Building Interactive Systems
Visual Representations

Professor Bilge Mutlu | Spring 2023

What will we cover today?

→   Overview of visual representations

→   2D interfaces

→   3D interfaces

→   Fundamental representations

→   Organization of representations

New Component: Representations

→ Defining Interactive Systems

→ Sensing, Modeling, Tracking

→ Planning, Adapting, Decision-Making

→ Interaction Paradigms

→ **Action & Representation**

→ Evaluation & Dissemination

Visual Representations

Recap: The "gulf" model of human-machine systems[1]

How do we help users overcome this gulf?

→ **Today:** Visual representations

→ **Next week:** Agentic representations
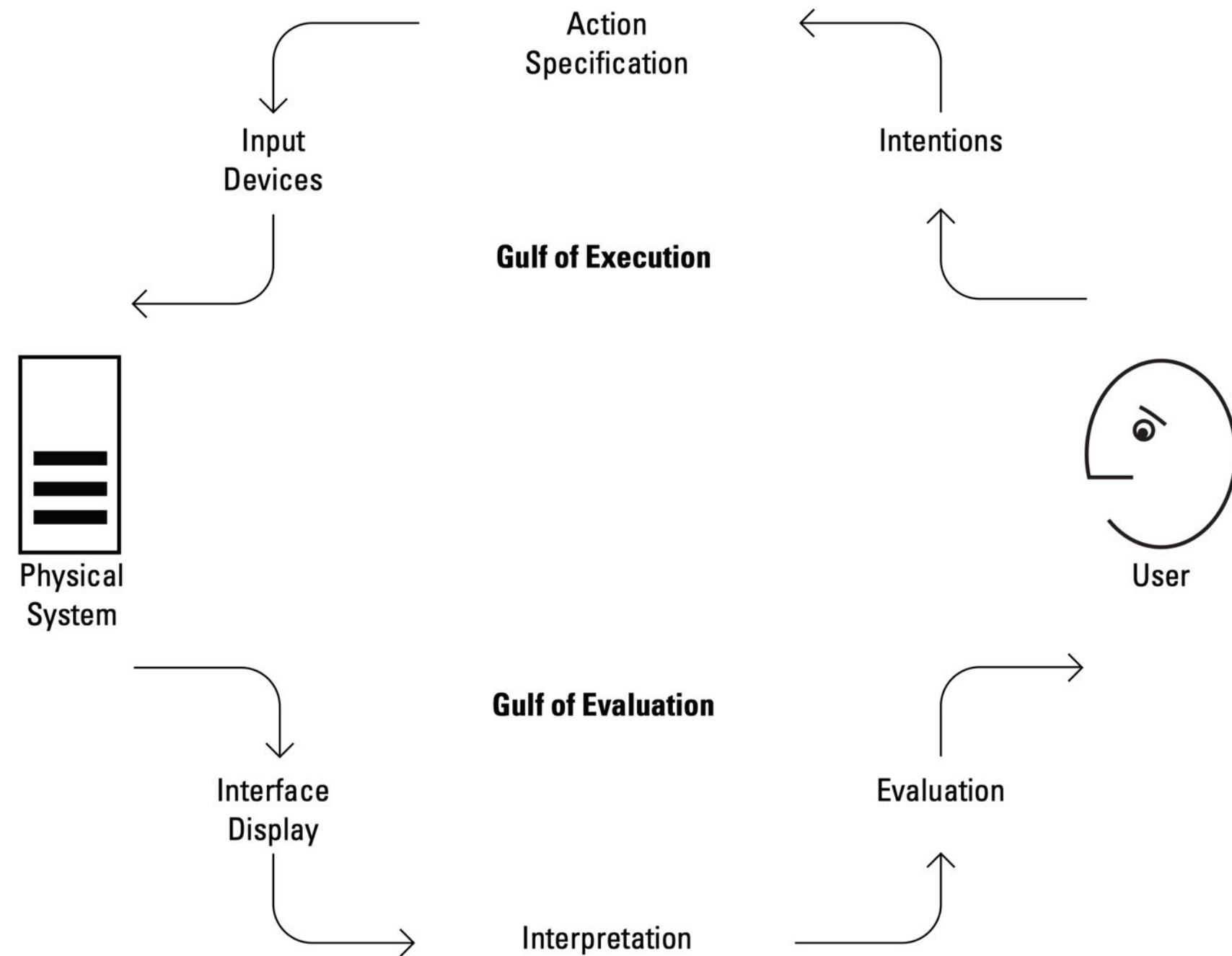
[1] Dubberly et al. (2009). ON MODELING What is interaction? are there different types?. *interactions.*

Five Dimensions of Interaction Design[2]

1. **1D**: Words

2. **2D**: Visual representations

3. **3D**: Physical objects and space

4. **4D**: Time

5. **5D**: Behavior

[2] Interaction Design Foundation

Five Dimensions of Interaction Design[3]

1. **1D: Words**

2. 2D: Visual representations

3. 3D: Physical objects and space
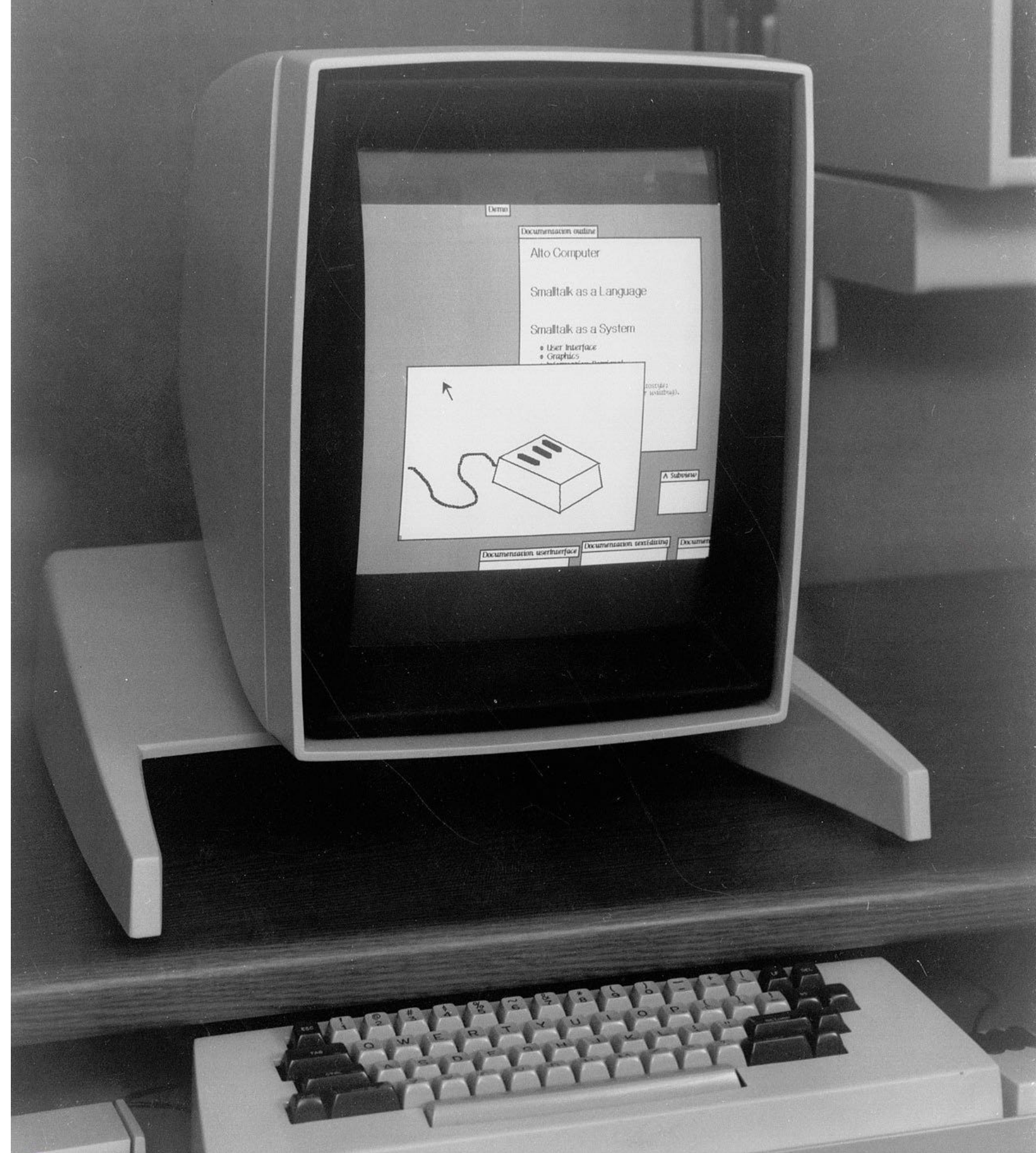
4. 4D: Time

5. 5D: Behavior

[3] DEC VT100 | Reading on the history of ANSII and the console

Five Dimensions of Interaction Design[4]

1. 1D: Words

2. **2D: Visual representations**

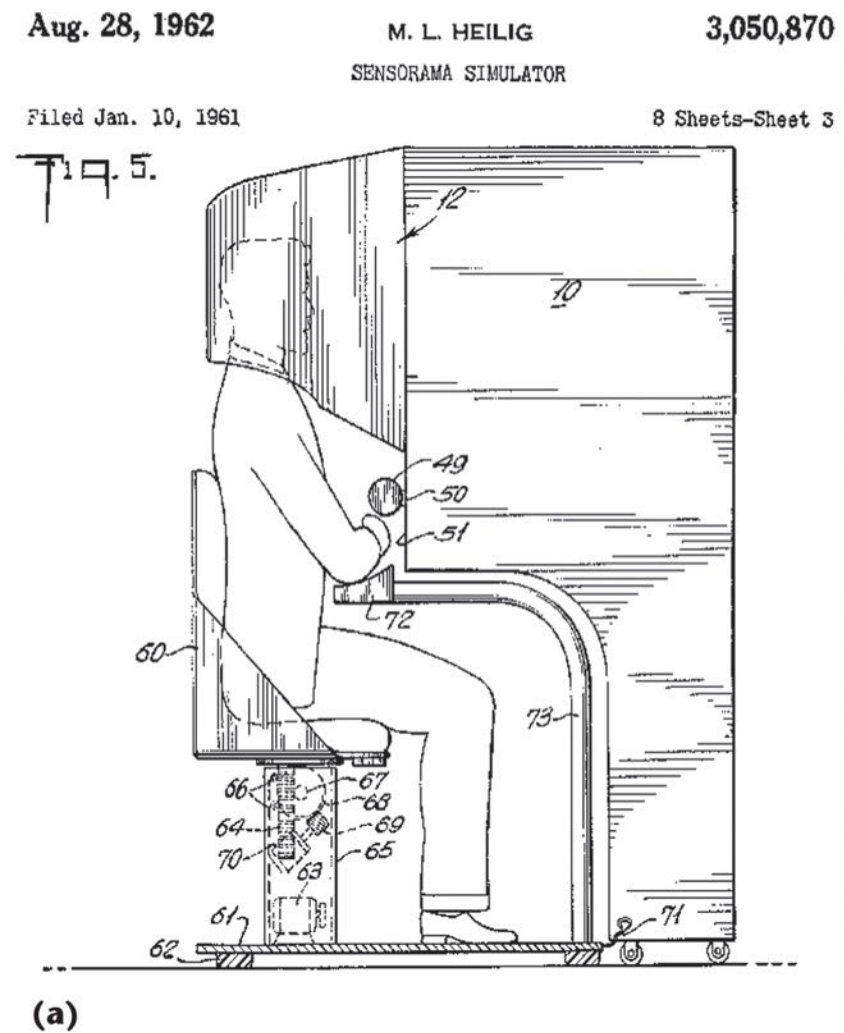3. 3D: Physical objects and space

4. 4D: Time

5. 5D: Behavior

[4] Xerox Alto | Excellent chronological history of the GUI
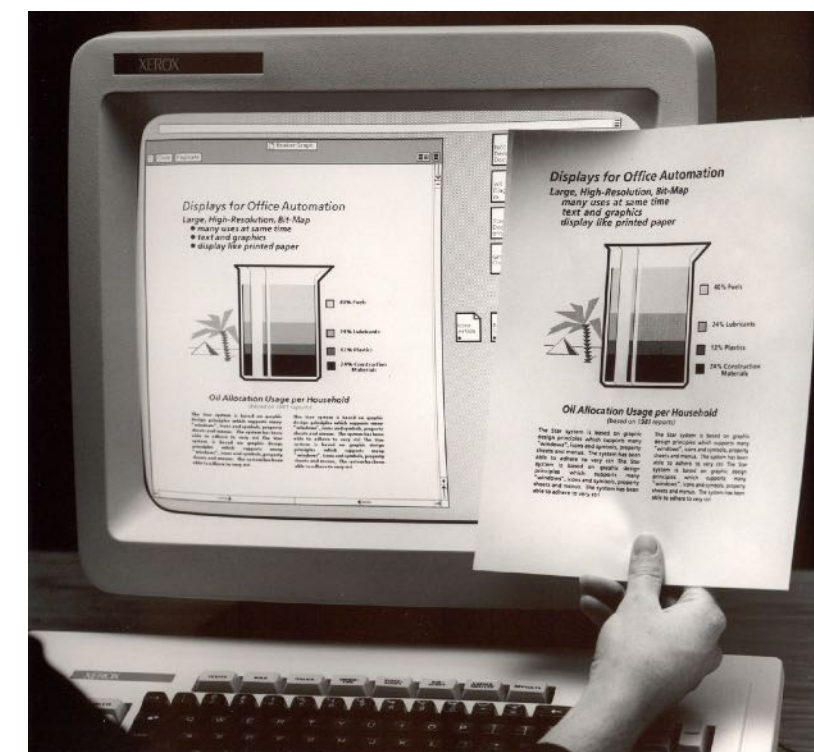
Five Dimensions of Interaction Design[5]
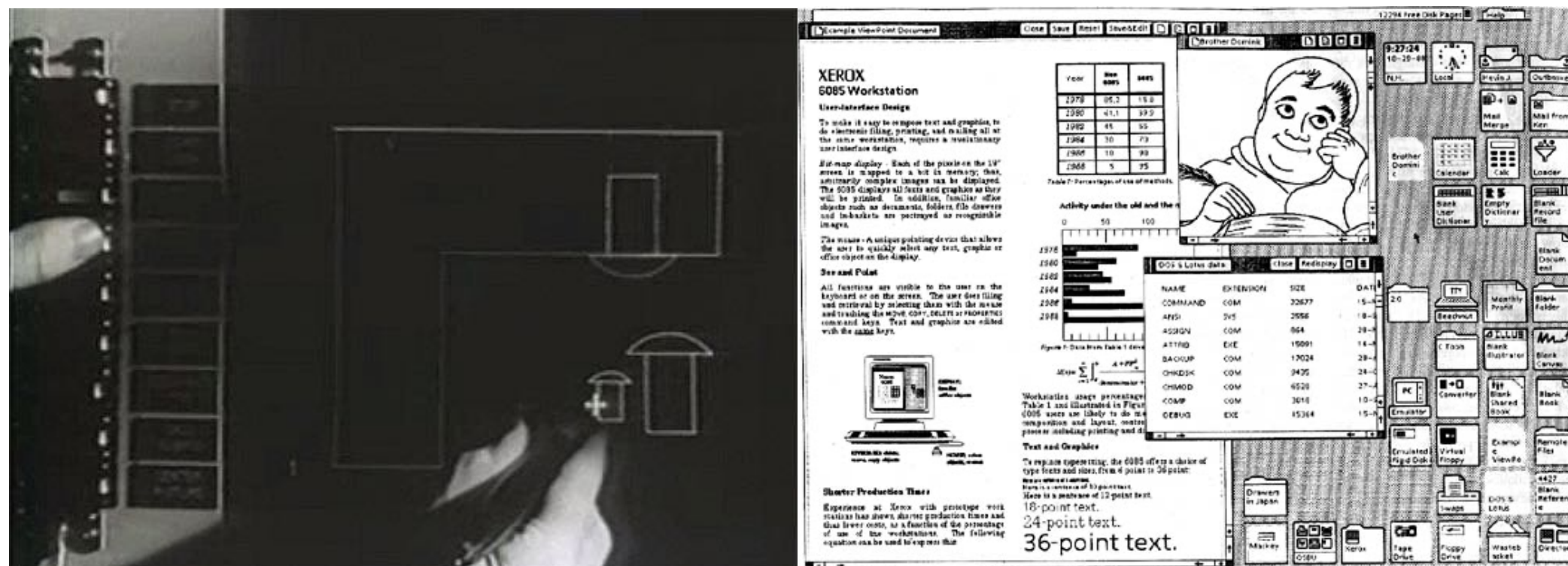
1. 1D: Words

2. 2D: Visual representations

3. **3D: Physical objects and space**

4. 4D: Time

5. 5D: Behavior

[5] Sensorama System, 1962 | Chronological history of VR

2D Interfaces

Historical Development[6]

[6] Image source: Left, Center, Right

Evolution of "Document" Icon Shape

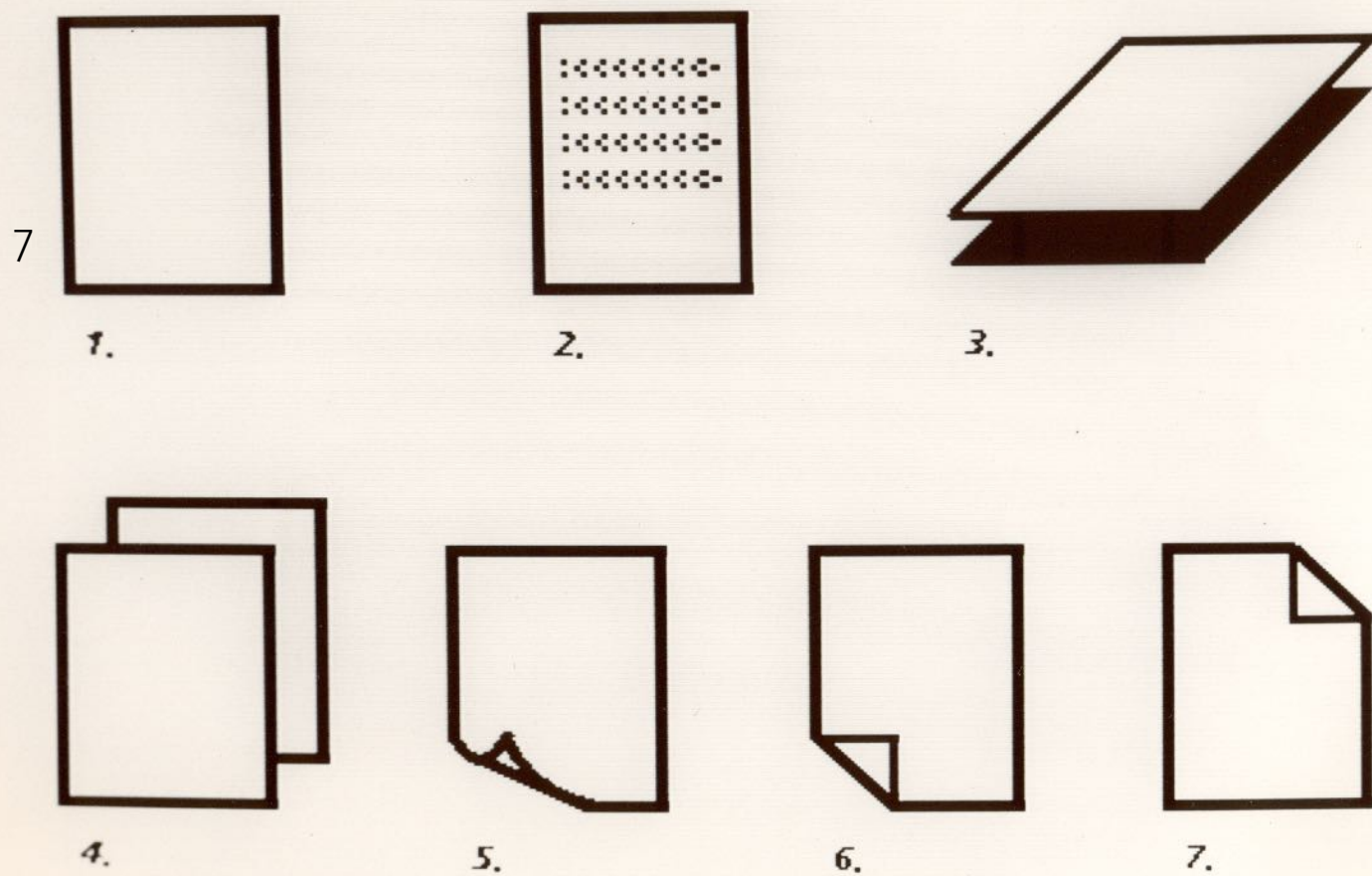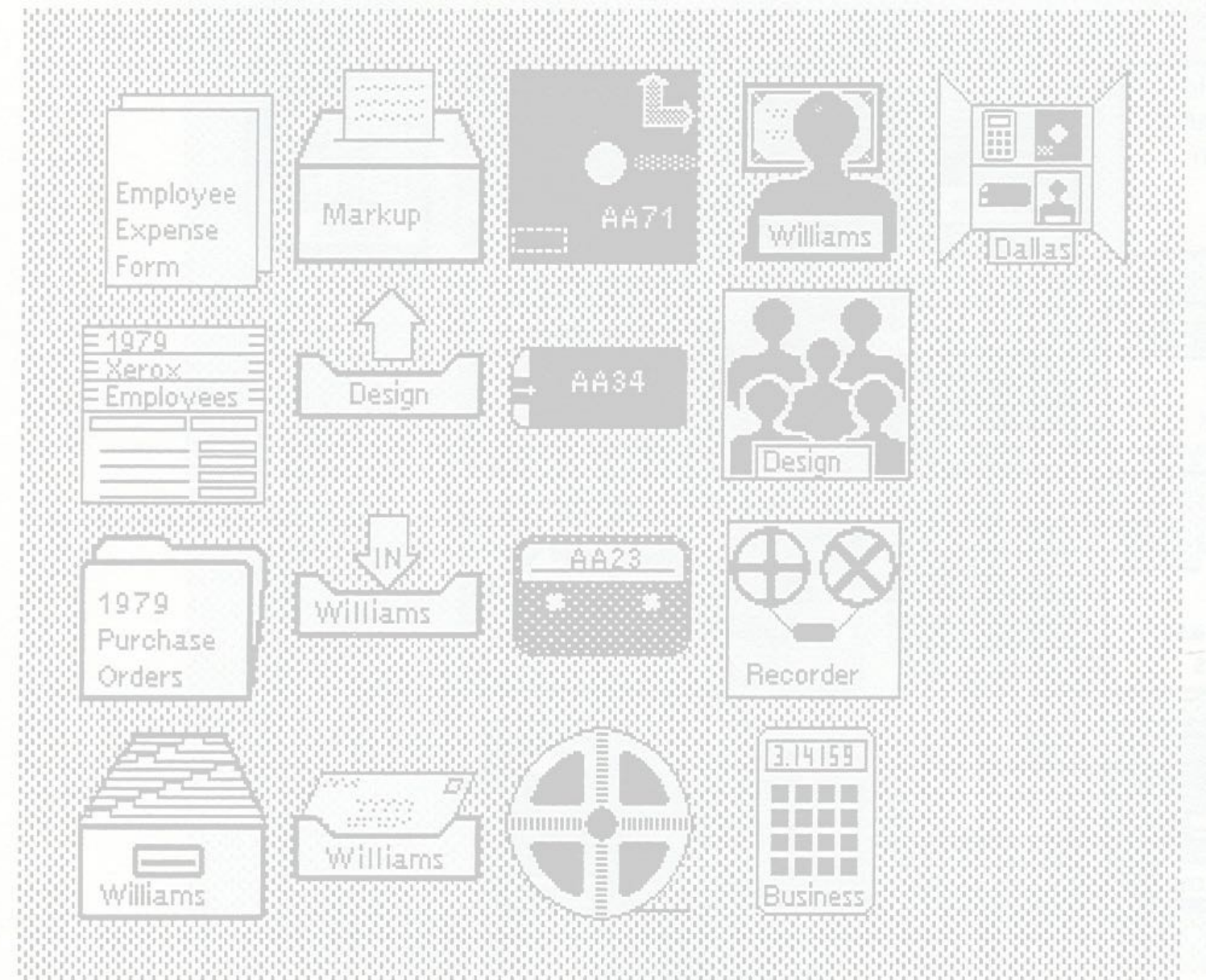1. 2. 3. 4. 5. 6. 7.

Figure 4.
Set 4 (Judd)

document	printer	floppy disk	user	directory
record file	out-basket	mag. card	group	
folder	in-basket	cassette	recorder	
file drawer	in-basket (with mail)	mag. tape	calculator	

7 Image source: Left, Right

Representation Design Paradigms

1.   Implementation-centric

2.   Metaphoric

3.   Idiomatic

Implementation-centric Design

Definition: Interaction design maps directly to how system functions are implemented.

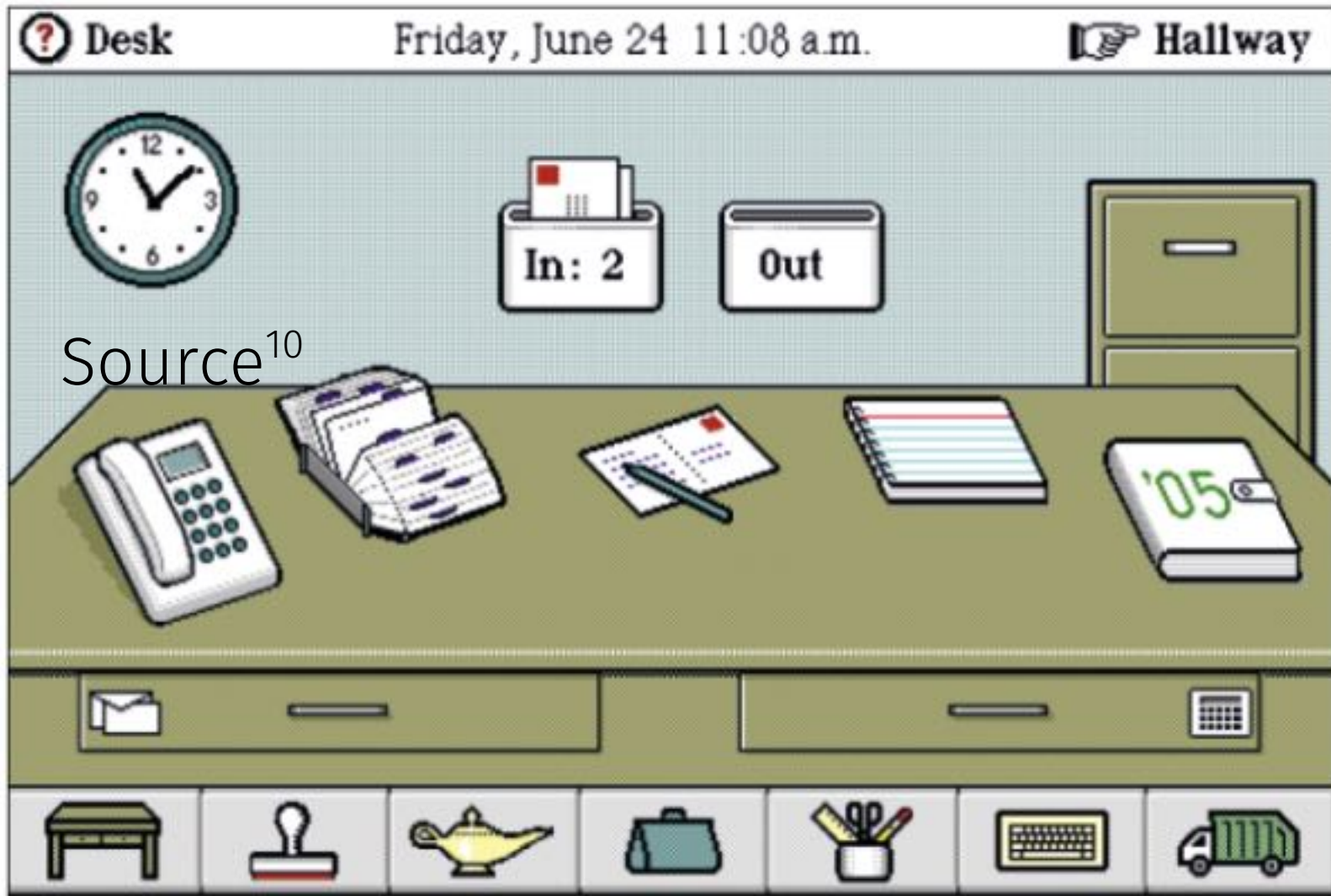Source[8]

[8] Images: Left, Right

Metaphorical Design

Definition: Following a real-world metaphor that users are expected to be familiar with.

Metaphorical designs "jump-start" user mental models, rely on their existing knowledge of how things work in the real-world, and thus eliminate learning.
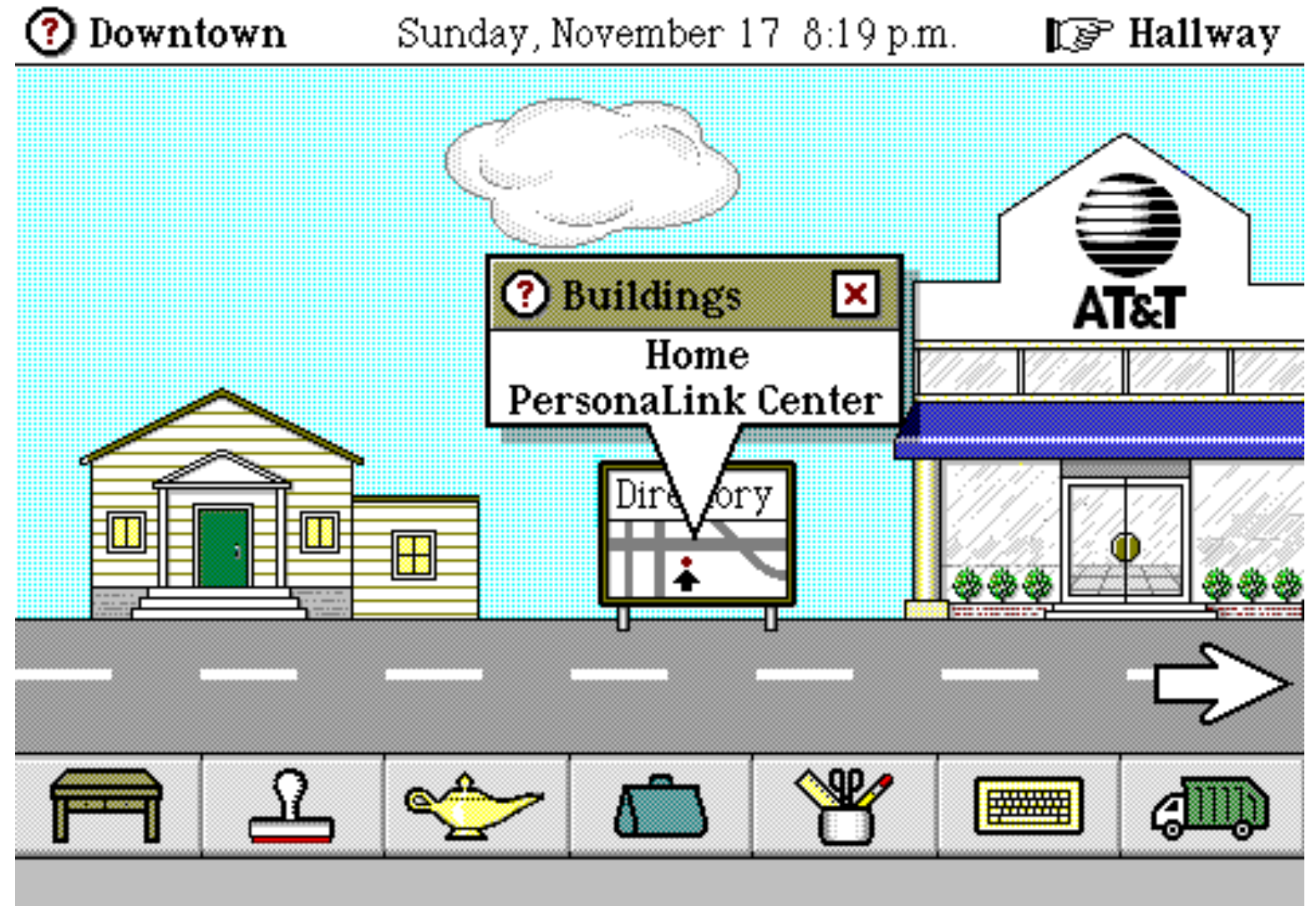
Global Metaphor: A *global metaphor* provides a single, overarching framework for all the metaphors in the system (*e.g.*, Magic Cap).[9]
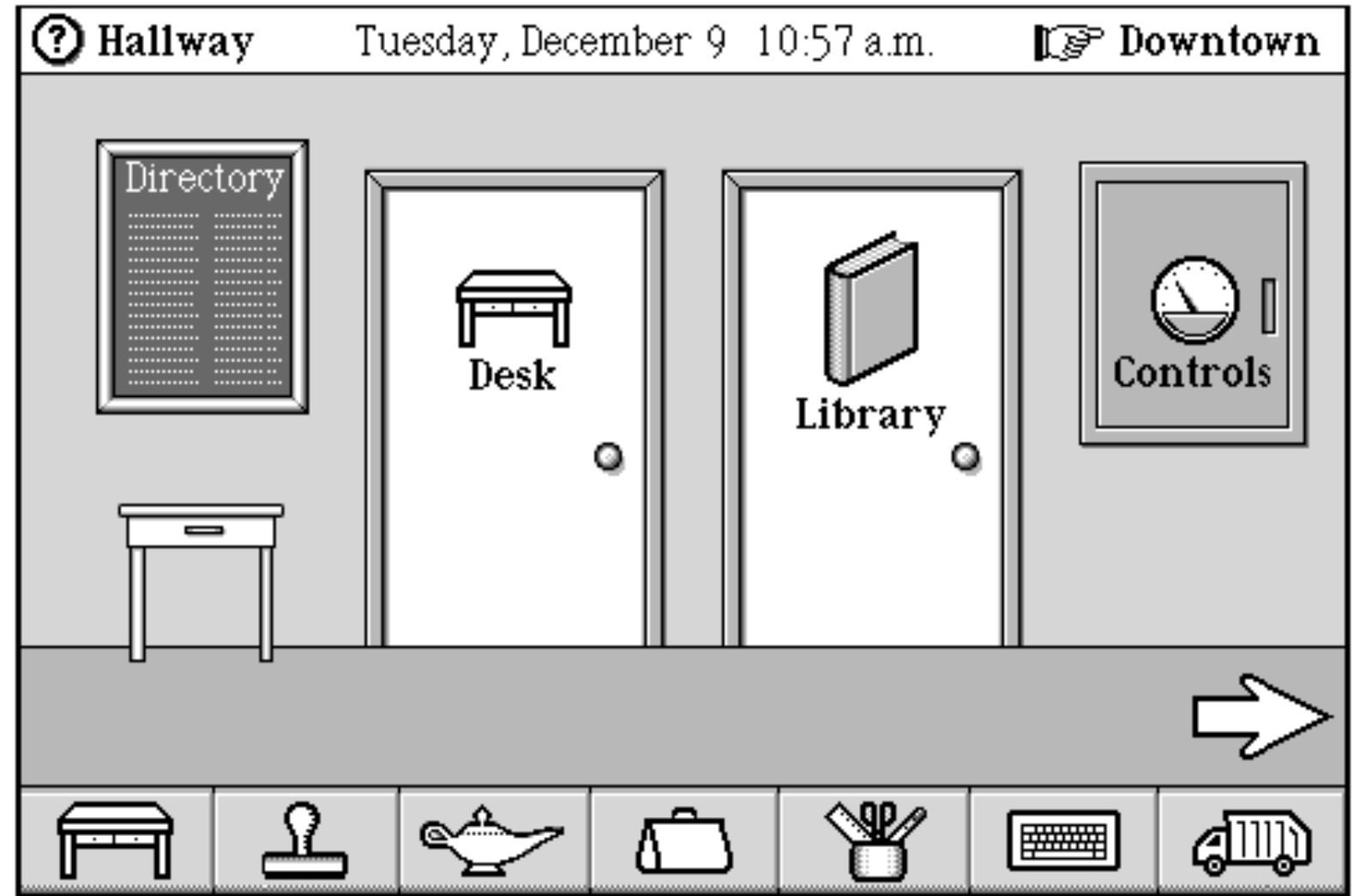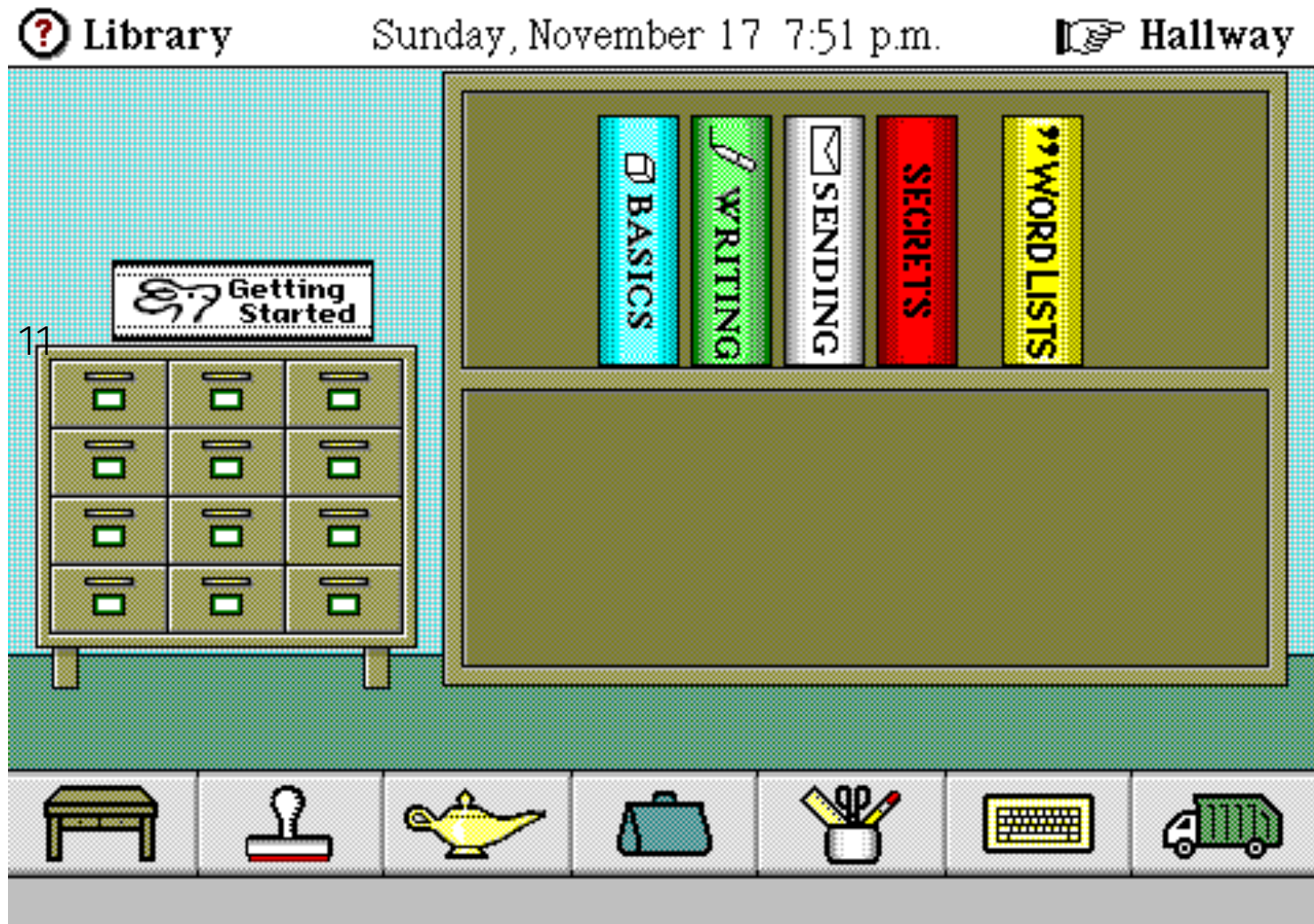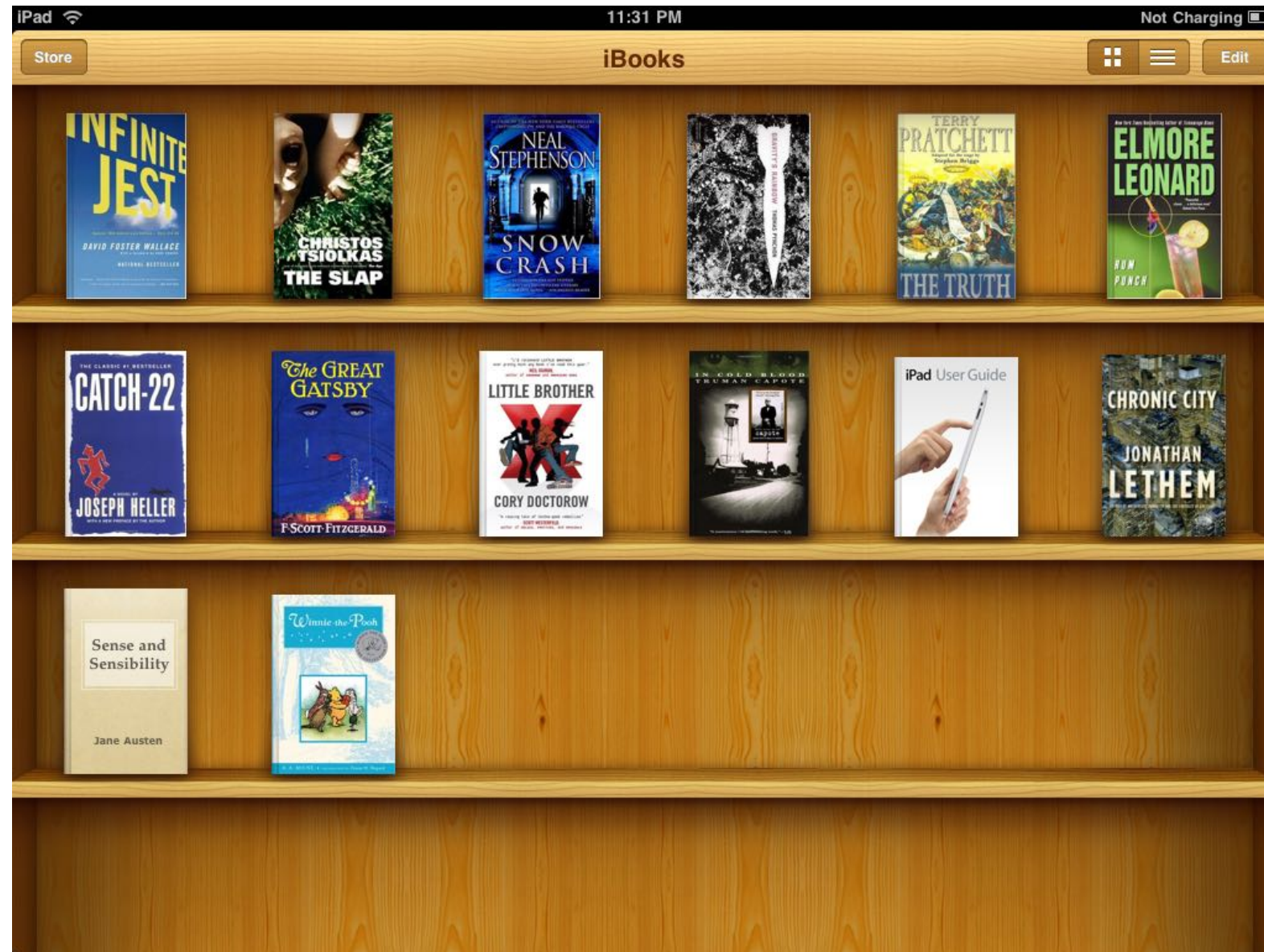
[9] Cooper et al., 2014, About Face

Source[10]

11

[11] Wikipedia: Magic Cap, NN Group: The Anti-Mac Interface

[13] Apple App Store: 76 Synthesizer
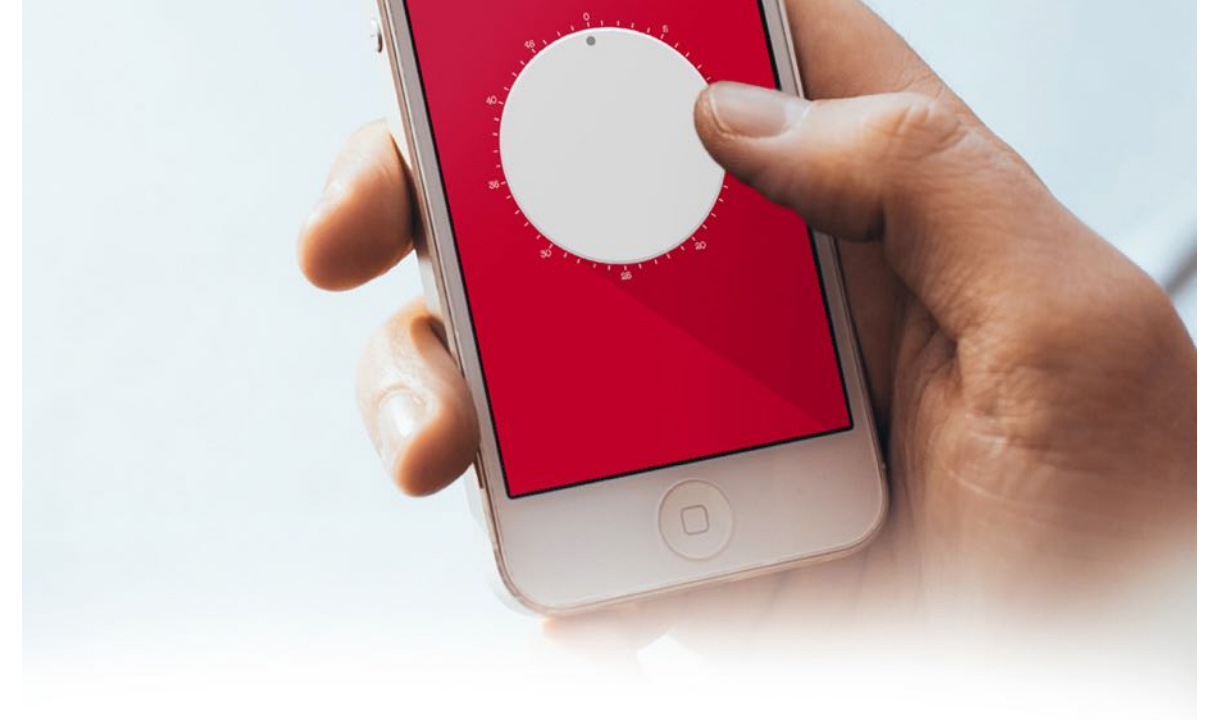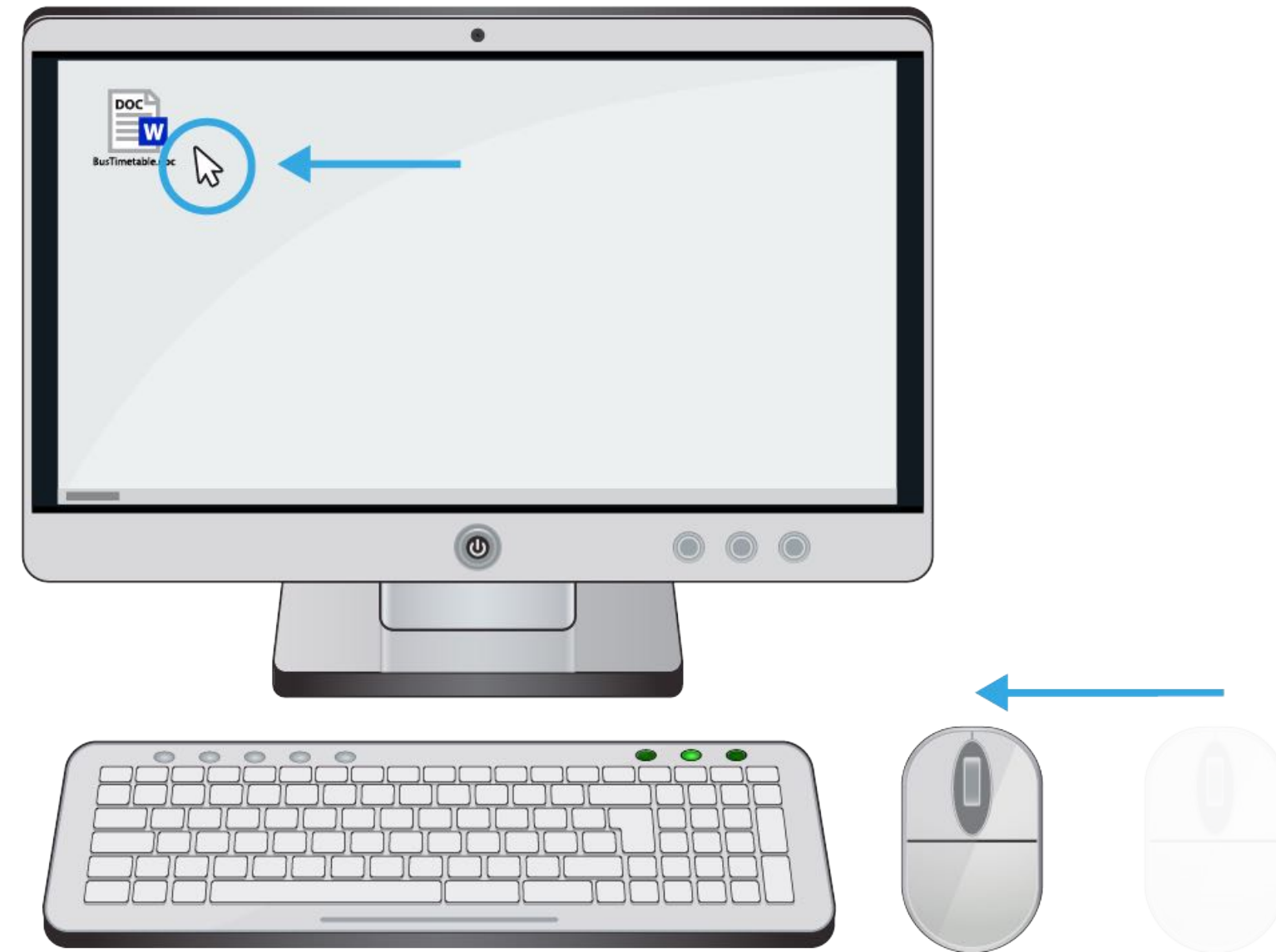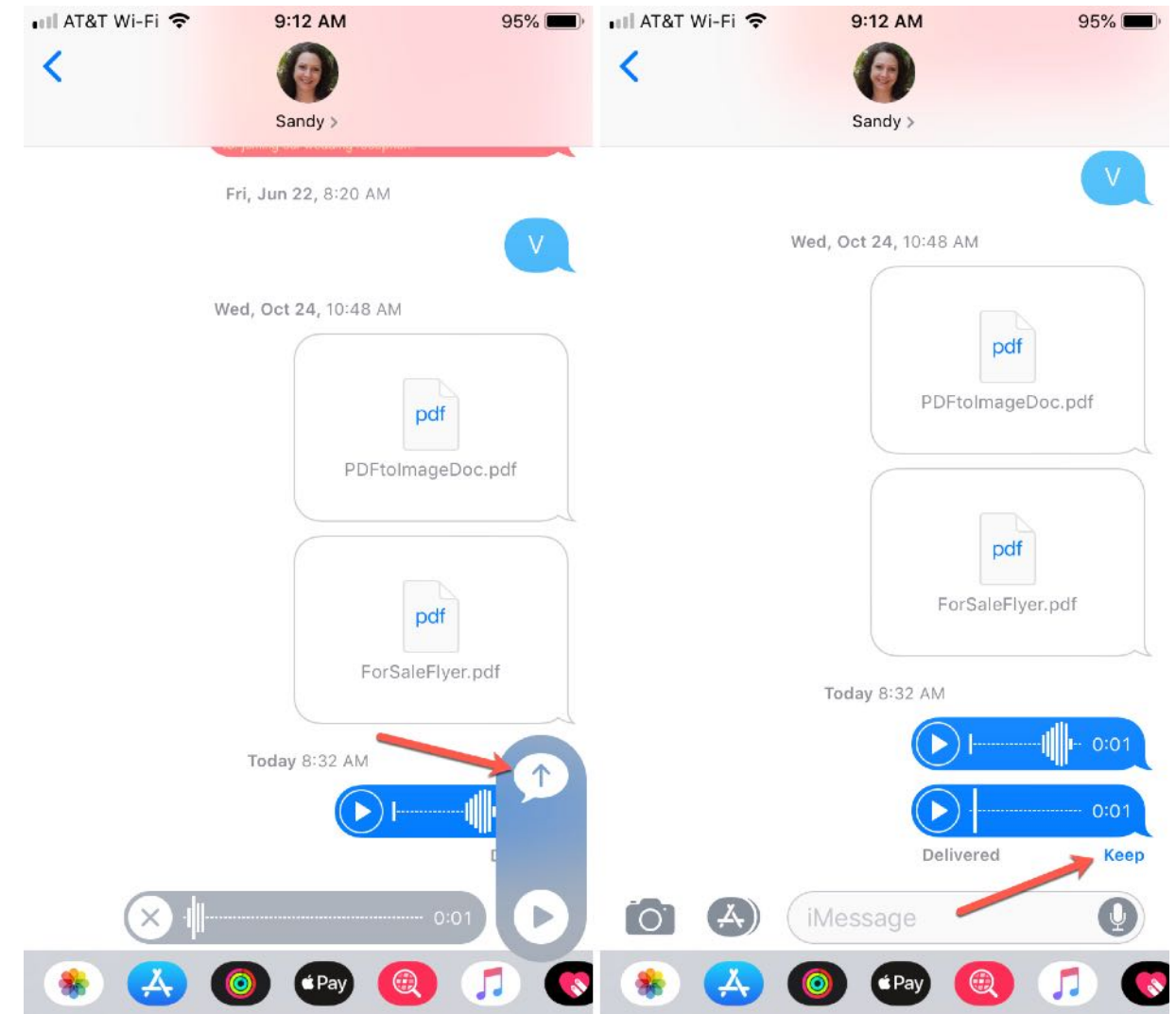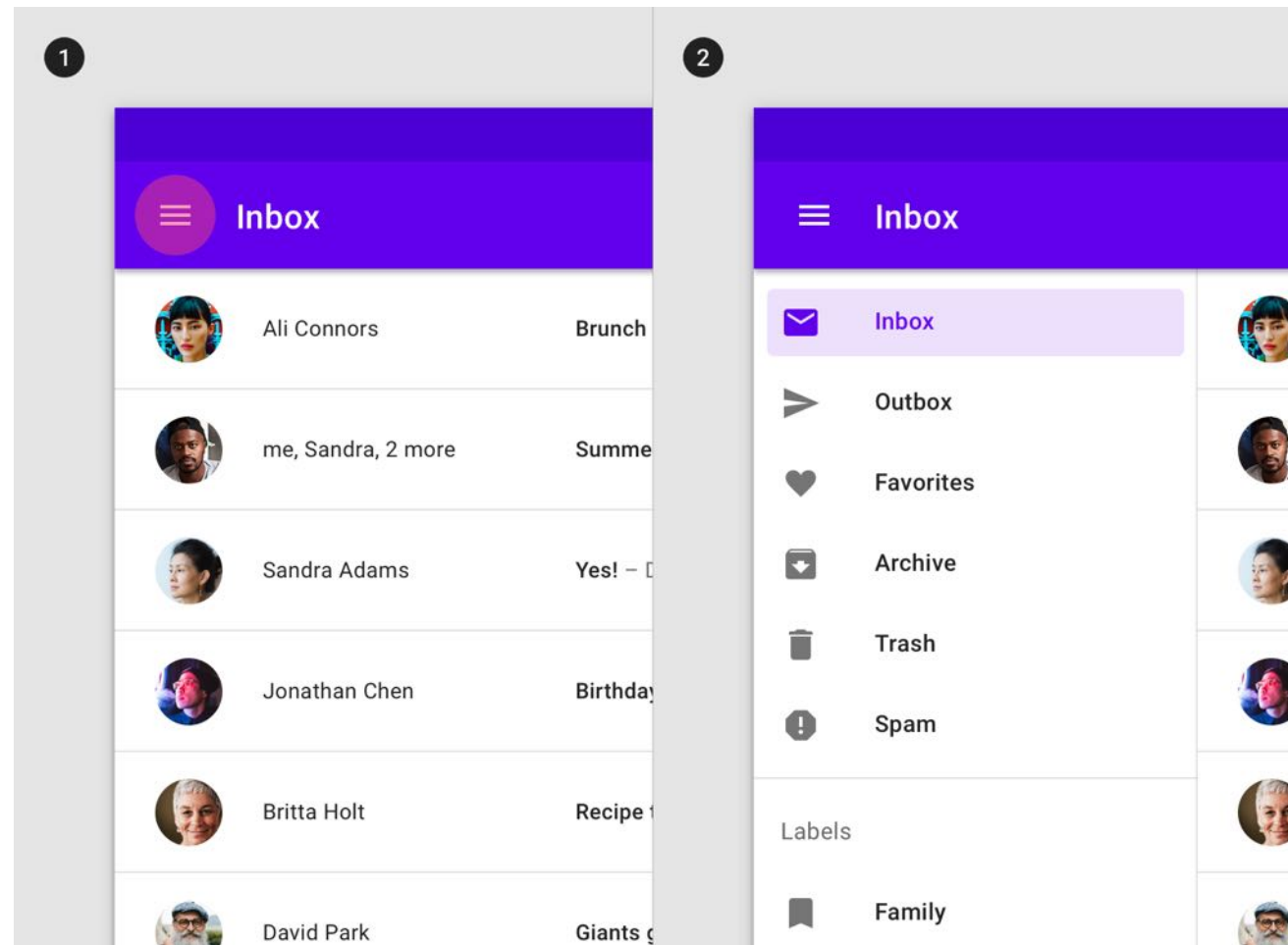
AND REDESIGN FOR APPLE WATCH

Idiomatic Design[14]

Definition: Building dedicated, highly expressive interaction capabilities that users must learn.

Mapping cursor movements on a screen to mouse movements is an extremely successful example.
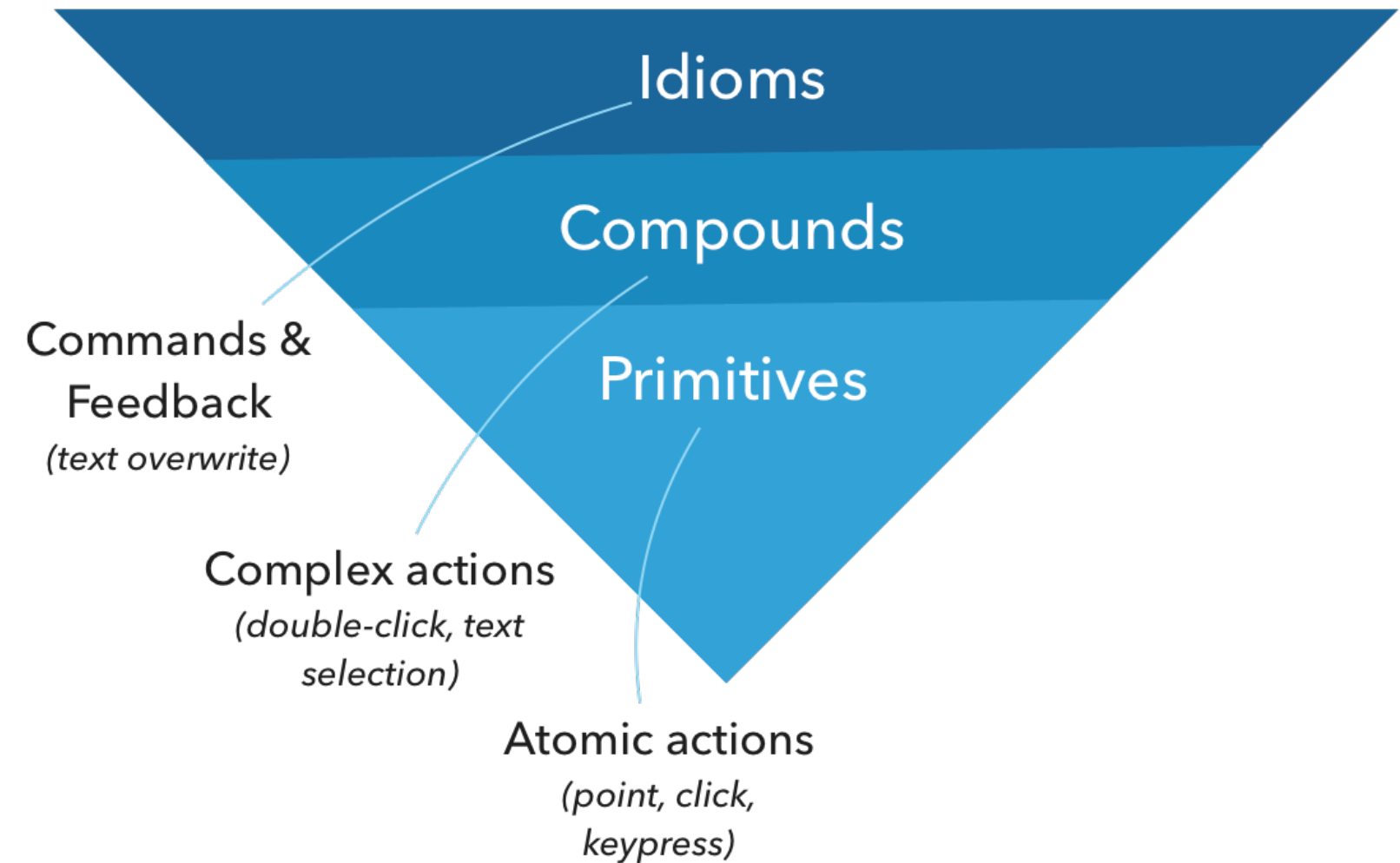

[14] Image Source

Developing Idioms[9]

In designing idioms involve, three elements are established:

1. **Primitives**: atomic actions, e.g., point, click

2. **Compounds**: complex actions, e.g., double-click

3. **Idioms**: higher-level elements, e.g., deleting text

Idioms

Compounds

Primitives

Commands & Feedback
(text overwrite)

Complex actions
(double-click, text selection)

Atomic actions
(point, click, keypress)

[9] Cooper et al., 2014, About Face

3D Interfaces

Variations of 3D Interfaces

1. **VR:** Creating virtual 3D representations

2. **AR:** Mapping virtual representations into the user's environment

3. **TUI:** Bringing interaction into the physical realm

Virtual Reality Interfaces

Definition: Virtual reality (VR) is the experience where users feel immersed in a simulated world, via hardware—e.g., headsets—and software.[16]
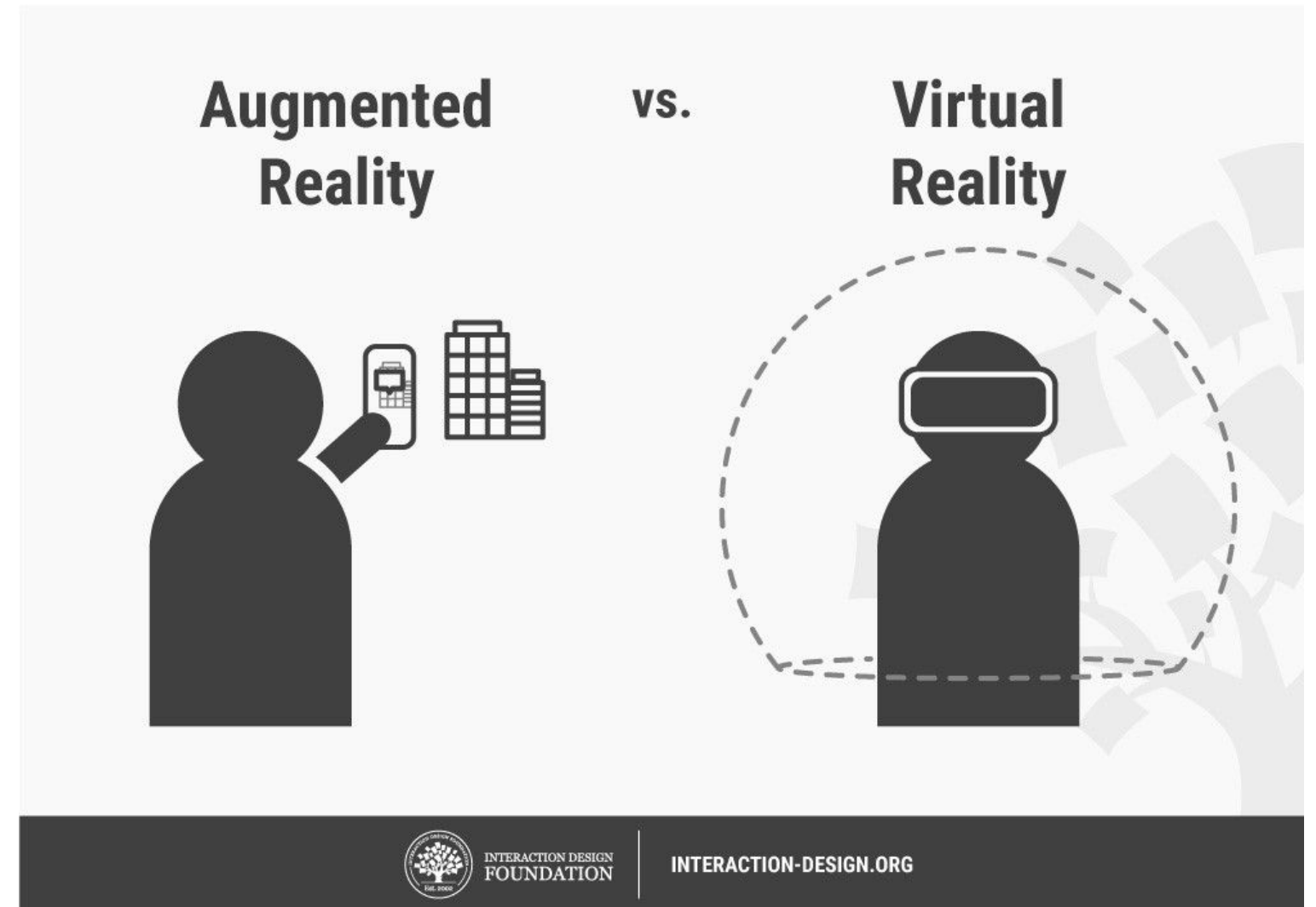
[16] Interaction Design Foundation%20is%20the,attain%20goals%E2%80%94e.g.%2C%20learning.)

Augmented Reality Interfaces

Definition: Augmented reality (AR) is the integration of digital information with the user's environment in real time.[17]
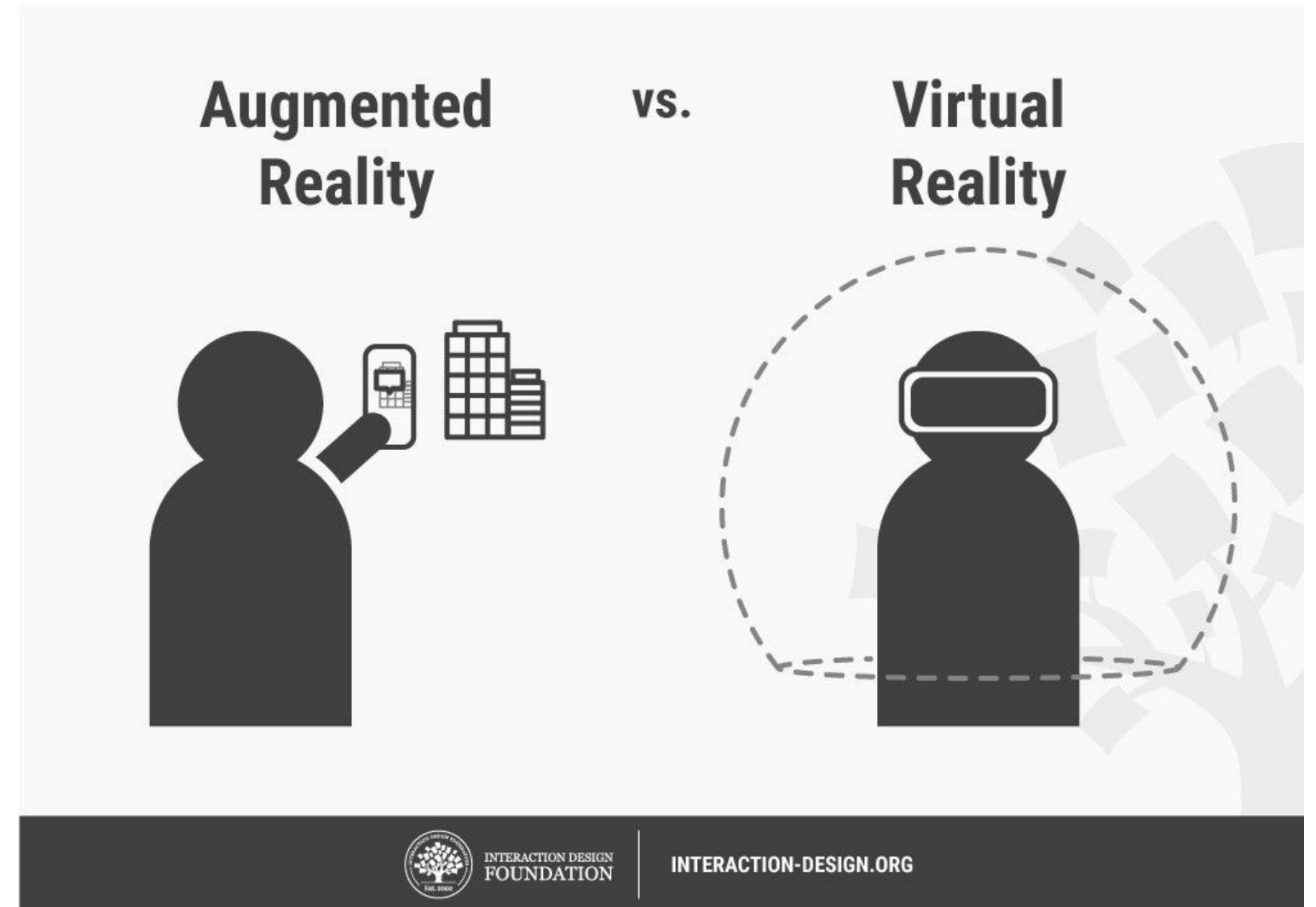
[17] TechTarget

Tangible User Interfaces[18]

Definition: A tangible user interface (TUI) is a user interface in which a person interacts with digital information through the physical environment.[19]

[18] Ideum

[19] Wikipedia

Fundamental Representations

Types of Fundamental Representations

1. Visualization

2. Database

3. Canvas

4. Tool panel

5. Hybrid
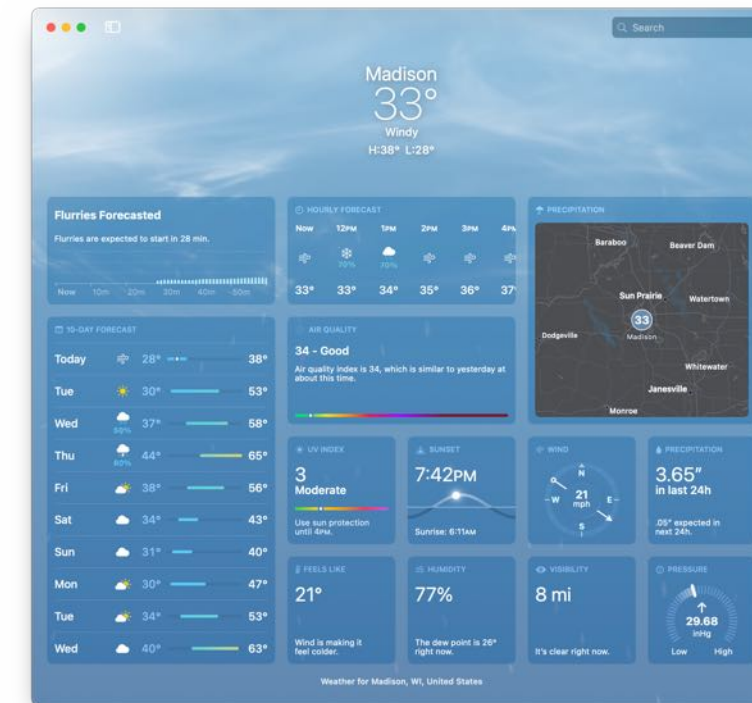
Similar to *structural categories:*[20]

1. Show one single thing

2. Show a list or set of things

3. Provide tools to create a thing

4. Facilitate a task

[20] Tidwell, 2010, *Designing Interfaces*

Fundamental Representations: Visualization[21]

Representations that primarily display information with some level of interactivity.

[21] Image source

Fundamental Representations: Database[22]

Representations that enable seeking information in a collection.
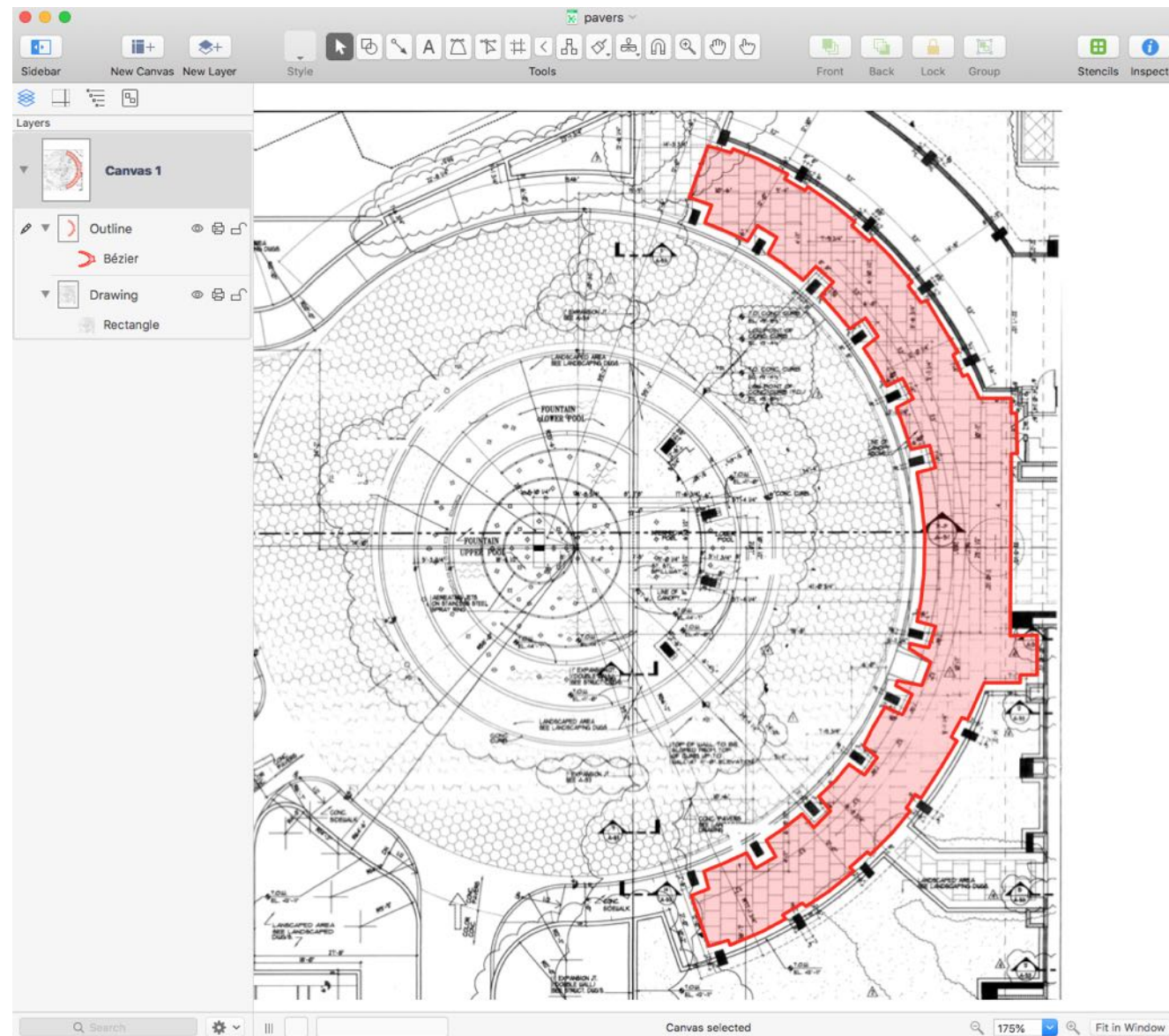

[22] Image
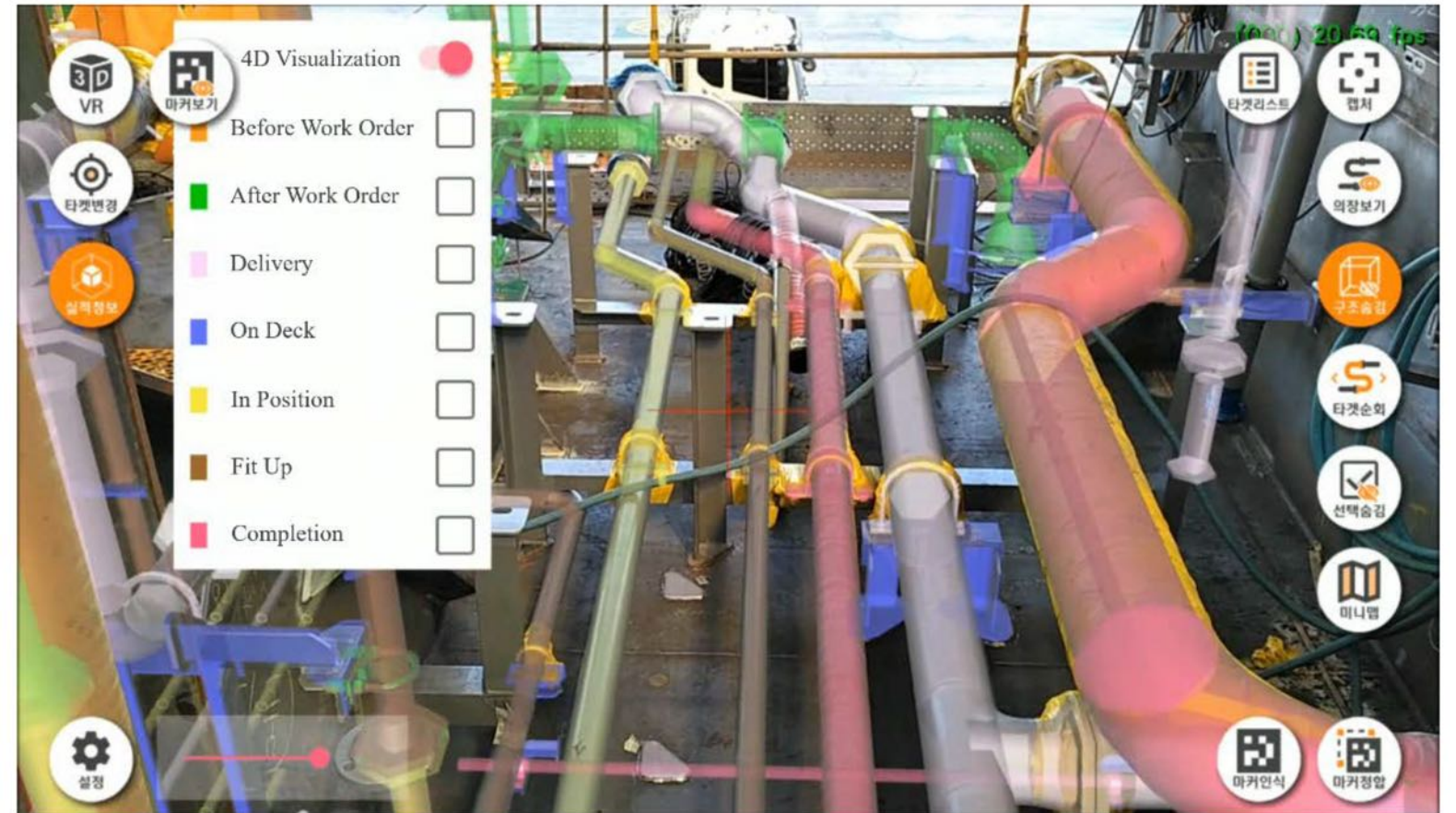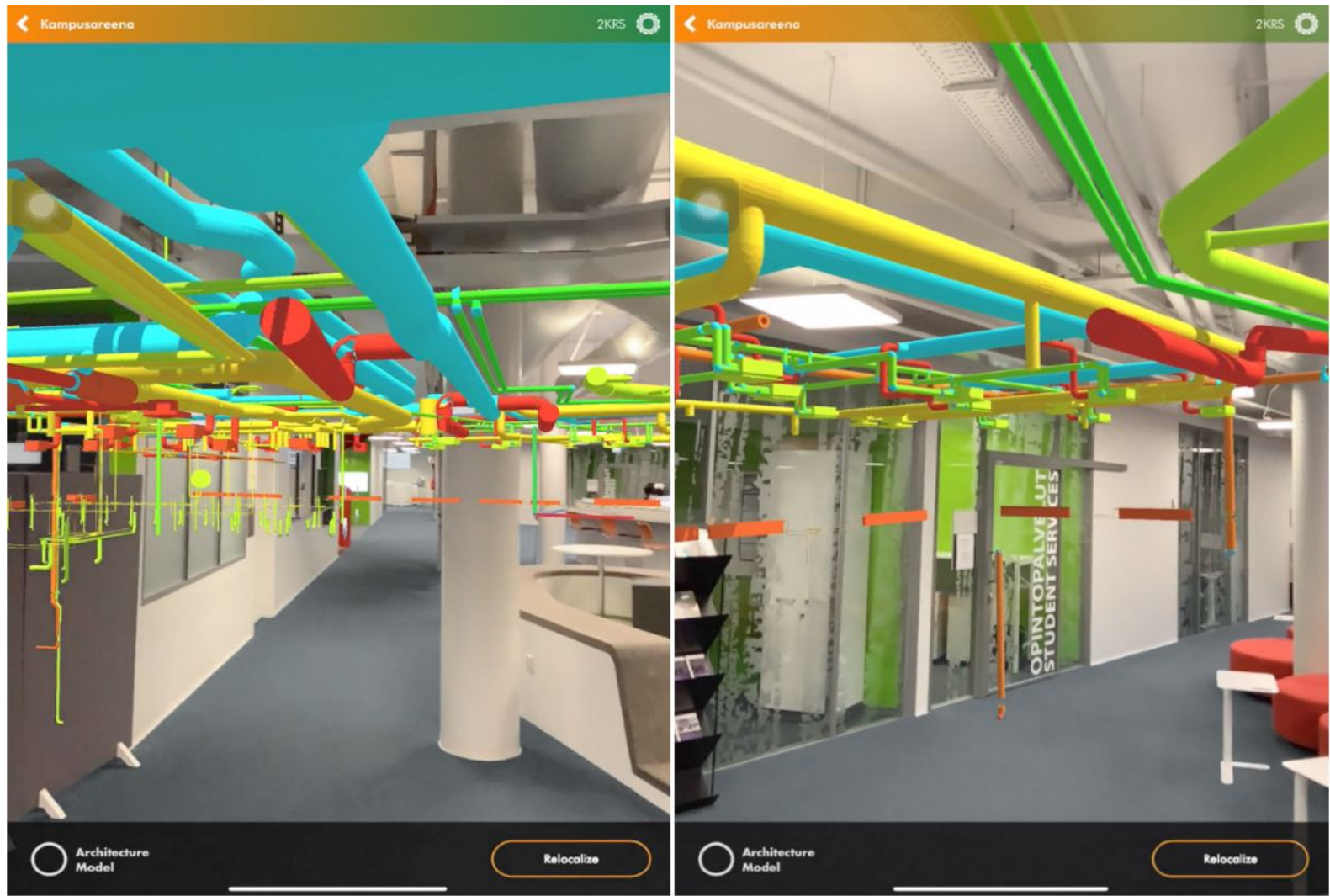
Instamuseum[23]

Fundamental Representations: Canvas
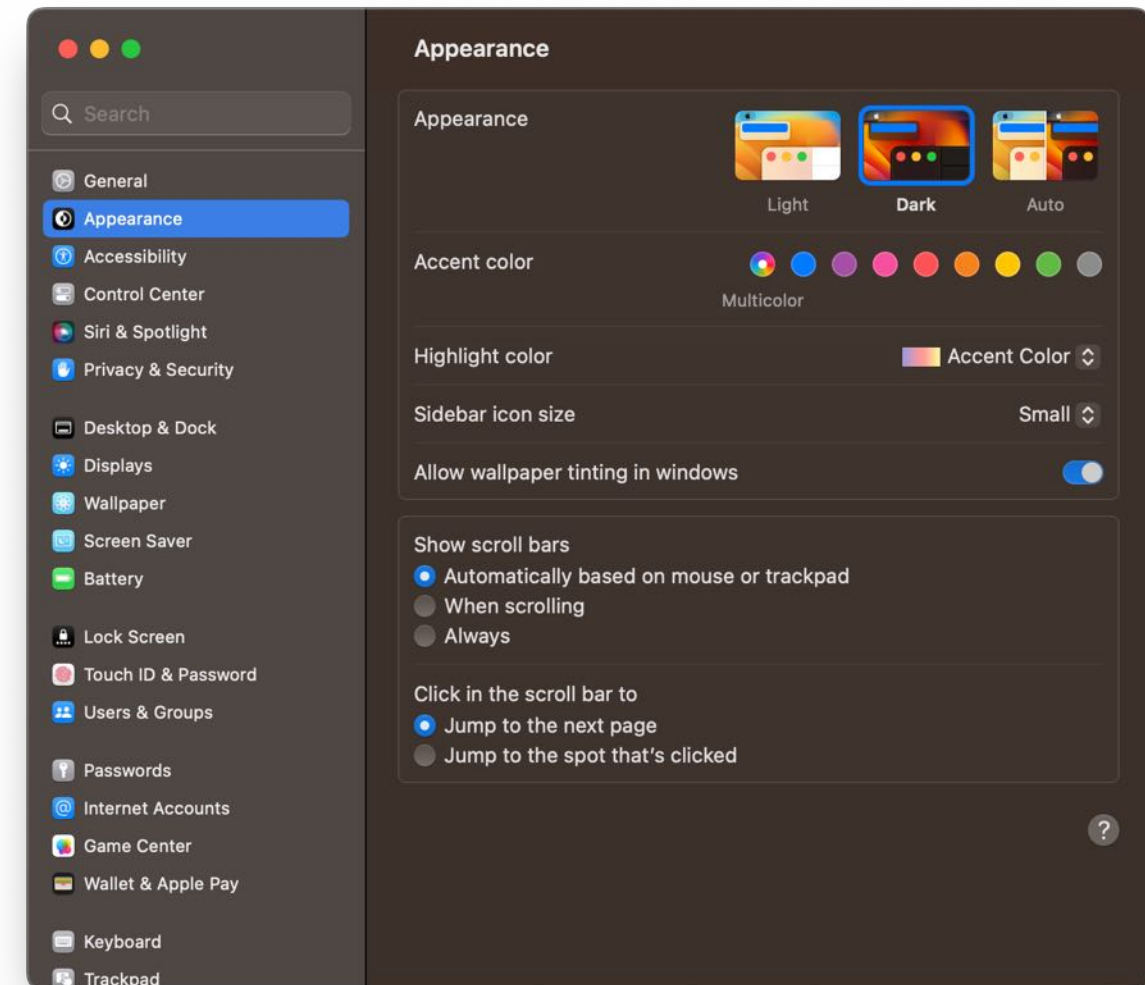
Representations that provide a canvas to generate new content.
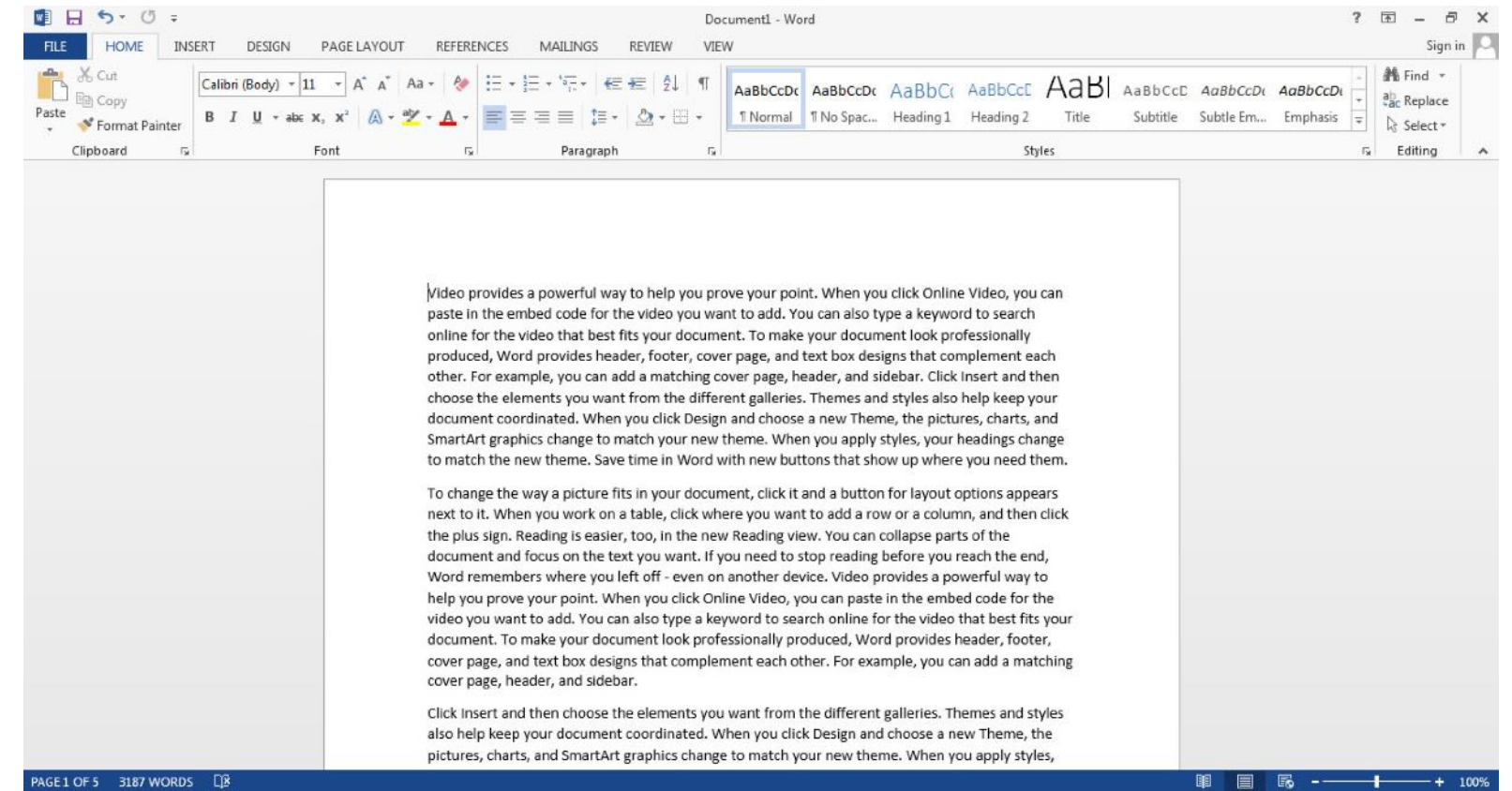
Fundamental Representations: Tool Panel[26]

Representations that provide access to tools, options, settings, etc. toward accomplishing specific tasks.

[26] Augmenta, Video

Fundamental Representations: Hybrid[27]

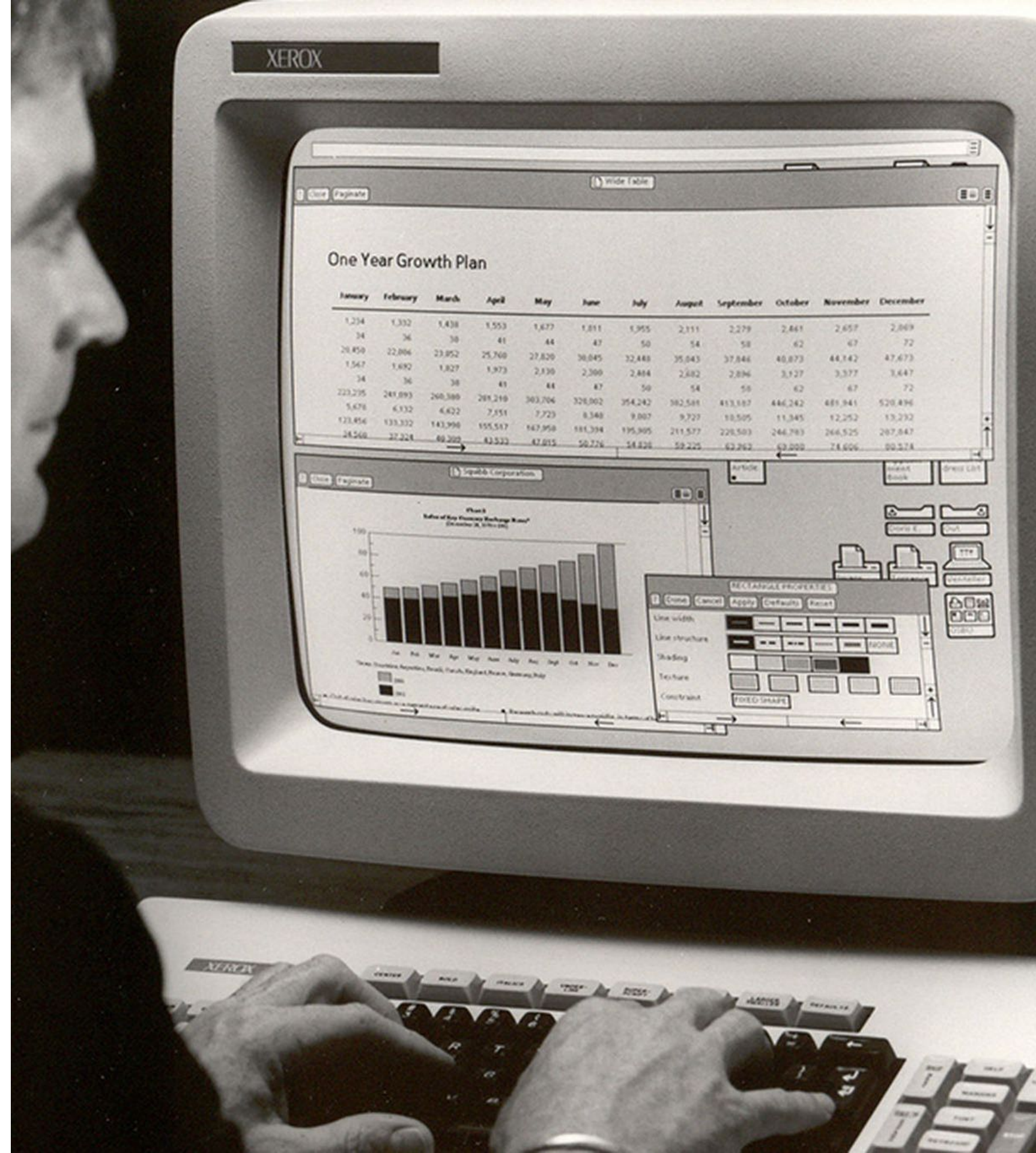Representations that integrate other fundamental elements to support specific user goals or tasks.

Organization of Representations

Organization in 2D: The WIMP Paradigm[28]

Definition: *Windows*, *icons*, *menus*, and *pointer*, or *WIMP*, is a design paradigm that current desktop interfaces follow that dates back to the Xerox Alto (1973).
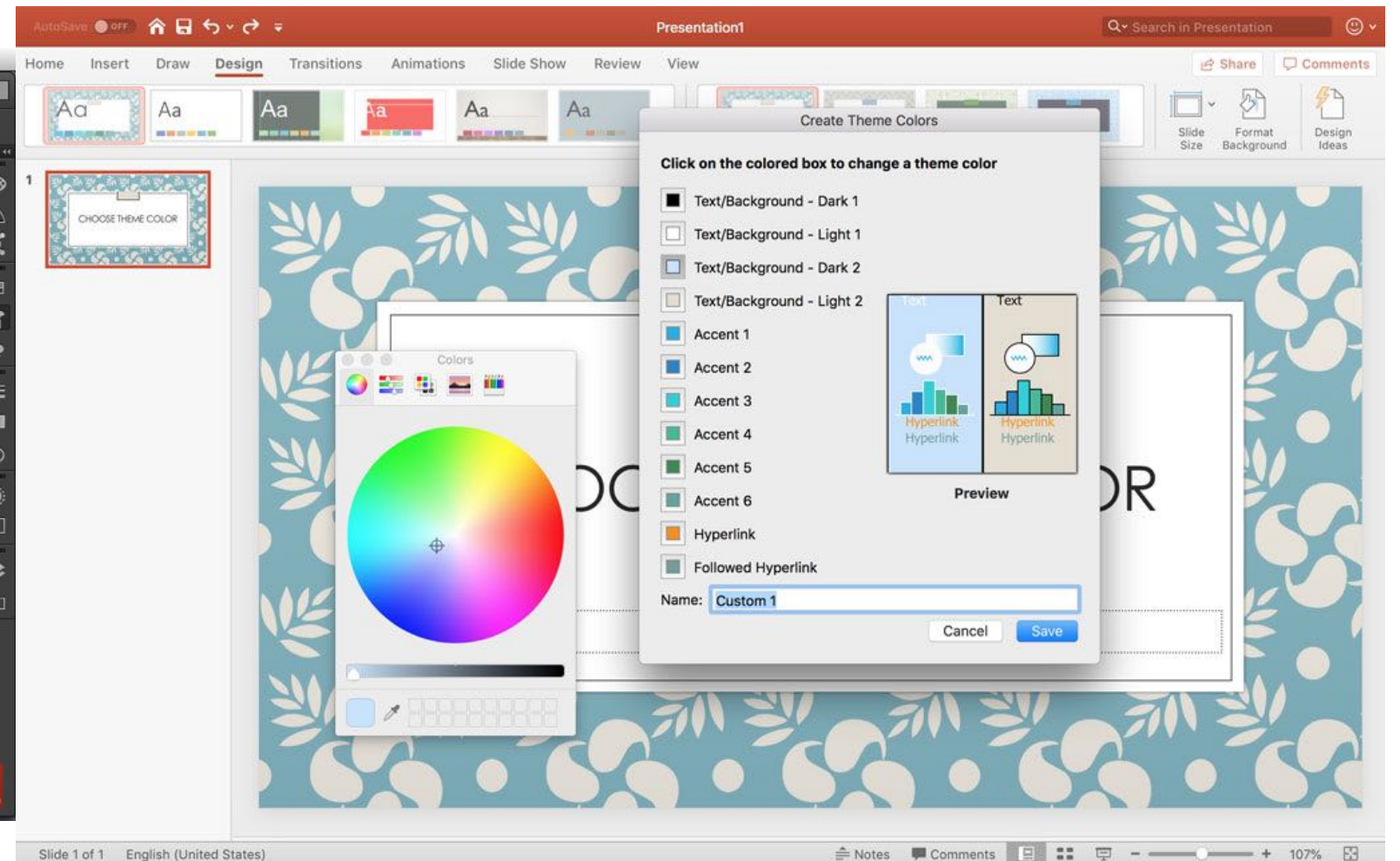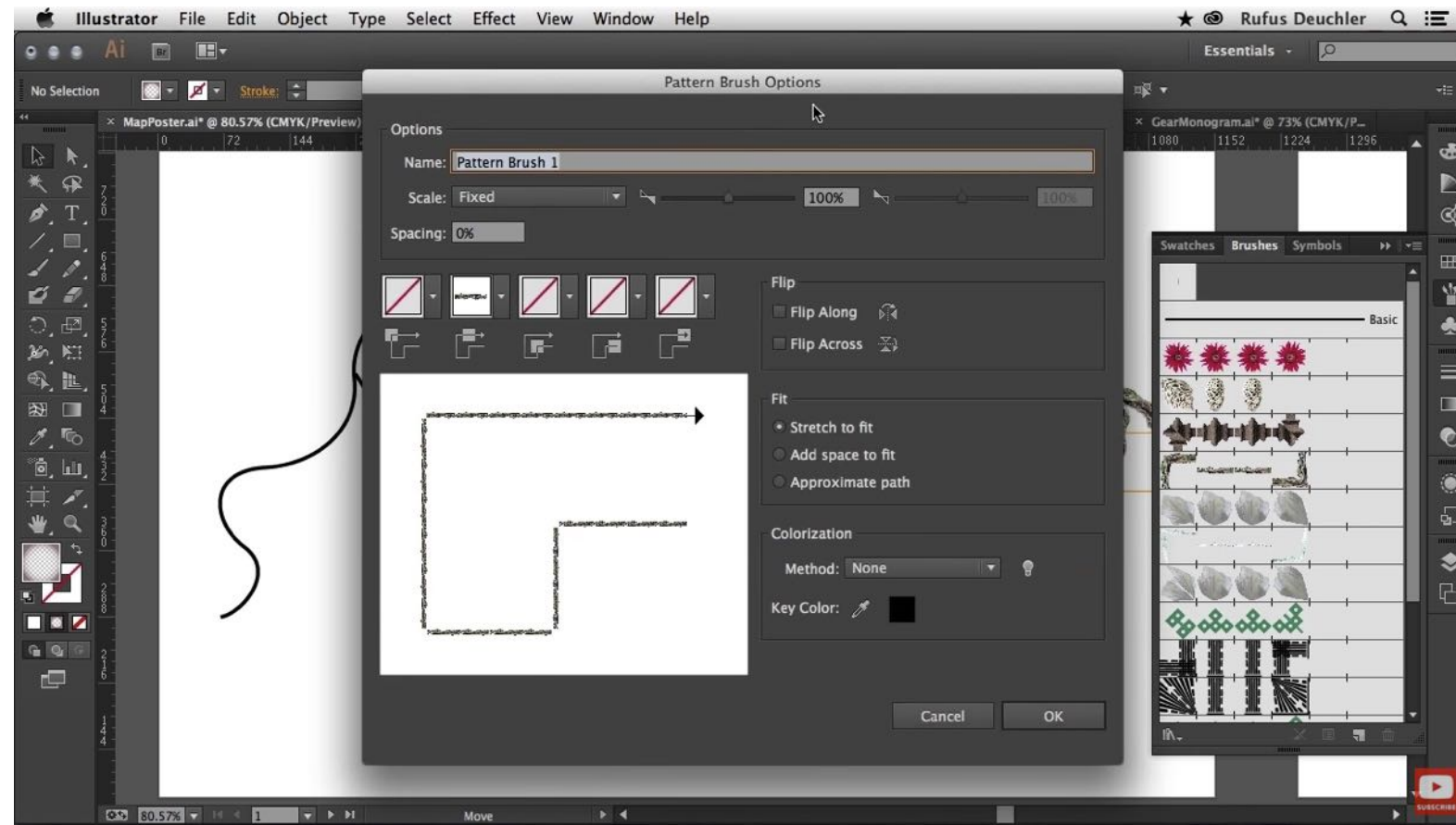
[28] Image source

Elements of the WIMP Paradigm: *Windows*

Definition: Windows are resizable containers of individual applications.

Primary windows contain elements for the main functionality of the application, such as a canvas. *Secondary* windows support main windows through modal panes, dialog boxes, etc.
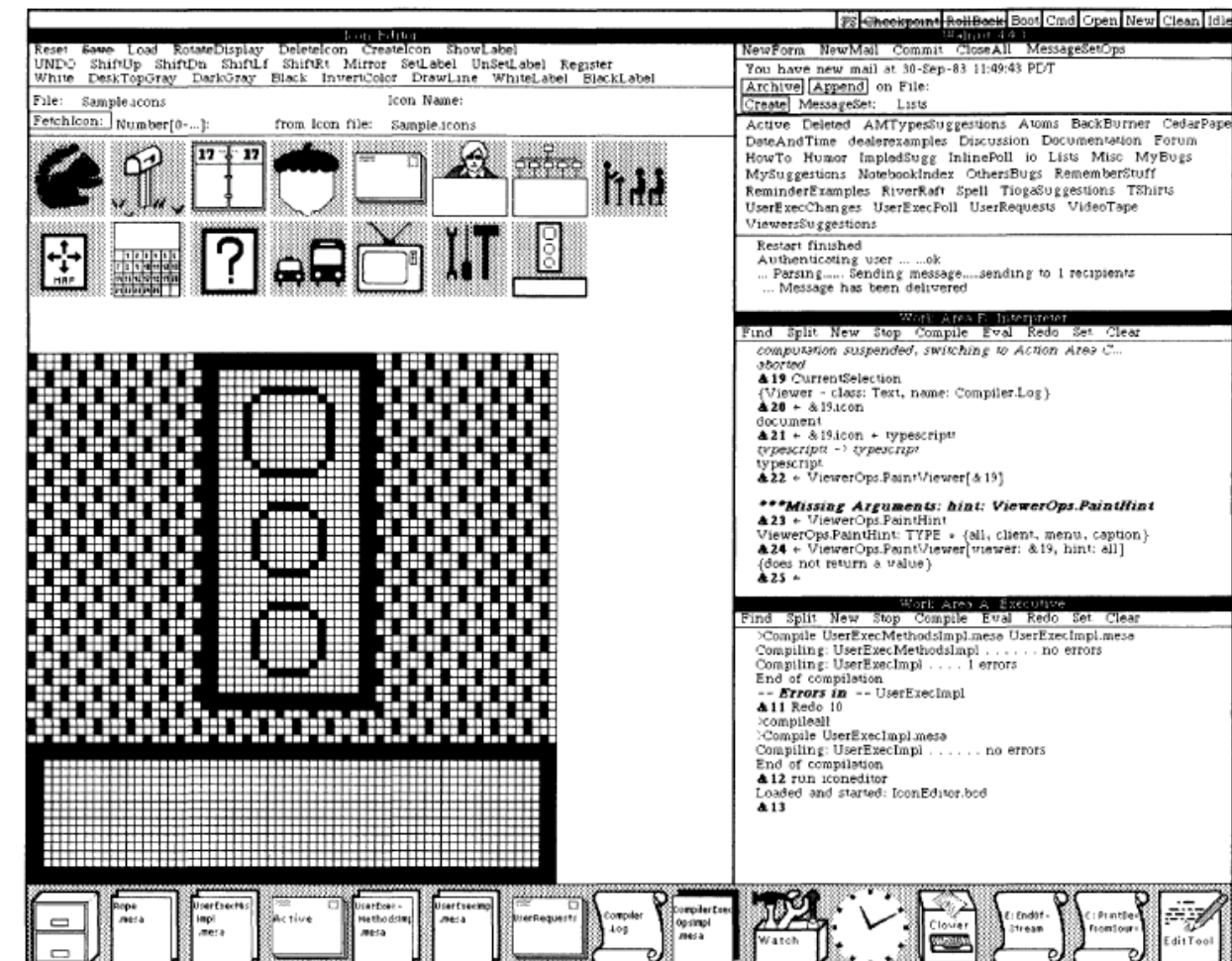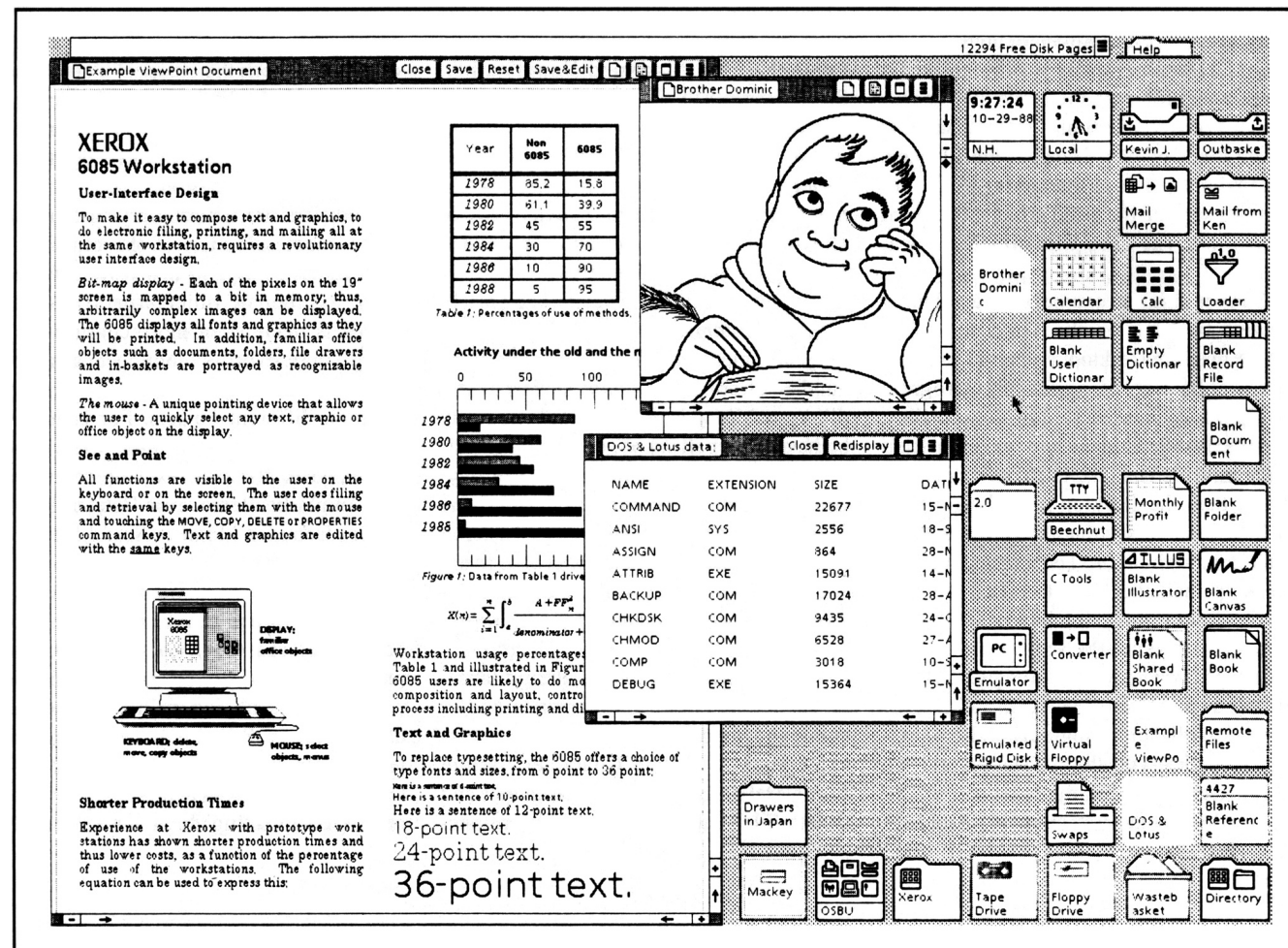
Window Organization[30]

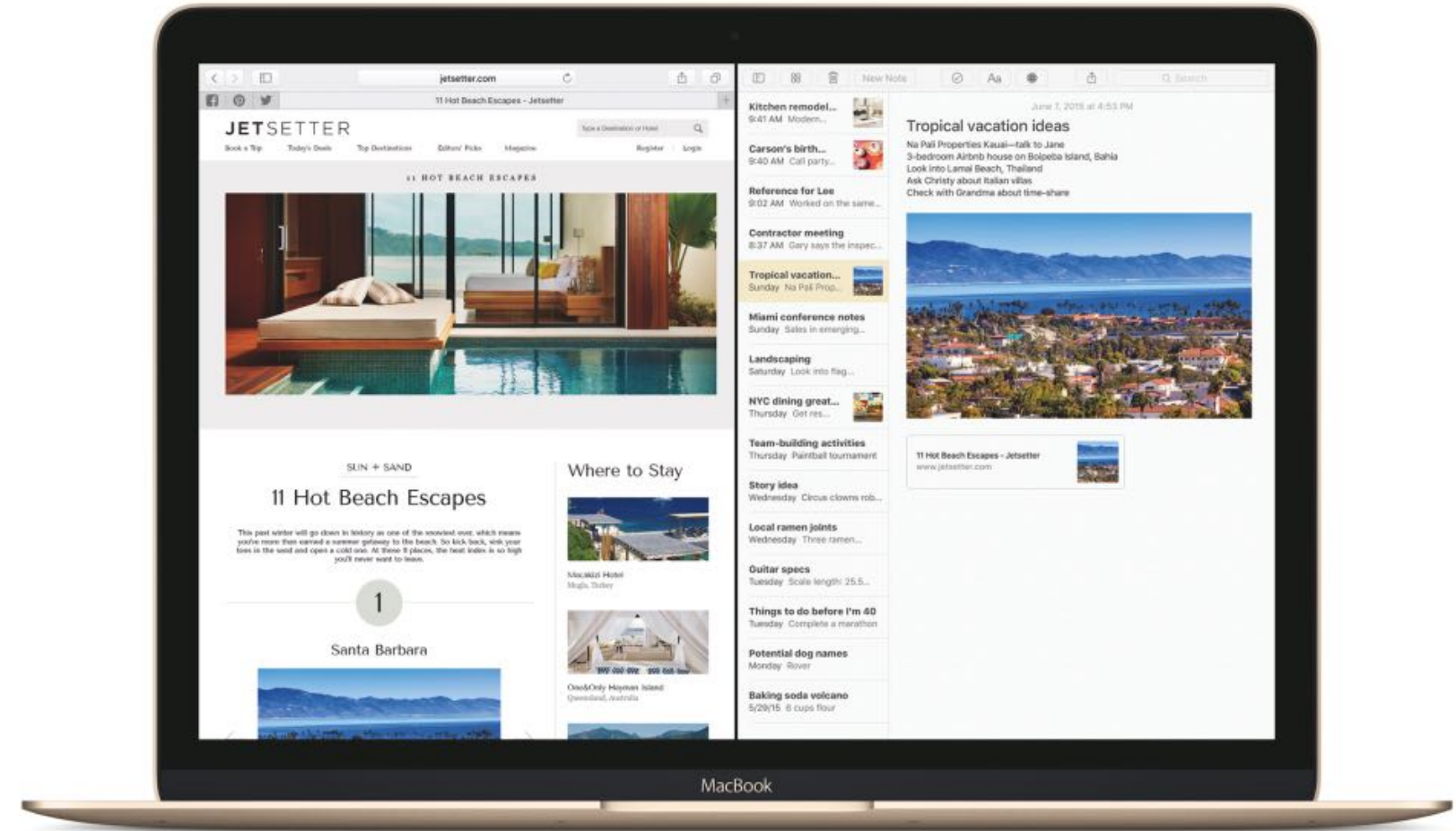**Definition:** Windows can be organized in a way that overlaps several windows or tiles them across the screen.
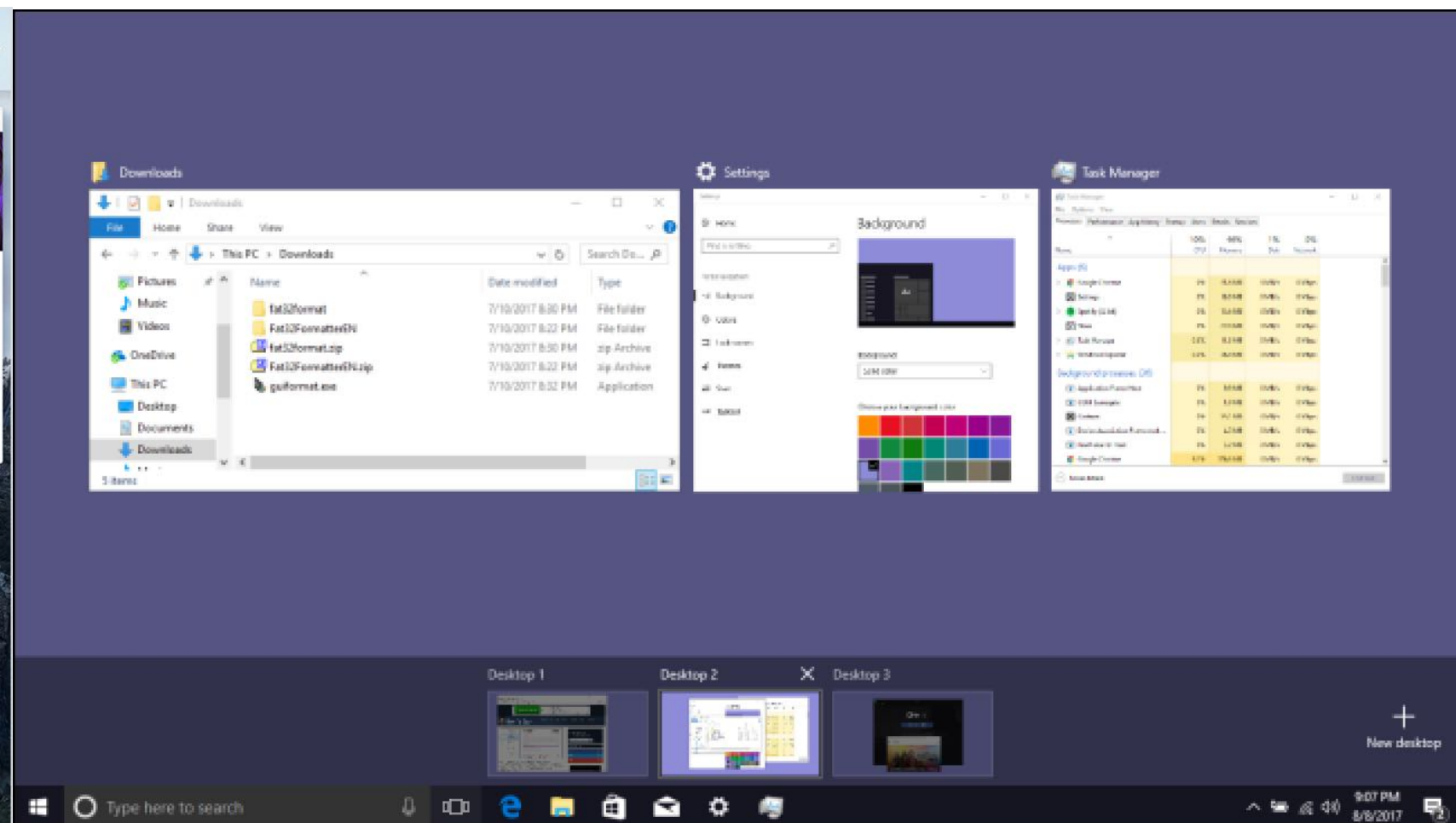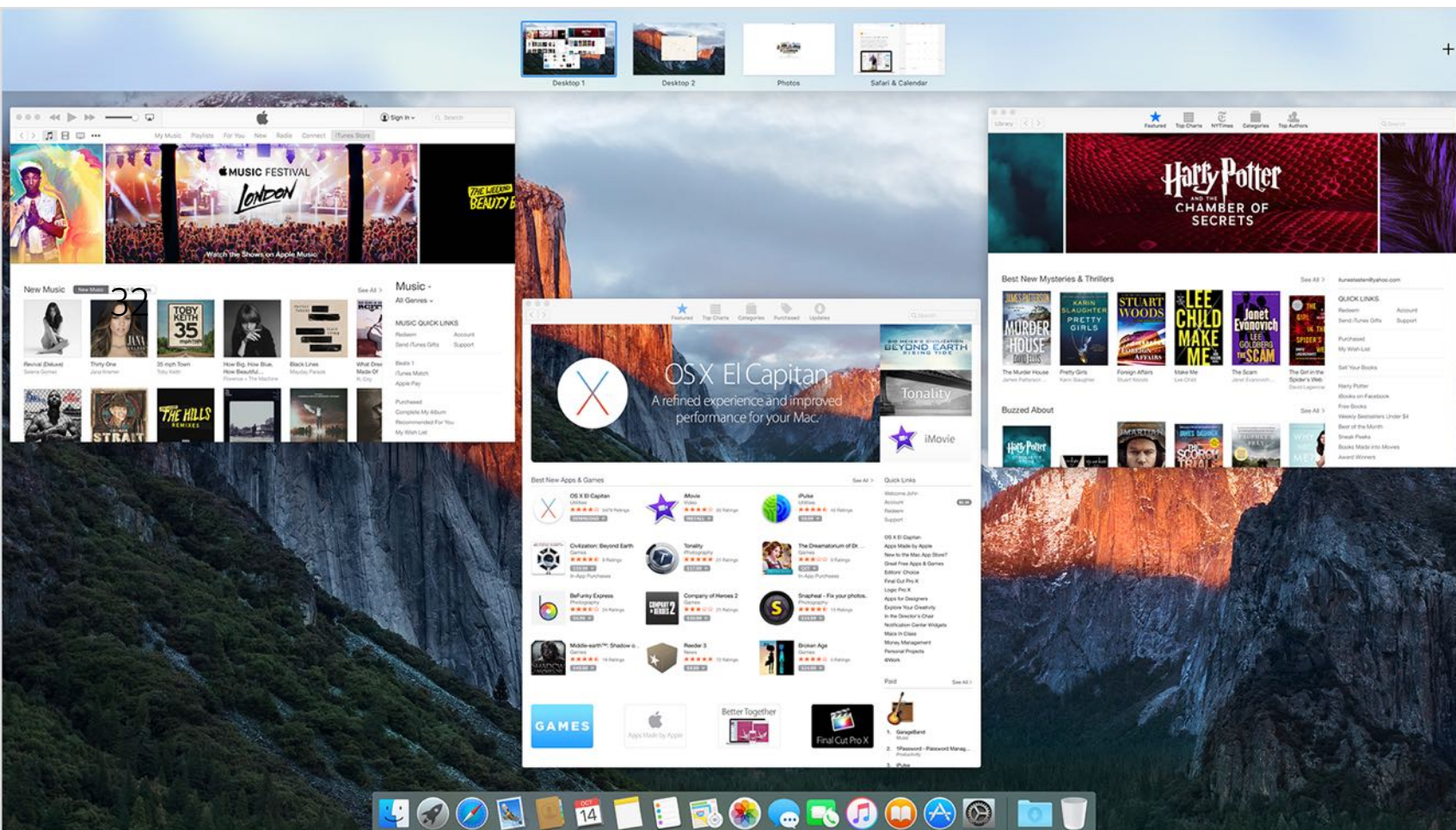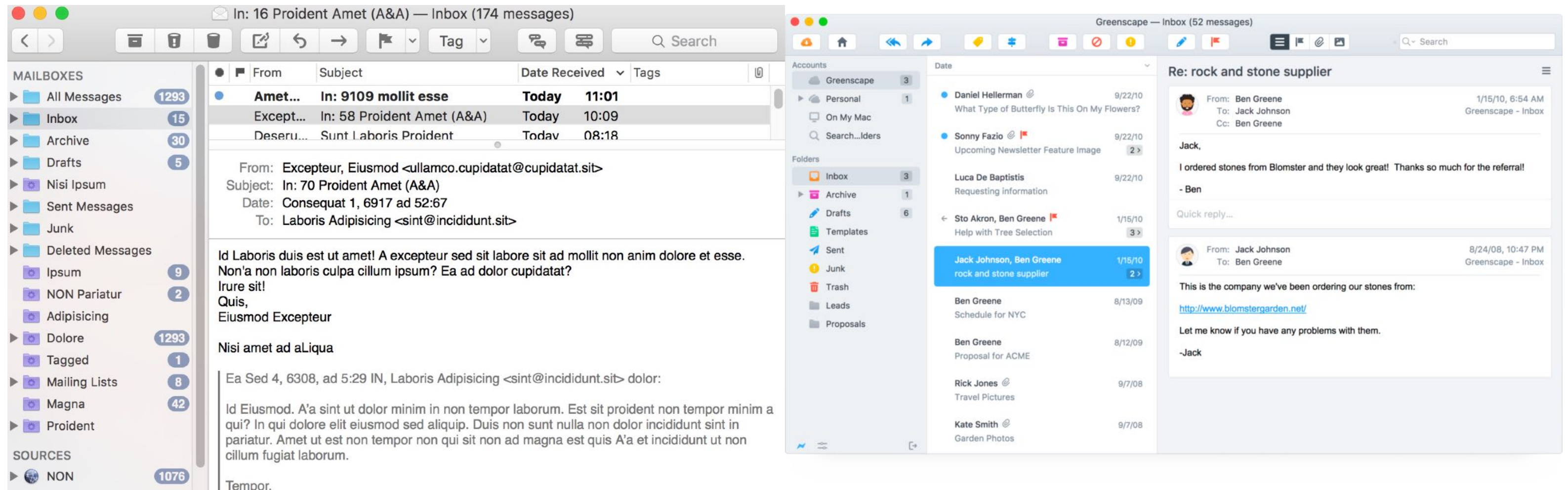
31

Window Structures[33]
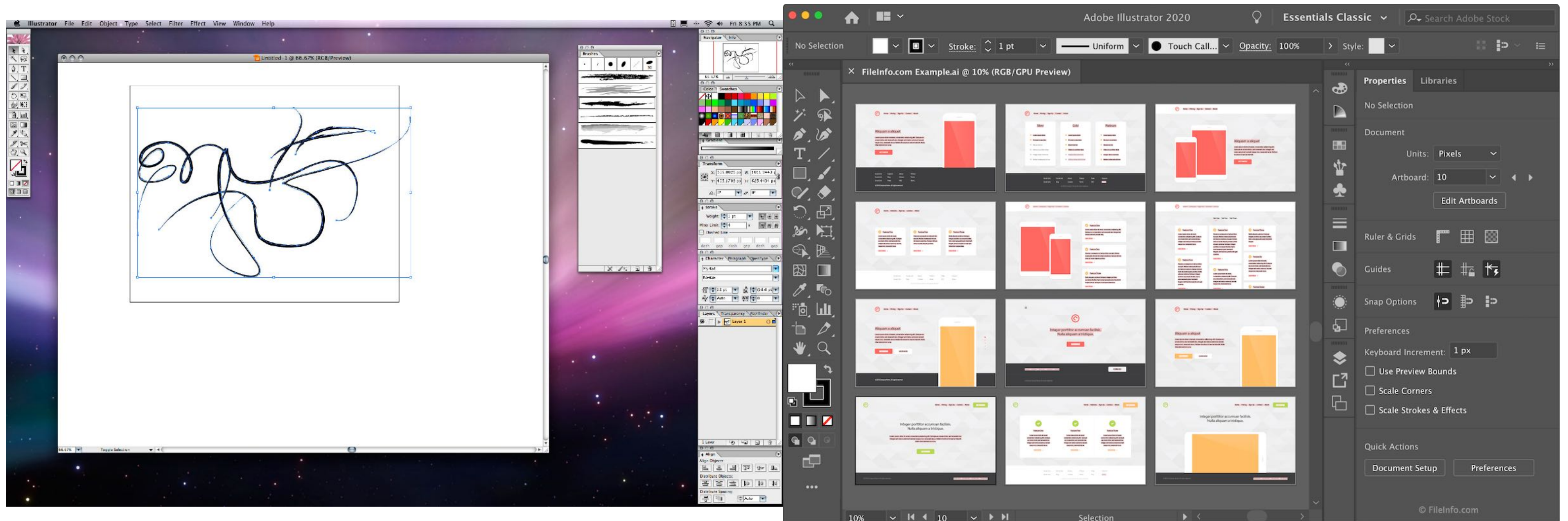
Windows bring together dedicated *panes* in different configurations.

[33] Image source: <u>Left</u>, <u>Right</u>

Secondary windows can be *docked*, *stacked*, and *floating*.[34]

Menus[35]

Definition: Menus list all the functions of the an application. Menu lists serve *educational* and *reference* purposes.

[35] Image source: Left, Center, Right

Toolbars, Palettes, Sidebars, & Tooltips[36]

Definition: *Toolbars*, *palettes*, *sidebars*, and *tooltips* facilitate (visual and manipulation) access to frequently used functions.
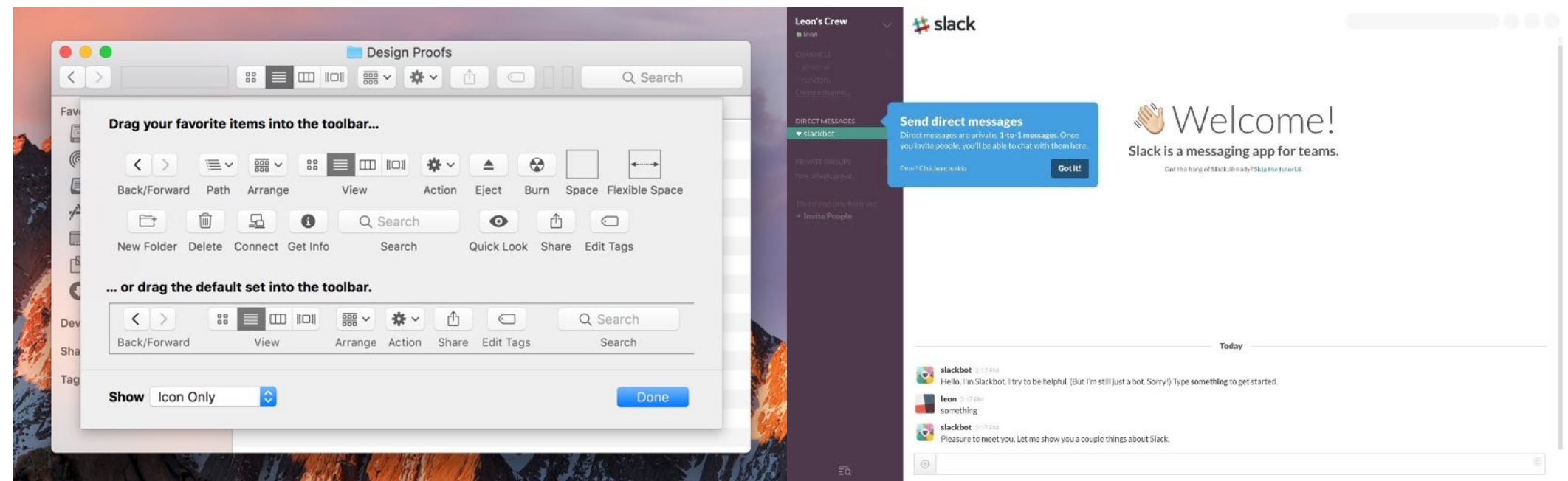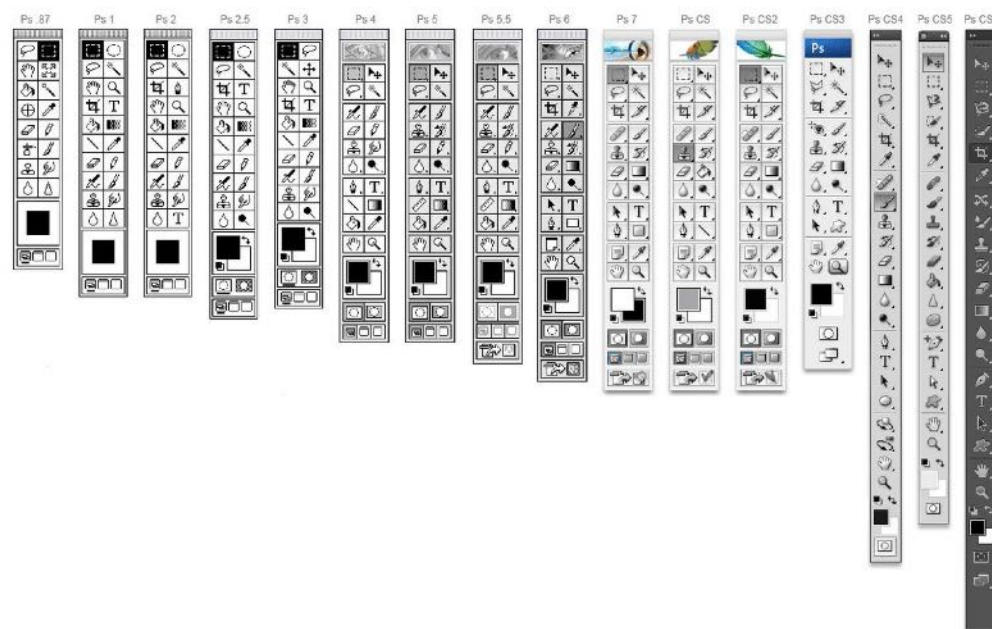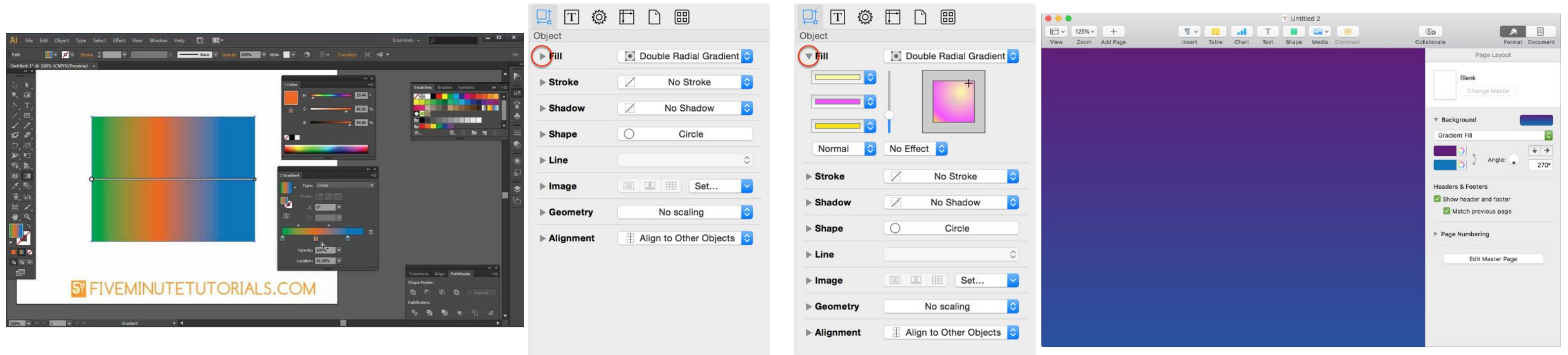

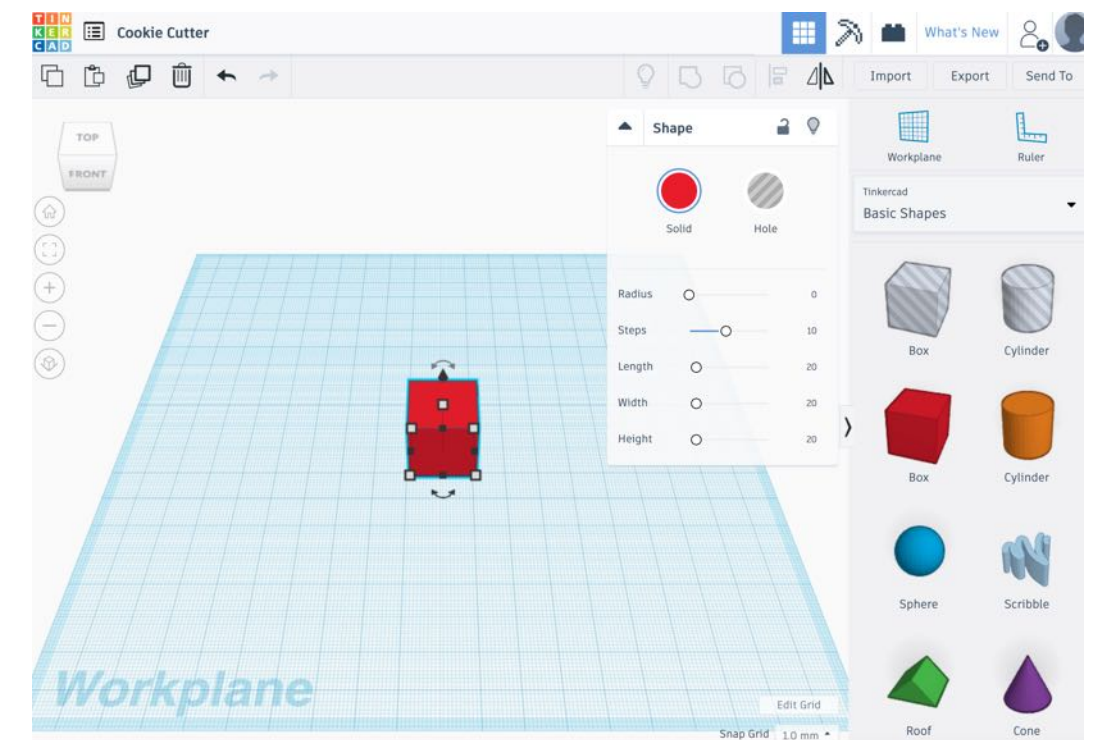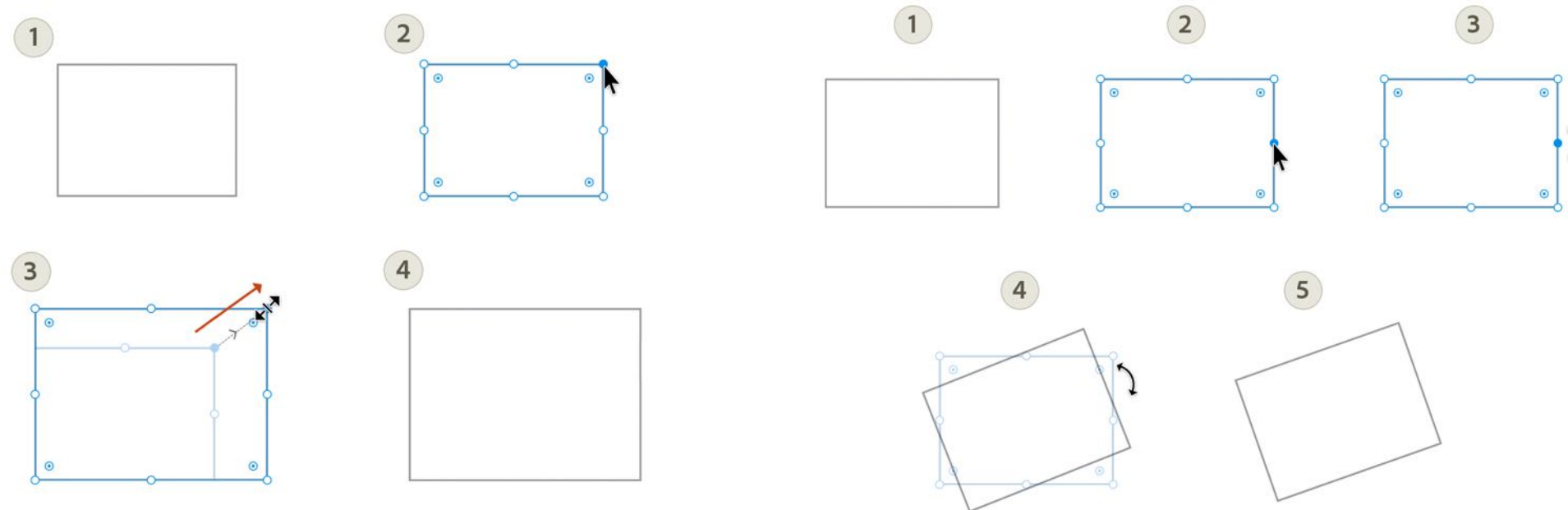[36] Image source: <u>Left</u>, <u>Center</u>, <u>Right</u>

Tool Palettes[37]

Definition: Tool palettes provide *advanced controls* for a particular function rather than frequently accessed functions.

Pointing[38]

Definition: *Pointing* on an application canvas enables a range of advanced capabilities for *direct manipulation.*

Design Patterns

Definition: A design pattern is a general, reusable solution to a commonly occurring problem within a given context.
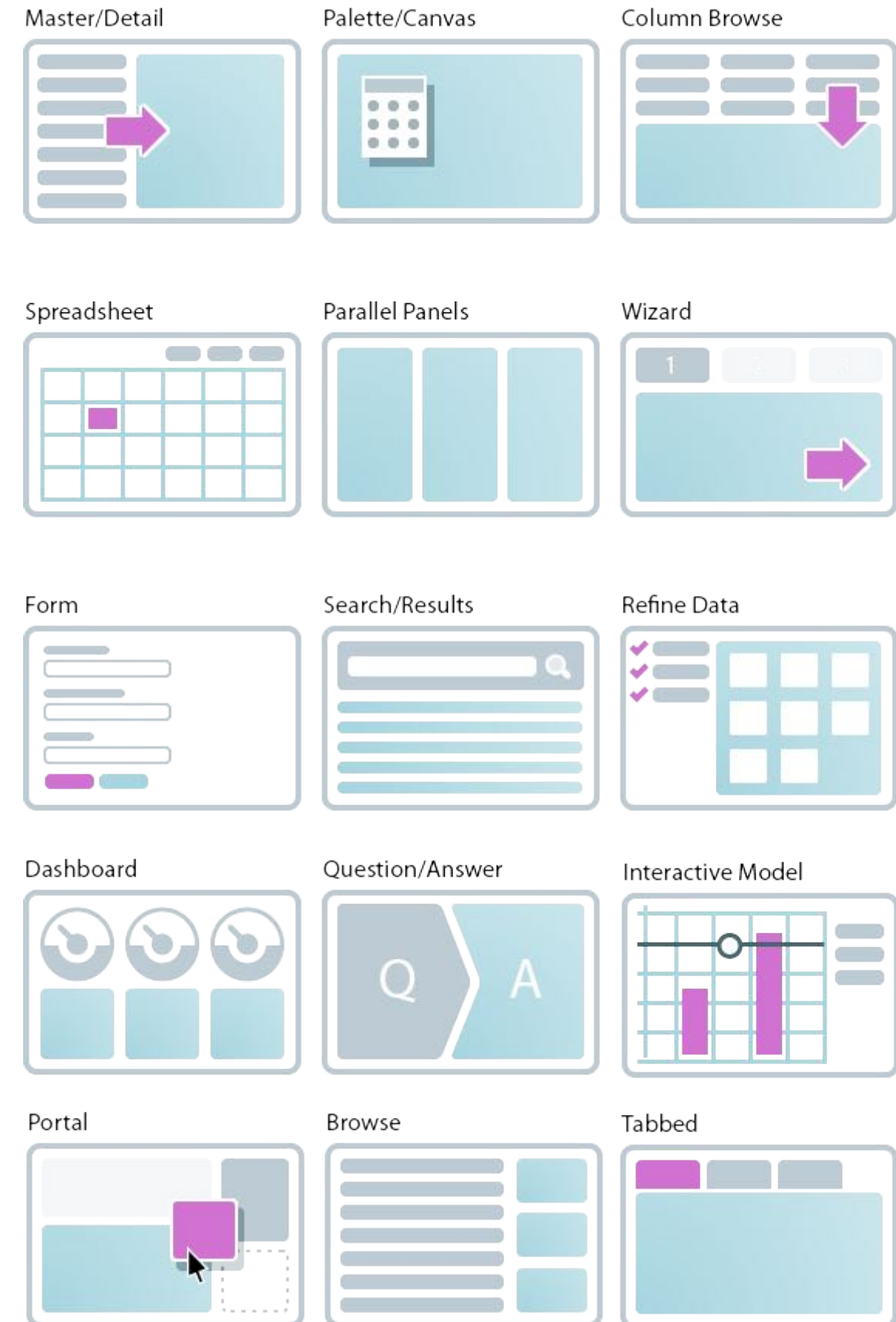
Originally developed by Christopher Alexander (1977; *A Pattern Language*) to address problems in architecture and city planning.[39]
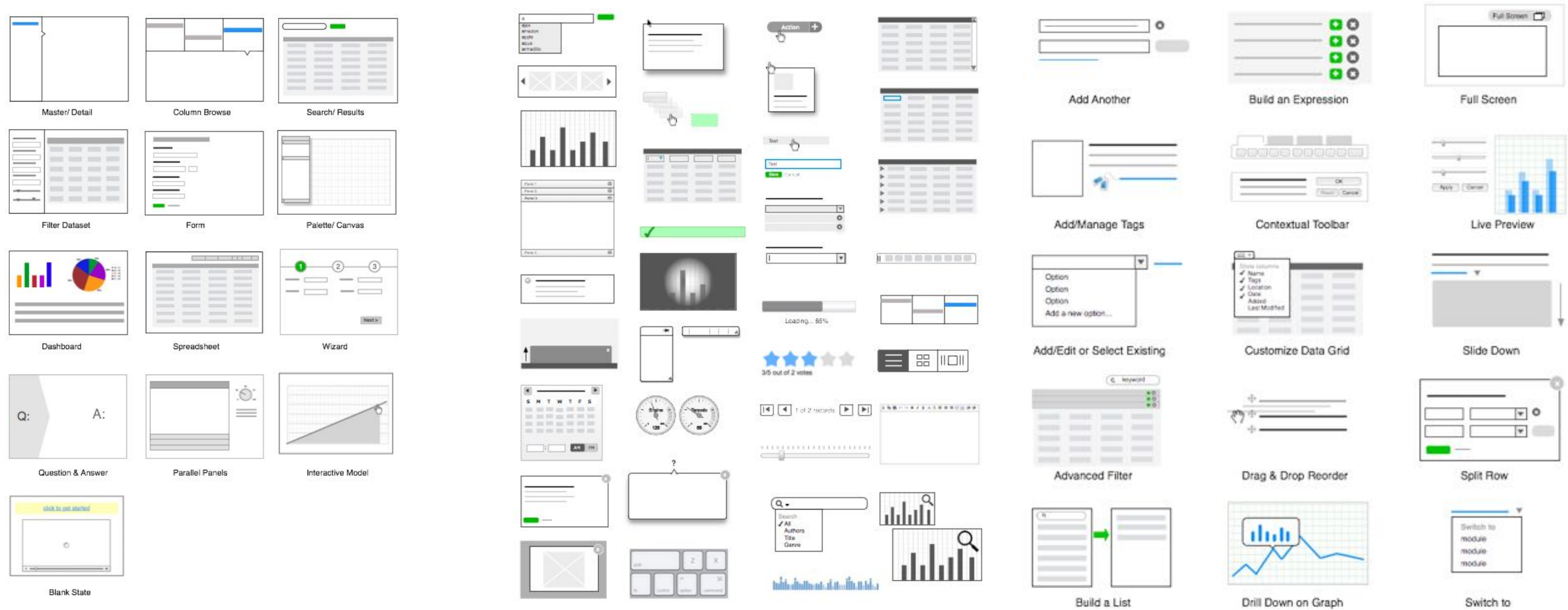

[39] Smart Cities Dive

Design Patterns in Visual Representations

In the last decade, designers have also developed and refined patterns for overall structure and organization, components and controls.[40]

[40] Neil, 2010, 12 Standard Screen Patterns

What did we cover today?

→   Overview of visual representations

→   2D interfaces

→   3D interfaces

→   Fundamental representations

→   Organization of representations