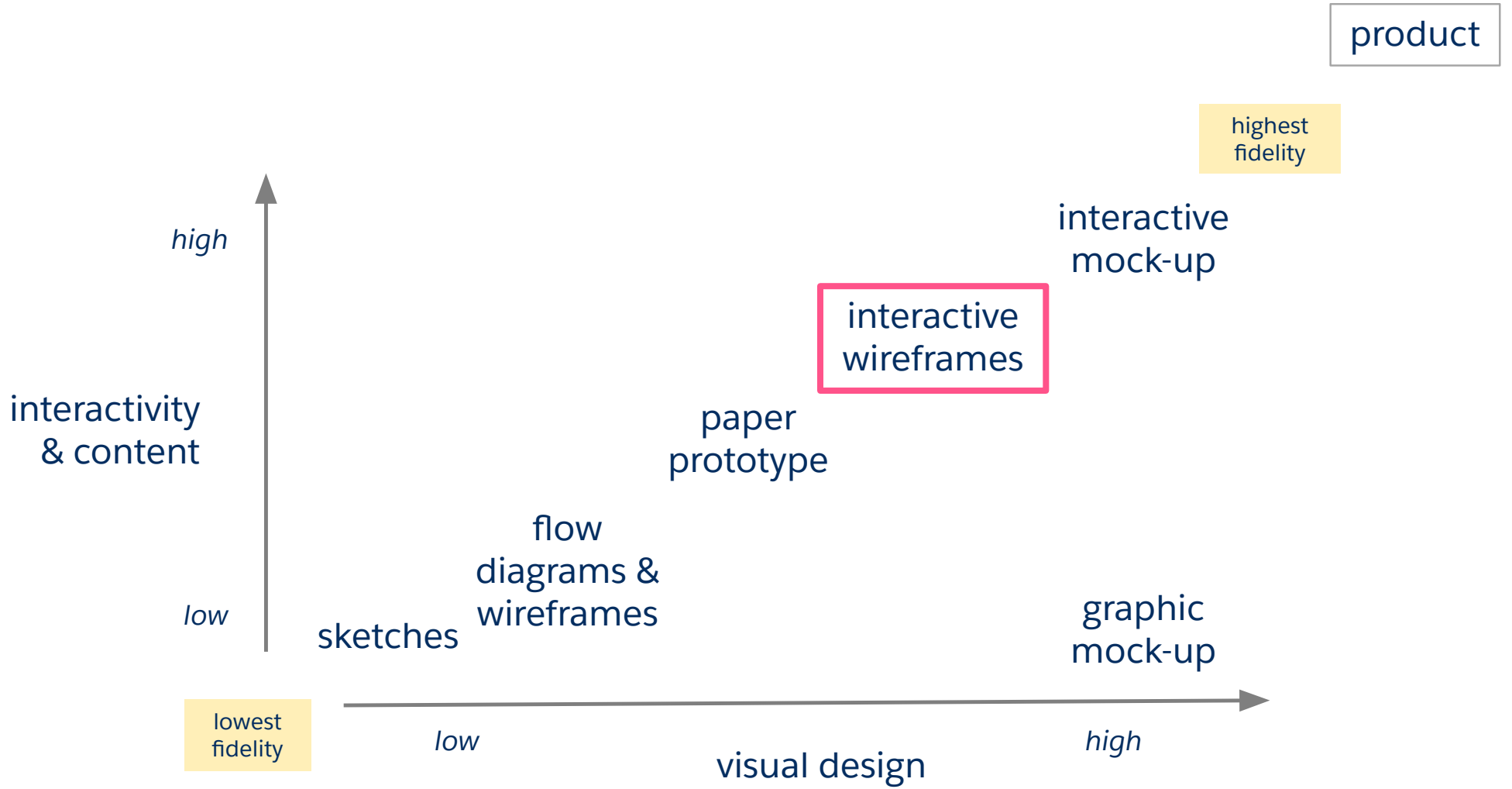
2. Create a defined space to display the current interface state
   ... this is what a study participant would look at during an evaluation
   ... this is what a camera can record to make a video demo

3. The human "computer" switches screens or components according to what a test participant does in a test or recording
   ... this is referred to as a "wizard of oz" technique

Interactive Wireframes

Low-fidelity prototype created using a digital drawing tool, made interactive using triggered animations

Prototype Fidelity



📖 Kyle Murphy: The 5 Dimensions of Prototype Fidelity (2019)

Interactive Wireframe Prototype

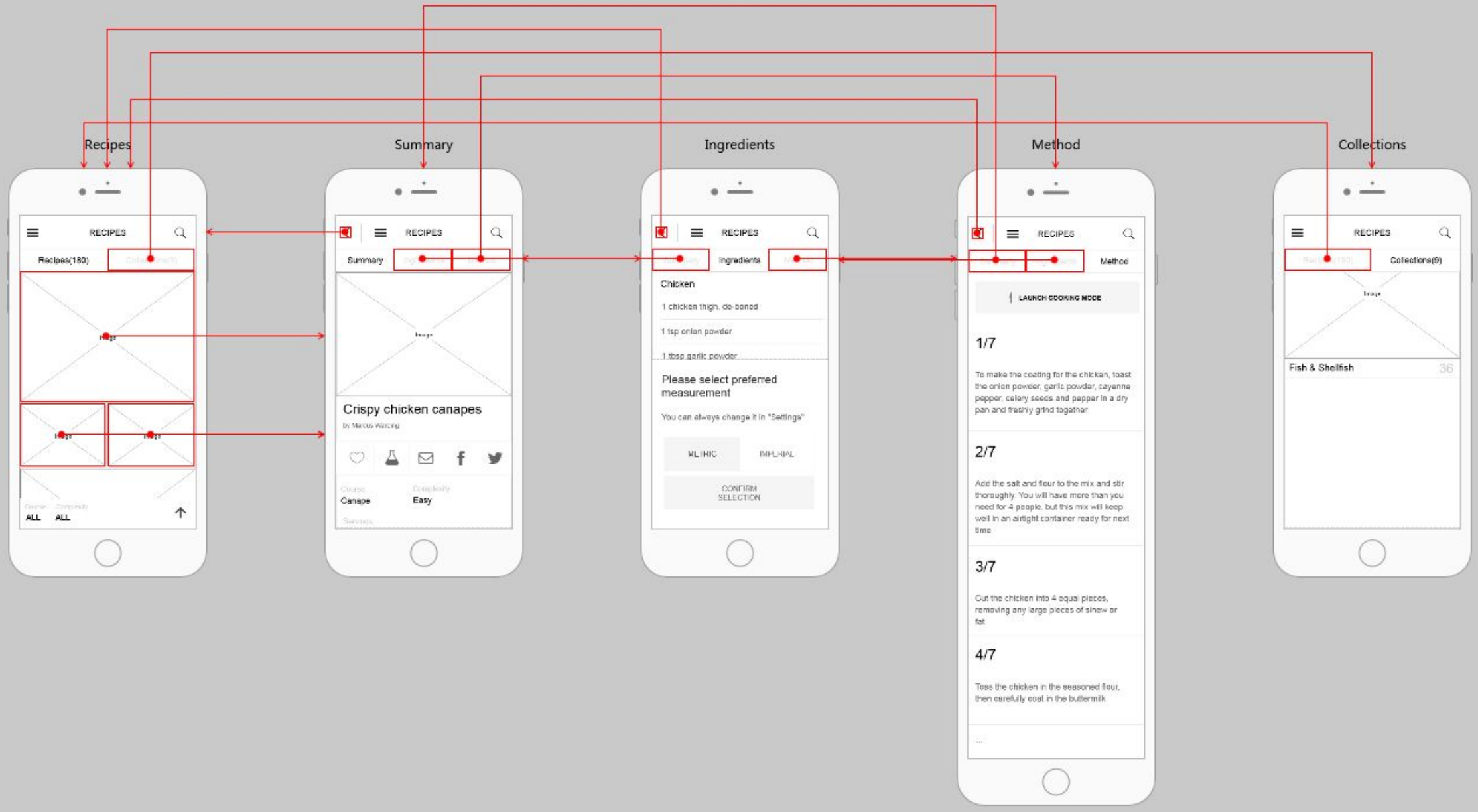
A low-fidelity prototype created using a digital drawing tool and made interactive using triggered animations

Benefits

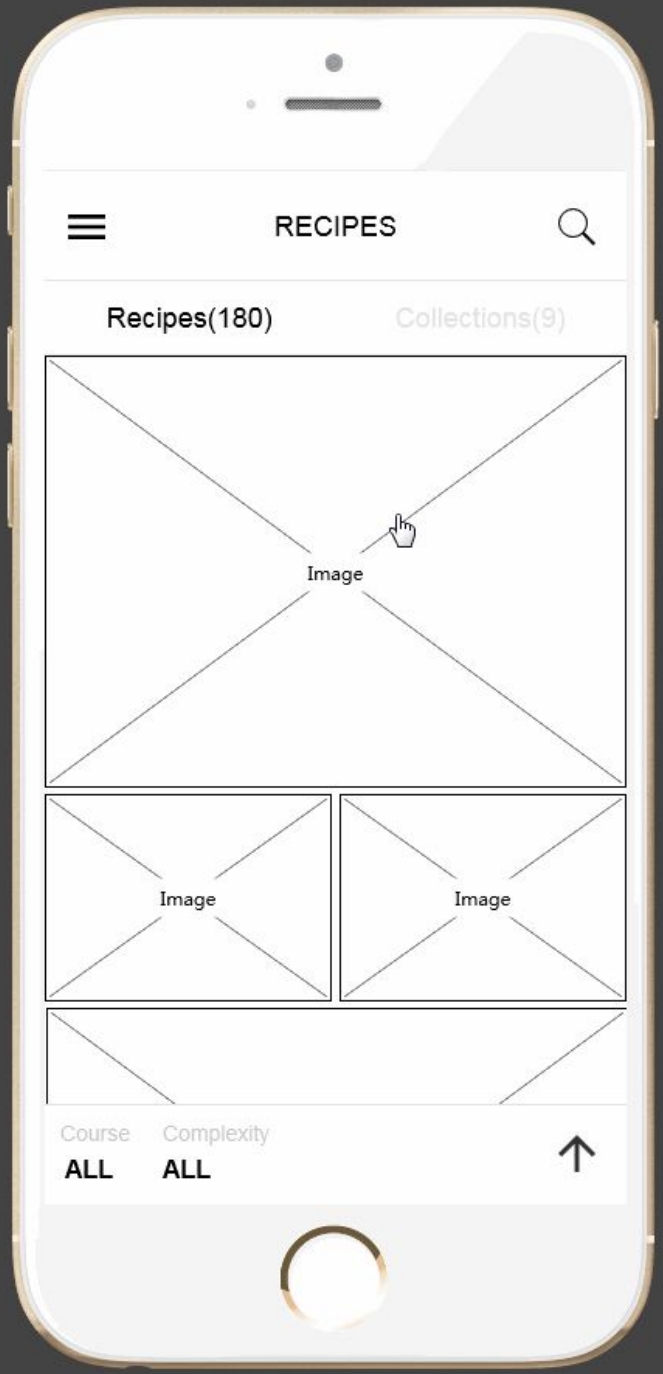
... easier to test, even remotely
... can be fast to create using copy/paste, components, styles, etc.

Drawbacks

... typically requires specialized software (e.g. Figma)
... can be harder for designer to not focus on details
... can be harder for test participant to not focus on details



mockplus.com/sample/post/recipes-2/?r=trista



mockplus.com/sample/post/recipes-2/?r=trista

Figma Low-Fidelity Wireframe Prototyping

1. Setup a device size and choose "None" for Prototype Device

2. Draw low-fidelity versions of screens and components using shapes/text
    ... keep it simple, grayscale, and show representative content
    ...can use libraries like "Paper Wireframe Kit" (but not necessary)

3. Use Figma "Prototype" tab to simulate interaction
    ... tap interaction to navigate to another frame
    ... add component instances and variants to simulate widget interactions

Paper Prototype Interaction with Figma

1. Draw interface screens and components on paper
   ... important to use clear device frame with consistent size

2. Capture drawings with phone camera (... crop and rectify images)

3. Import images into Figma

4. Draw transparent rectangles over widgets you want to add interactivity (... buttons, menus, etc.)

5. Use Figma "Prototype" tab to simulate interaction
   ... tap interaction to navigate to another frame
   ... add component instances and variants to simulate widget interactions

Fidelity of Content

Prototypes should use realistic content (words, images)

- ... can be very simplified, but should be understandable as "content"
- ... "Gibberish" text can confuse participants (i.e. avoid "lorem ipsum ...")

Avoid using colour for graphic design

- ... use black pen on white paper, or grayscale digital drawing
- ... some colour can show emphasis (i.e. primary button, overlay dialog)

Resist the urge to polish the graphic design and layout

- ... use single simple font with normal, bold, italic styles
- ... hand drawn style better than crisp aligned graphics

Paper Prototypes

Pros:

- Fast to create and update
- Everyone can do it
- Realize out-of-the-box designs

Cons:

- Hard to interpret design
- Testing only in person
- Need to turn into digital

vs. Interactive Wireframes

Pros:

- More realistic
- A tester can interact with it themselves

Cons:

- Take more time to create
- Require design tools
- Constrained by design tools

HINT: You can user your storyboards to kick start ideas about your flows!

UX Prototyping: Low to High

Low-Fidelity Prototypes → Design Specifications, Interaction Sequences, Interface Schematics

Design Specifications

Flows and / or wireframes that include enough detail so that someone could begin designing and implementing system logic ...

... Visual arrangement of content/information
... Functionality of interface (widgets, forms, data)
... Navigational and content ordered to convey structure and meaning
... Indicates the relative significance of all elements

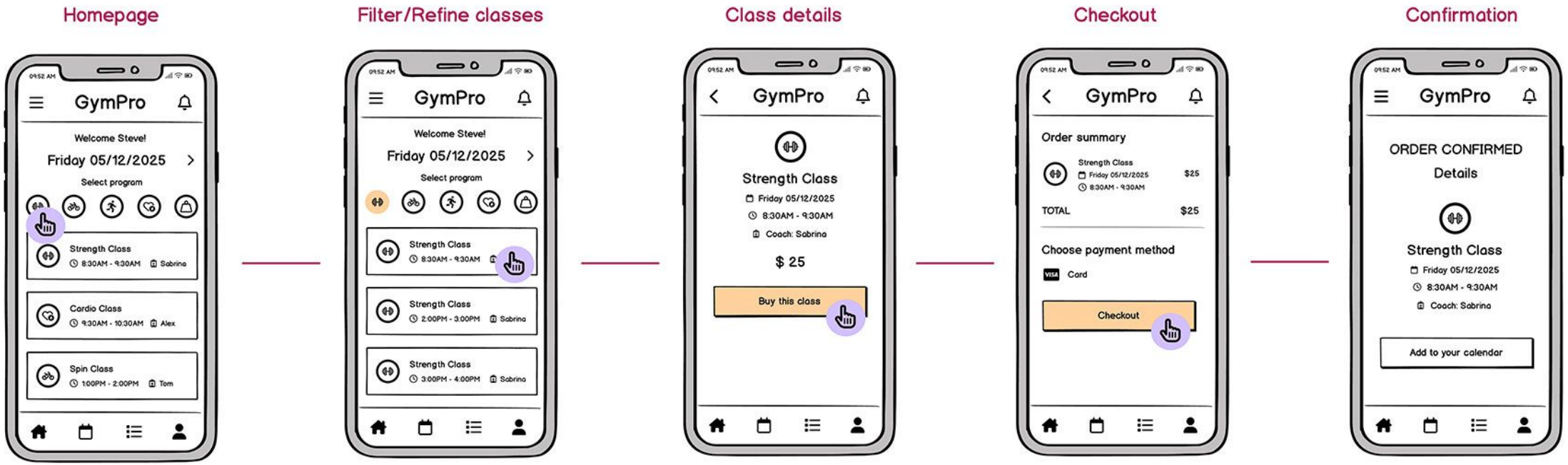
Used after ideation, for prototyping or implementation

... often includes important aspects of system functionality
... important for communicating interaction design to broader team

Interaction Sequences & Interface Schematics

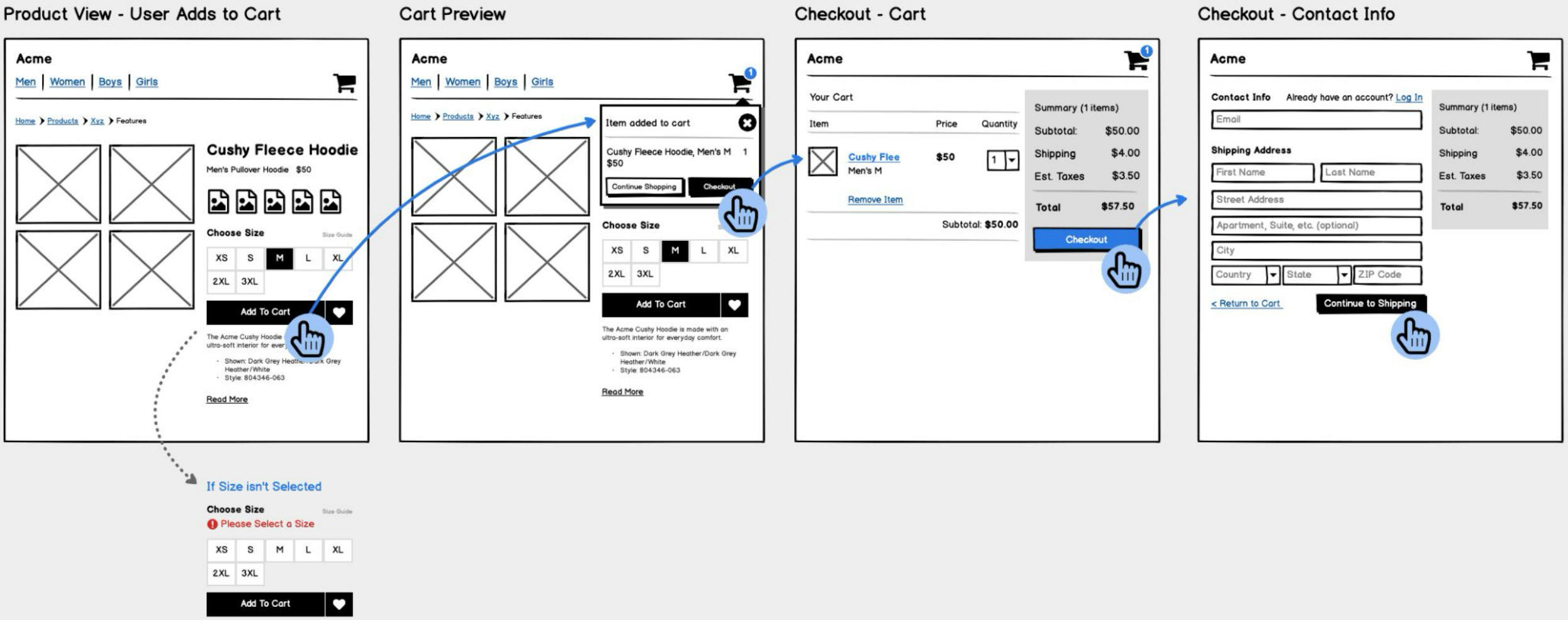
Interaction Sequences convey the "big picture“ of system interaction, like flows, but captures full interface structure

Interface Schematics convey essential content, and functionality at individual steps of interaction, like wireframes, but more detailed and descriptive

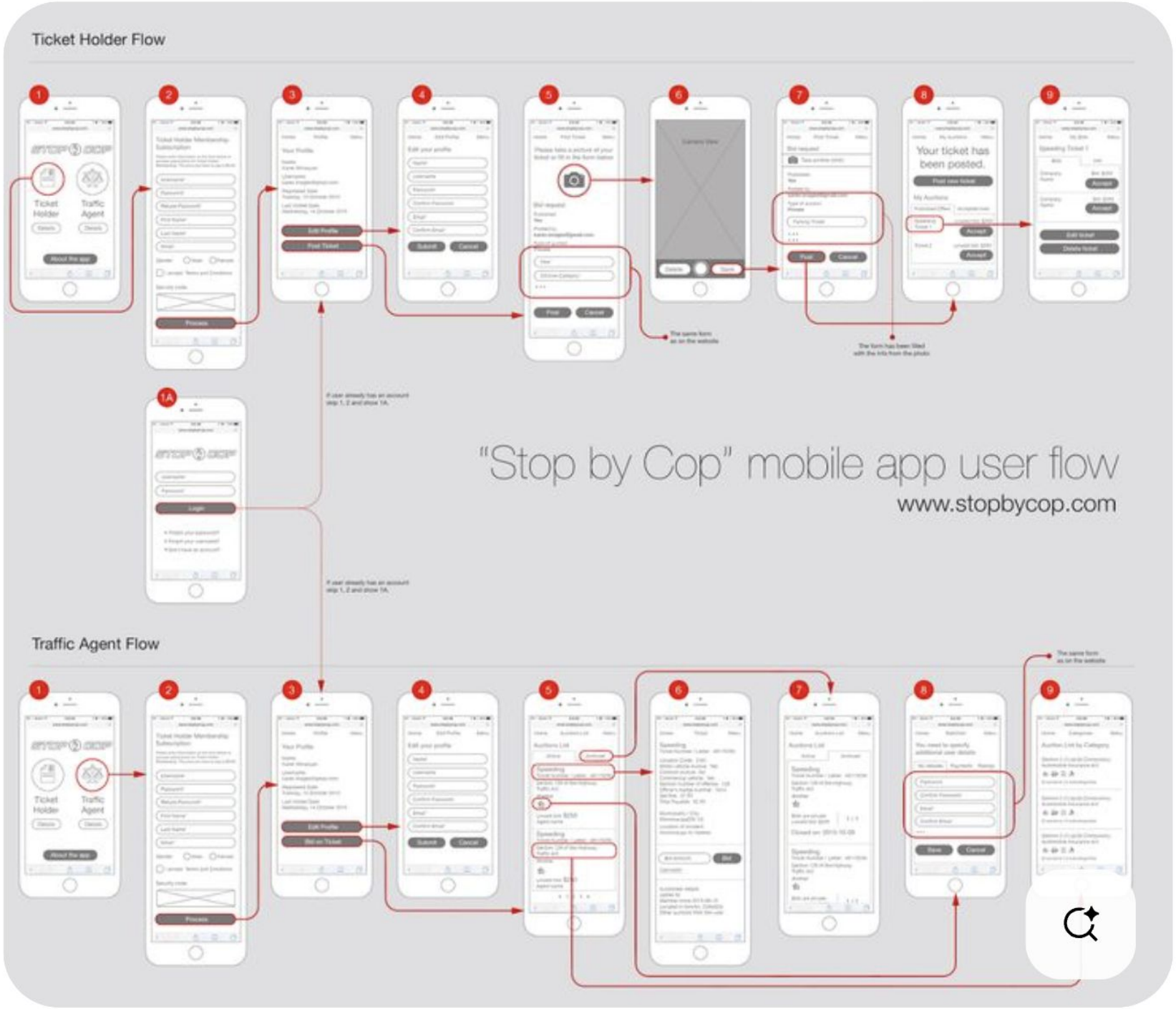


📖 Nick Babich: How to create mobile app wireframes (in just 8 steps) (2025)

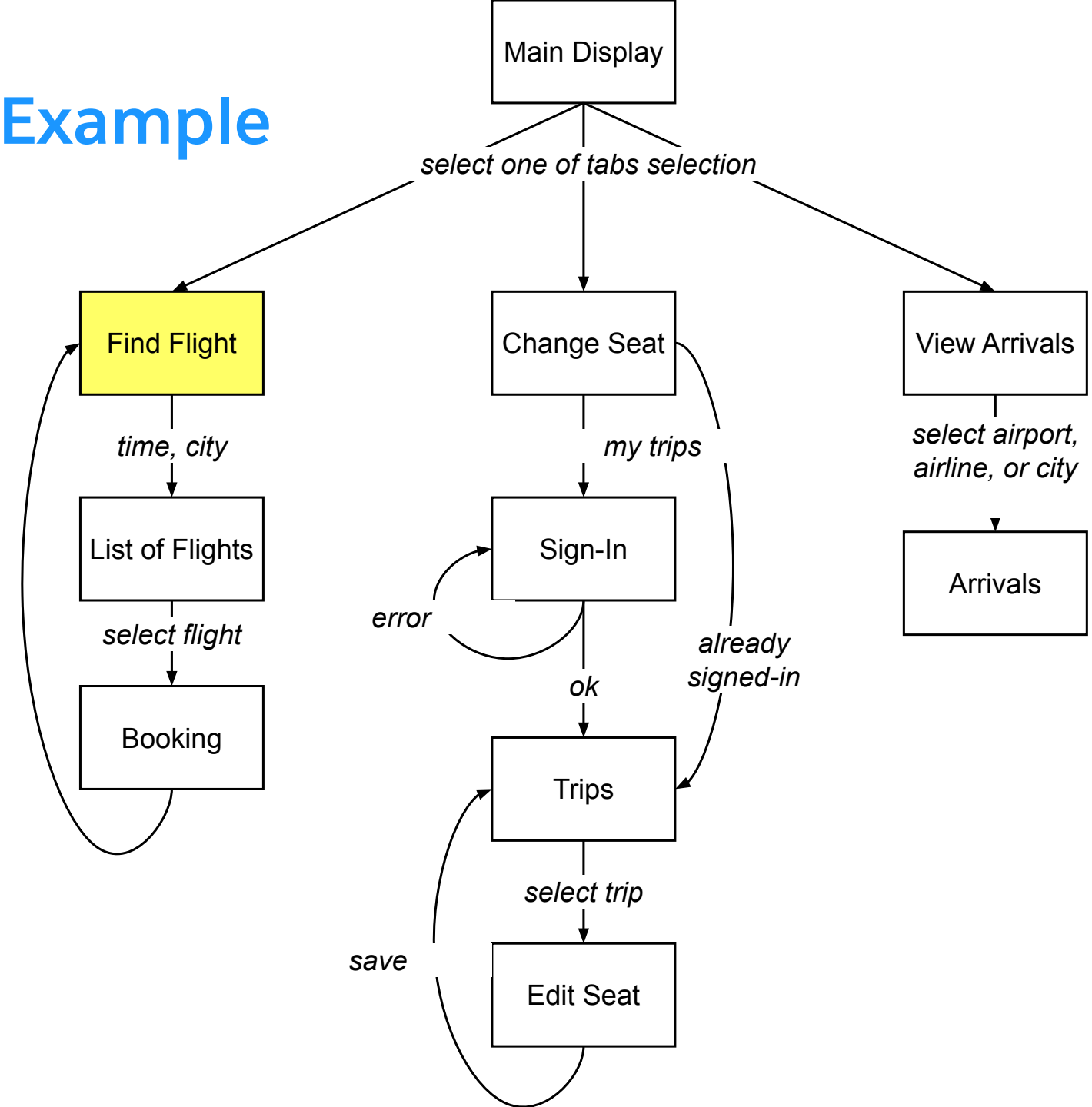
Interaction Sequence Example



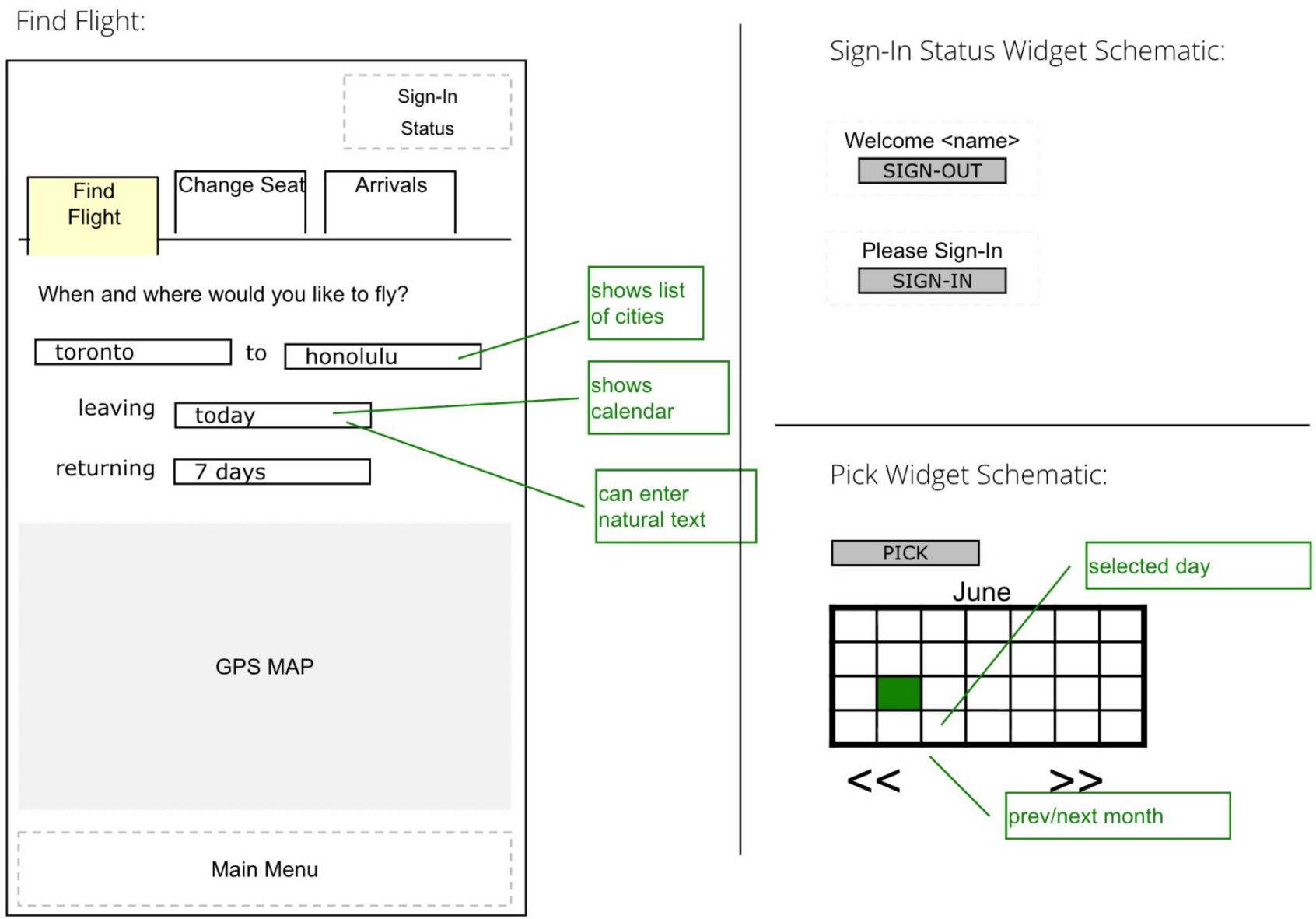
📖 Mike Angeles: Wireflows: A beginner's guide to clearer UI design (2025)


Ticket Holder Flow
"Stop by Cop" mobile app user flow
www.stopbycop.com
Traffic Agent Flow

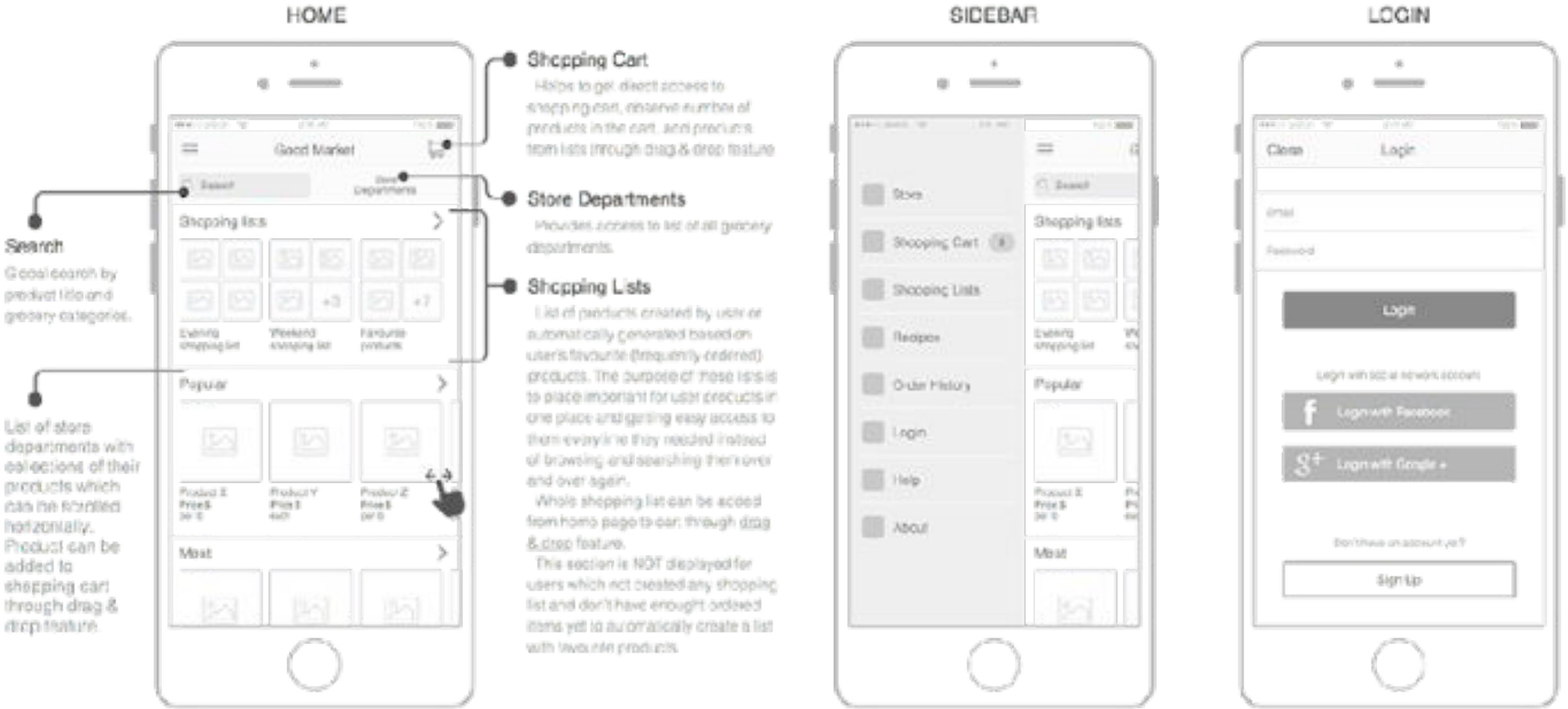
Interaction Sequence Example



Interaction Schematic Example



Interaction Schematic Example



Building Flows From Sketches



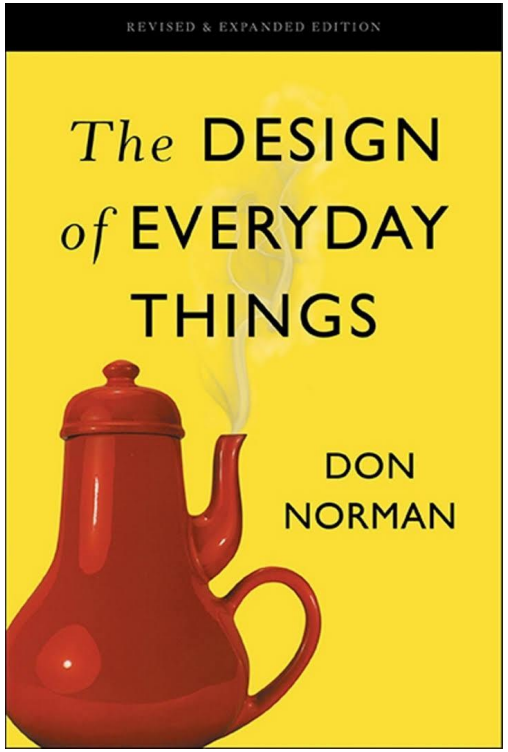
in.pinterest.com/pin/sketching-planning-creative-app-design-layout--1548181166028284/


Class Name
Topics
Your question

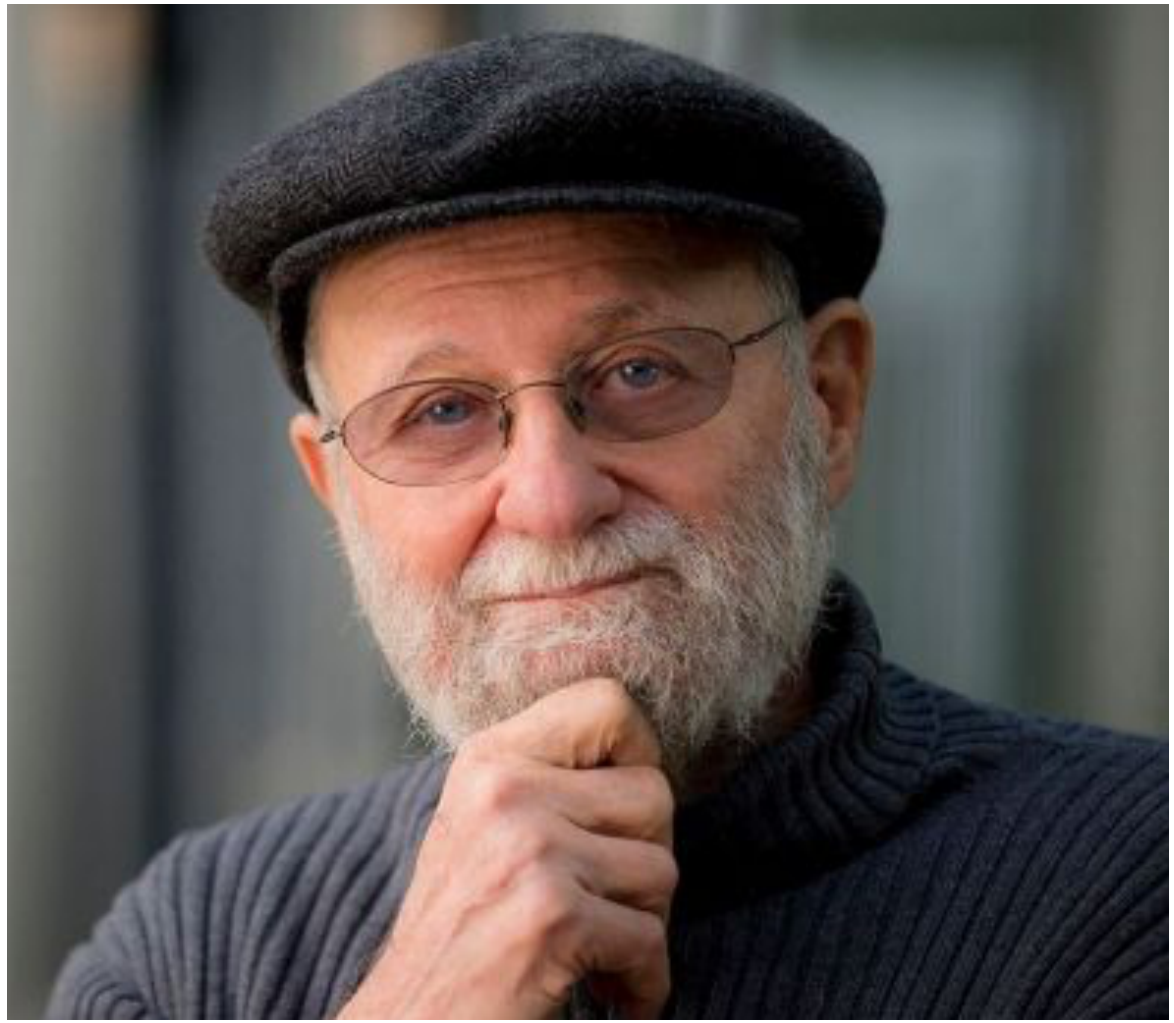
Models & Design Principles for Interaction

Affordances, Signifiers, Constraints, Feedback, Discoverability, Mapping

Don Norman
Nielsen Norman Group, UCSD Design Lab



Don Norman, *The Design of Everyday Things*, 1988



Norman's Models of Interaction

Illustrate the cognitive journey people undertake when interacting with systems,

Highlighting the critical points where misalignments between a person's intent and system design lead to usability issues

> ... Aims to minimize the gap between what someone intends to do and what the system allows and communicates
>
> ... Also aims to minimize the gap between the system's output and a person's ability to understand it.

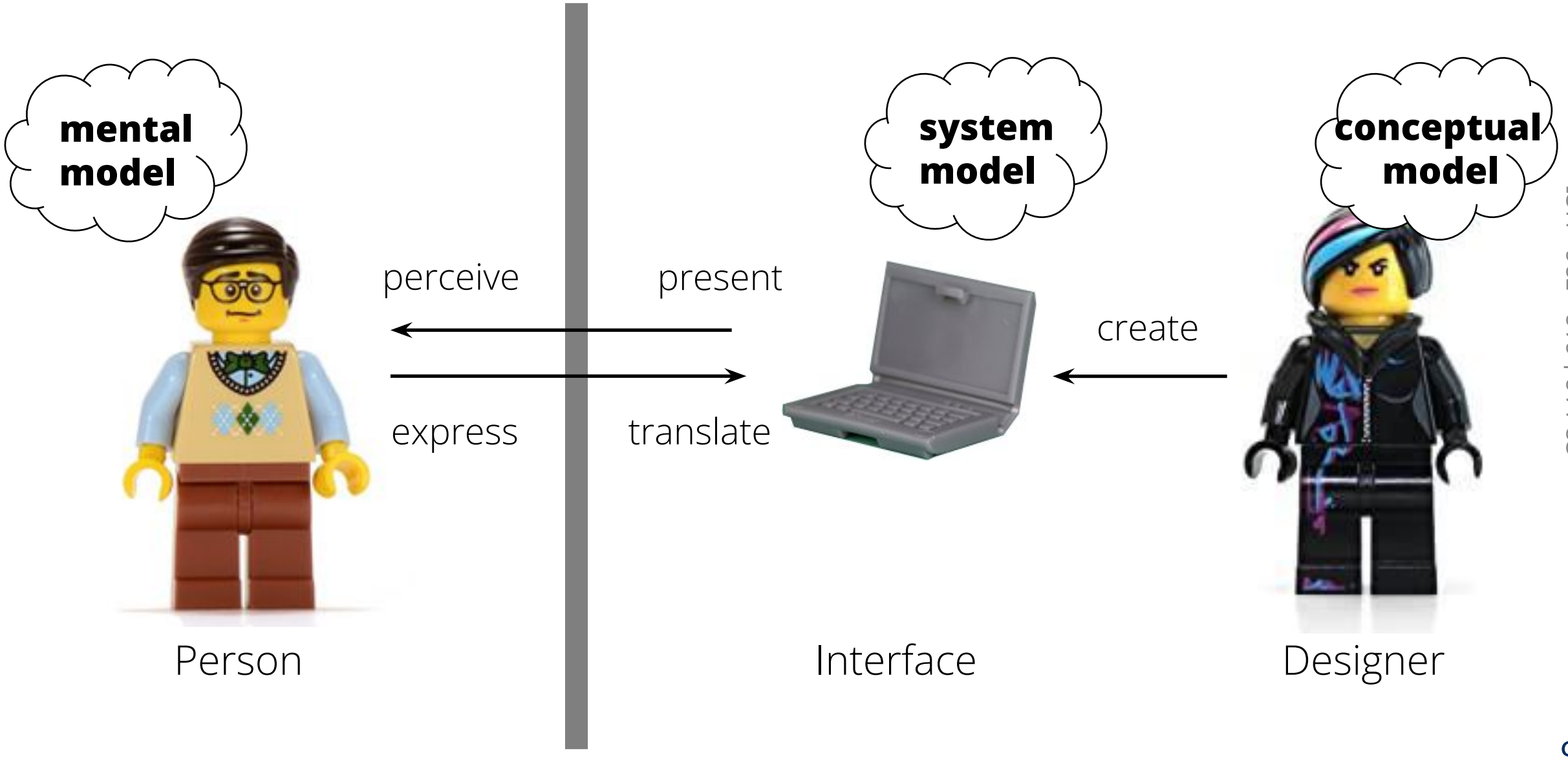
Norman's Models of Interaction

Mental Model (Human):
The internal representation a person has of how something works, formed through experiences and understanding

System Model (Interface):
The actual, visible, and interactive representation of how the system functions, conveyed through the interface and its behaviours

Conceptual Model (Designer):
The high-level, abstract design plan and underlying logic created by the designer that dictates how the system is intended to work.

Norman's Models of Interaction



Mental Models

What someone believes about the system (how it works, what state it's in)
"if I do _____, the system will do _____"
"the system is _____ right now"

Frequently, a mental model is inaccurate or incomplete compared to actual system model

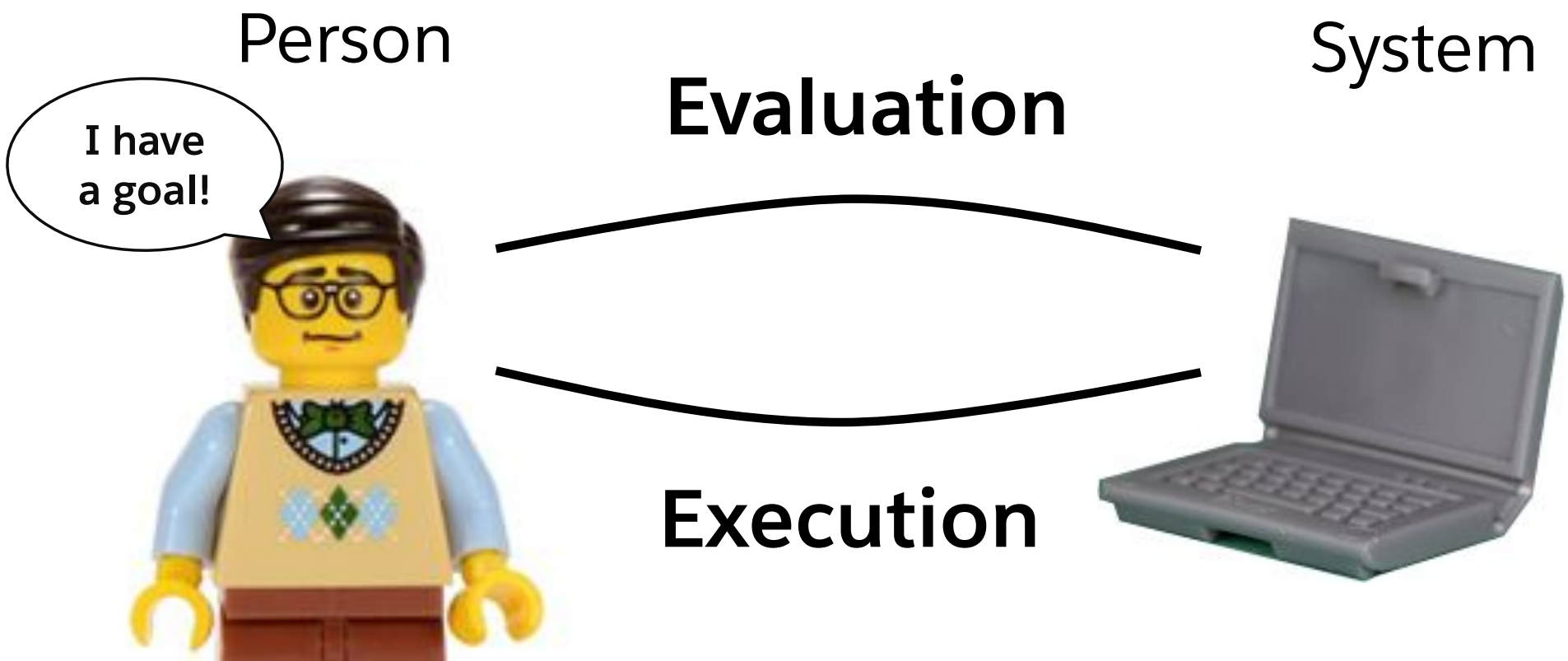
There's lot of interesting academic research around:

- ... Understanding & externalizing a person's mental models
- ... Helping them evolve their mental models

Norman's Models of Interaction

Execution: What we want to do to the system

Evaluation: Comparing what happened with our goal

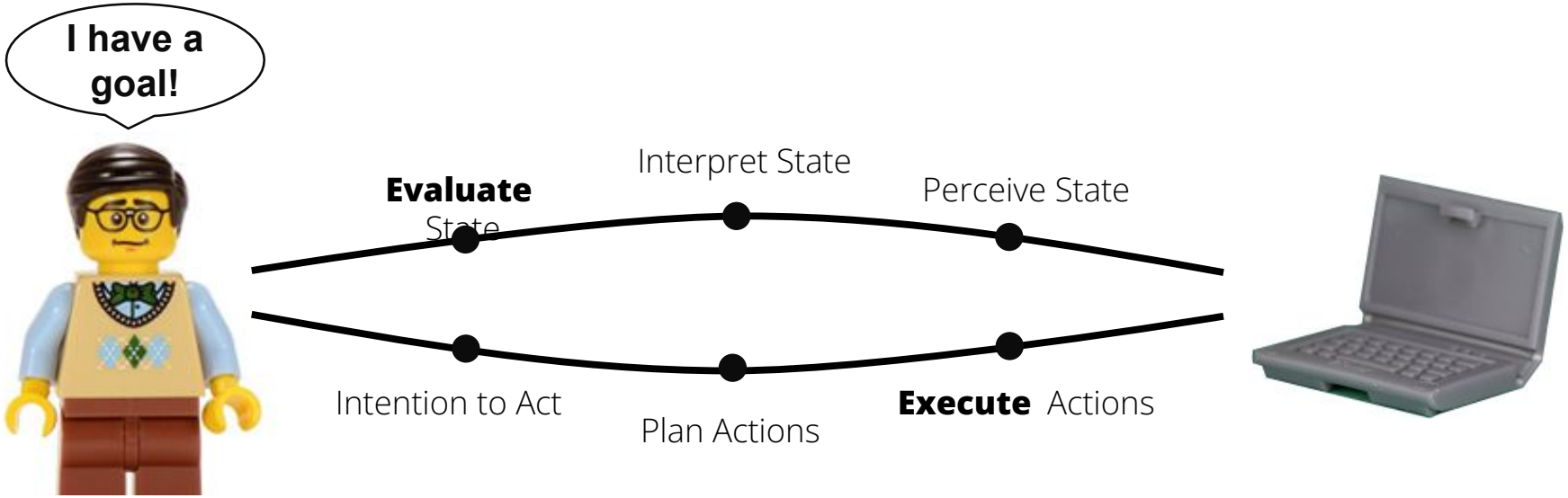


Execution

1. Form an **intention** to act to achieve a goal
2. Plan a sequence of **actions** to fulfill that intention
3. **Execute** planned actions with physical movements

Evaluation

1. Physically **perceive** the current state of the system
2. **Interpret** that perception according to experience
3. **Evaluate** the interpreted state compared to our goal

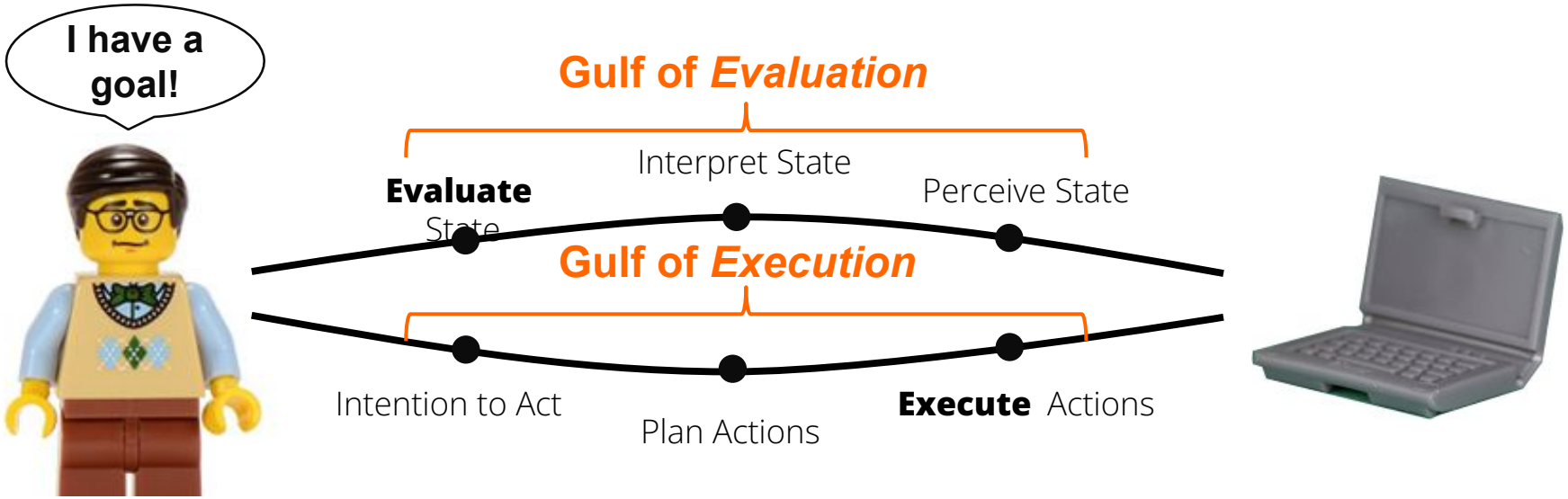


Gulf of Execution

Difficulty in translating someone's intentions into actions allowed by system. Can they carry out their intentions directly?

Gulf of Evaluation

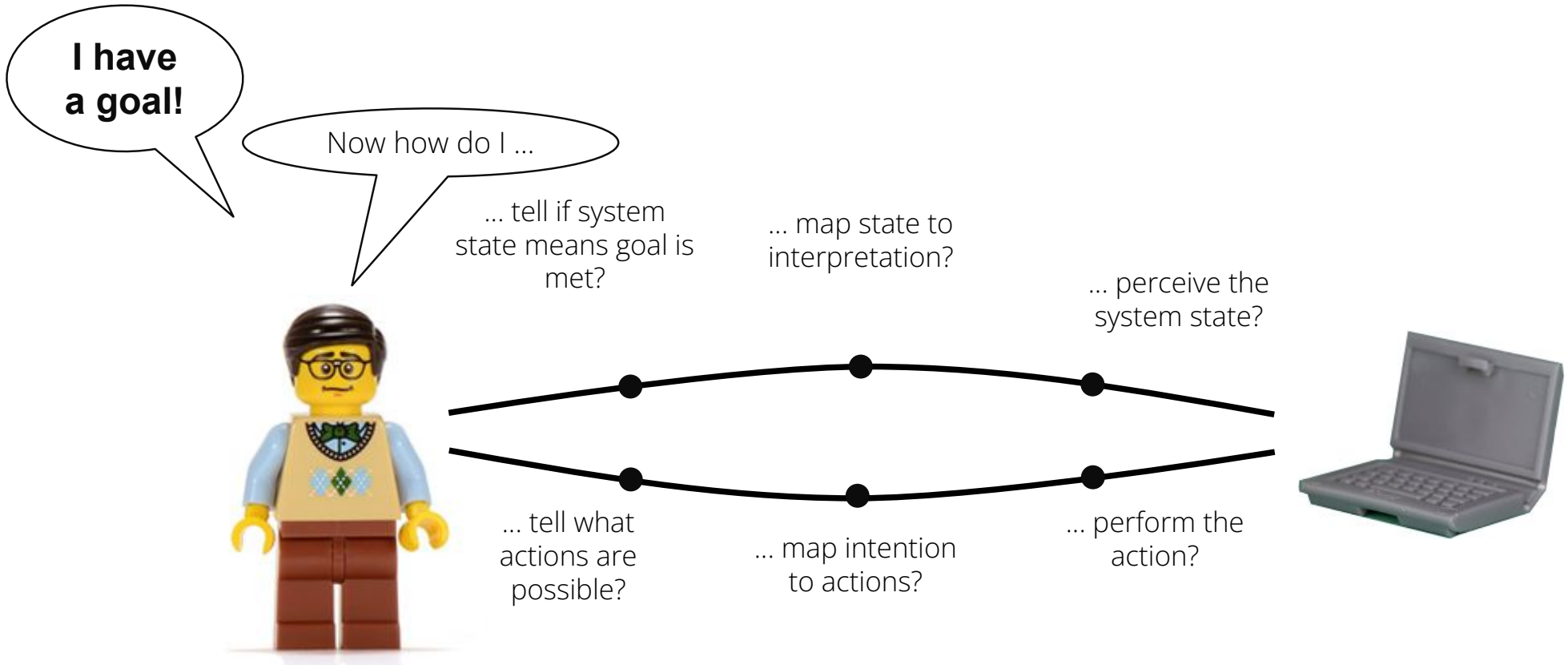
Difficulty in interpreting the state of the system to determine whether the goal has been met.



The Value of Norman's Model of Interaction

The model provides concrete questions to ask when designing an interface

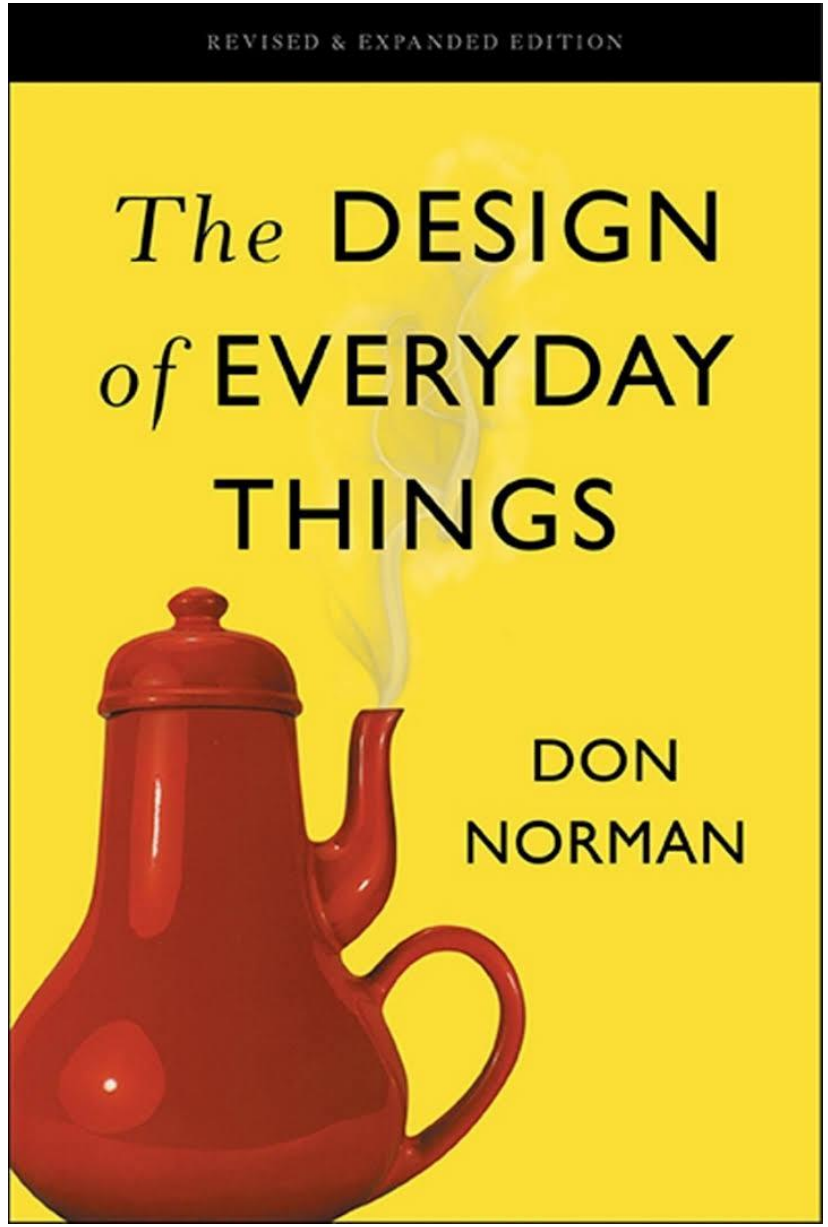
A primary design goal is to minimize gulf of execution and gulf of evaluation



Design Principles

These principles aim to make interfaces intuitive and easy to understand, guiding people naturally through interactions

Affordance
Signifier
Constraints
Feedback
Discoverability
Mapping



📖 Don Norman: The Design of Everyday Things : Revised and Expanded Edition (1988)

Affordances

Describes all actions that are made physically possible by the properties of an object or an environment. (Gibson, 1979)





- Apples
- Bananas
- Mangos

📖 Avadh Dwivedi: Affordance in user interface design (2017)

Perceived Affordance

The actions a person perceives to be possible, distinct from those which are actually possible.





Signifier

Indicator or perceivable cues (in the physical or digital world) that communicate meaning

... used to enhance affordance by reducing the possible interpretations of how to interact with something

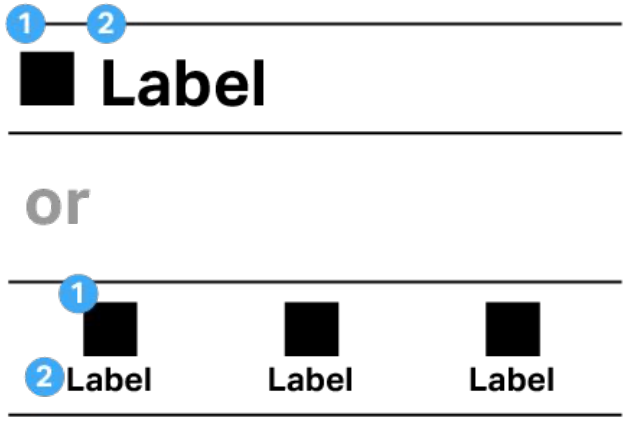
... e.g., below, there is clearer boundaries for where to click



Affordance / Signifier Relationship

An object's affordance is determined by a person's interaction

Basic Affordance/Signifier



Two signifiers are used to identify that this object affords linking.

1. Icon - an illustration of content or subject matter.
2. Label - identifies content/subject matter

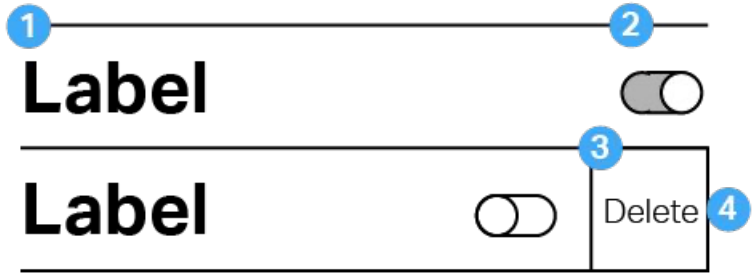
Complex Affordance/Signifier



Three signifiers reveal this object's enhanced affordance

1. Remove/Add (New)
2. Label
3. Draggable

Hidden Affordance/Signifier



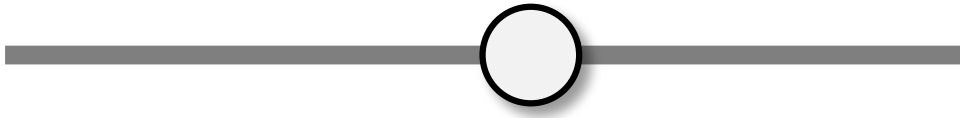
1. Label indicates function/content
2. Signifies On/Off
3. Discoverable affordance through swipe
4. Label is instructional

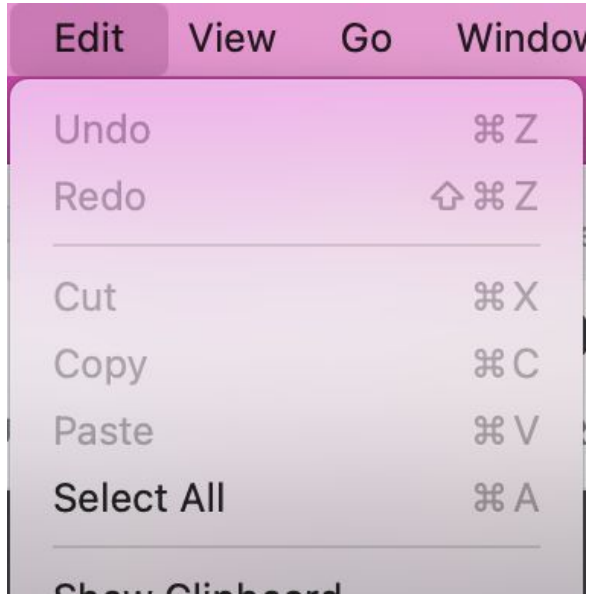
📖 Ben Olson: It's Not You, It's the Interface (2017)

Constraints

Restrictions that limit the possible actions available with an object

Physical: caused by physical features
Cultural: based on what is culturally accepted
Semantic: based on the meaning of the situation
Logical: use reasoning to determine the alternatives





Constraints





Feedback

Conveys effects of a person's actions

Location: Where am I?
Current Status: What's happening – and is it still happening?
Future Status: What will happen next?
Outcomes & Results: What just happened?



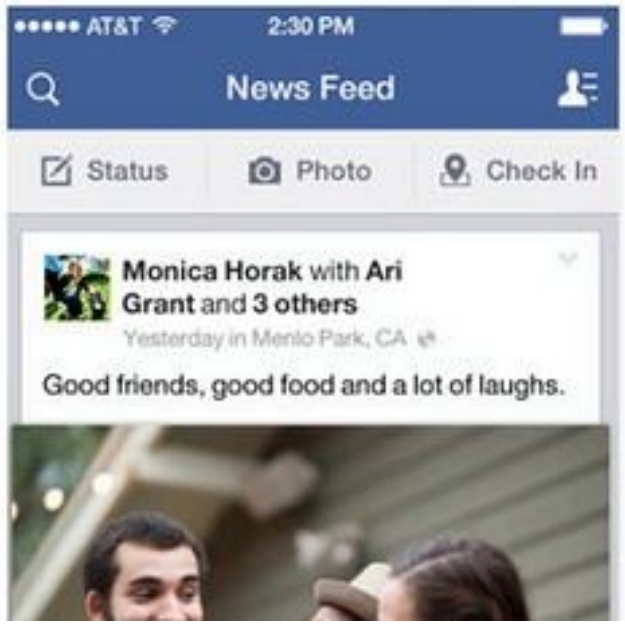
📖 Joe Natoli: Feedback: 5 Principles of Interaction Design To Supercharge Your UI (5 of 5) (2023)

Discoverability

Ability for someone to understand how to use something

Visibility: if it is easy to find the content
Learnability: if it is easy to learn how to use the functionality



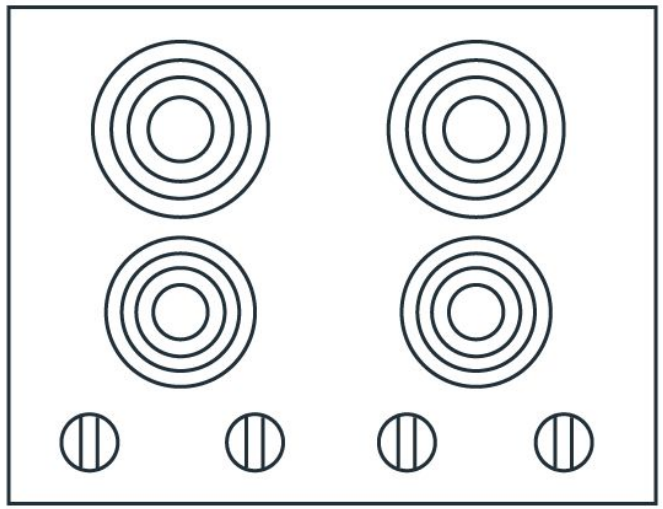


📖 Sachin Rekhi: Don Norman's Principles of Interaction Design (2017)

Mapping

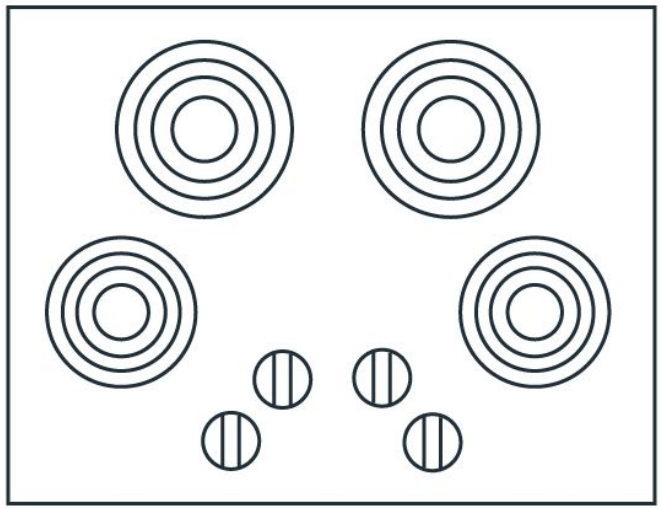
Indication of the relationship between controls and their effects





POOR MAPPING

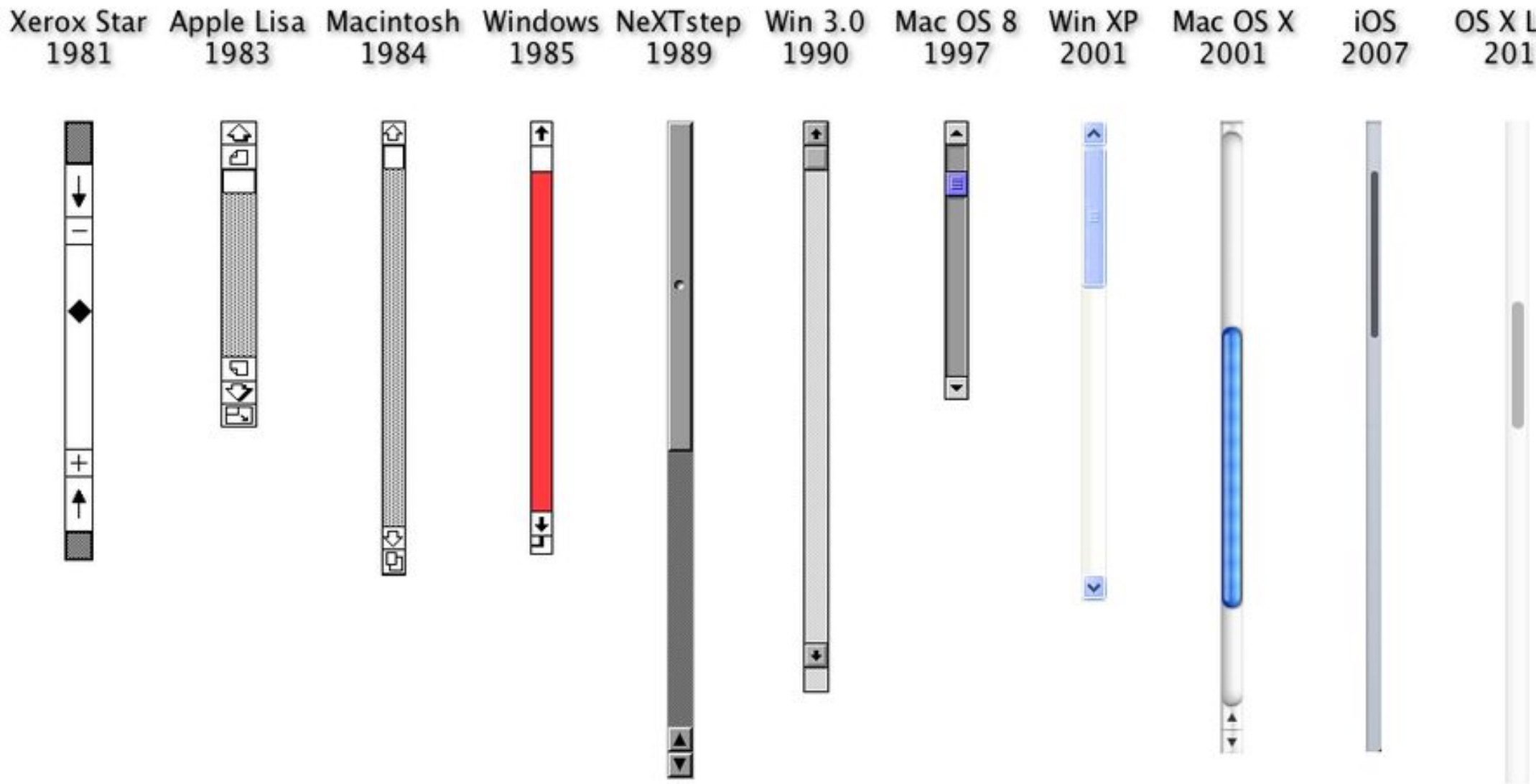
Note clear which button pertains to which elements



Good Mapping

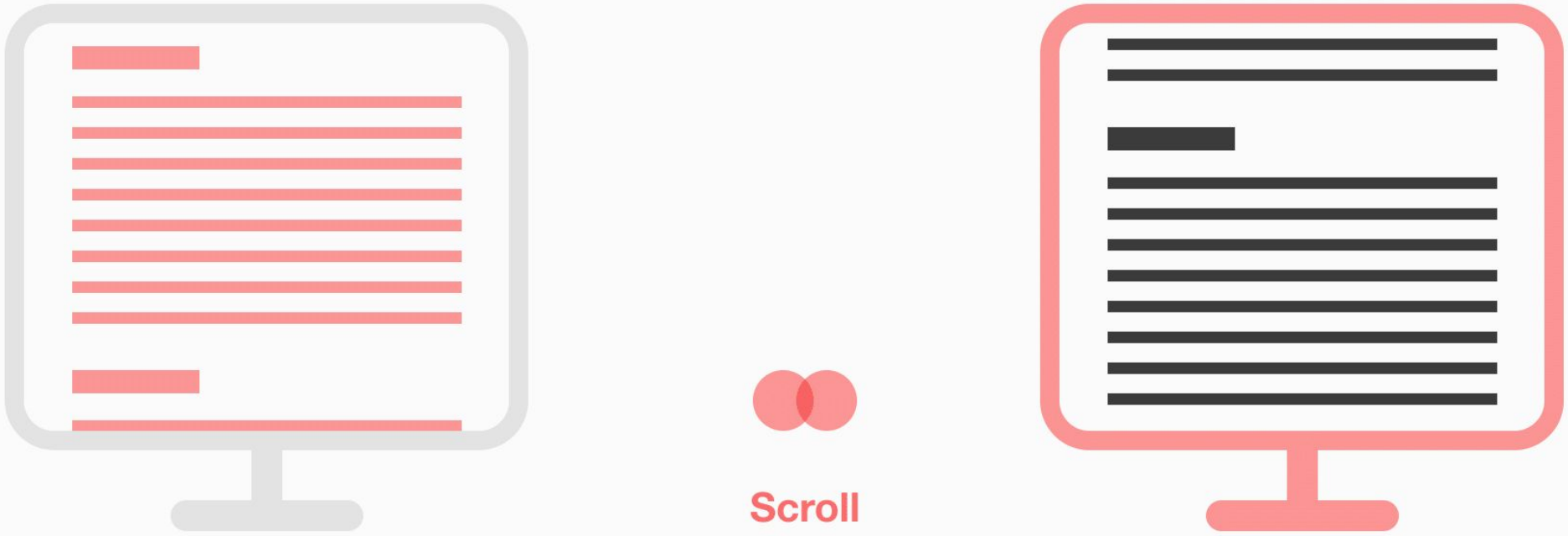
Buttons in similar orientation to the element layout

Mapping Example : Scroll bars



📖 Sébastien Matos: Evolution of the Scrollbar (2019)

Mapping Example: Mac vs. Windows Scrolling



Natural Scrolling
(Mac)

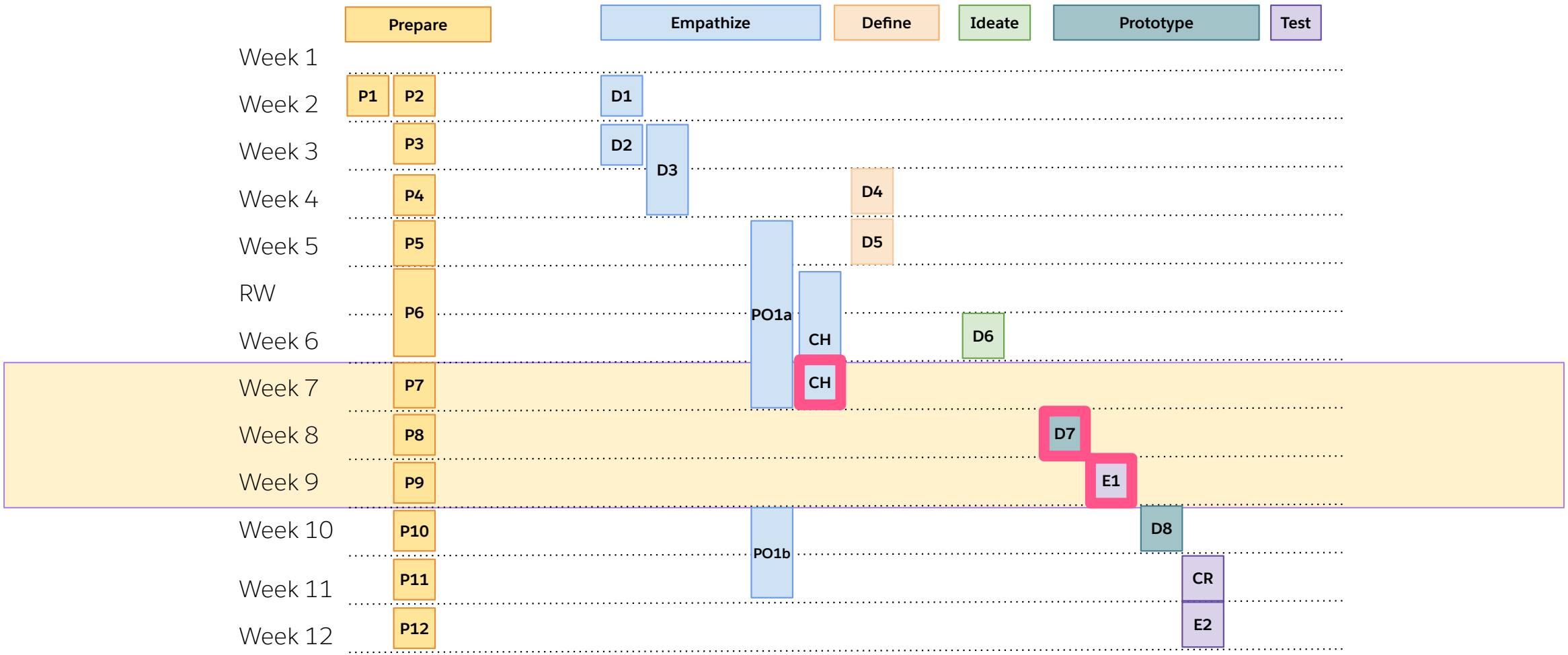
Reverse Scrolling
(Windows)

📖 Kunal Rathore: Natural scrolling (Mac) vs Reverse scrolling (Windows) (2021)

Week 7 Studio Prep (P7)

Preparing for CH2 Challenge Report Presentations

Project Deliverables Build on Each Other



Week 7 Studio Prep: CH2 Challenge Report Presentation

Share a link to a Google Slides presentation slides with your TA via your Teams channel as well as in your design notebook in the "**P7: Prepare for Next Studio**" section at 12pm the day before the Week 7 studio.

Apart from the requirement that your presentation be at most **5 slides** with the slide-by-slide guidance listed on the course website, there is no slide template.

See full **CH2** instructions on course website

Week 7 Studio CH2 Presentation Logistics

We will run the Google Slides presentation deck from a single laptop…

… { 5 minutes total + 2 – 3 minutes questions + 1 minute transition } x 8 project teams = 72 minutes

… Session will be screen- and audio-recorded so that TAs can revisit during marking, … recordings will be stored securely via O365 and deleted after the course ends

See full **CH2** instructions on course website

Looking Ahead to Week 8 + 9

Guest lectures: HCI Research PhD candidates **Brandon Lit**, **Anchit Mishra**, **Delara Forghani**, **Lucas Gomez Tobin**

Looking Ahead to Week 8 + 9 Studios

D7 Low Fidelity Prototyping (Week 8) + **E1** Prototype Evaluation (Week 9)

D7: Low-Fidelity Prototyping (Week 8 Studio)

Choose 2 features and create flows to prototype

... choose most important, most risky, most uncertain flows

Create 1 paper prototype for one user flow

... no Figma, all hand drawn sketches on paper

... interaction with a "human computer"

Create 1 low-fidelity wireframe prototype for the other flow

... draw low-fidelity wireframes in Figma or use photos of sketches

... interaction uses Figma "Prototype" animations

See full **D7** instructions on course website

E1: Low-Fidelity Prototype Evaluation (Week 9 Studio)

As a team pick 2 user flows that you developed in the design session - you will use these to conduct evaluations with your classes.

You will be conducting 2 rounds of evaluation with your paper prototype (20-25 minutes each) with your classmates.

Come up with a test plan, what tasks will you ask people to do with your prototype? Why these tasks?

See full **E1** instructions on course website

Human-Computer Interaction

CS 449 | 649 – F26

Week 7: Oct 26 – Oct 30 🎃

UX Prototyping:

Sketches, flows, wireframes, paper prototypes

Models & Design principles for interaction

Evaluating low-fidelity prototypes

* Updated Oct 26 2026

UNIVERSITY OF WATERLOO | DAVID R. CHERITON SCHOOL OF COMPUTER SCIENCE

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