User Interface Design

Engineering Considerations

What is a web page anyway? (1990-2005)

- The Web is young and was visually based on desktop operating system UIs
- Web "pages" were essentially a document format (like Microsoft Word)
- Web pages were static
  - No JavaScript or limited/buggy JavaScript capabilities.
  - Could not make network requests
  - Most complex user interactions required a new web page to be generated and loaded by the user
- Visual customization was limited
  - Flow was the only layout mode, designed for text -- so businesses and individuals started using "hacks" to achieve particular designs:
    - Misusing the <table> element to create a grid layout
    - Using multiple decorative or spacer images to create 3D effects, etc.

Yahooligans.com in 1997

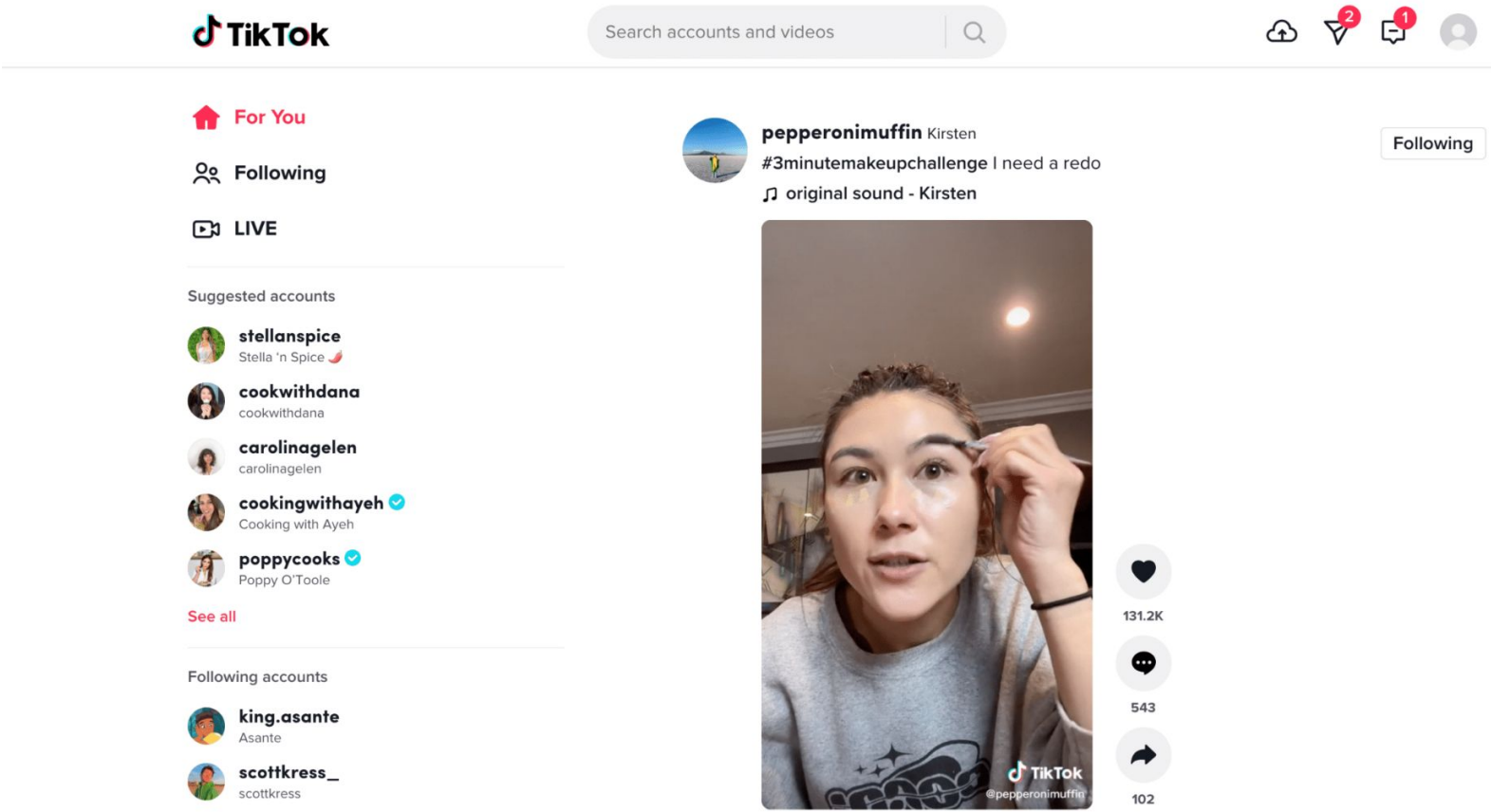
What is a web page anyway? (2005-2015)

- The initiative to introduce CSS began in part because HTML hacks degraded screen reader user accessibility
- CSS became widespread by around 2005
  - Font styling
  - Float-based layouts
- CSS3 became widespread by 2009
  - Rounded corners (border-radius)
  - Gradients (linear-gradient())
  - Media Queries to make web pages visually respond to screen size
- Predecessor to Fetch API was widespread by around 2005
- Predecessor to DOM API was widespread by 2005
- Suddenly web pages felt more like dynamic applications

Facebook.com in 2005

What is a web page anyway? (2015-Present)

- New layout modes in CSS made it easier to match visual designs
  - Flexbox widespread by 2015
    - Constraint-based auto layout
    - Allowed vertical centering
  - Grid widespread by 2017
    - Replaced <table> hacks
  - Subgrid widespread by 2023
    - Simple, consistent grid systems
- Web Application Manifest API was standardized recently
  - Installable Web Apps on Android, iOS, Windows, MacOS
- Improved JS ergonomics:
  - Web components, standardized DOM API, standardized Fetch API

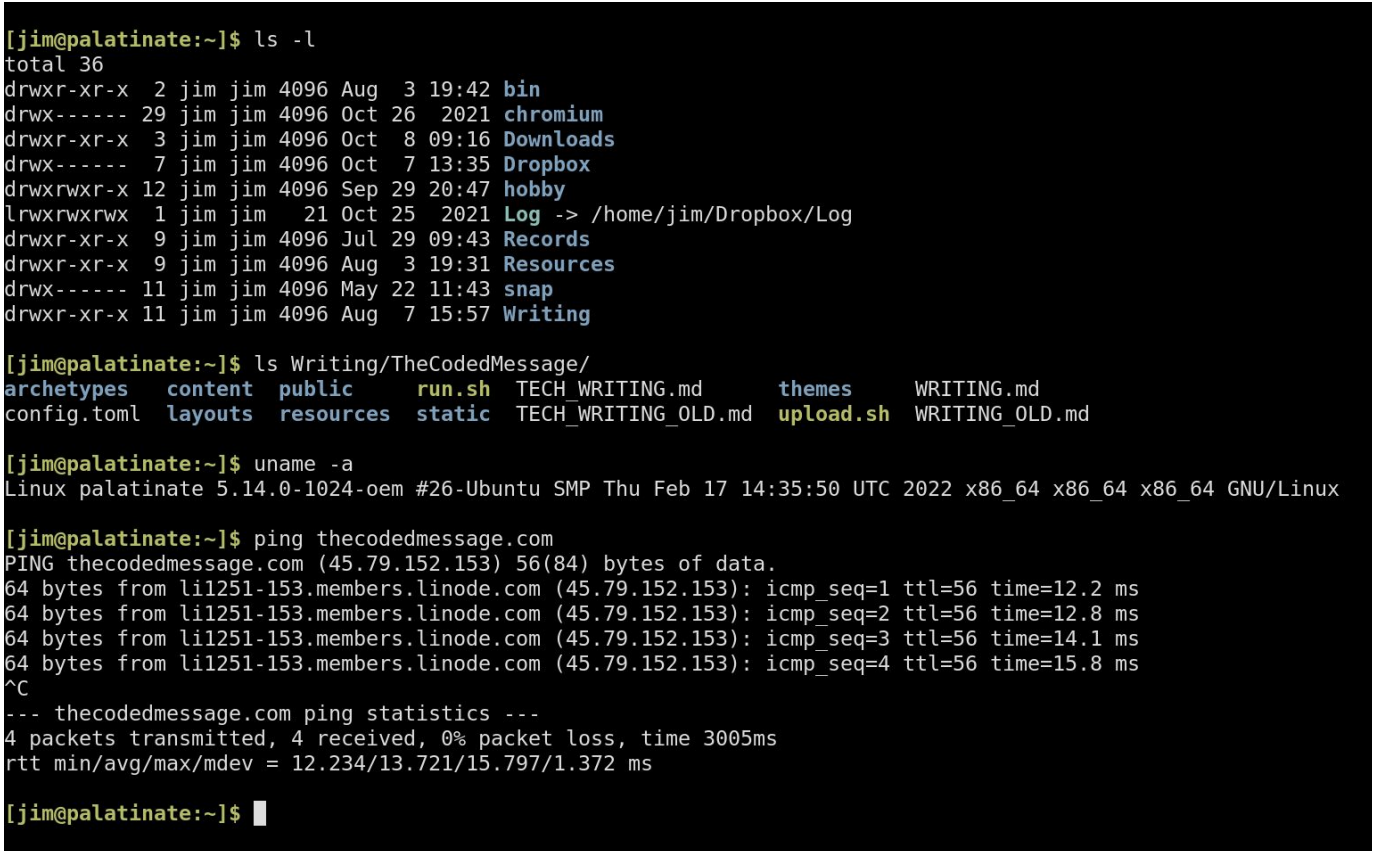


TikTok.com in 2024

Why has the Calculator app looked different over time?

Operating System Design - 1970s

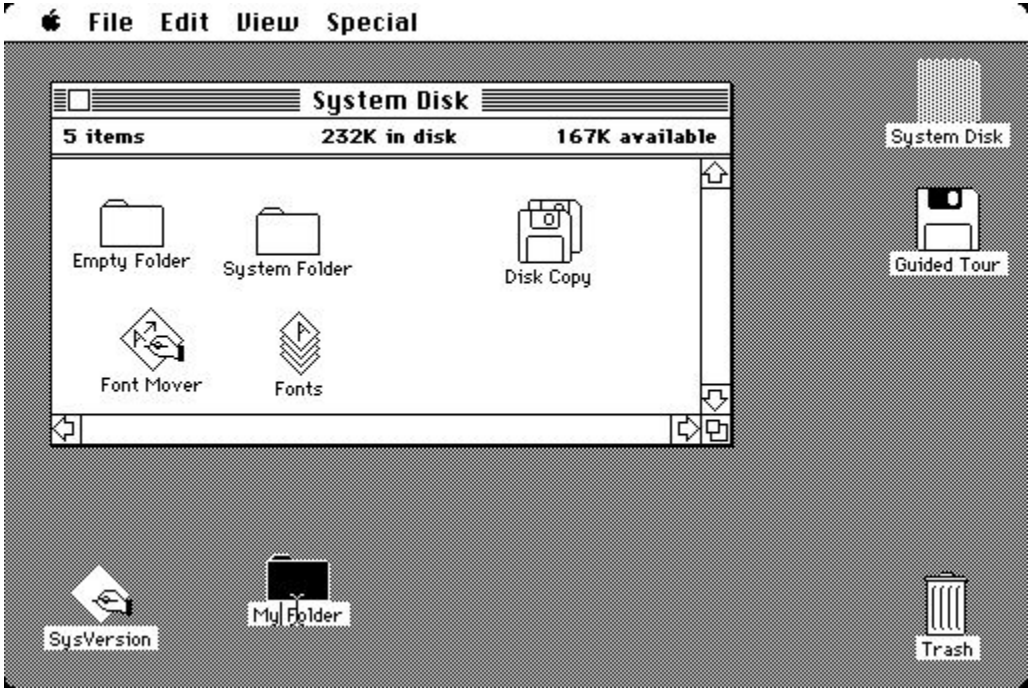
- **Text interfaces with limited graphics**
- Complex processing would be performed by a single **mainframe** computer
- Users would connect to the mainframe through one of many **terminals** and send text commands as instructions
- Today terminals are **emulated** and provide a way to send instructions to the operating system or to other computers over a network
- Terminal emulators are still used by programmers:
  - Bash, GitBash
  - Windows Command Prompt, Windows PowerShell



Terminal Emulator (Bash)

Operating System Design - 1980s

- **First Graphic Interfaces**
- **Monitors were limited** in size, shape, number of pixels/colors, etc.
- Graphics had limited pixel grid space and a grayscale color palette
- Desktop metaphor popularized by original Macintosh (1984) by Apple
  - **WIMP: Windows, Icons, Menus, Pointer**
- Apple made the first attempt to standardize human-computer interaction
  - "Not very long ago, most users of personal computers were also programmers."
  - [Apple provides] "a consistent and familiar computer environment to perform all kinds of tasks that were formerly done without computers."
  - "**People aren't trying to *use* computers—they're trying to get their jobs done**." -- from Apple's Human Interface Guidelines (1987)



Macintosh Operating System (1984)

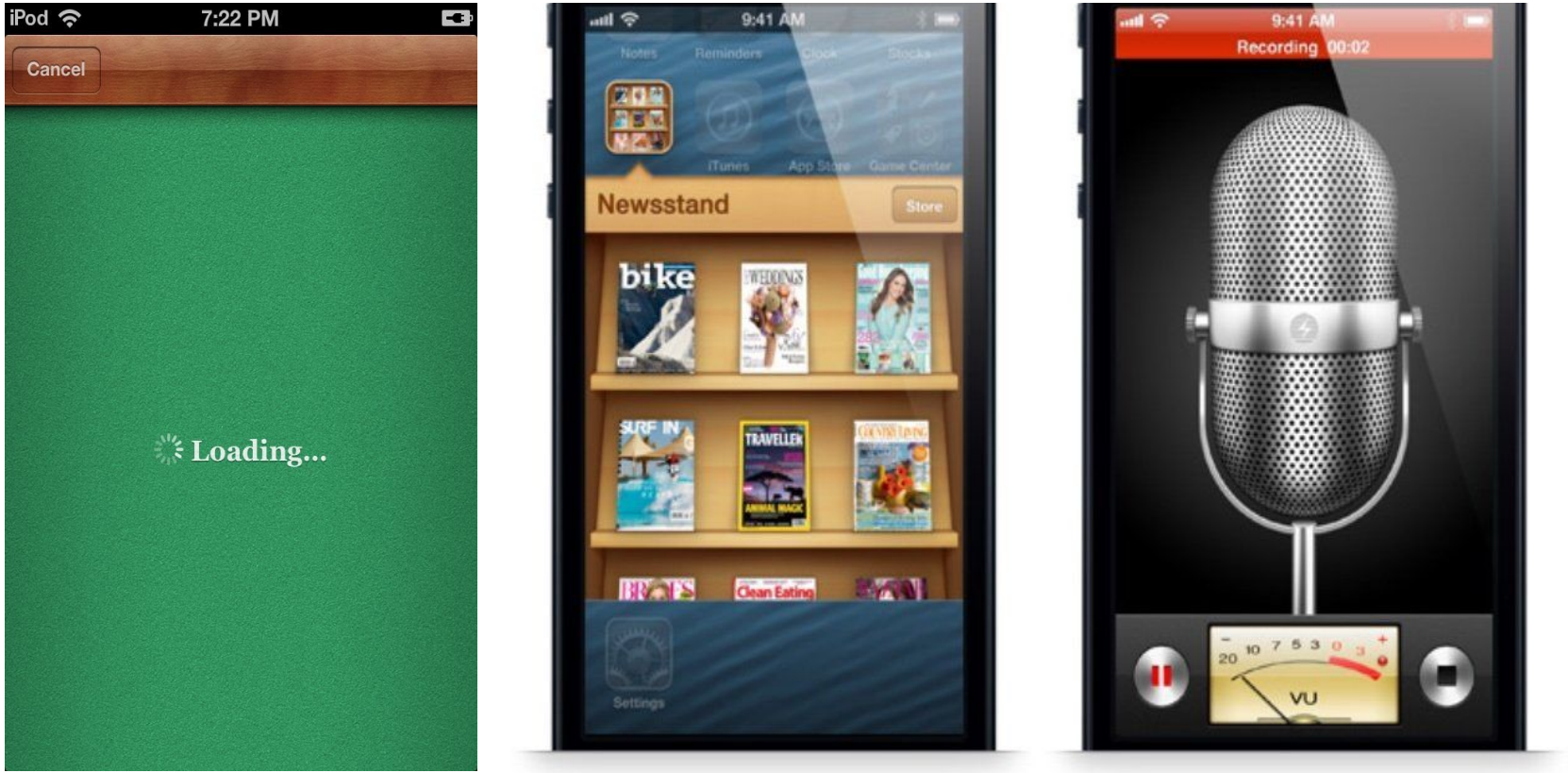
Operating System Design - 1990s

- **Improved Monitor Hardware**
- **3D Effects** were often purposeful, i.e., to make a button look raised
- Rounded corners, drop shadows, soft edges, crisp typography
- Popularized by Windows 95 and Windows XP
- Iterative improvements over 1980s designs
- Wider color palette encouraged neon/funky designs

Windows XP (2001)

Operating System Design - 2000s

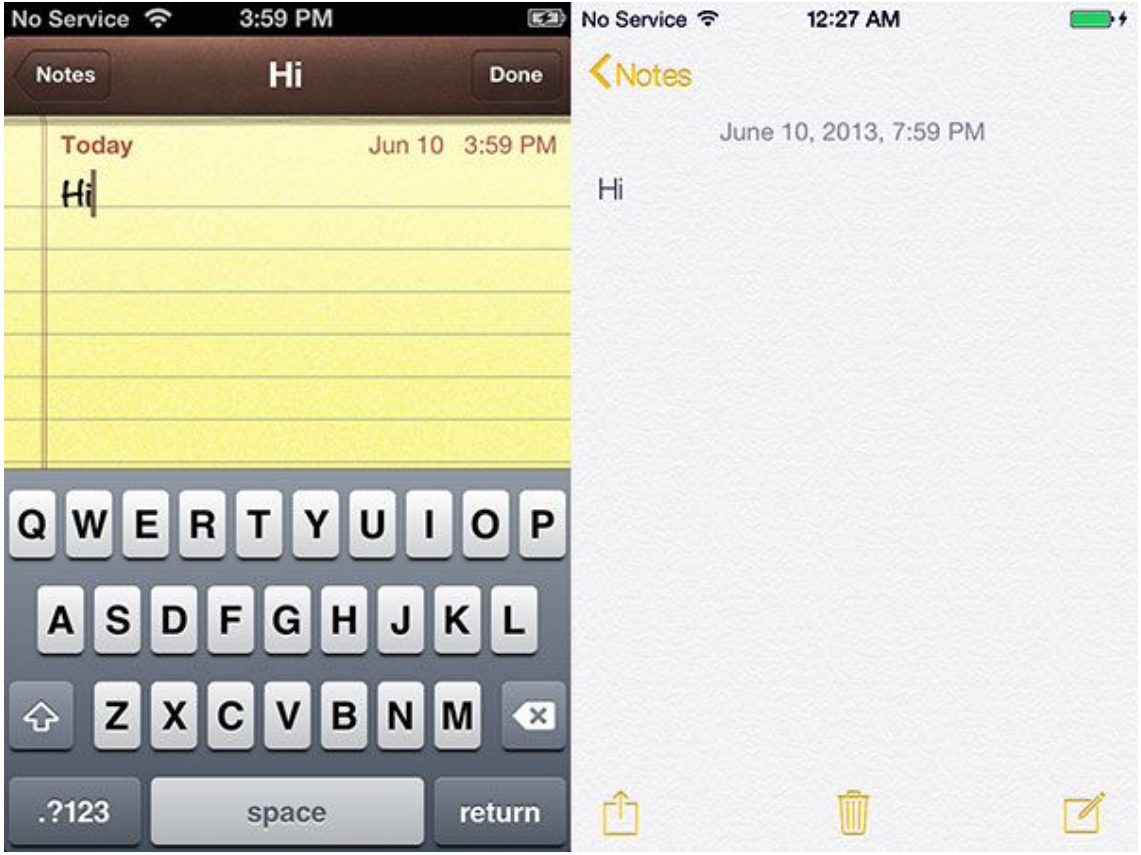
- **Mobile devices were a new form factor**
  - Everyone was suddenly using a new kind of computer with a touch interface, even people who had not used desktop computers
  - Interfaces needed to be **familiar and instructional**
- **Skeuomorphism**
  - To hint an app's concept to the user, interfaces emulated or took cues from **real-world objects**
    - Stitched, textured, or patterned interface elements
    - Referenced familiar objects, like a billiard table for Games app
  - iPhone OS 1 - iOS 6
  - Android 1 - Android 4



iOS 6 - Game Center, Books, Voice Memos

Operating System Design - 2010s

- Skeuomorphism lessened over time, as more users became familiar with how to operate mobile devices
- **Flat Design**
  - Apple Human Interface Guidelines for iOS and iPadOS
    - Apple iOS 7 - iOS 18
  - Google Material Design v1-v3
    - Google Android 5 - Android 15
  - Microsoft Design Language / Fluent Design System
    - Microsoft Windows 8 - 11



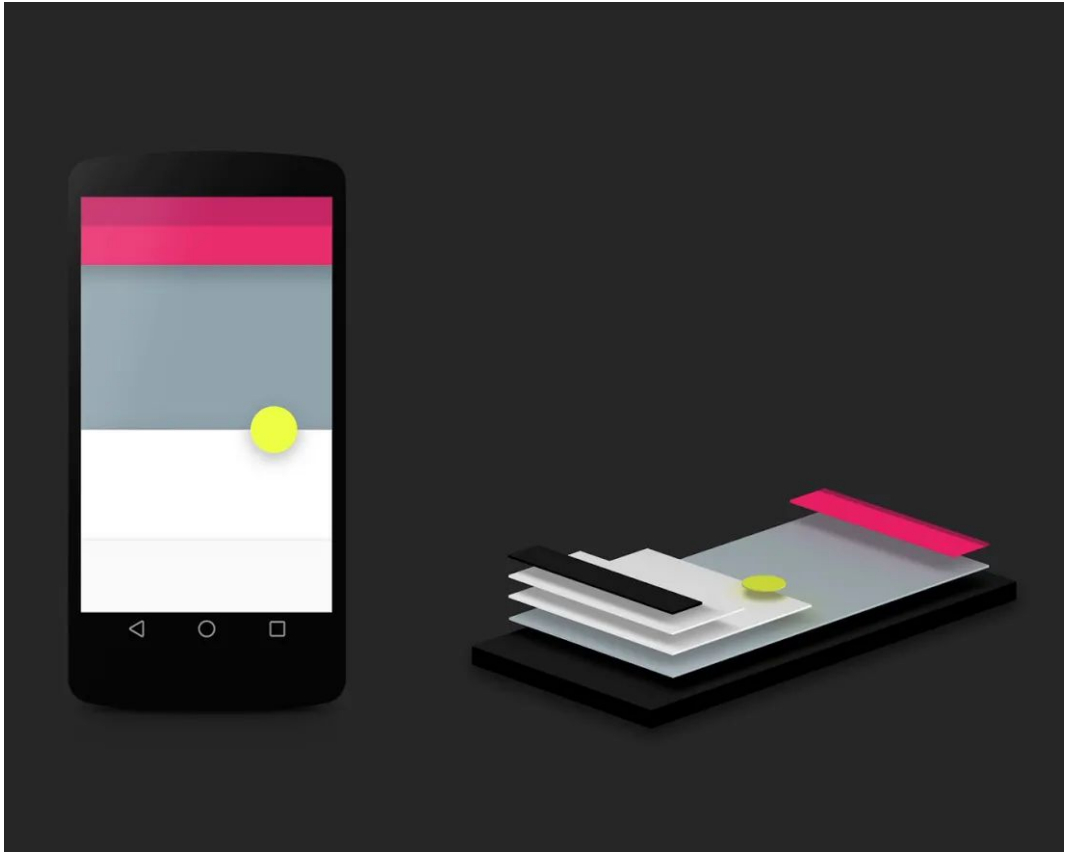
Apple Notes App (iOS 6, iOS 7)

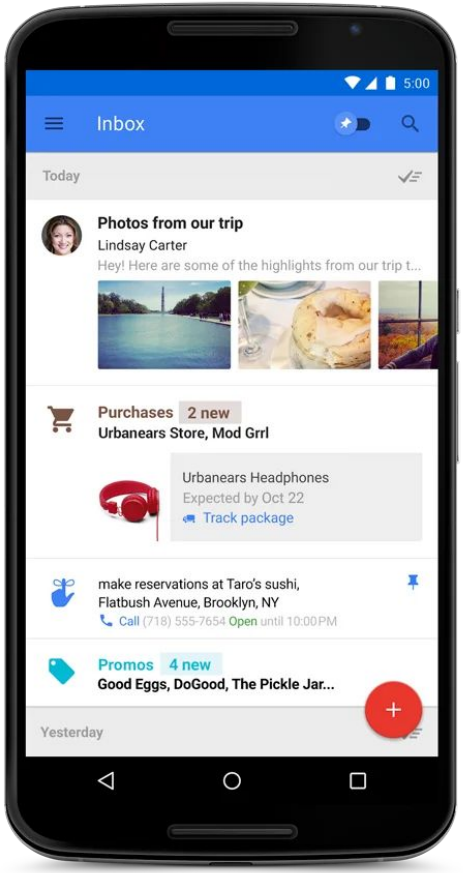
Design Systems and Standards

- **Design systems promote consistency, usability, and accessibility** across different platforms and applications
- The default UI elements when building an app are themed by the OS
- Examples of influential design systems:
  - **Google Material Design**: Emphasizes the concept of space and depth
  - **Apple's Human Interface Guidelines**: Emphasizes clean design, clarity, and user-friendliness (Apple's operating system for desktop and for mobile/tablet are different)
  - **Microsoft Design Language / Fluent Design System**: Prioritizes adaptable design across a range of devices (Windows on small tablets is the same operating system as Windows on desktop)

Google Material Design

- https://m3.material.io
- Originally "Quantum Paper"
  - Hinting at both "Quantum Physics" and "Paper"
  - What is the digital world "made of"?
  - Do the physics of our world need to always reflect in the digital world?
  - https://www.youtube.com/watch?v=Y0UEGsvcYvk
  - https://www.youtube.com/watch?v=rrT6v5sOwJg
- Inbox for Gmail by Google (Now defunct)
  - https://www.youtube.com/watch?v=bzNTjpUMOp4
  - "It's called Inbox. Years in the making, Inbox is by the same people who brought you Gmail, but it’s not Gmail: it’s a completely different type of inbox, designed to focus on what really matters."





Google Material Design and Google Inbox (2014)

Paper for Facebook by Meta (Now Defunct)

- https://about.fb.com/news/2014/01/introducing-paper-stories-from-facebook
- https://www.youtube.com/watch?v=Ne2uHFi_e_M
- https://www.youtube.com/watch?v=U1Xx1v6232E
- "Everything responds to your touch so you can **pick up or thumb through stories with simple, natural movements**"
- "**Articles unfold** in the app and appear fullscreen for a focused reading experience"
- "Paper makes storytelling more beautiful with an **immersive design** and fullscreen, distraction-free layouts."

Paper from Facebook (2014)

Color Swatch Generator Demo

https://www.w3.org/TR/WCAG20-TECHS/G17.html

https://readtech.org/ARC/tests/visual-readability-contrast/?tn=criterion