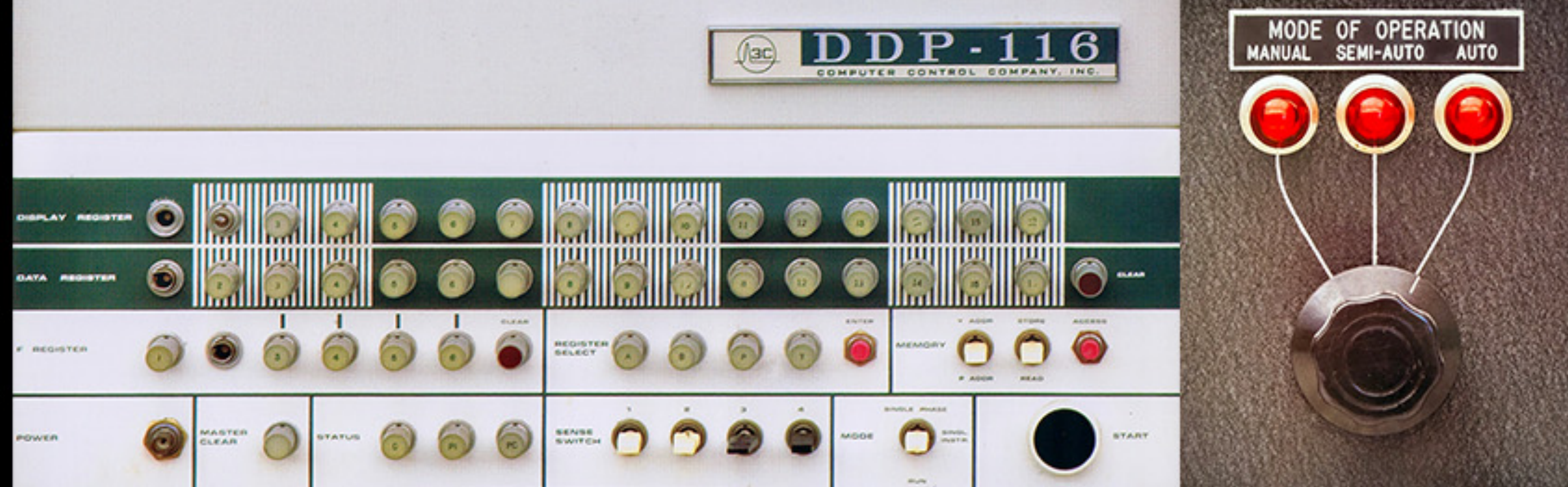


CS160

USER INTERFACE DESIGN

FALL 2026



MODES, METAPHORS, AND INPUT DEVICES

28 SEP 2026

ANNOUNCEMENTS

DESIGN 03 — Your feedback due by 4 Oct

DESIGN 03 — Due 9 Oct

PROG 02 — Due 16 Oct

Required Attendance Class — 30 SEP

SECTION: AI API (for PROG 02)

MIDTERM

28 OCT

IN CLASS (DSP offsite - details TBA)

80 MIN

Closed notes and books

Covers all material up to 21 October

No coding questions

Bring your brilliant mind and a pen or pencil (maybe extra)

Possible types of questions:

- Multiple choice
- Short answer
- Some sketching and drawing (i.e. diagram or interface)
- Design study (i.e. how would you perform a study for a particular design)
- Redesign with justification/details

This is a closed book, individual test.

SAMPLE

You are not allowed to use your notes, texts, or any electronic devices including laptop computers, calculators, mobile phones, smartwatches, VR headsets, smart clothing, interactive tattoos, or ingested electronics.

You have 80 minutes for this exam.

There are a total of 44 questions worth 110 points and 3 extra credit questions worth 6 points. The last series of questions is worth a significant amount of the exam and requires more effort and time. Please allow time to complete that section. The exam is 16 pages front and back.

Use your time accordingly. Before you begin, write your name on every page! You will lose 1 point if you do not do this.

Please write neatly. We cannot give credit for what we cannot read.

If you find a question ambiguous, document the ambiguity. Indicate the way you interpreted the question in a set of separate sentences next to the question. The questions on the exam are not intended to be ambiguous, but sometimes another meaning is interpreted by the examinee that we did not take into consideration.

Good Luck!

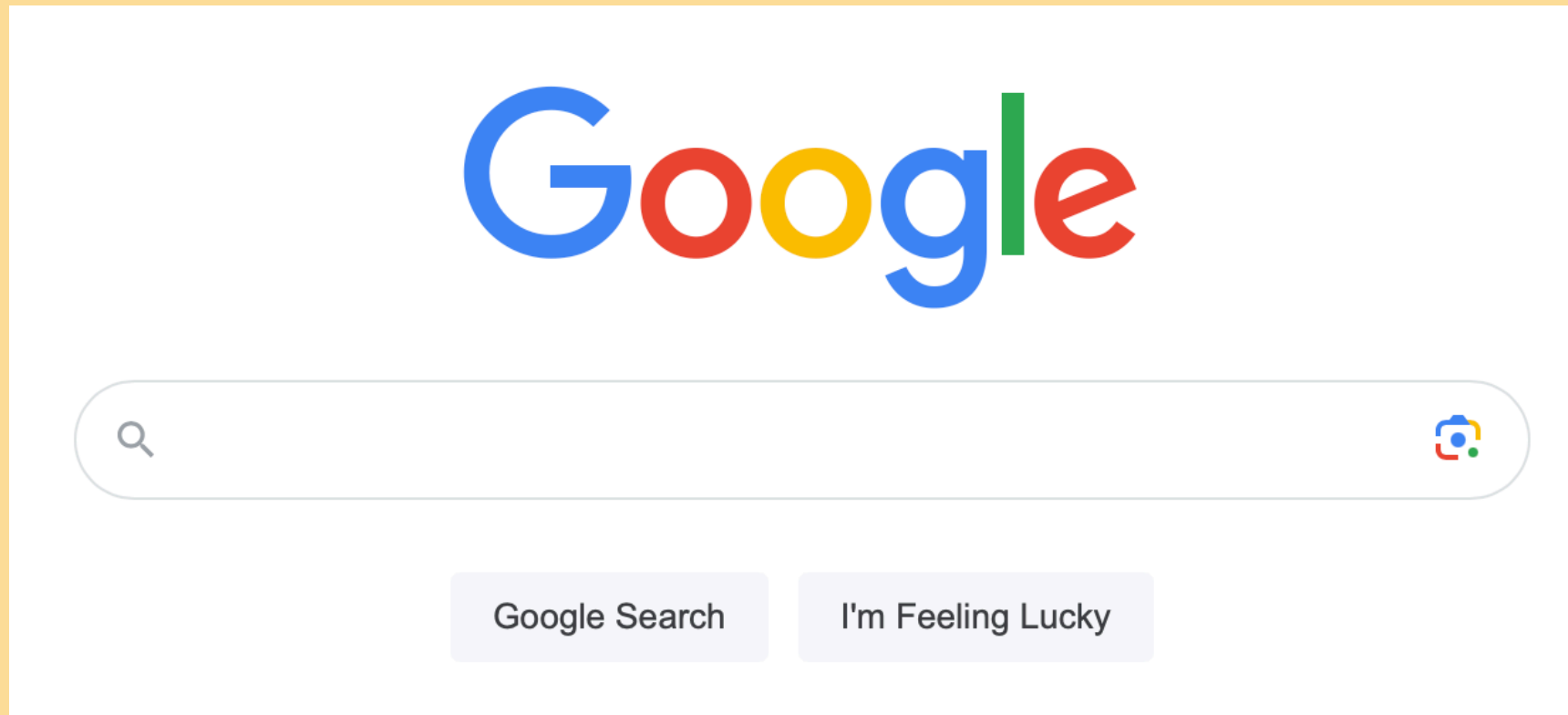
SEARCH

Convert into search term

Find all relevant information

Sort and filter results

Manual select and (hopefully) get the answer



You

Where are the 5 tallest buildings and when were they built?



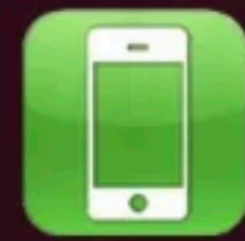
ChatGPT

As of my last update in April 2023, the five tallest buildings in the world and their years of completion are:

1. **Burj Khalifa** in Dubai, United Arab Emirates - Completed in 2010. It stands at 828 meters (2,717 feet) tall, making it the tallest building in the world.
2. **Shanghai Tower** in Shanghai, China - This building was completed in 2015. It reaches a height of 632 meters (2,073 feet).
3. **Abraj Al-Bait Clock Tower** in Mecca, Saudi Arabia - Finished in 2012, it has a height of 601 meters (1,972 feet).
4. **Ping An Finance Center** in Shenzhen, China - Completed in 2017, it stands at 599 meters (1,965 feet) tall.
5. **Lotte World Tower** in Seoul, South Korea - This skyscraper was completed in 2016 and is 555 meters (1,819 feet) tall.

These are the tallest buildings as of my last update. However, new skyscrapers are continually being planned and constructed, so this list may change in the future.

Use natural language to ask a question



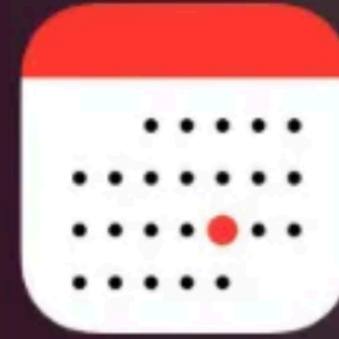
iOS 1



2007–2013



iOS 7



2013–2015



iOS 9



2015–2017



iOS 11



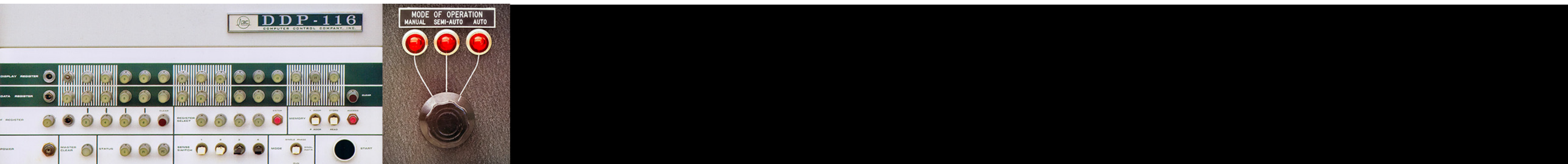
2017–2020



iOS 14

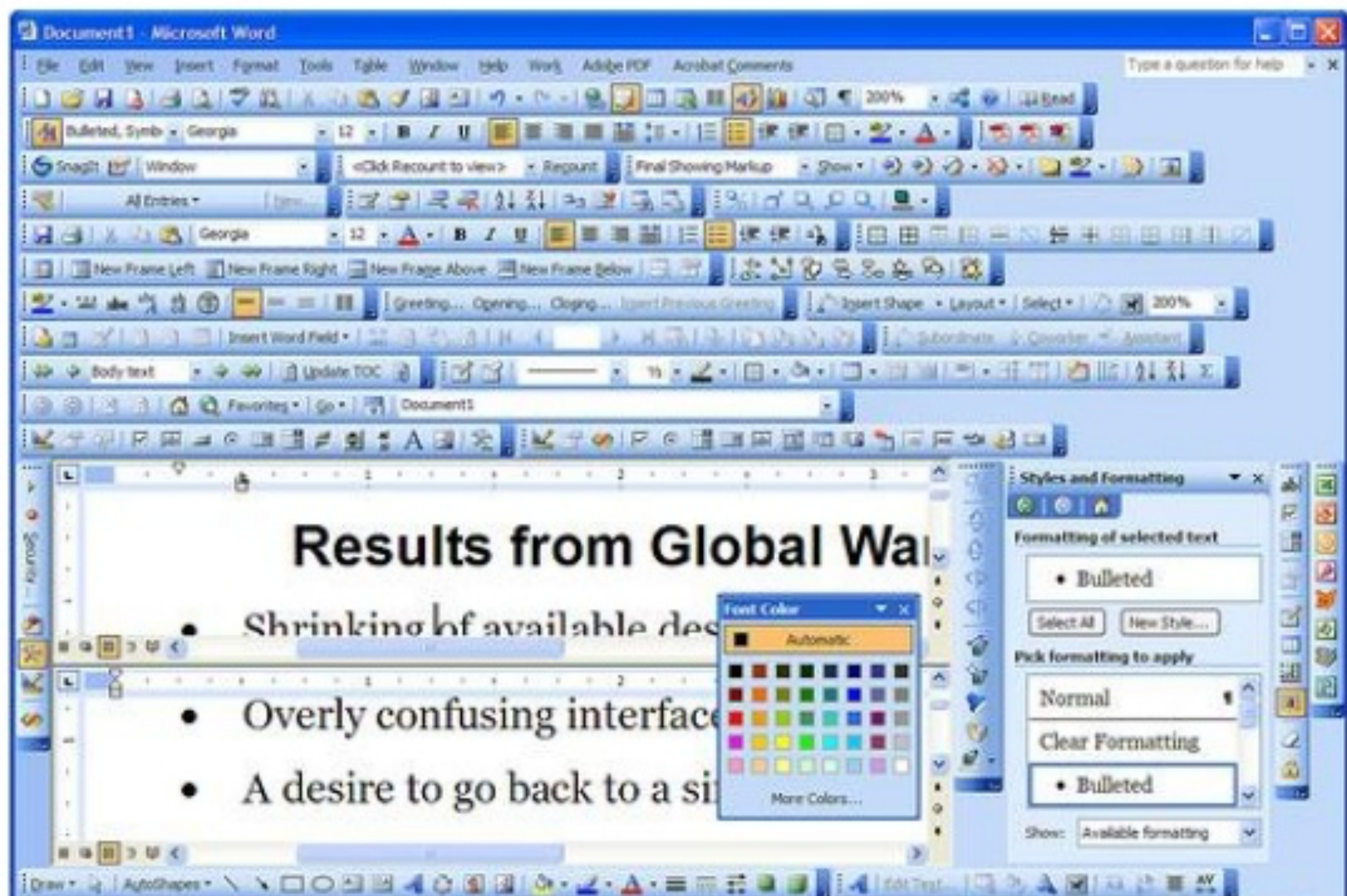


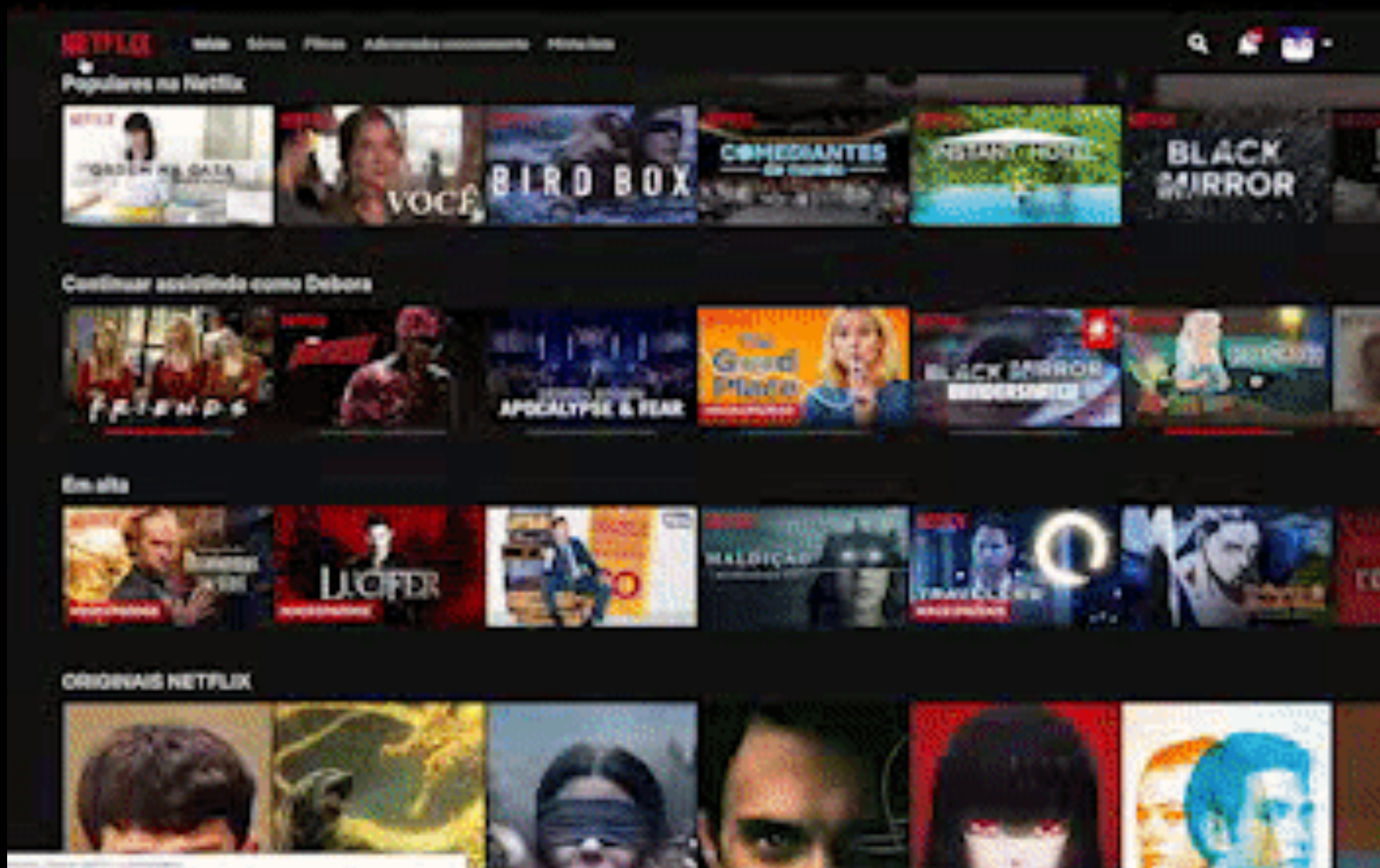
2020–Present



DECISION MAKING AND LEARNING



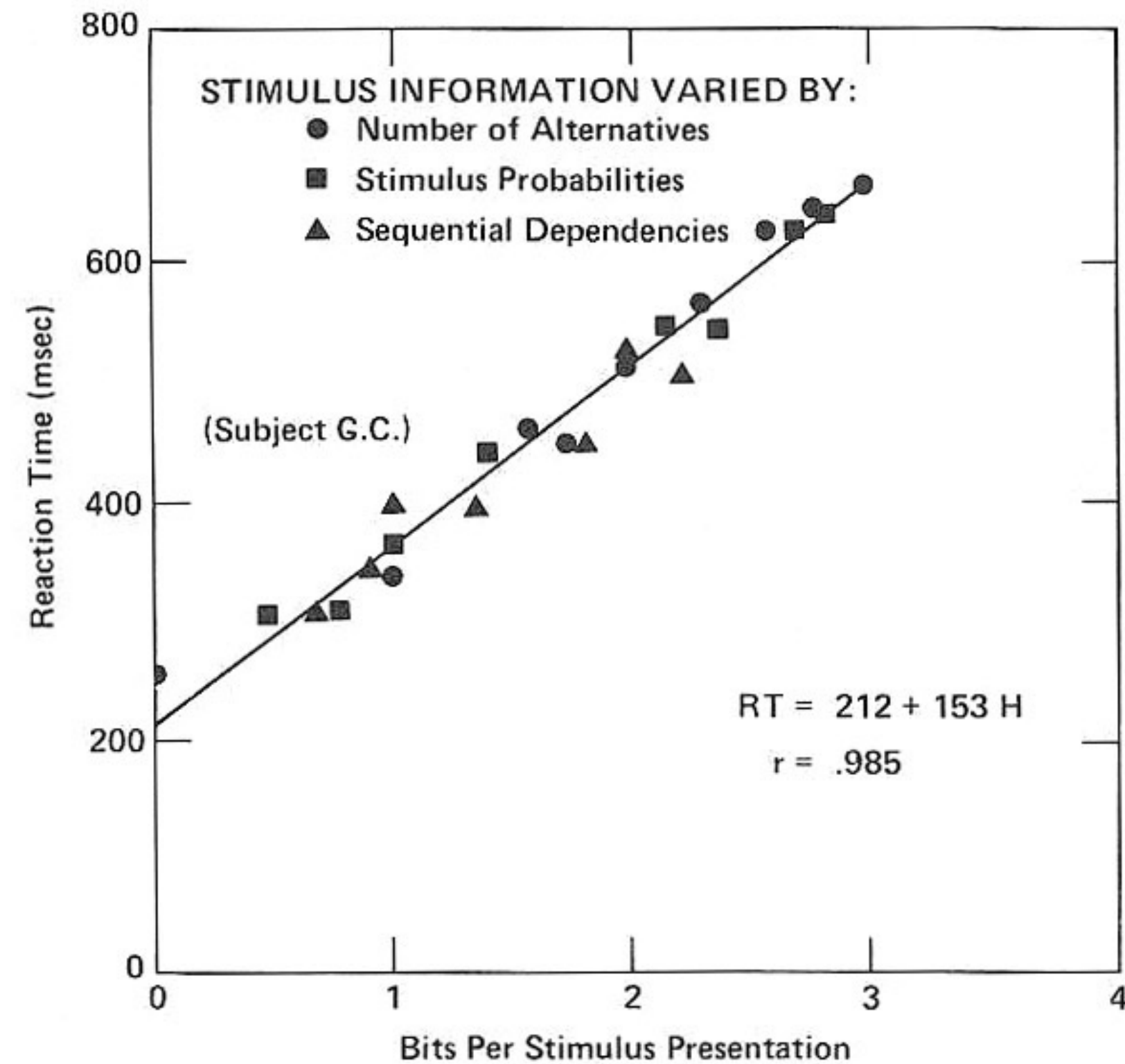
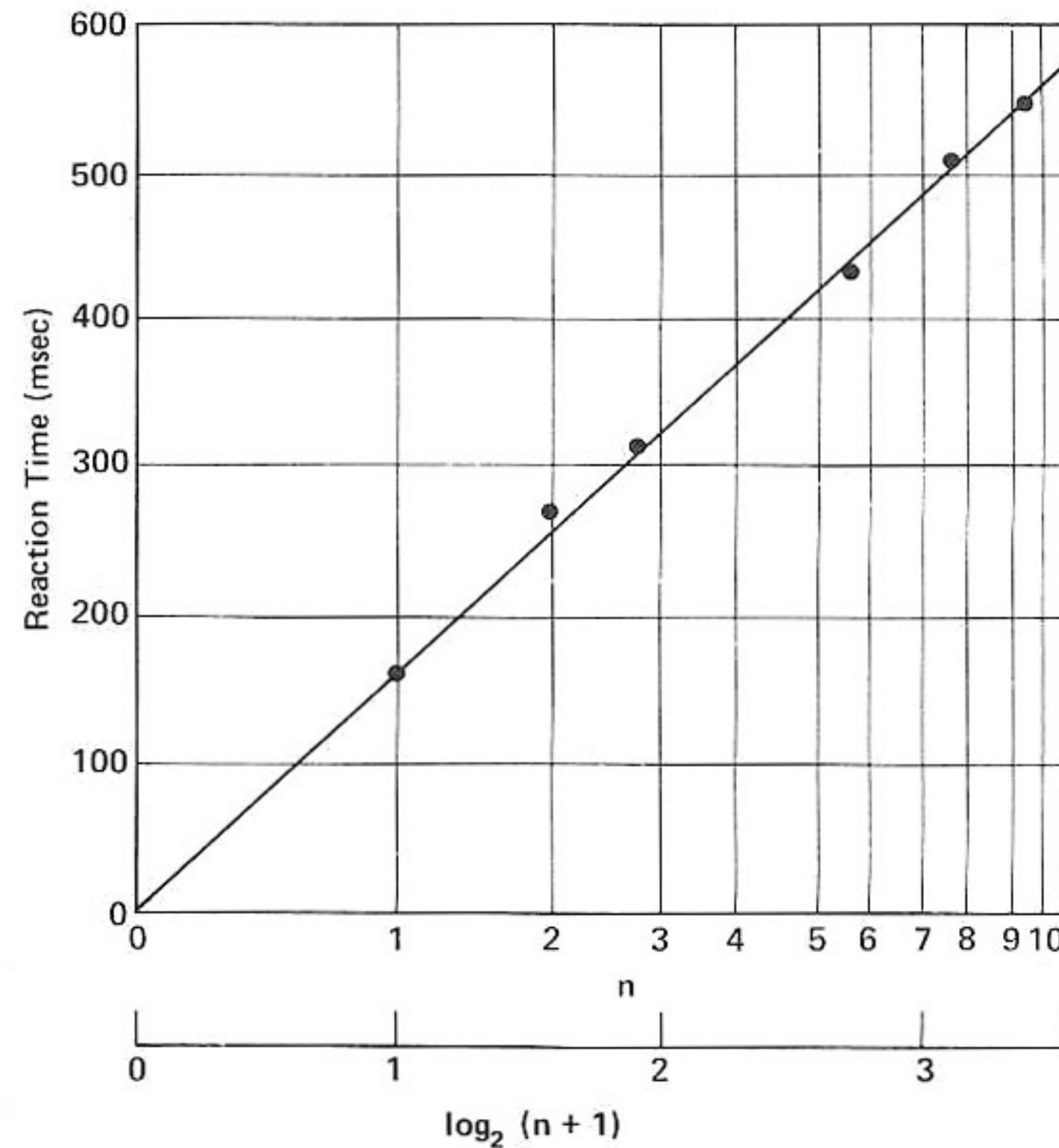




HICK'S LAW

Cost of taking a decision:
n = number of choices

$$T = a + b \log_2(n + 1)$$



increasing the number of choices will increase the decision time logarithmically

POWER LAW OF PRACTICE

Task time on the n th trial follows a power law

$$T_n = T_1 n^{-a} + c$$

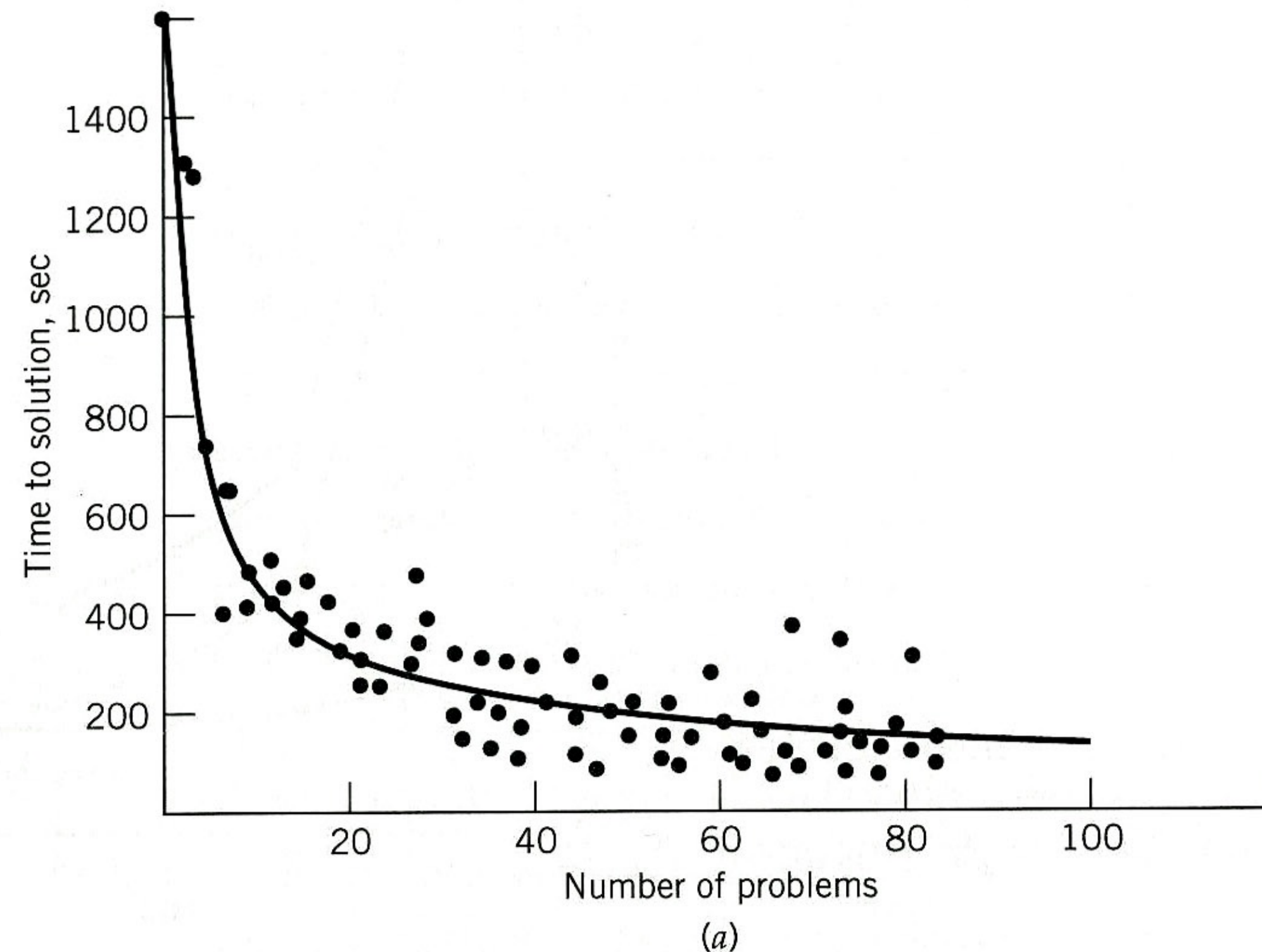
where $a = .4$, $c =$ limiting constant

POWER LAW OF PRACTICE

Task time on the n th trial follows a power law

$$T_n = T_1 n^{-a} + c$$

You get faster the more times you do something!

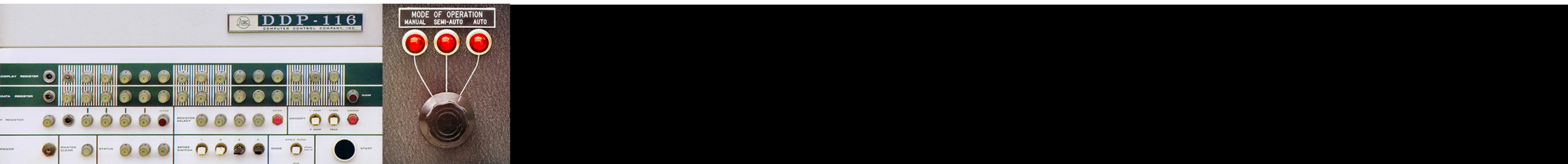


THIS CURVE IS EXPONENTIAL DECAY

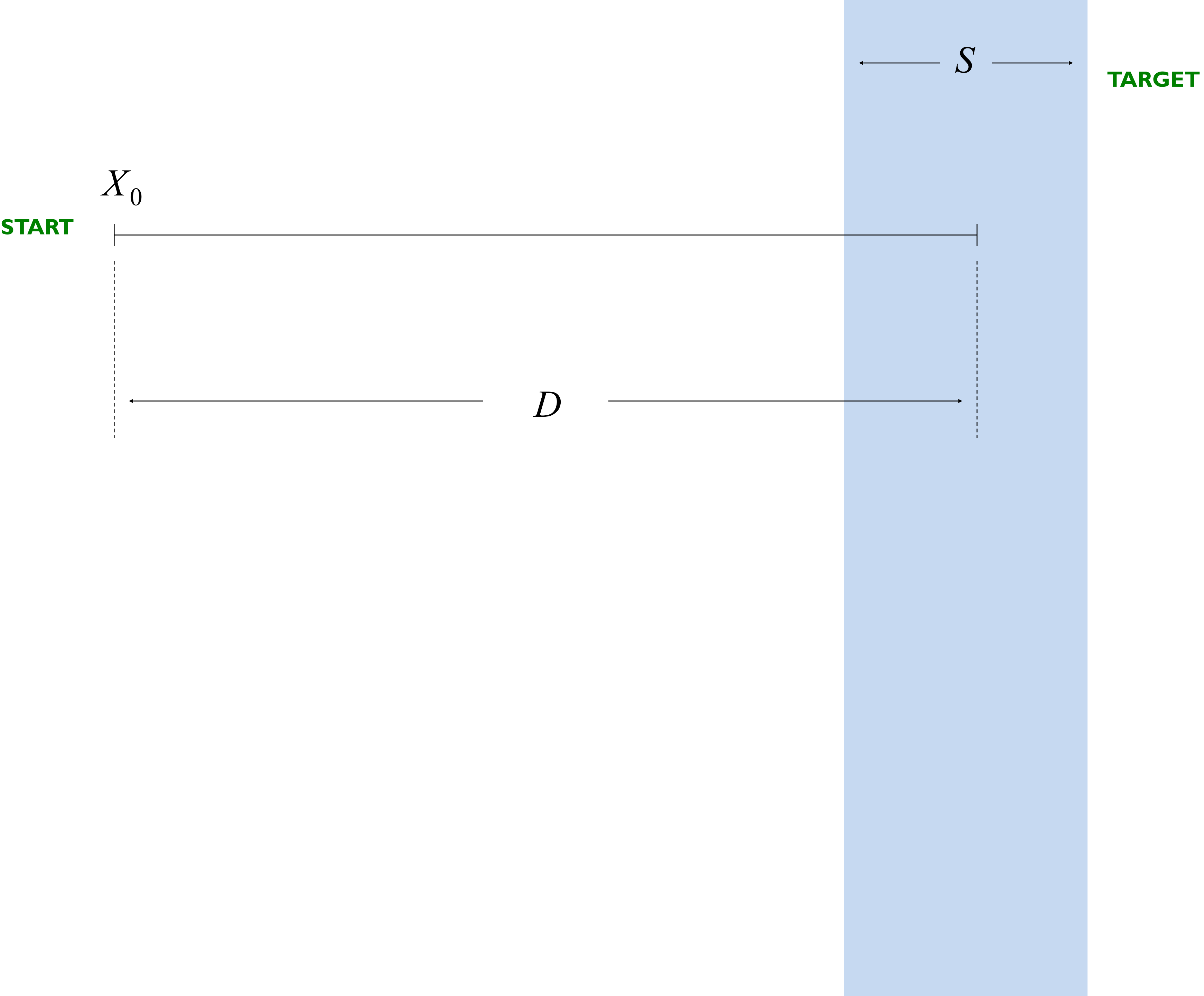
THE MORE YOU PRACTICE THE BETTER YOU GET

MOST OF WIN IS EARLY ON IN CURVE

SLOWER IMPROVEMENT LATER



FITTS' LAW



FITTS' LAW

Models well-rehearsed selection task

T increases as the ***distance*** to the target increases

T decreases as the ***size*** of the target increases

$$T = a + b \log_2(D / S + 1)$$

a, b = constants (empirically derived)

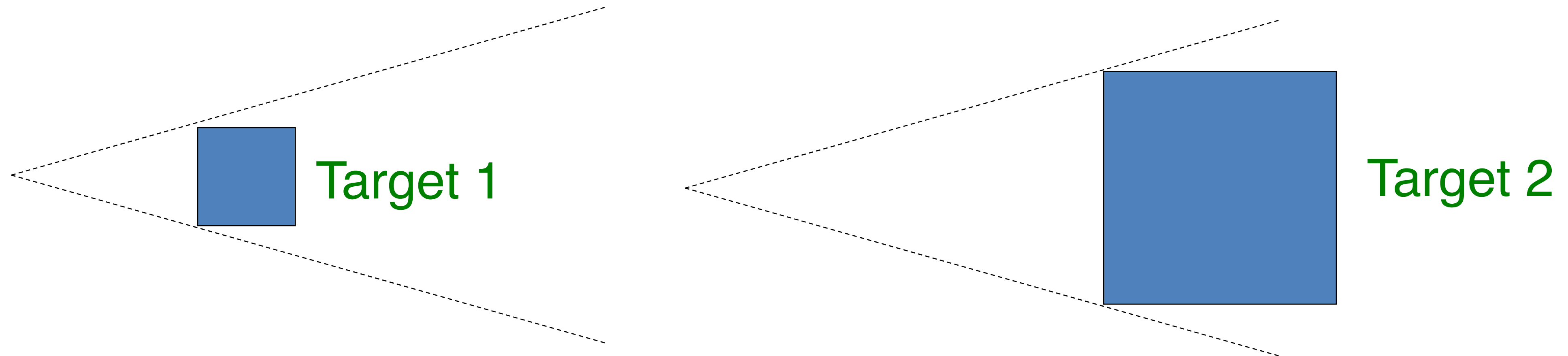
D = distance

S = size

ID is Index of Difficulty = $\log_2(D/S+1)$

CONSIDERS DISTANCE AND TARGET SIZE

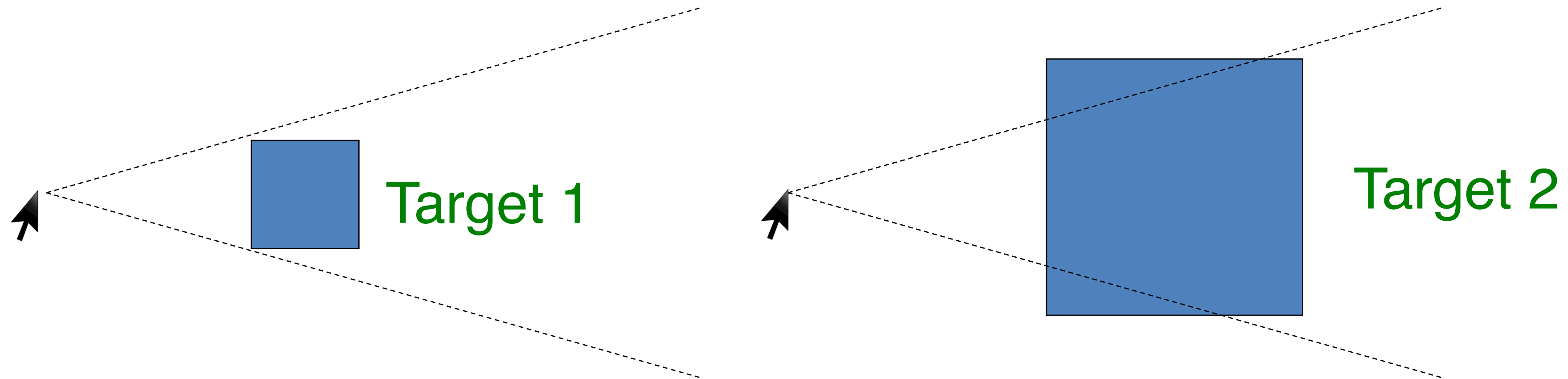
$$T = a + b \log_2(D/S + 1)$$



Same ID → Same Difficulty

CONSIDERS DISTANCE AND TARGET SIZE

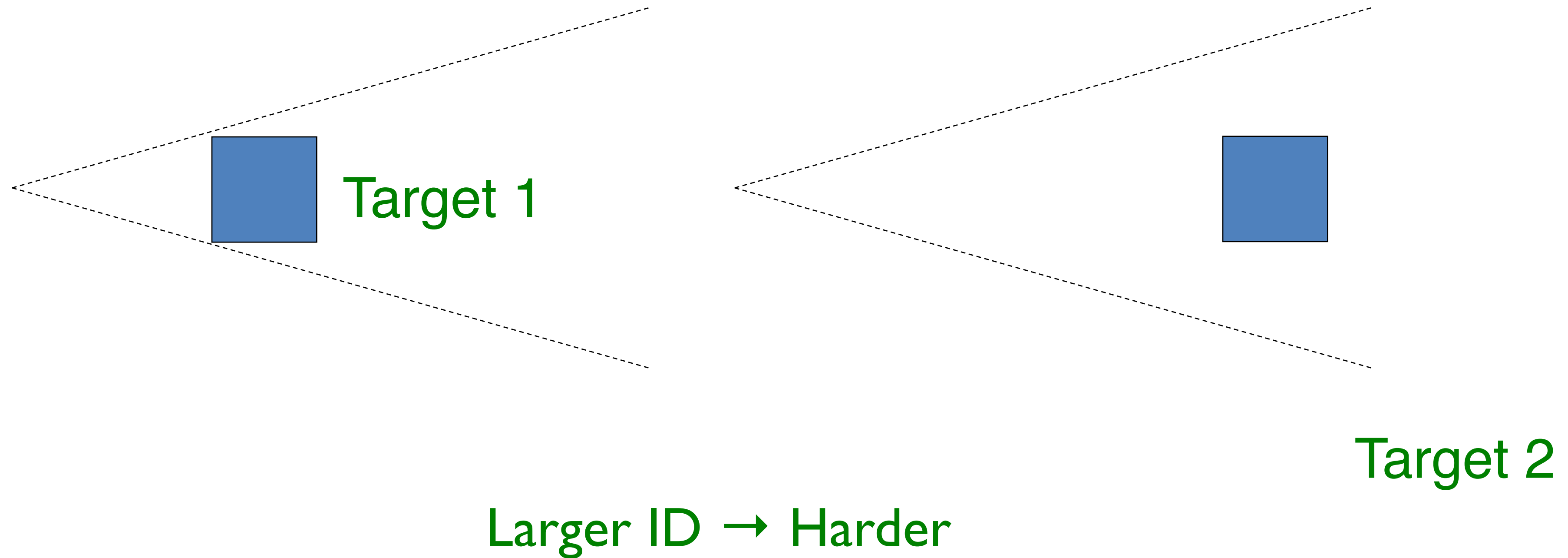
$$T = a + b \log_2(D/S + 1)$$



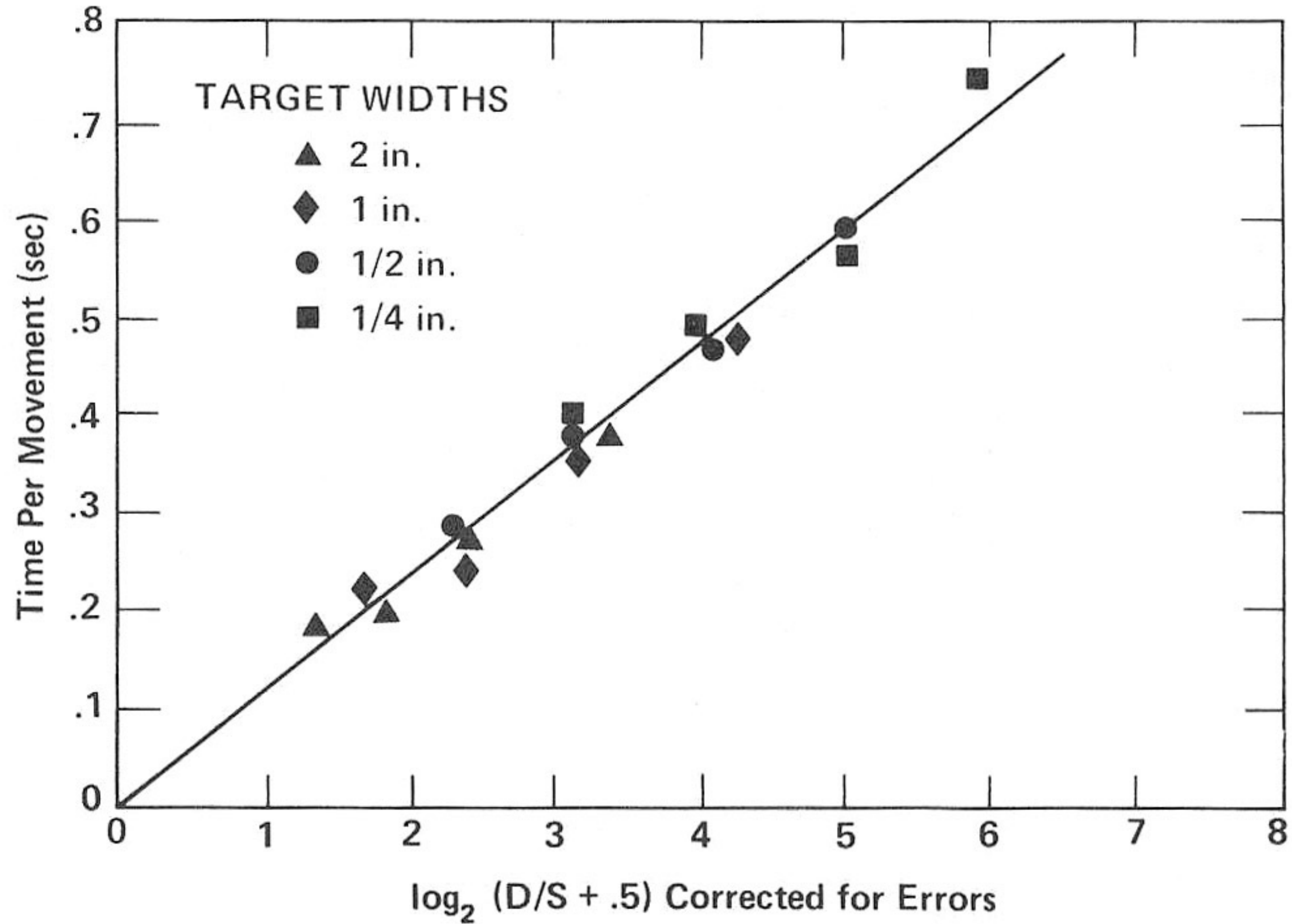
Smaller ID → Easier

CONSIDERS DISTANCE AND TARGET SIZE

$$T = a + b \log_2(D/S + 1)$$



EXPERIMENTAL DATA

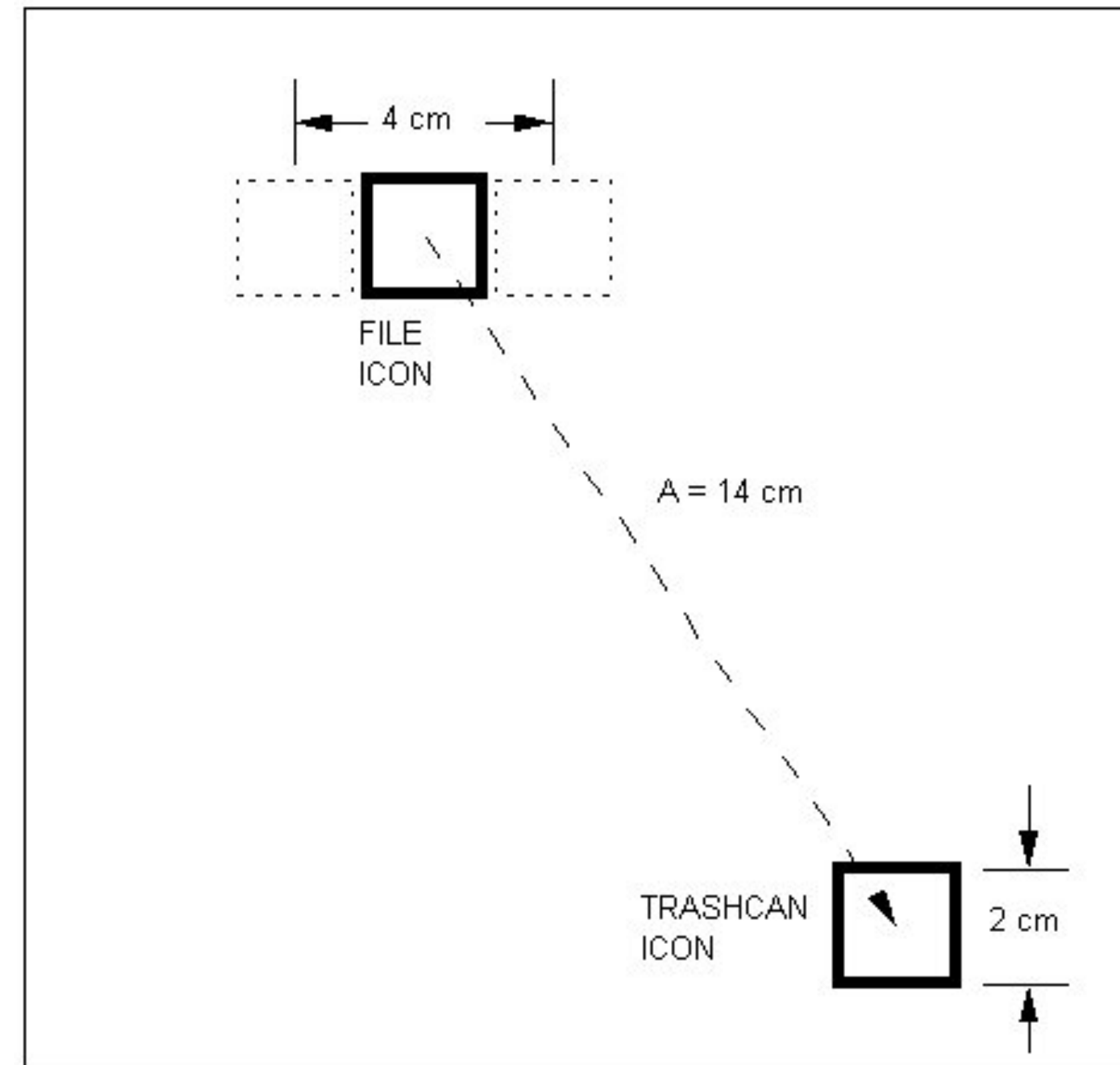


DESIGNING WITH FITTS' LAW

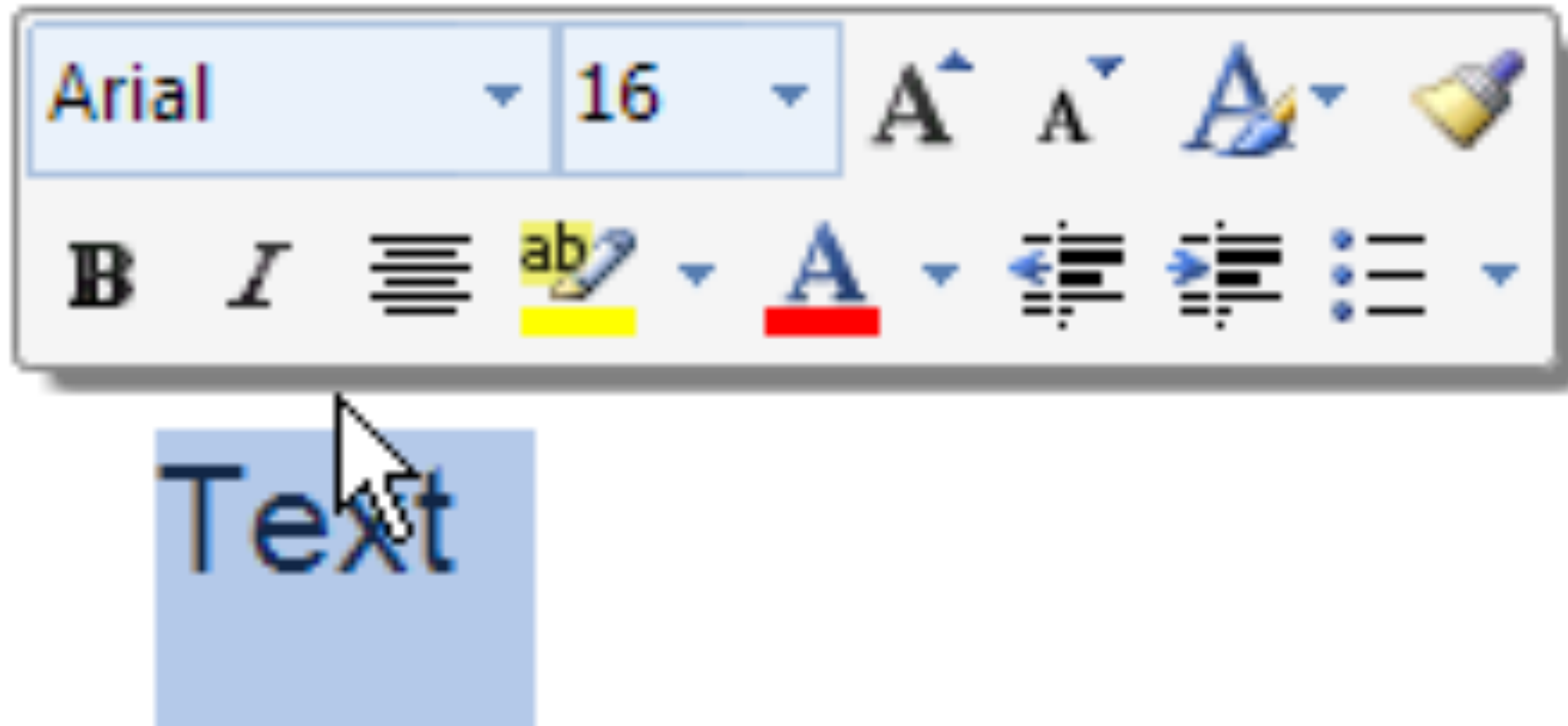
Bring items closer to the cursor

Make them larger

Exploit the edges



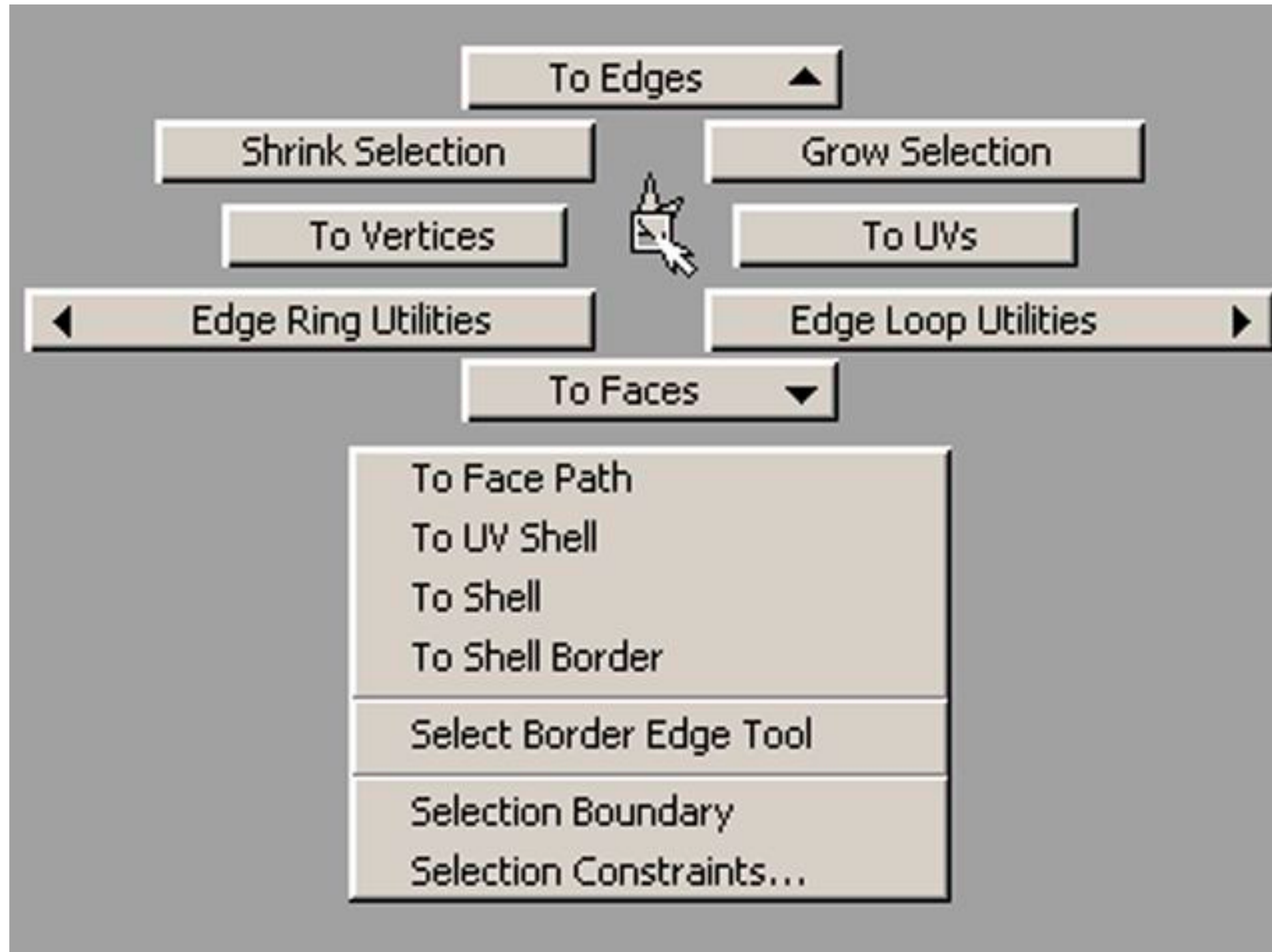
BRING ITEMS CLOSER TO THE CURSOR



BRING ITEMS CLOSER TO THE CURSOR



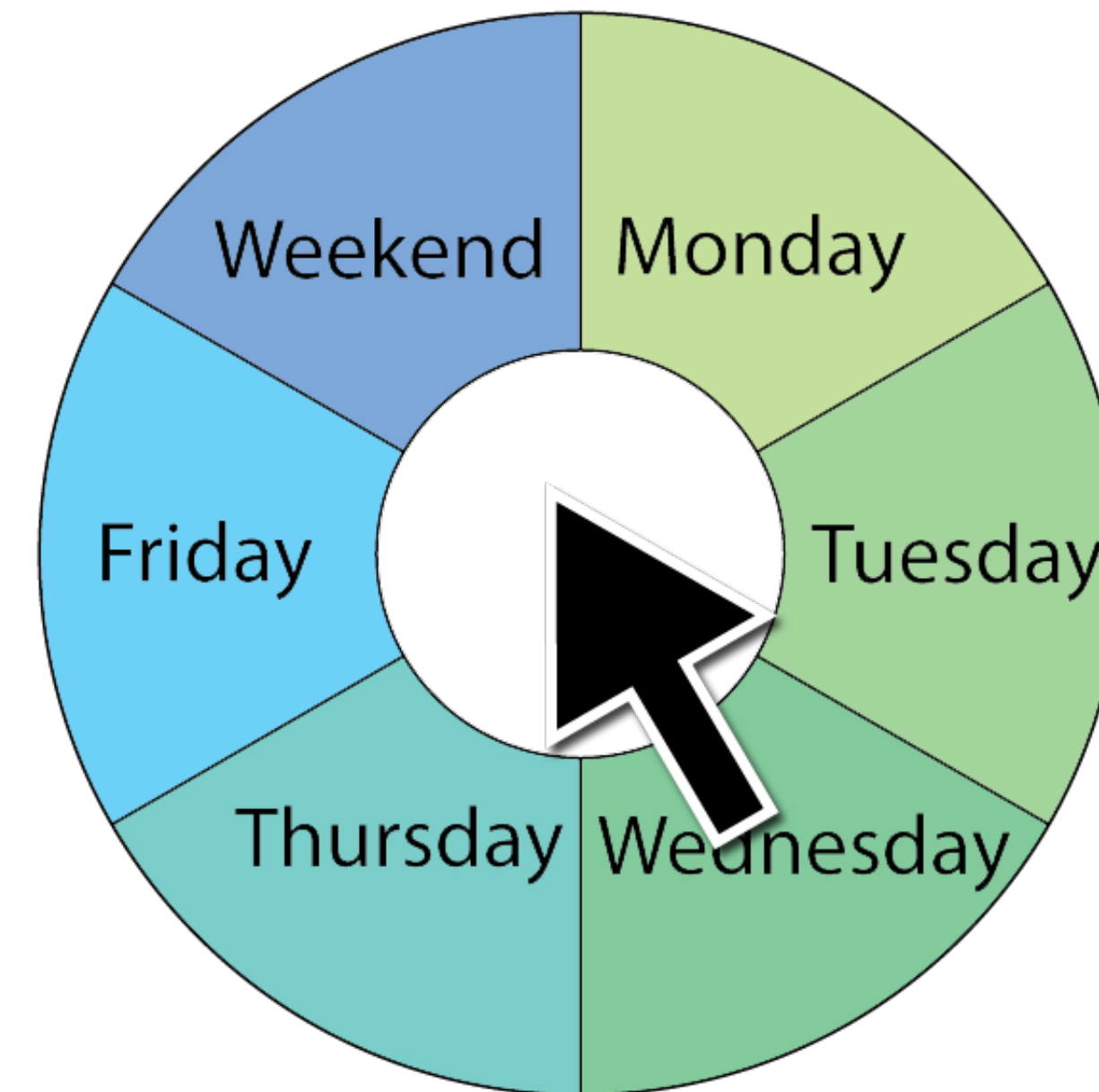
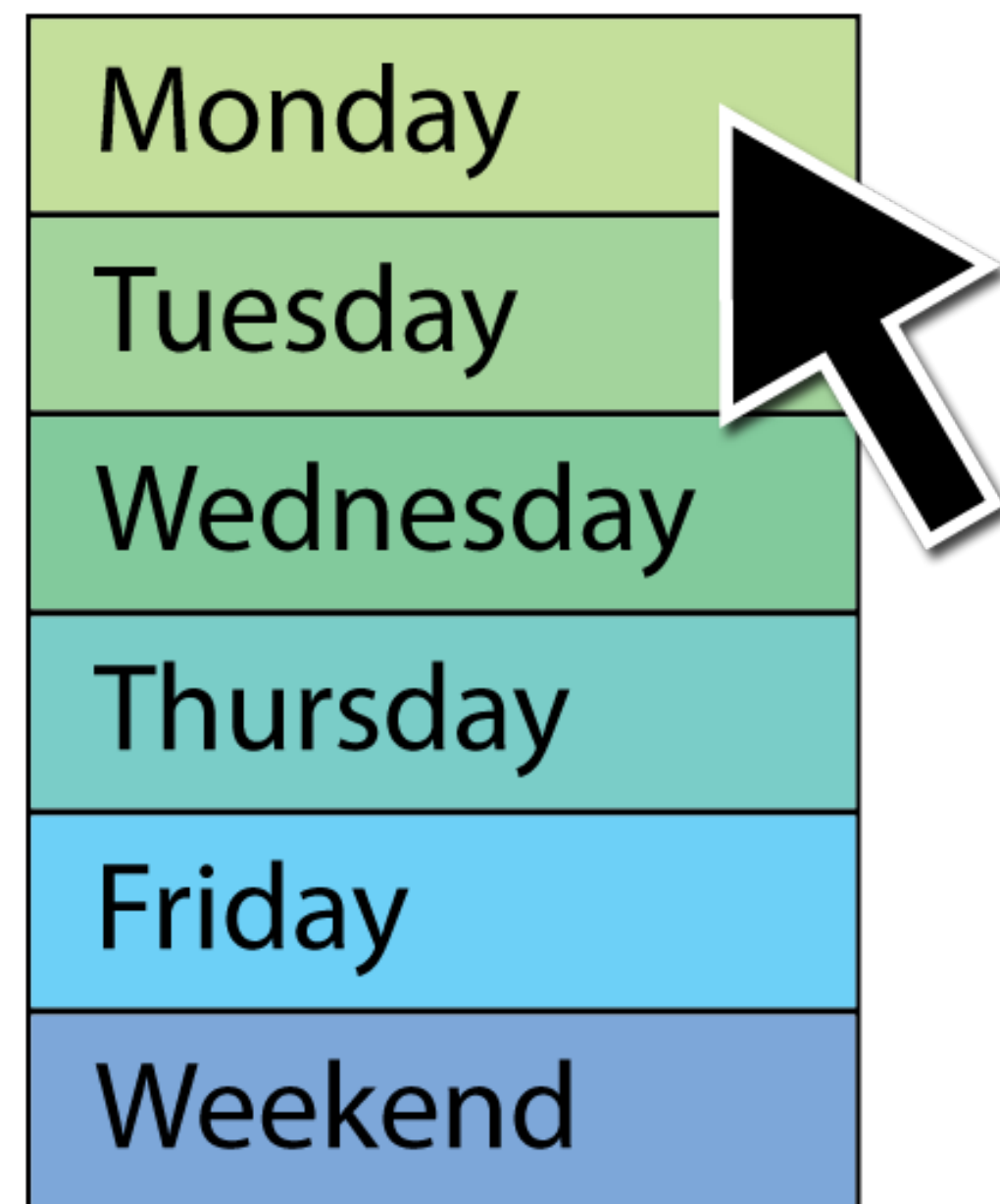
FITTS' LAW EXAMPLE



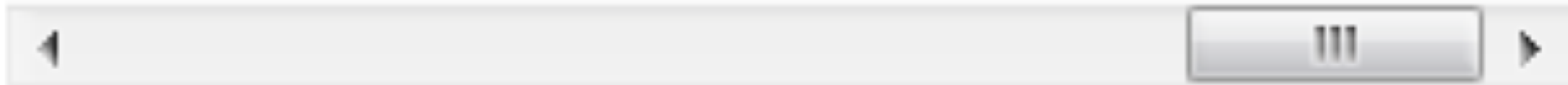
FITTS' LAW EXAMPLE

Which will be faster on average?

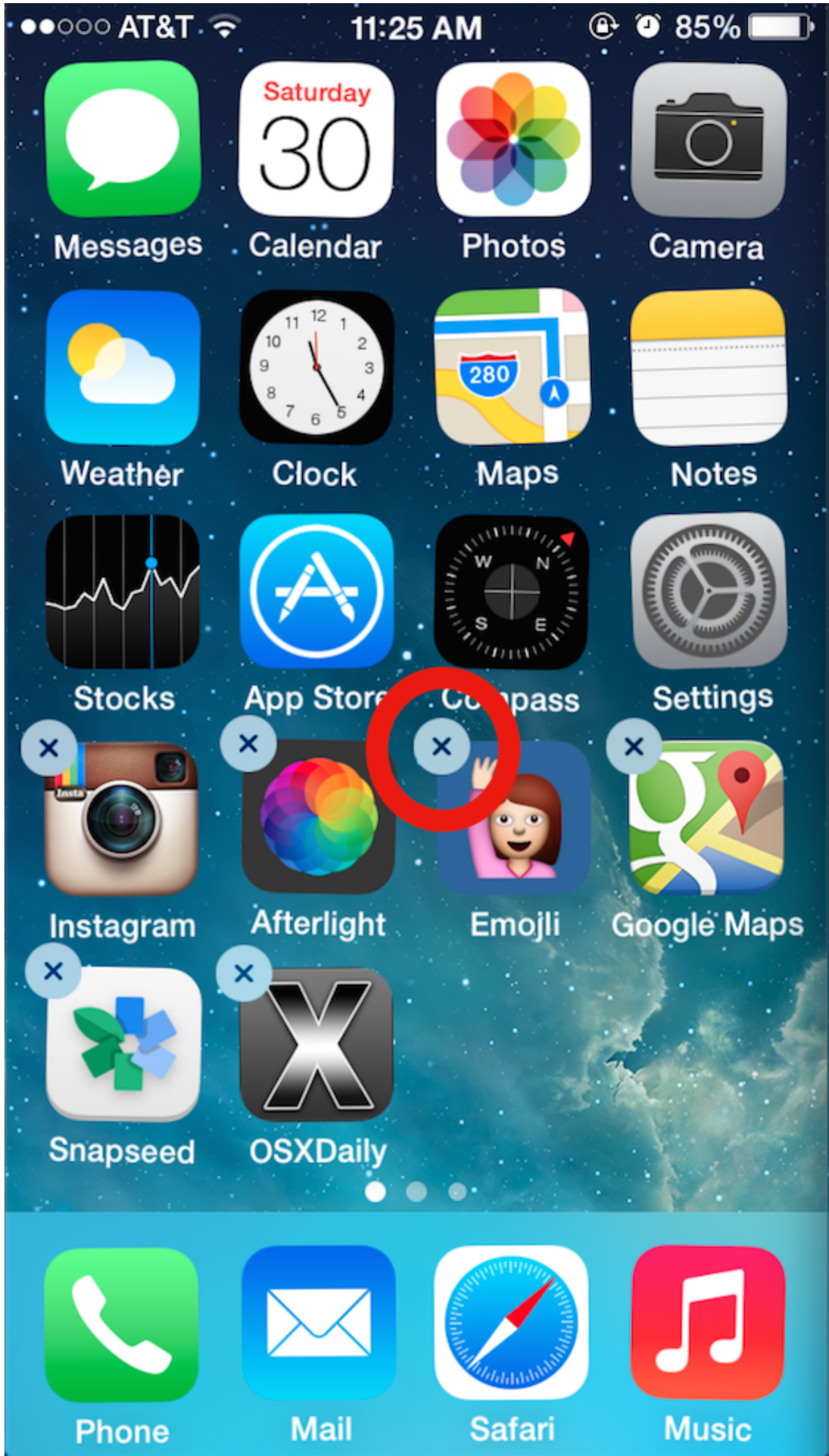
pie menu (bigger targets & less distance)



FITTS' LAW EXAMPLE



FITTS' LAW EXAMPLE

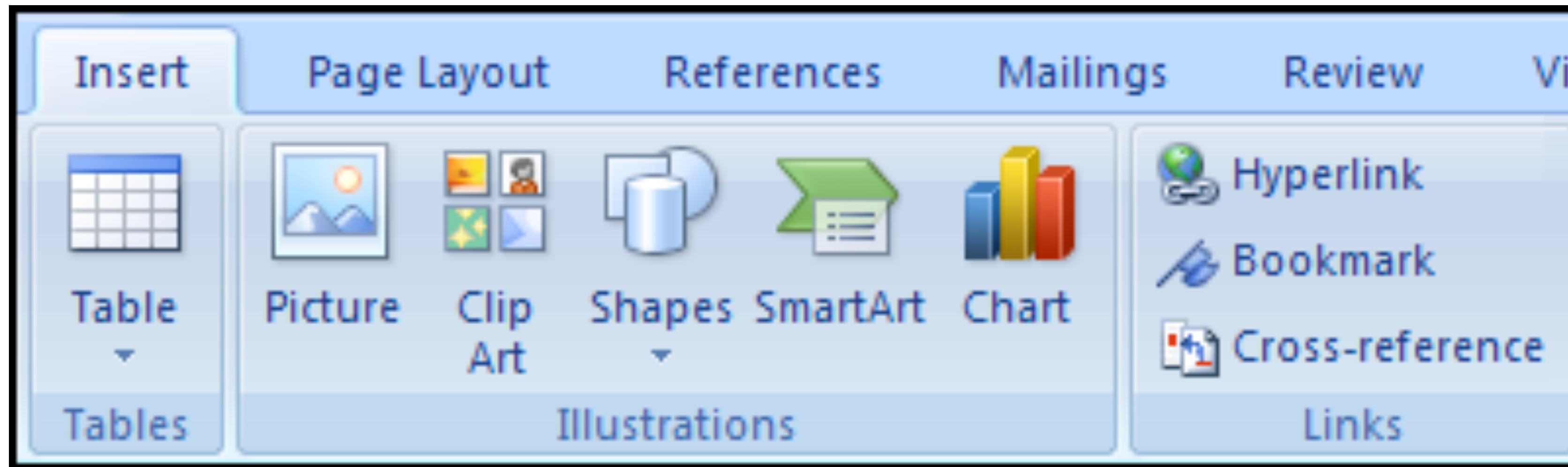


FITTS' LAW EXAMPLE

Download

Delete

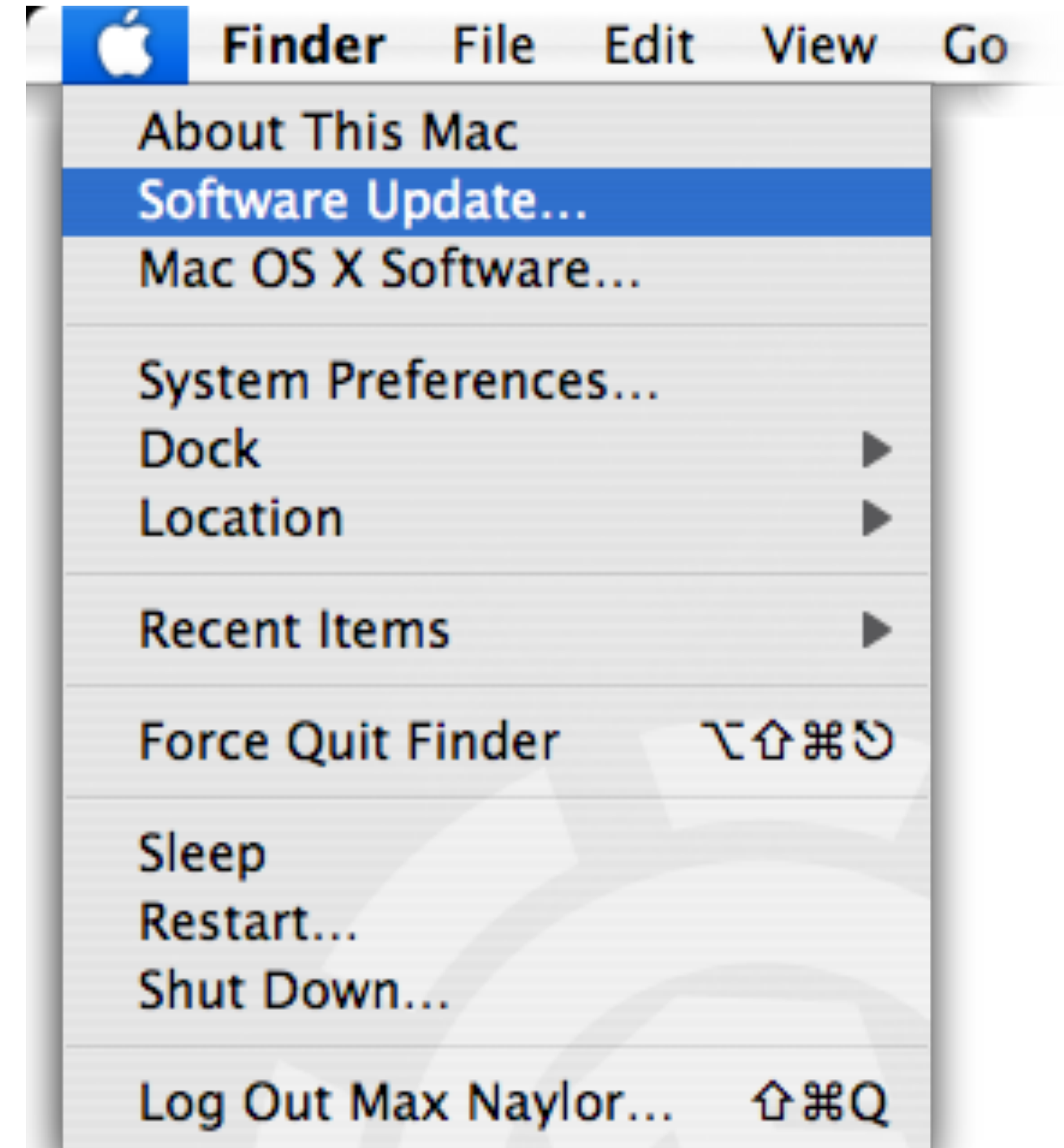
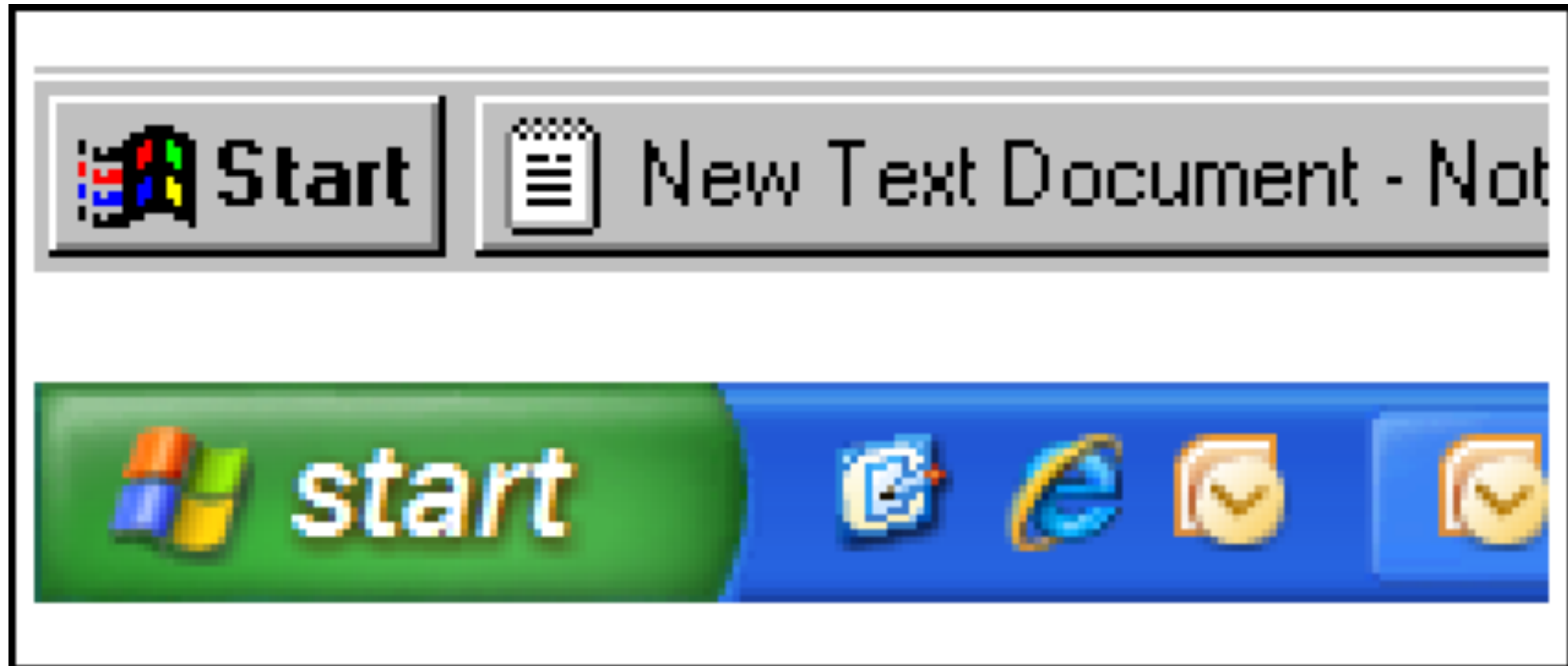
INCREASE TARGET SIZE



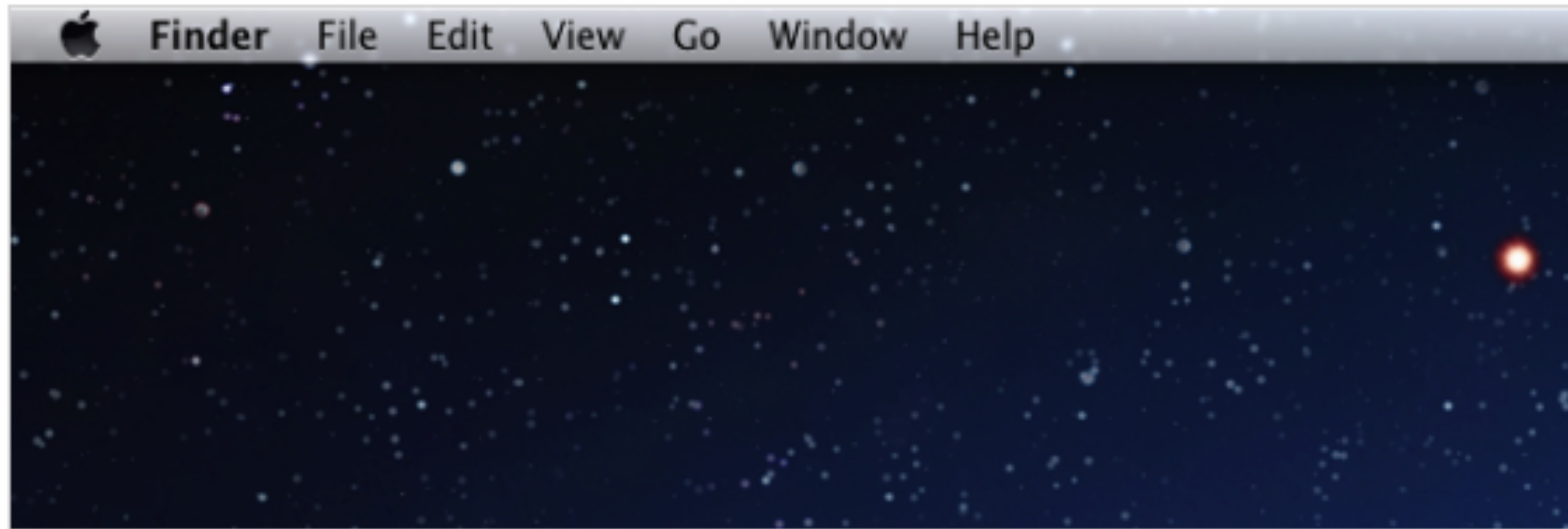
Larger, labeled controls can
be clicked more quickly



EXPLOIT THE EDGES



EXPLOIT THE EDGES



DOES FITTS' LAW ONLY APPLY TO MOUSE POINTING?

Journal of Experimental Psychology

VOL. 47, No. 6

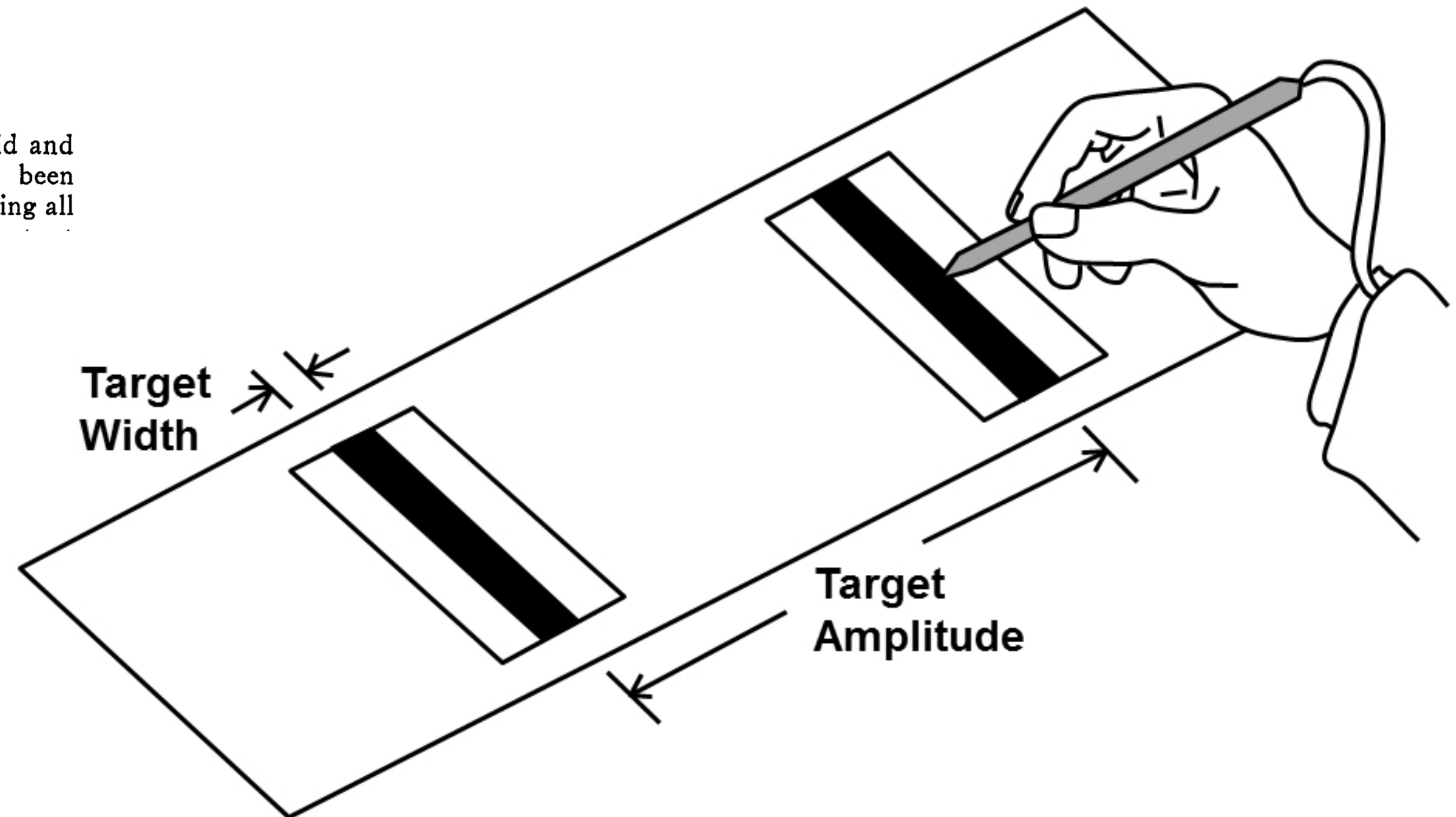
JUNE, 1954

THE INFORMATION CAPACITY OF THE HUMAN MOTOR SYSTEM IN CONTROLLING THE AMPLITUDE OF MOVEMENT¹

PAUL M. FITTS²

The Ohio State University

Information theory has recently been employed to specify more precisely than has hitherto been possible ever, by asking S to make rapid and uniform responses that have been highly overlearned, and by holding all



DOES FITTS' LAW APPLY TO MOBILE DEVICES?

Yes! Original experiment by Fitts was on human arm movement, not mouse pointing!

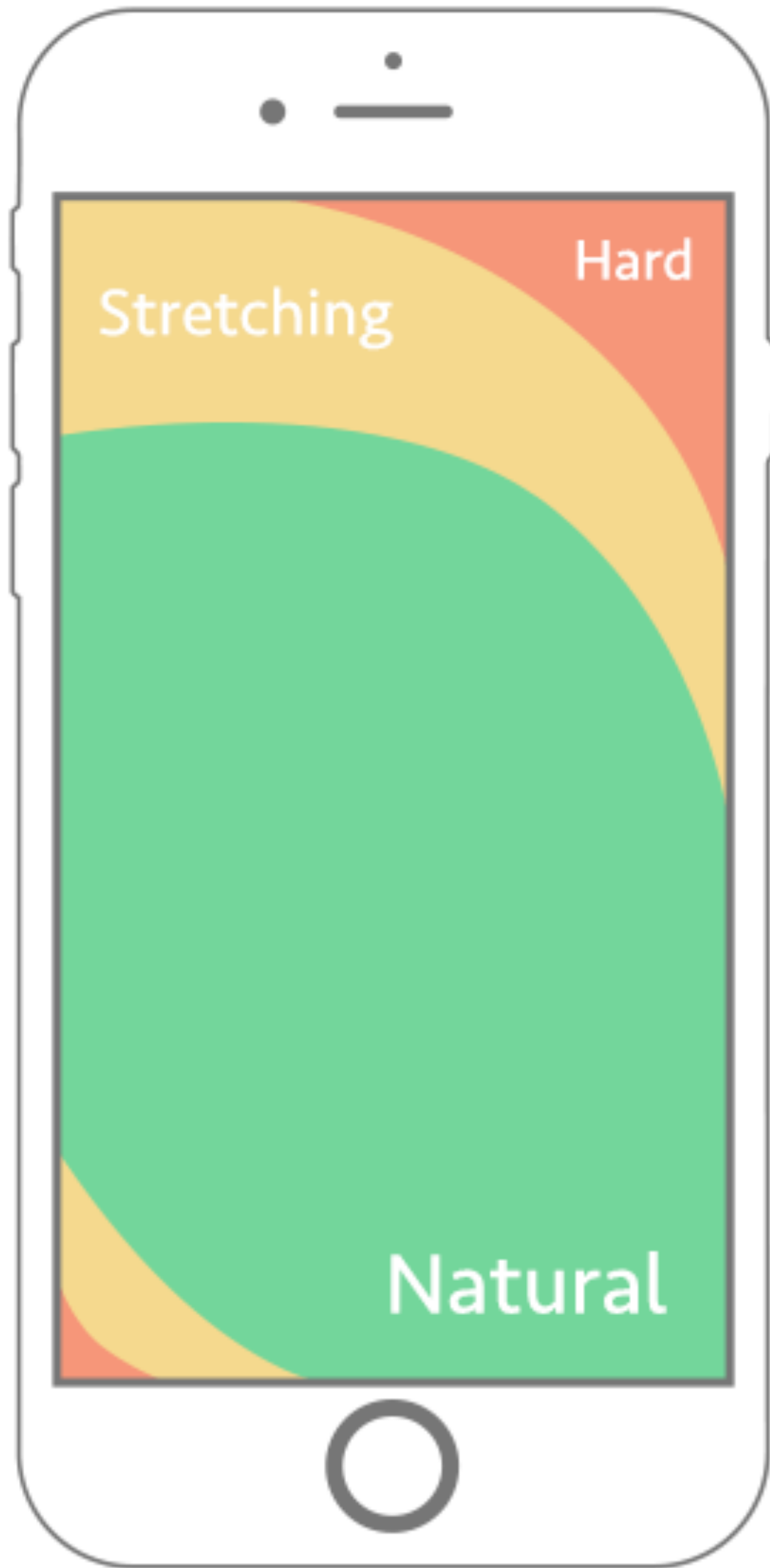
Extension to target acquisition with mouse was a big result of Card et al. and not obvious.

Tablet setting is closer to original experimental setting.

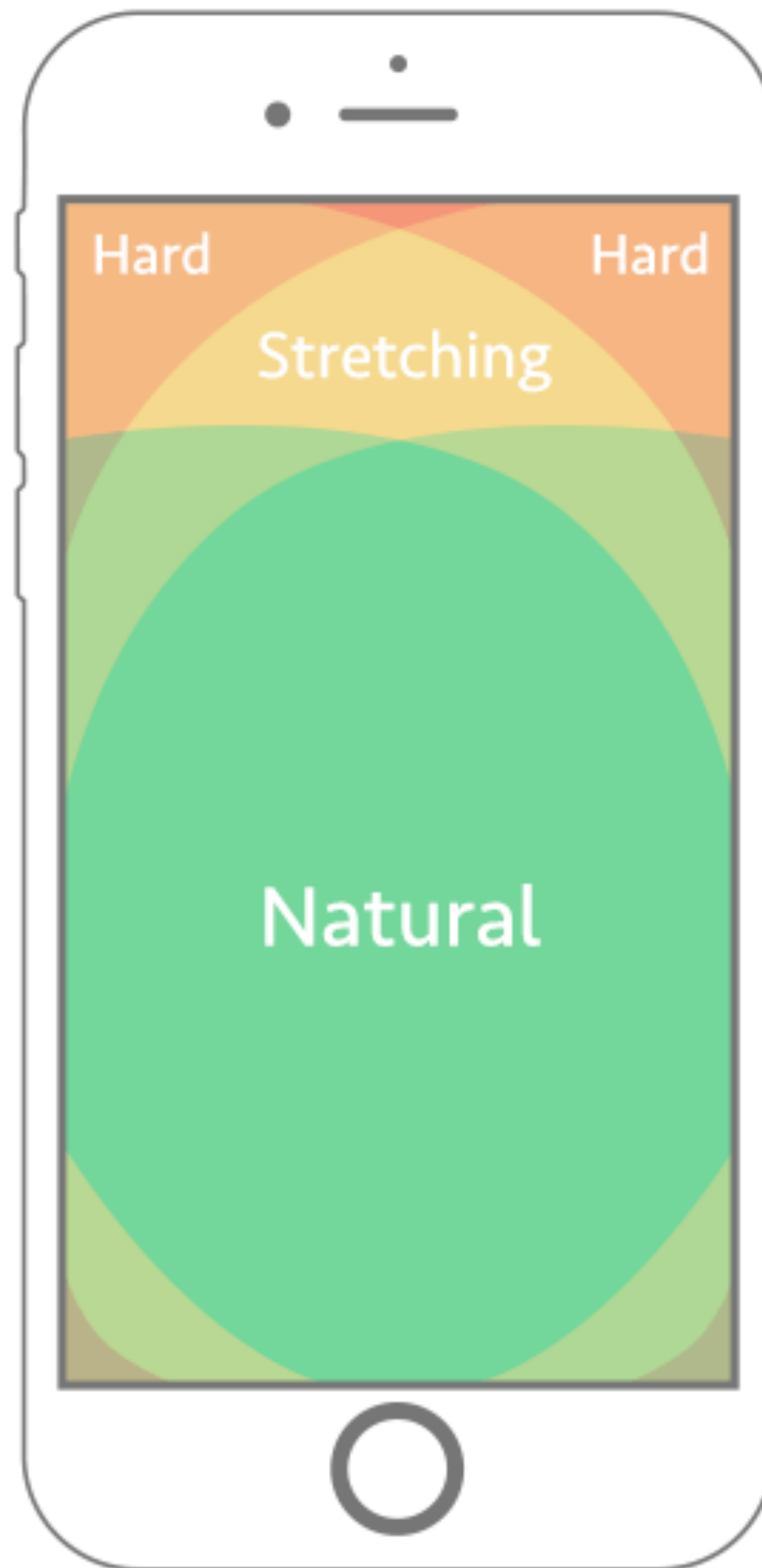
No more benefit on device edges

How device is held

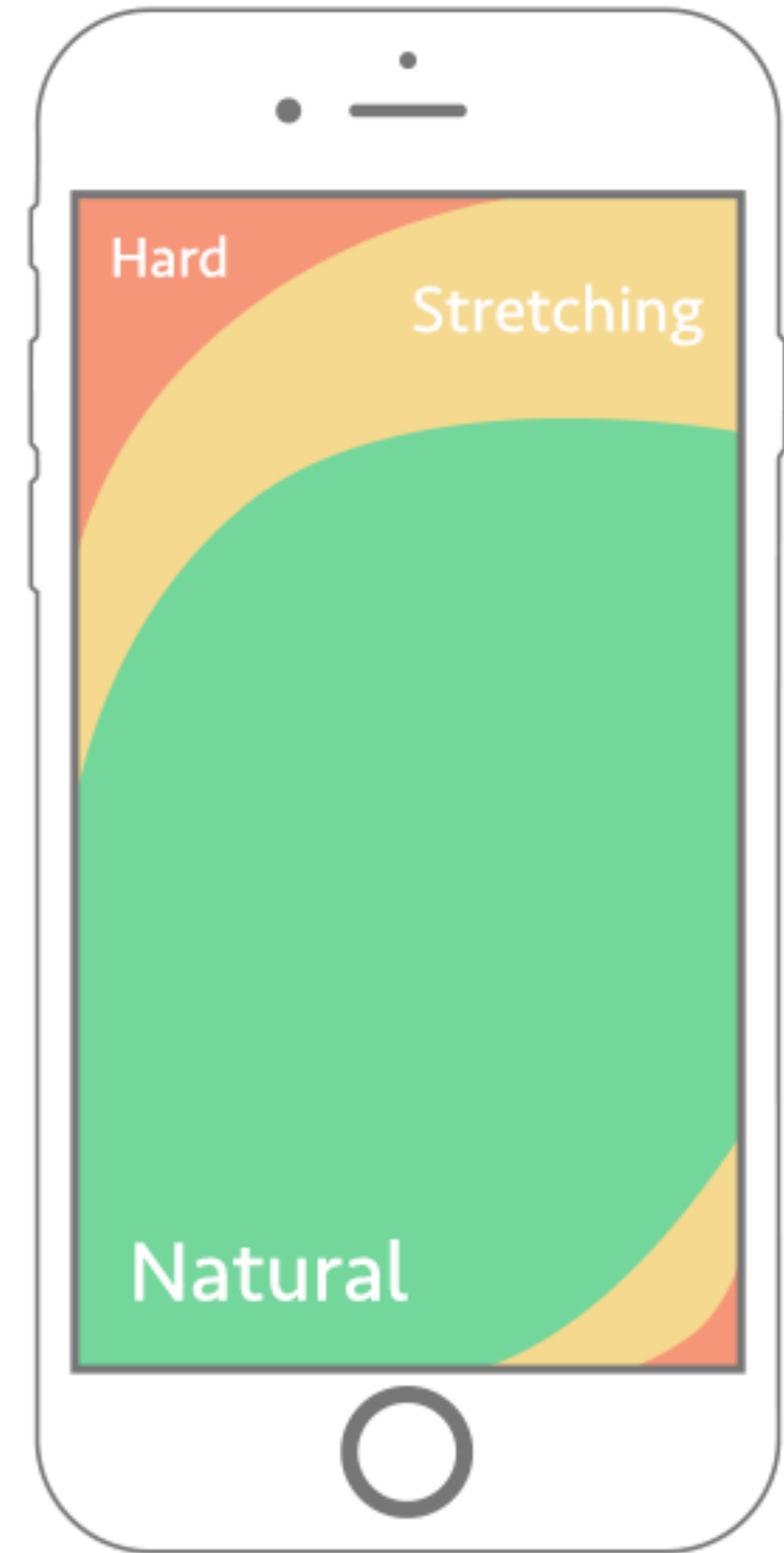
MOBILE



Left Hand

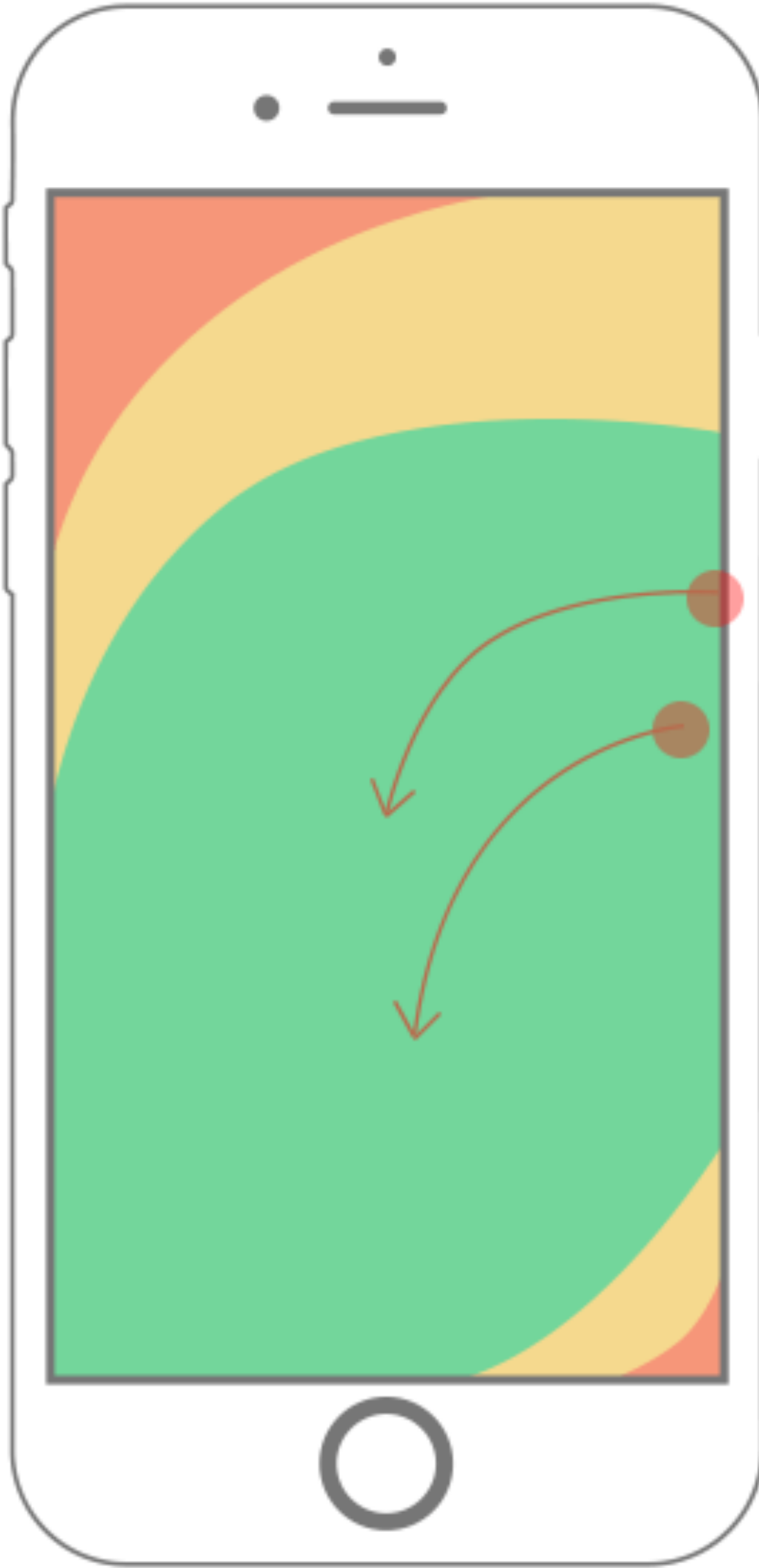
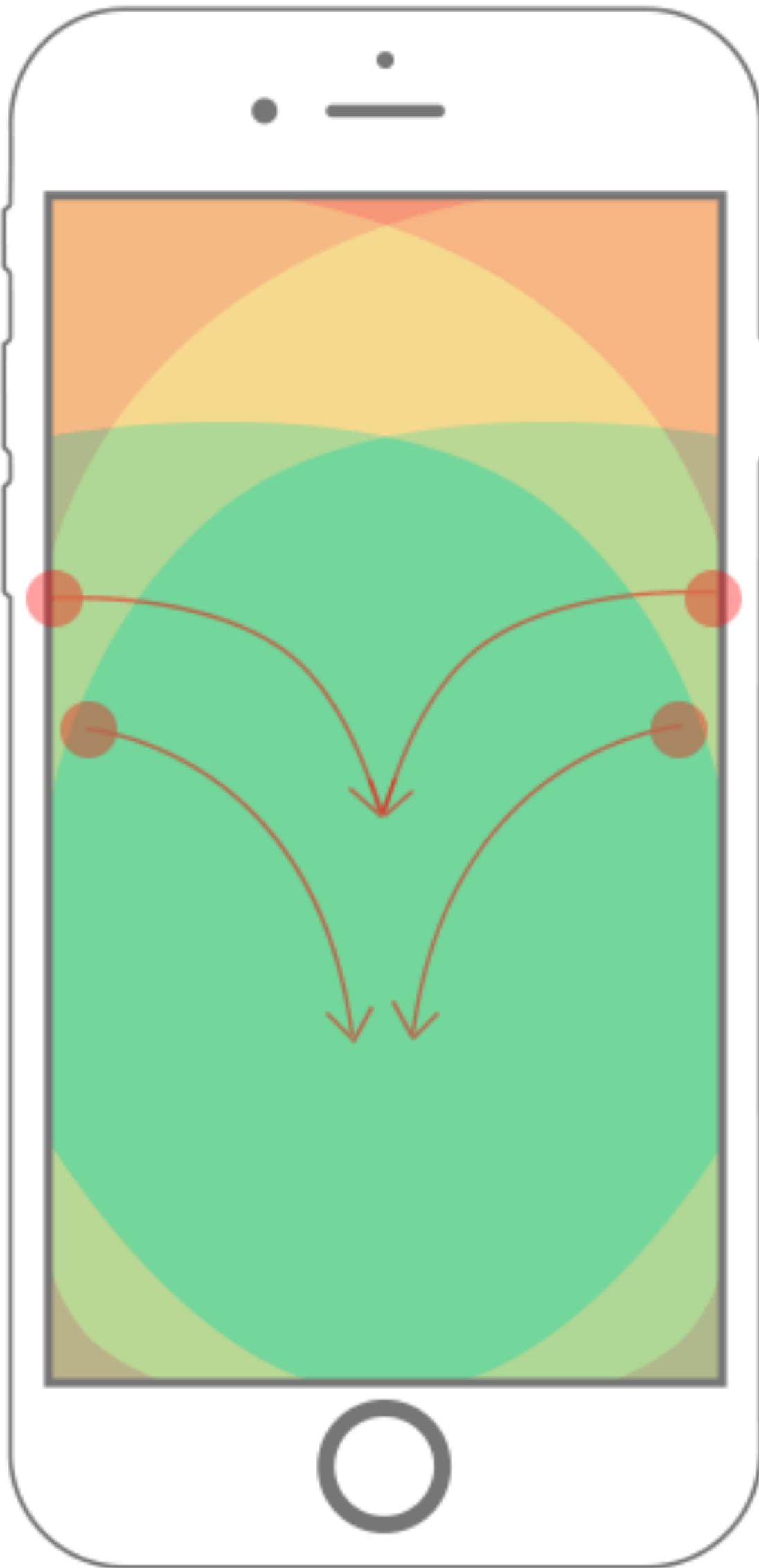
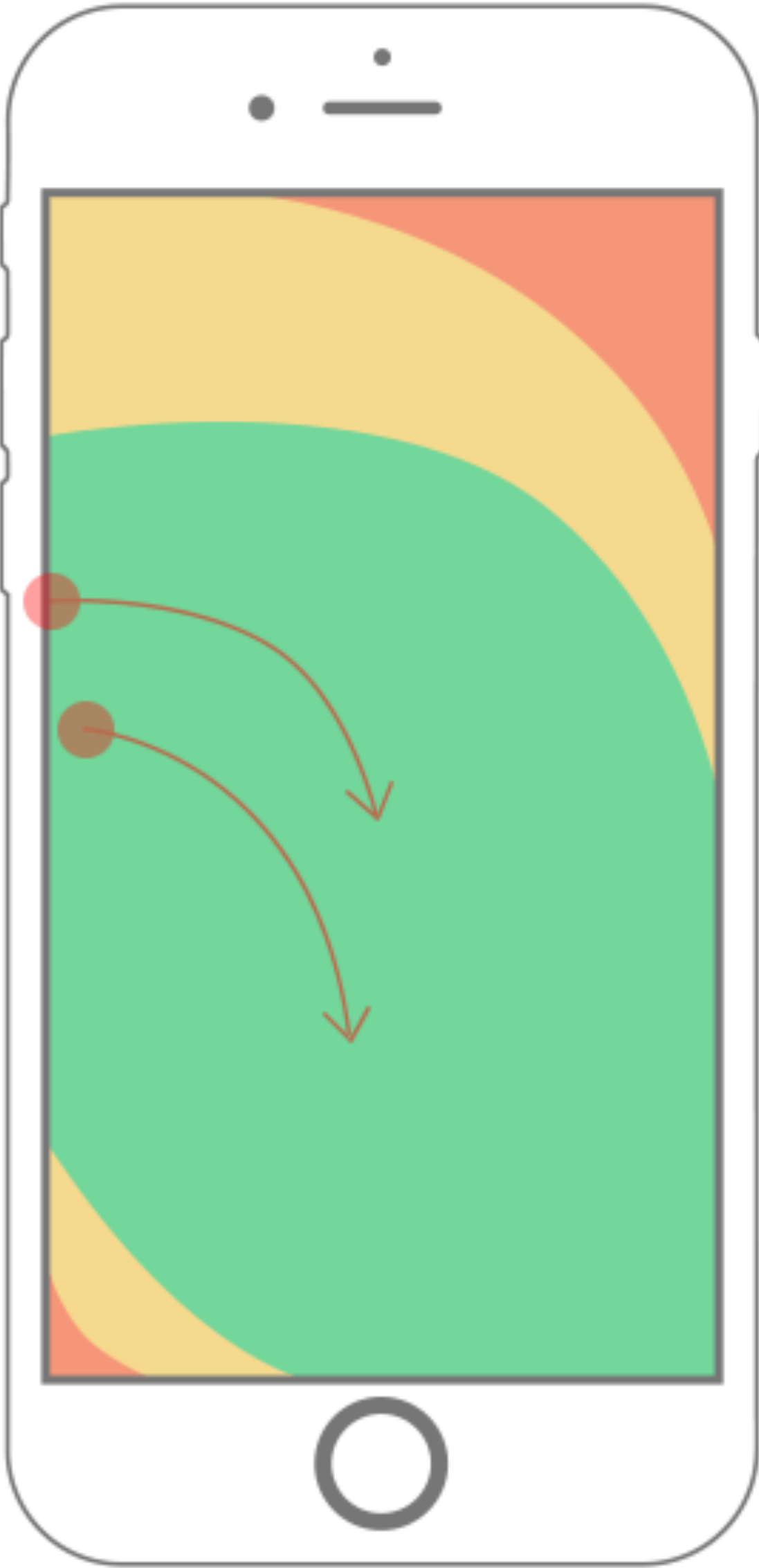


Combined



Right Hand

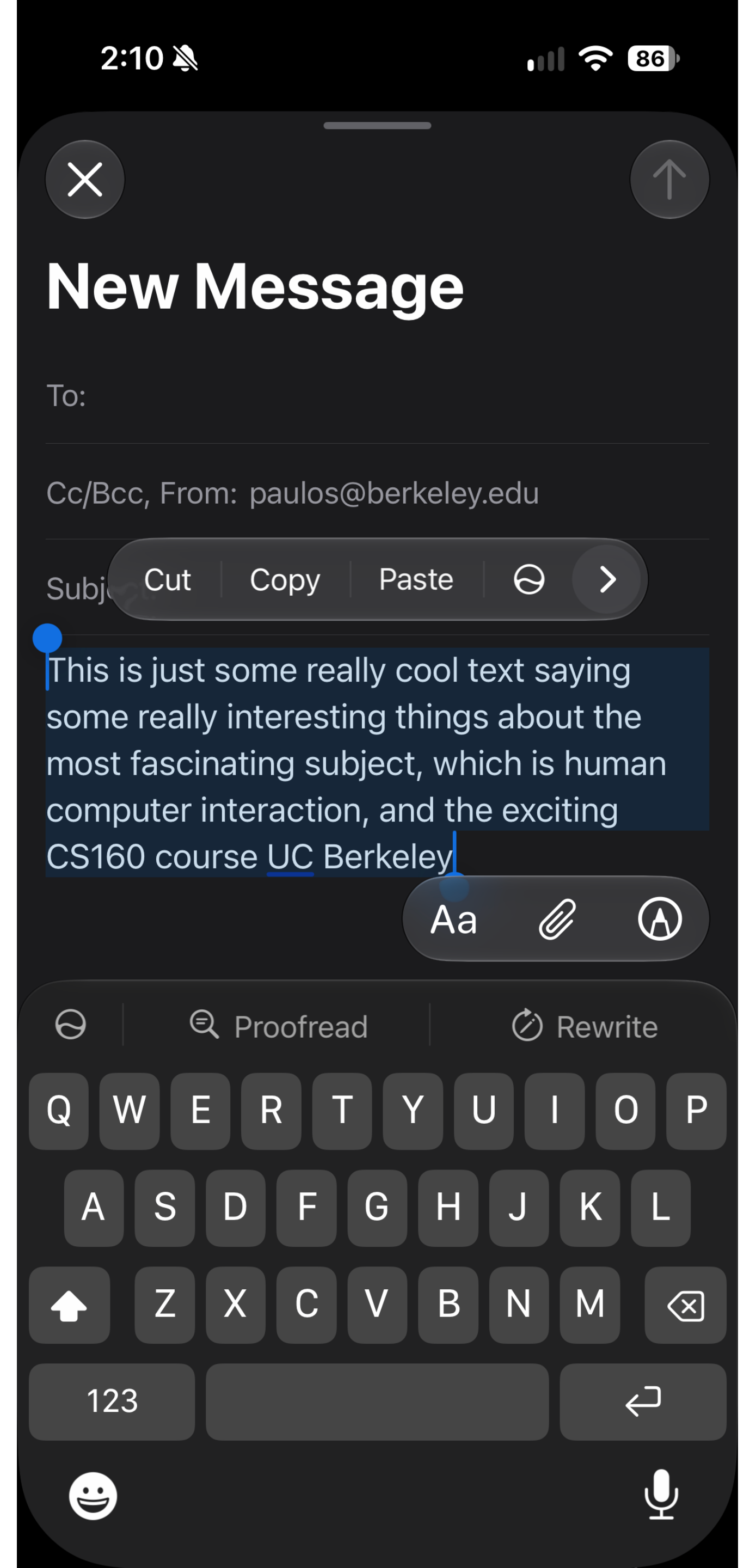
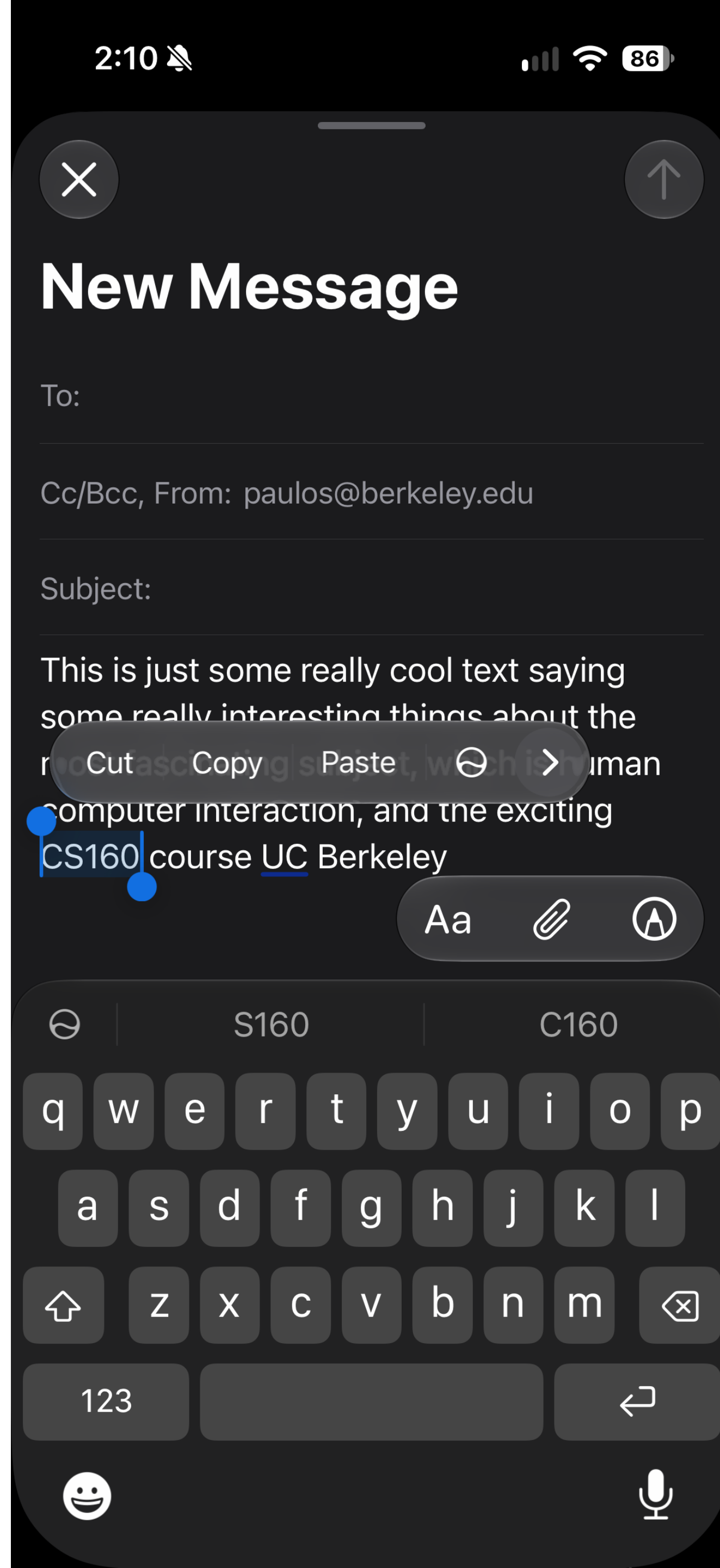
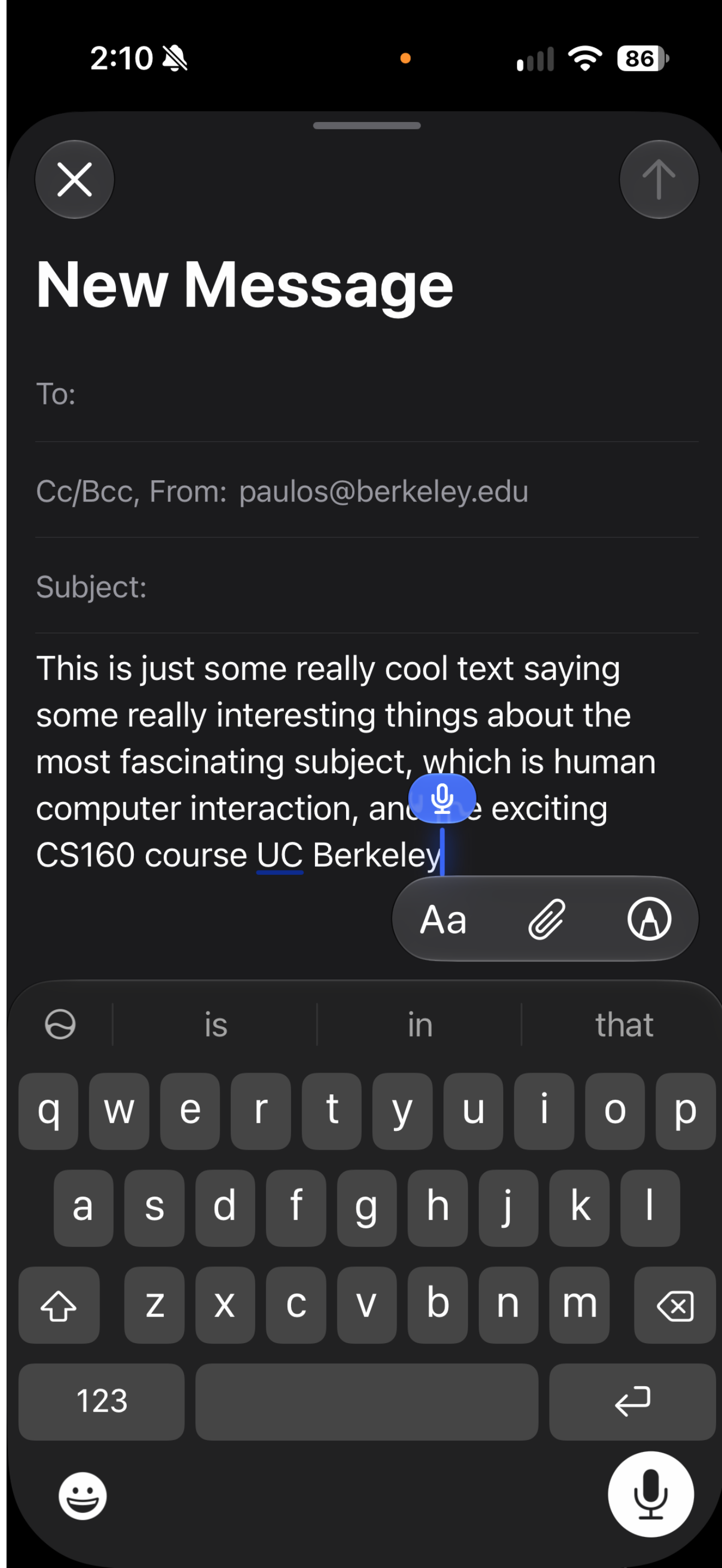
MOBILE

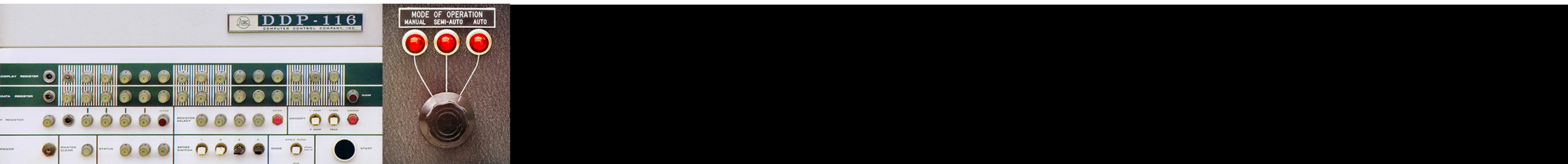


DARK PATTERN







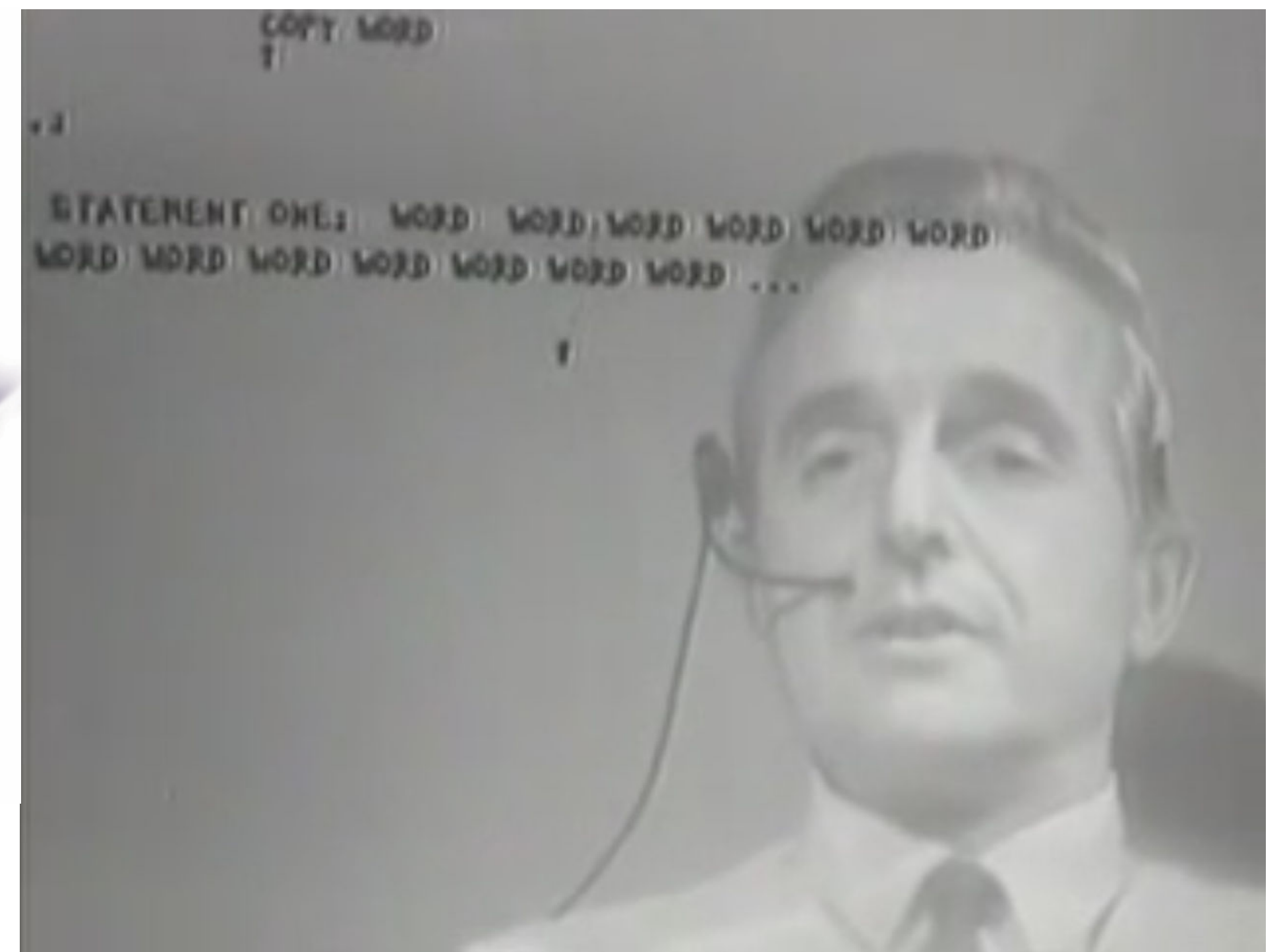


METAPHOR IN USER INTERFACES

THE MOTHER OF ALL DEMOS

Doug Engelbart's December 9, 1968, computer demonstration at the Fall Joint Computer Conference in San Francisco. The 90-minute presentation essentially demonstrated almost all the fundamental elements of modern personal computing

- windows
- hypertext
- graphics
- video conferencing
- the computer mouse
- word processing
- dynamic file linking
- revision control
- collaborative real-time editor





Your Professor (as a PhD student) and Doug Engelbart in 1998

December 9, 1968: The Demo

The Basics

Control Devices

Real-Time Collaboration

1968

nearly 50 years before...

windows

hypertext

video conferencing

the computer mouse

word processing

dynamic file linking

revision control

collaborative real-time editor

METAPHOR

Definition

The transference of the relation between one set of objects to another set for the purpose of brief explanation

Lakoff & Johnson

"...the way we think, what we experience, and what we do every day is very much a matter of metaphor."

in our language & thinking - "argument is war"

...she attacked every weak point

...criticisms right on target

...if you use that strategy

Metaphors can highlight some features, suppress others

INTERFACE METAPHORS

Purpose

Leverages knowledge of familiar, concrete objects/experiences
Transfer this knowledge to abstract tasks and concepts

Problem

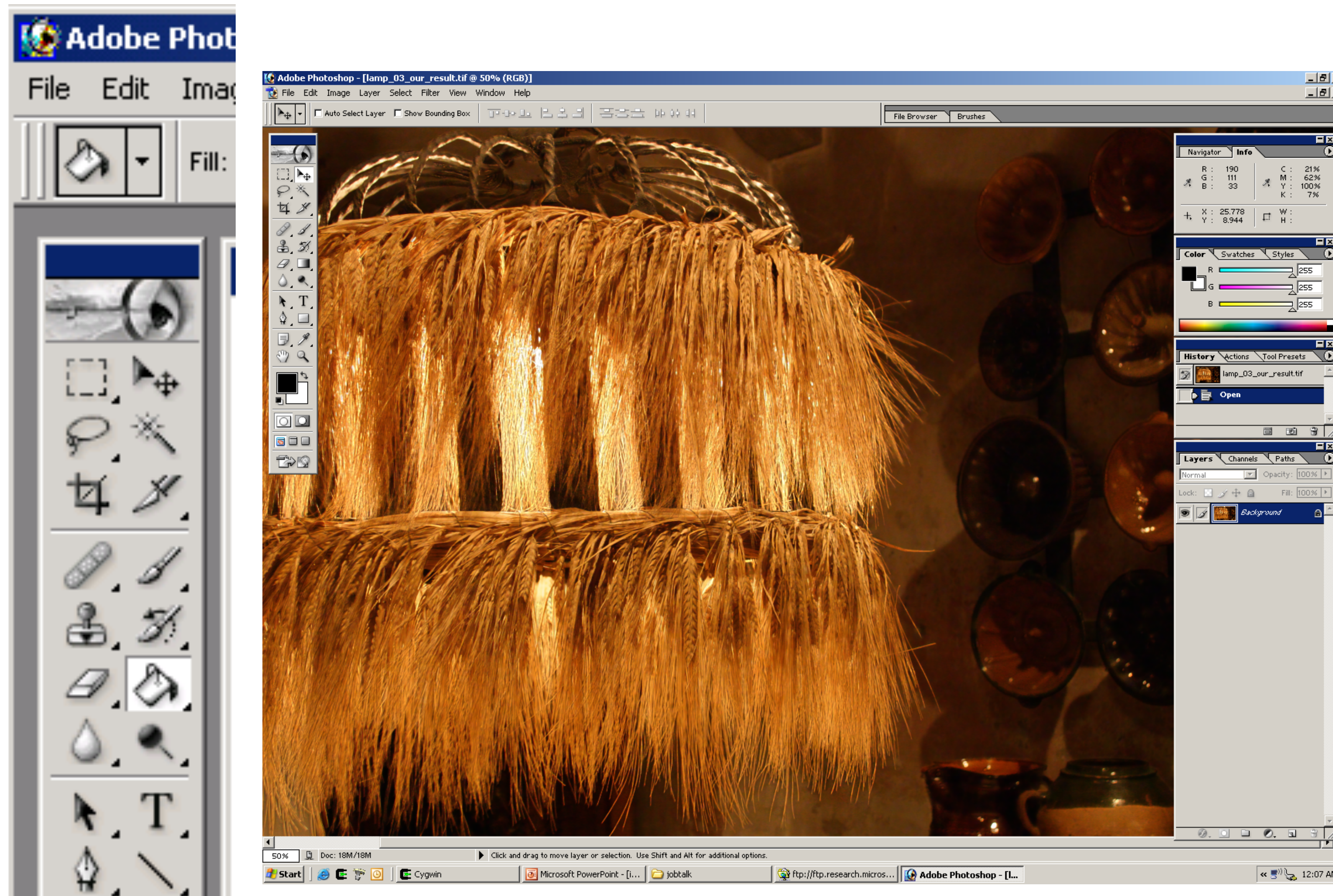
Inaccurate or naive conceptual model of the system



*A presentation tool
is like
an slide projector*



THE PAINTING METAPHOR



THE DESKTOP METAPHOR

Started at Xerox PARC

Xerox Star

Bitmapped screens made it possible

Not meant to be a real desktop

Organize information the way people use information

Allow windows to overlap – make screen act as if on



MICROSOFT BOB'S DESKTOP METAPHOR



BOB'S "LIVING ROOM" METAPHOR





Good afternoon.

Click on the door to
sign in...



EXIT

3D DESKTOPS



Robertson 2000



Sun's Looking Glass

GOOGLE ART PROJECT

[Navigate Floor Plan](#)



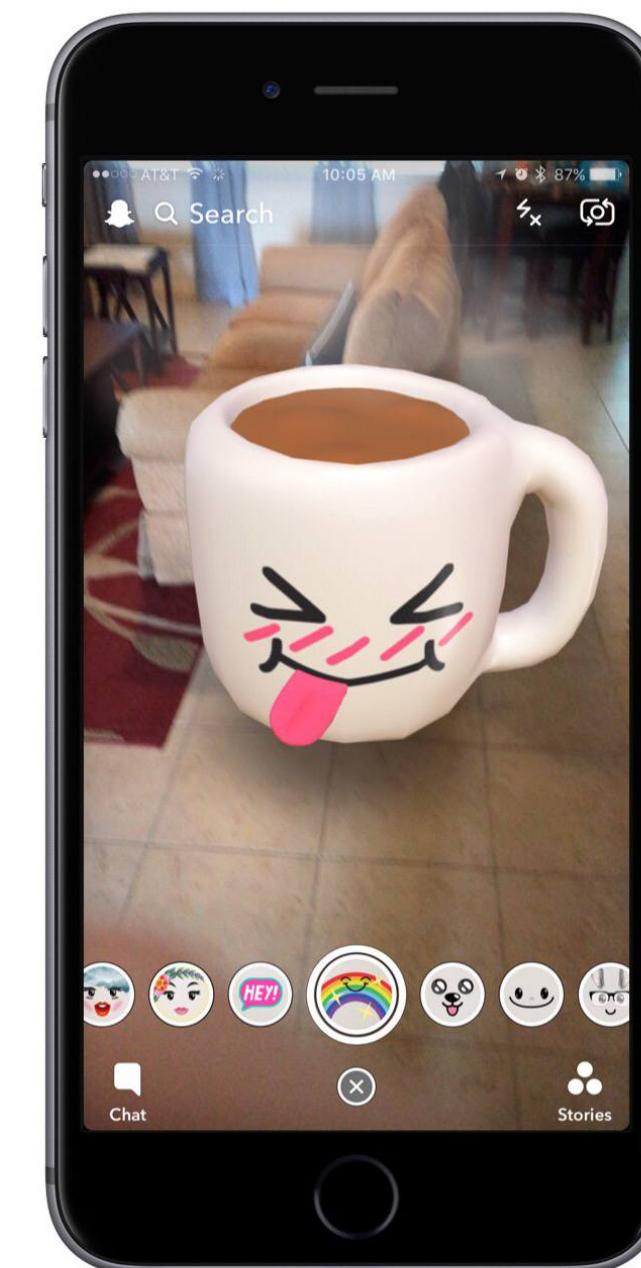
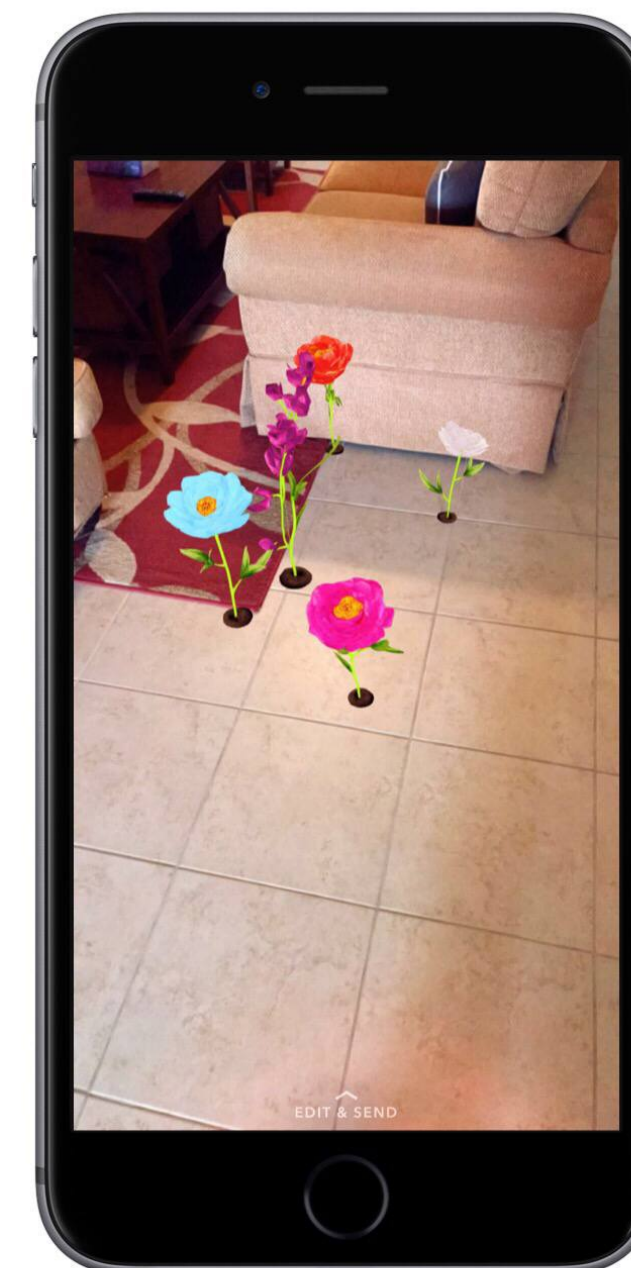
VIRTUAL ASSISTANT METAPHOR



VIRTUAL REALITY



AUGMENTED REALITY





METAPHOR CAVEATS

Too limited

The metaphor restricts interface possibilities

Too powerful

The metaphor implies the system can do things it can't

Too literal or cute

Makes it difficult to understand abstract concept

Mismatched

The metaphor conveys the wrong meaning

MISMATCHED METAPHORS

What is being controlled here?



MISMATCHED METAPHORS



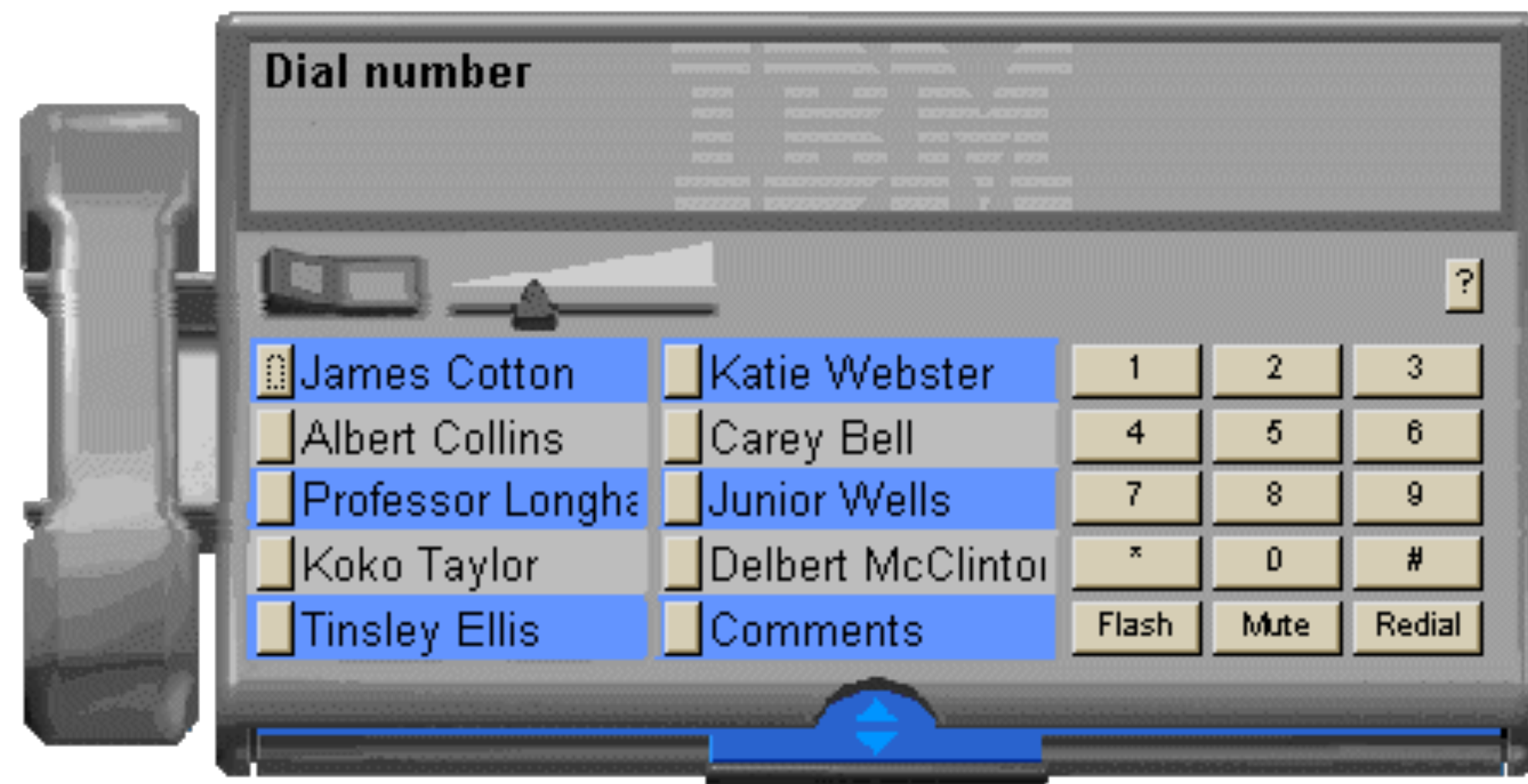
MISUSED METAPHORS

Direct translations

Software music player that requires turning volume knob with mouse

Software telephone that requires the user to dial a number by clicking on a simulated keypad

Airline web site that simulates a ticket counter!



Southwest Airlines Home Gate

The Home of Southwest Airlines on the World Wide Web



Southwest Airlines Home Gate

The Home of Southwest Airlines on the World Wide Web

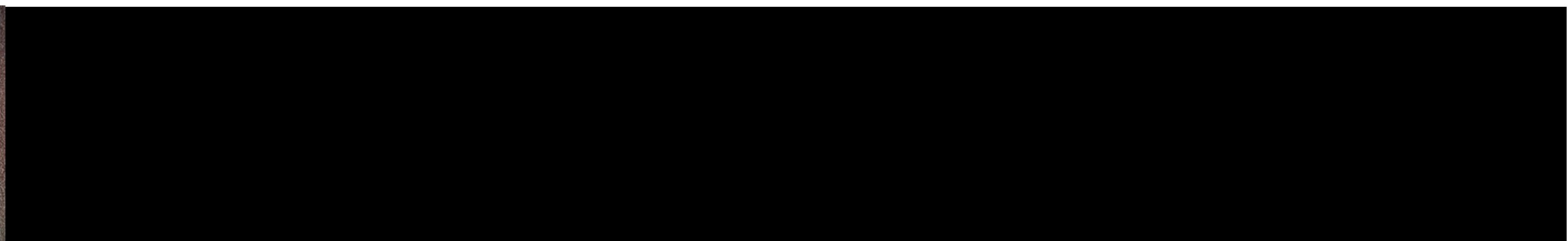
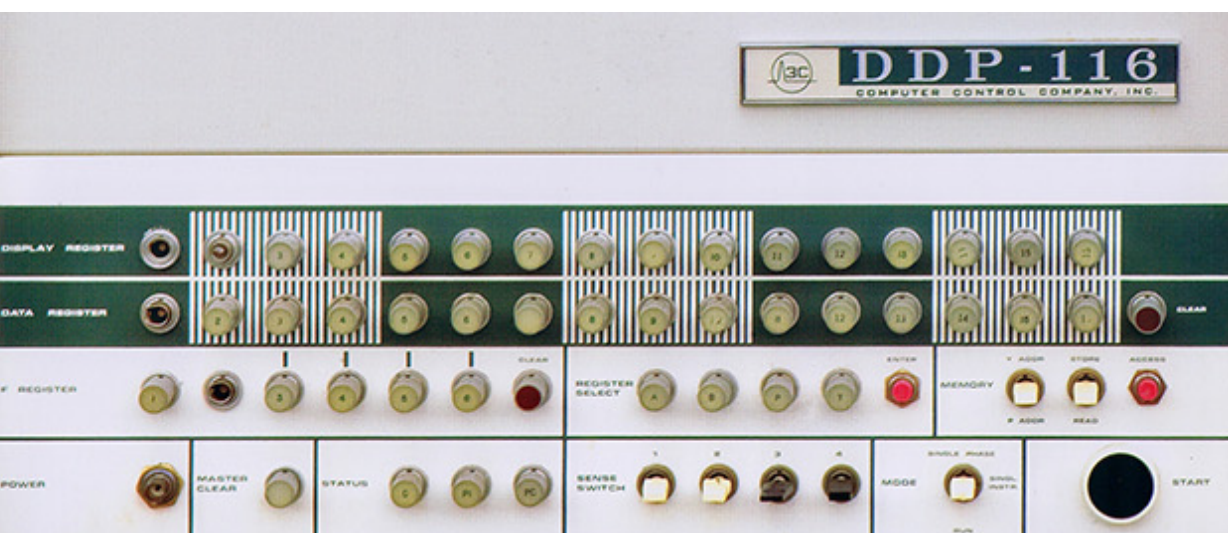
GUIDELINES FOR DESIGN

Good Metaphors

Capture essential elements of the event / world

Deliberately leave out / mute the irrelevant

Appropriate for user, task, and interpretation



MODES

MODES: DEFINITION

The same user actions have different effects in different situations.

MODES: EXAMPLES



TEXAS INSTRUMENTS

TI-30Xa

390625

ON/C

2nd

LOG

LOG

LN

OFF

1/x

TAN

COS

TAN

y^x

π

1/x

x^2

$\sqrt{x}$

+

$\Sigma+$

EE

(

)

$\times$

STO

7

8

9

$\div$

RCL

4

5

6

$\pm$

a^b/c

1

2

3

$\pm$

Undo ⌘Z
Redo ⇧⌘Z

Cut ⌘X
Copy ⌘C

Paste ⌘V
Paste and Match Style ⇧⇧⌘V

Delete
Complete ⌘⌘
Select All ⌘A

Insert ▶
Add Link... ⌘K

Find ▶

Spelling and Grammar ▶

Substitutions ▶

Transformations ▶

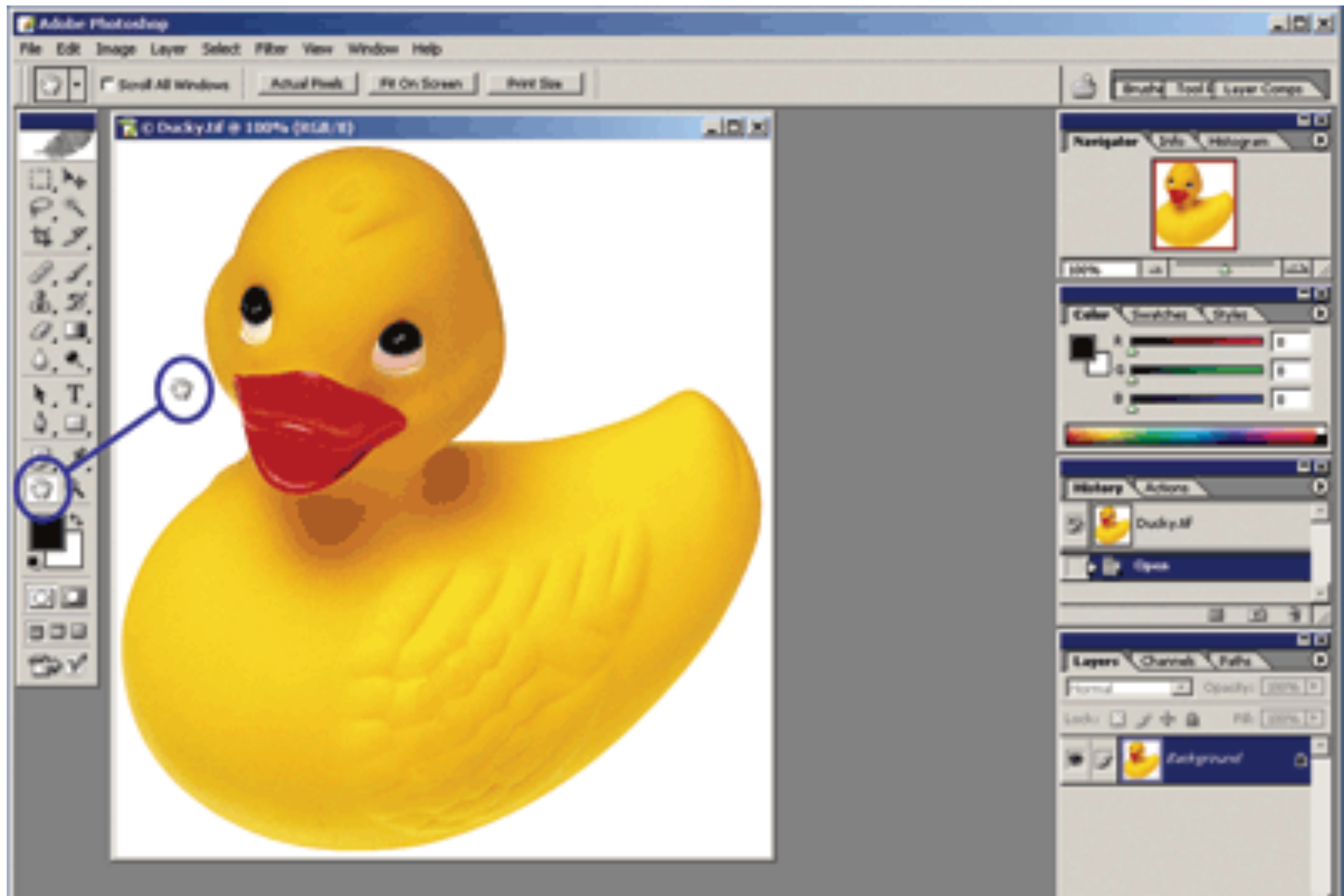
Speech ▶

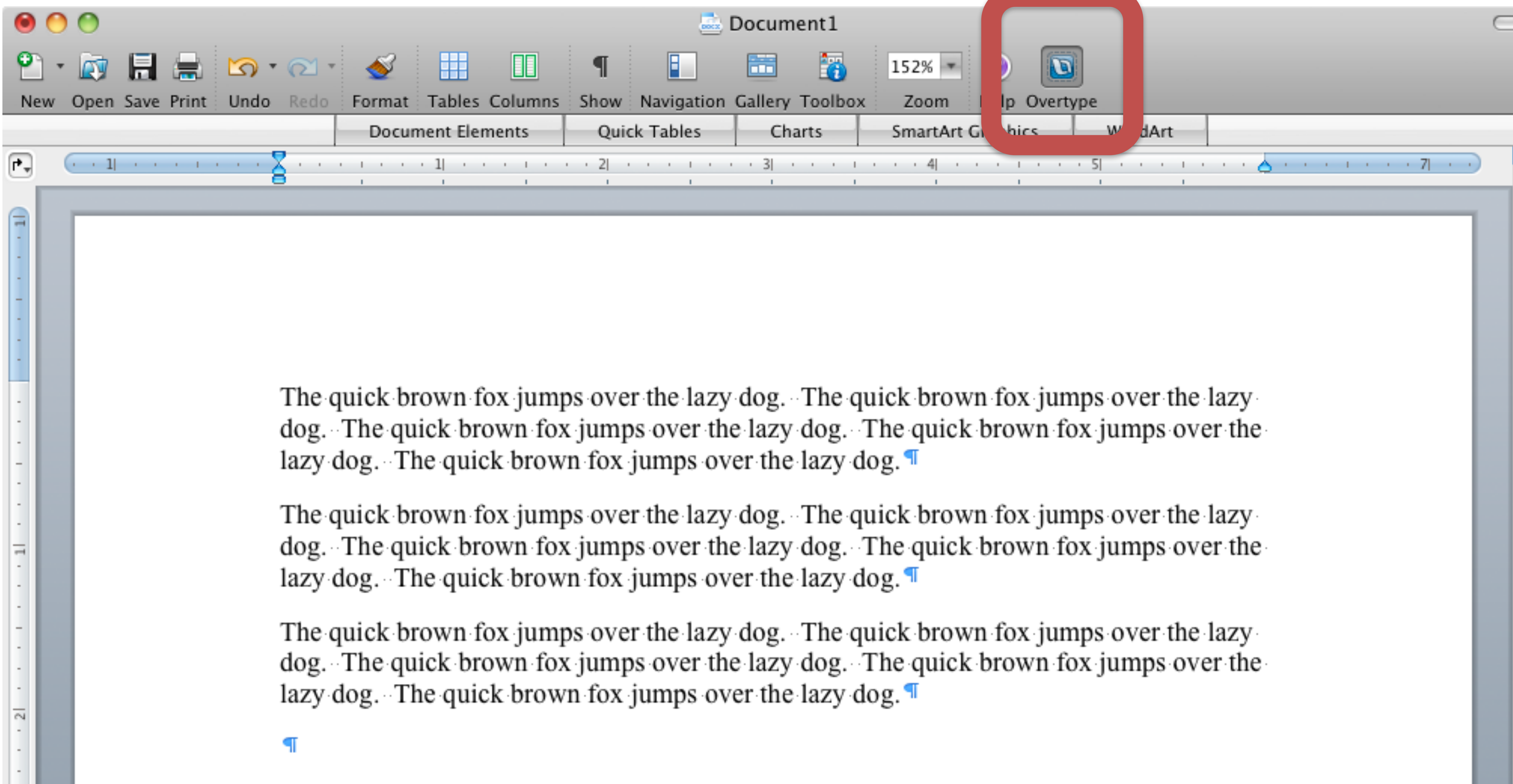
Special Characters... ⌘⌘T

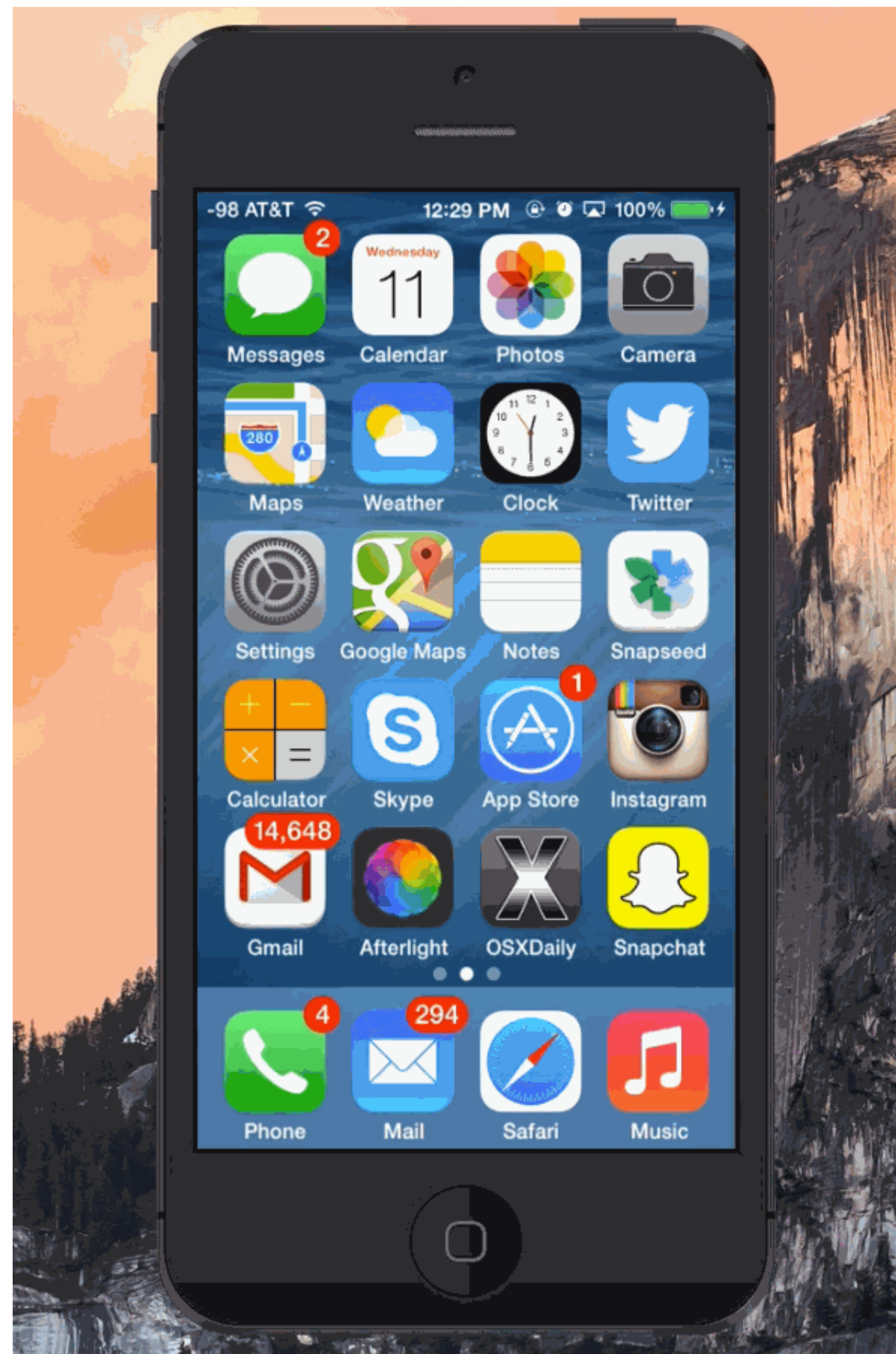
Show Spelling and Grammar ⌘:
Check Document Now ⌘;

✓ Check Spelling While Typing
Check Grammar With Spelling

✓ Correct Spelling Automatically







USING MODES IN INTERFACES

When are they useful?

Temporarily restrict users' actions

When logical and clearly visible and easily switchable

Drawing with paintbrush vs. pencil

Why can they be problematic?

Big memory burden

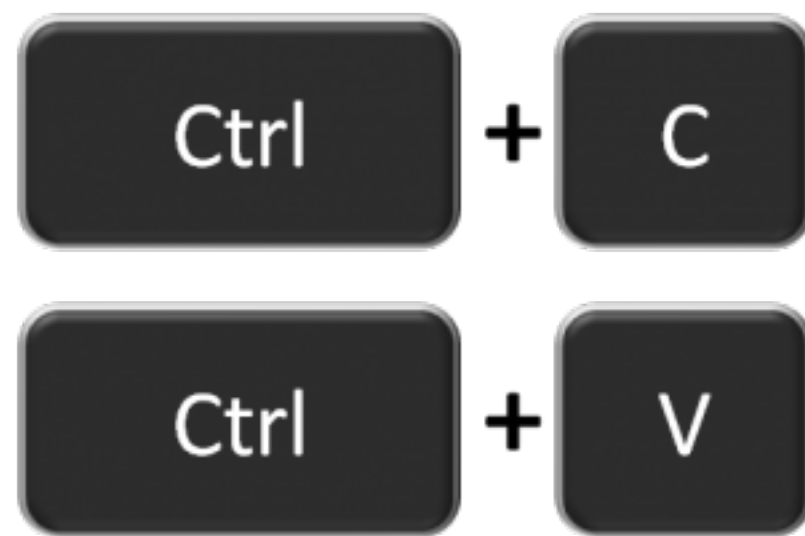
Source of many serious errors

How can these problems be fixed?

Don't use modes – redesign system to be modeless

Redundantly visible

LARRY TESLER

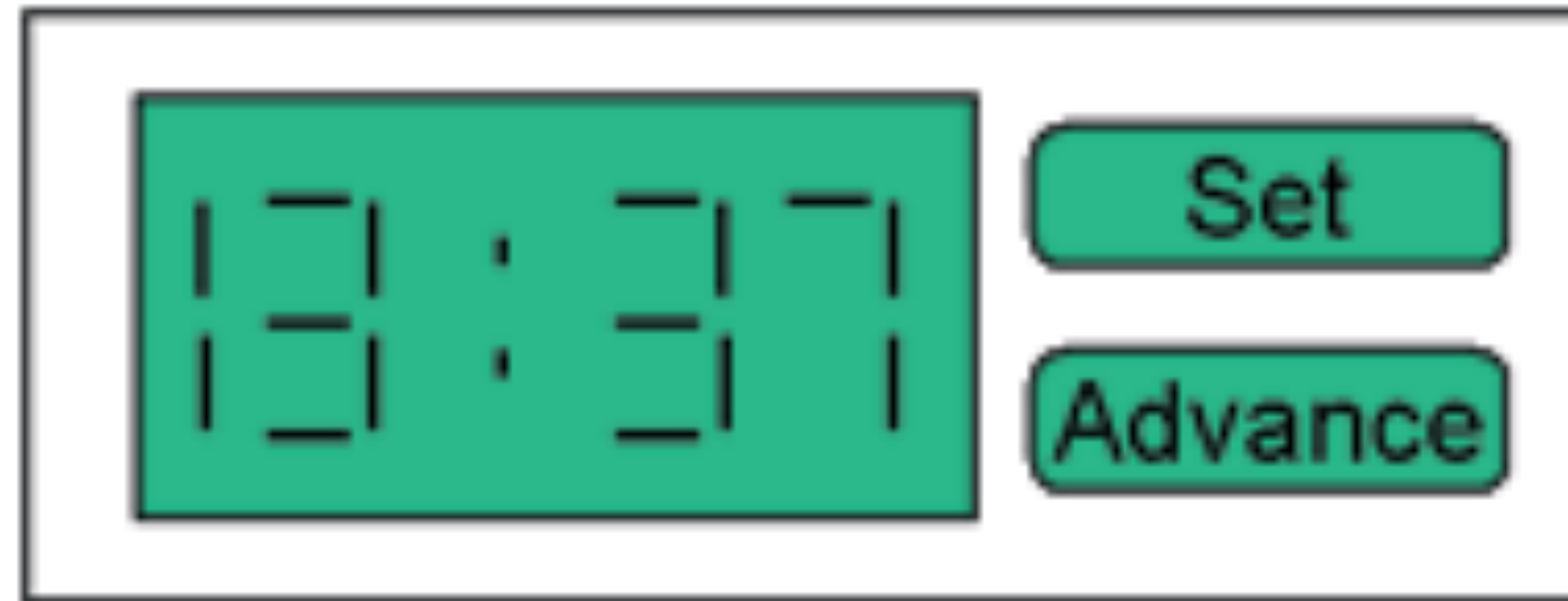


nomodes.com

- Developed the idea of **copy and paste** functionality and the idea of **modeless software** (with Tim Mott)
- **Smalltalk**, the first dynamic object-oriented programming language
- **Gypsy**, the first word processor with a graphical user interface (GUI) for the Xerox Alto
- At Apple, worked on the **Apple Lisa** and the **Apple Newton** and much, much, more

REDESIGNING TO AVOID MODES

Setting the time on a clock



Modal

REDESIGNING TO AVOID MODES

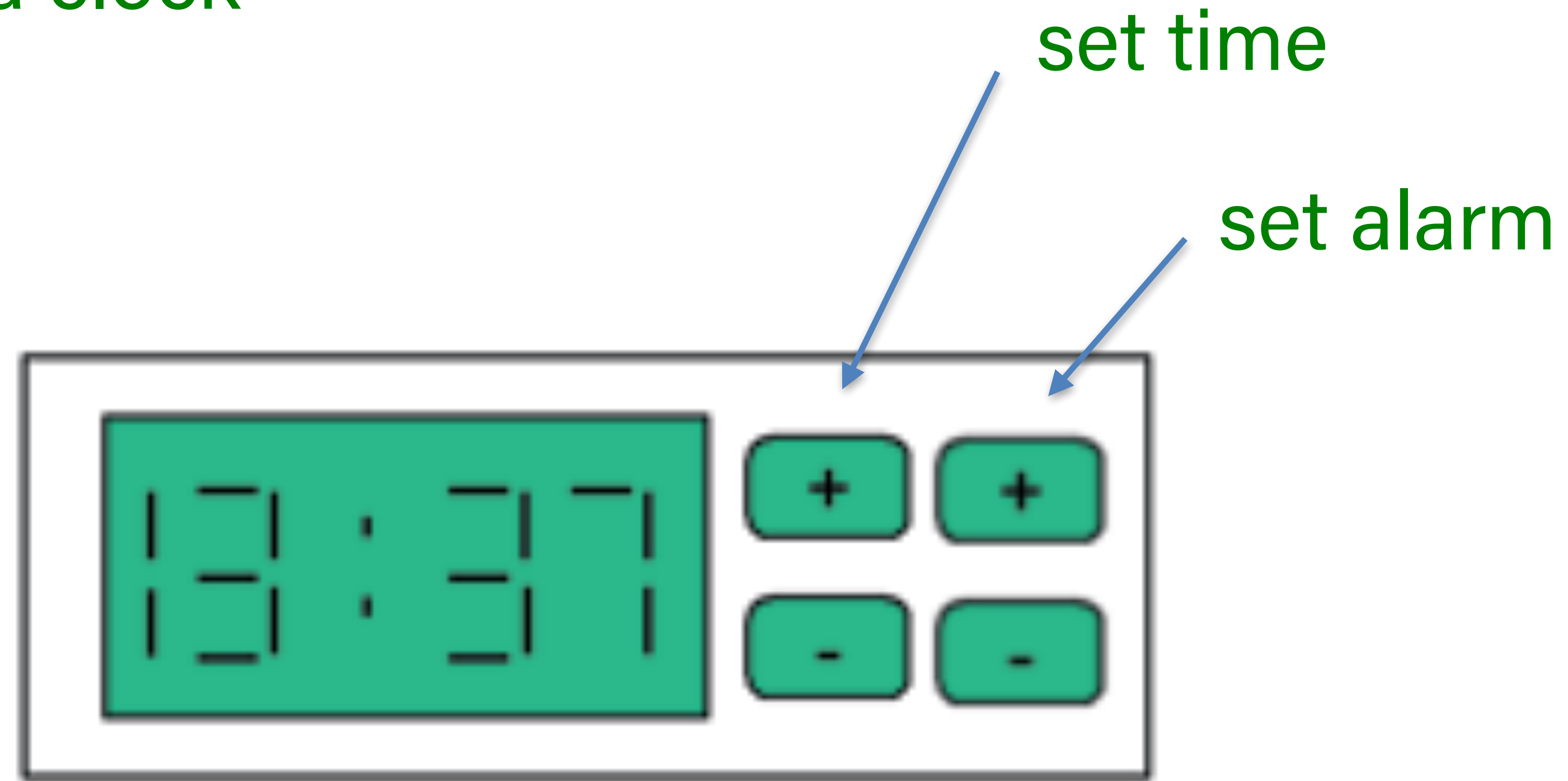
Setting the time on a clock



Modeless

REDESIGNING TO AVOID MODES

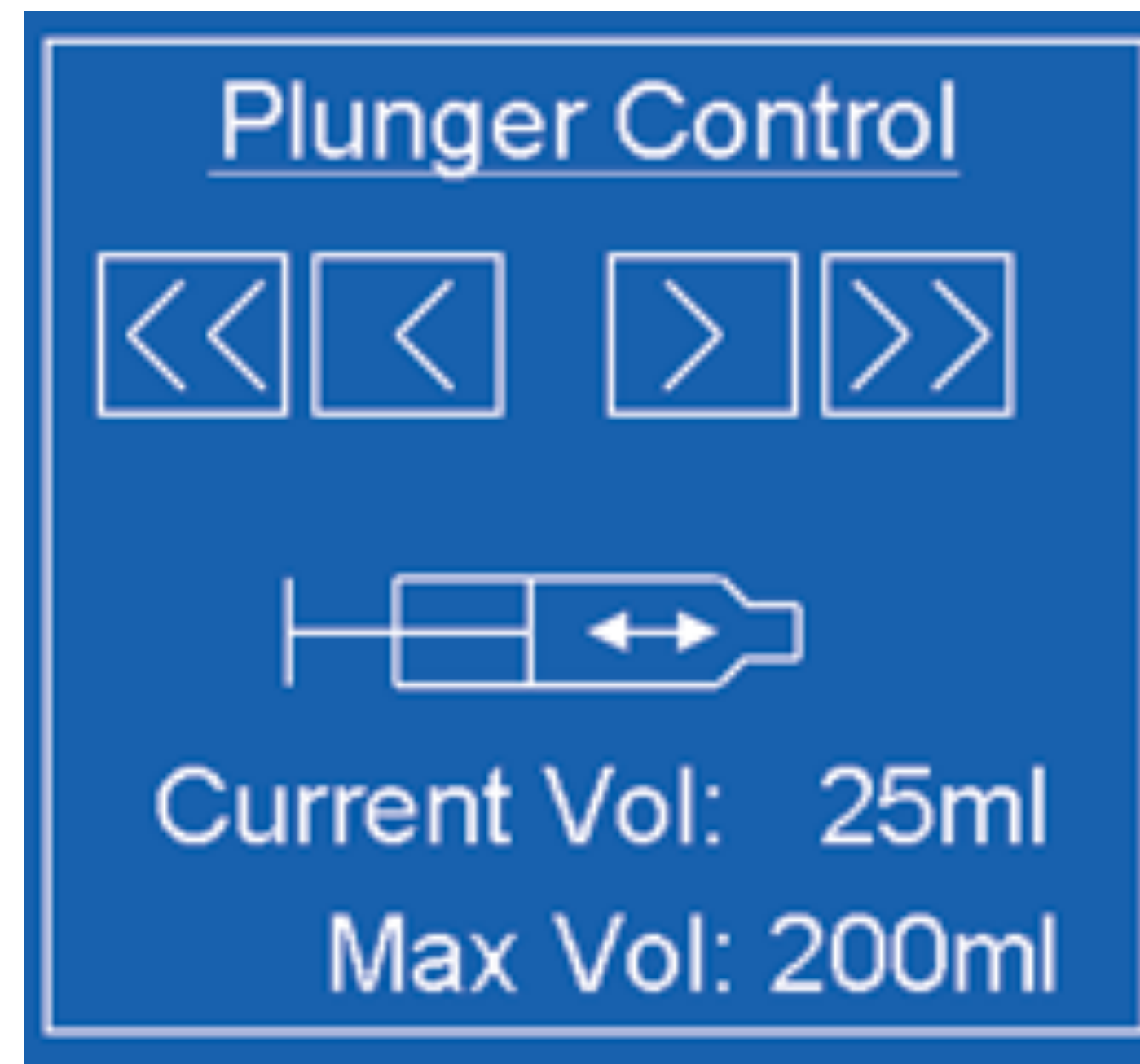
Setting the time on a clock



Modeless

MODES ARE SOMETIMES GOOD

Fill and empty syringe



Modeless

MODES ARE SOMETIMES GOOD

If task requires modes, interface may also contain modes

Fill Syringe

Vol:



Current Vol: 25ml
Max Vol: 200ml

Fill Mode

Deliver Solution

Vol:

Rate:



Current Vol: 25ml

Deliver Mode

QUASIMODES

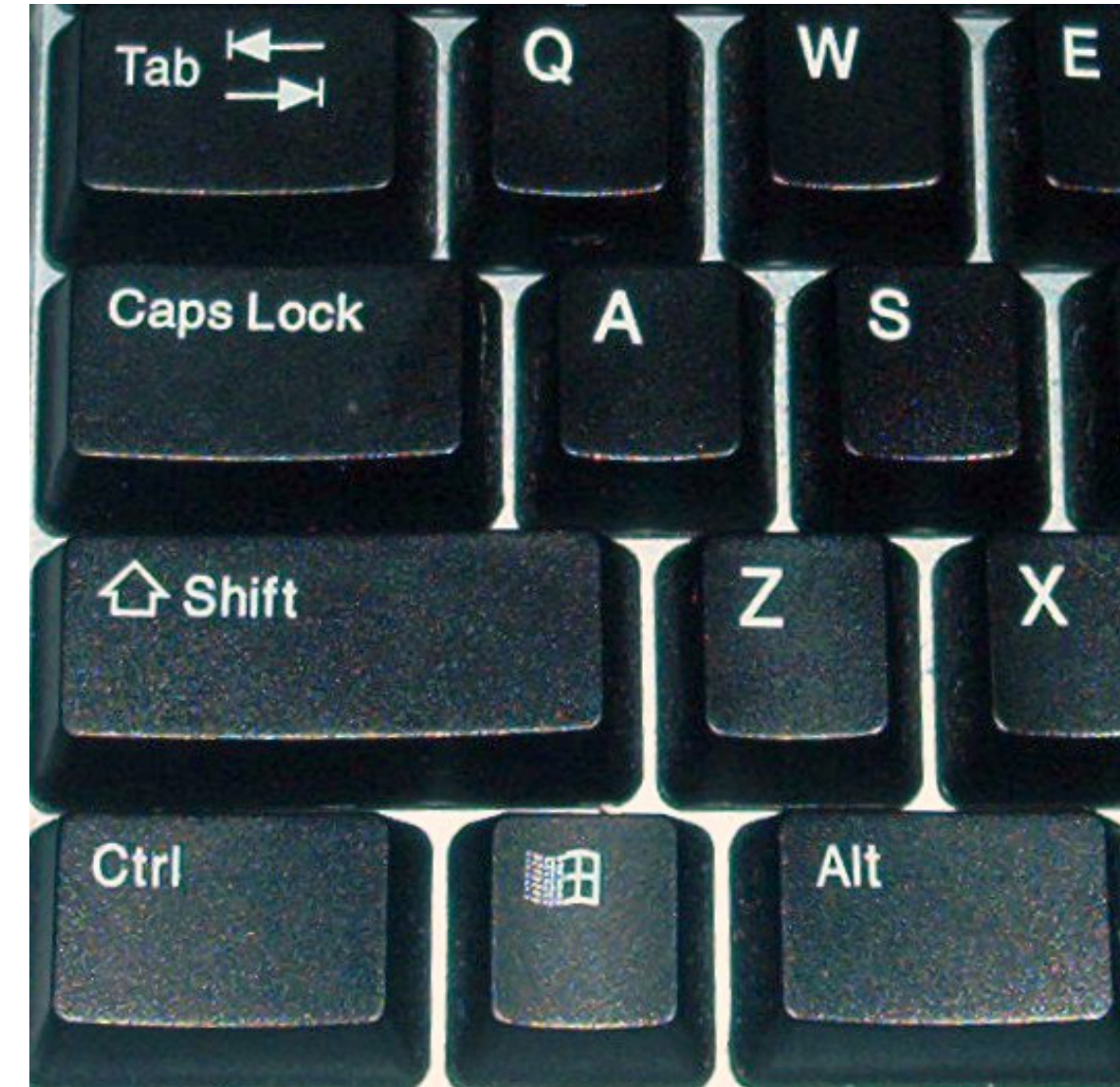
Set and hold a mode via conscious, continuous action

Shift key to capitalize (vs. Caps Lock)

Foot pedal that must remain pressed

Pull down menus

Muscle tension reminds users they are holding a mode



Also known as “spring-loaded modes”



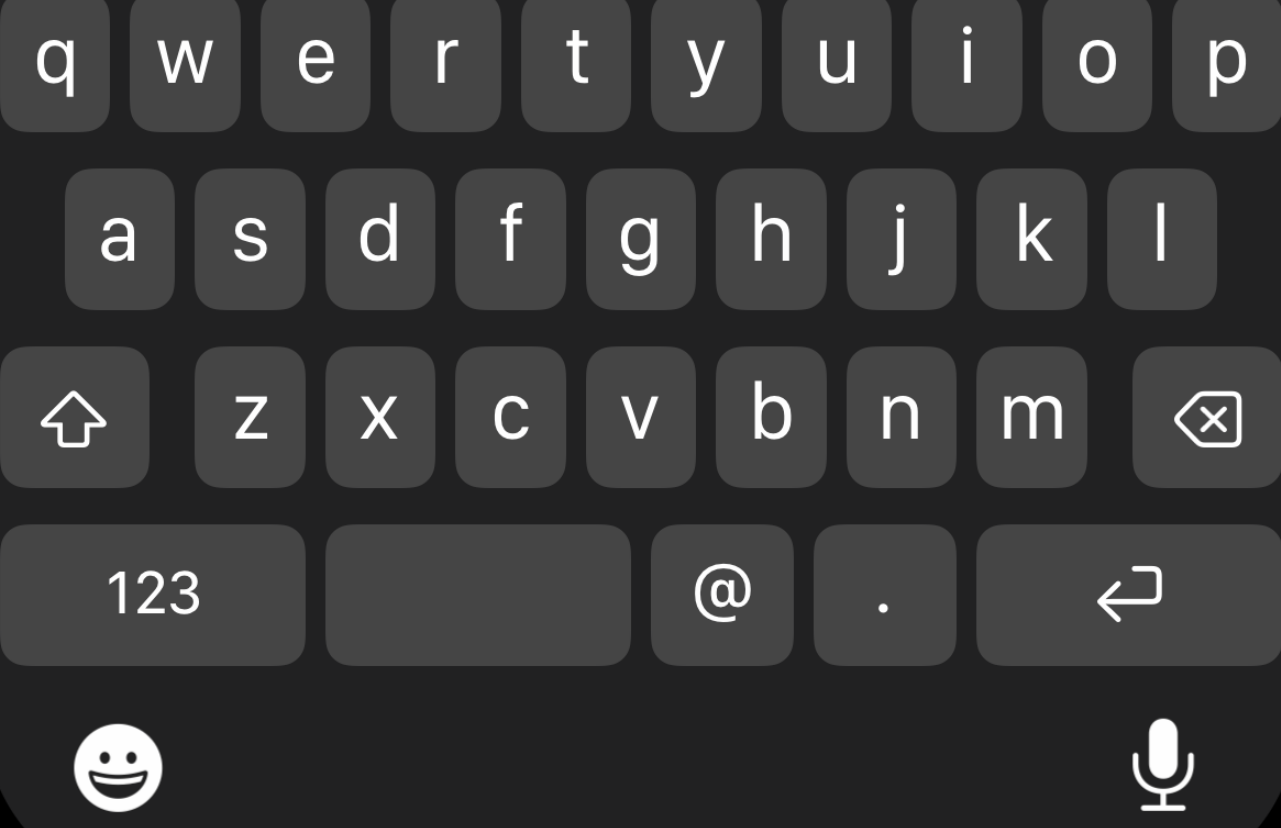
2:32

93%

New Message



To: |



SUMMARY

Metaphor

Leverages knowledge of familiar objects & experiences

Transfer this knowledge to abstract tasks and concepts

Easily mismatched or misused so be careful!

Modes

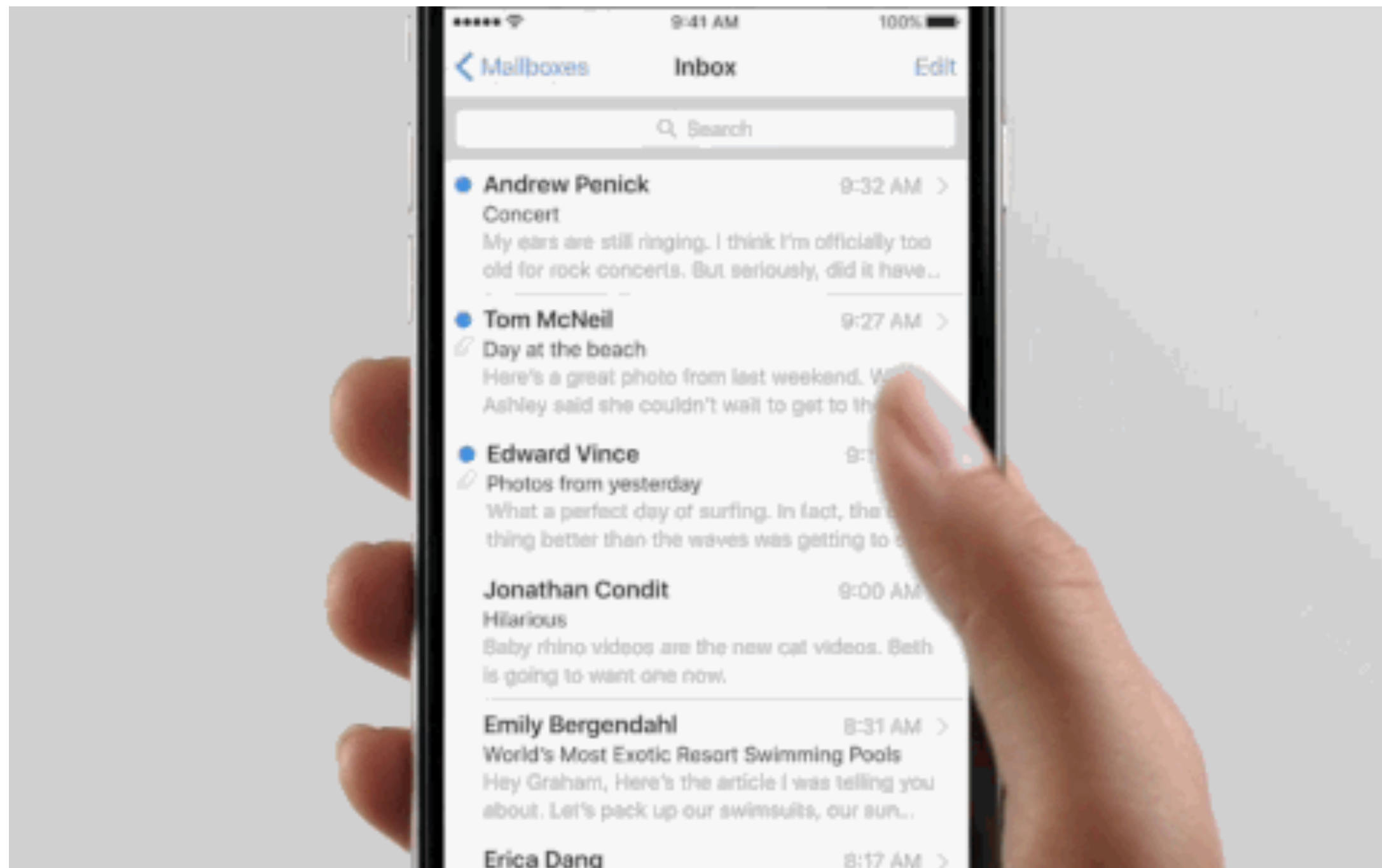
Can create memory issues and cause serious errors

Avoid modes in your designs!

Reducing the number of modes will reduce the user's mental effort in using your interface

Design modes that match user tasks

3D TOUCH AND HAPTIC TOUCH

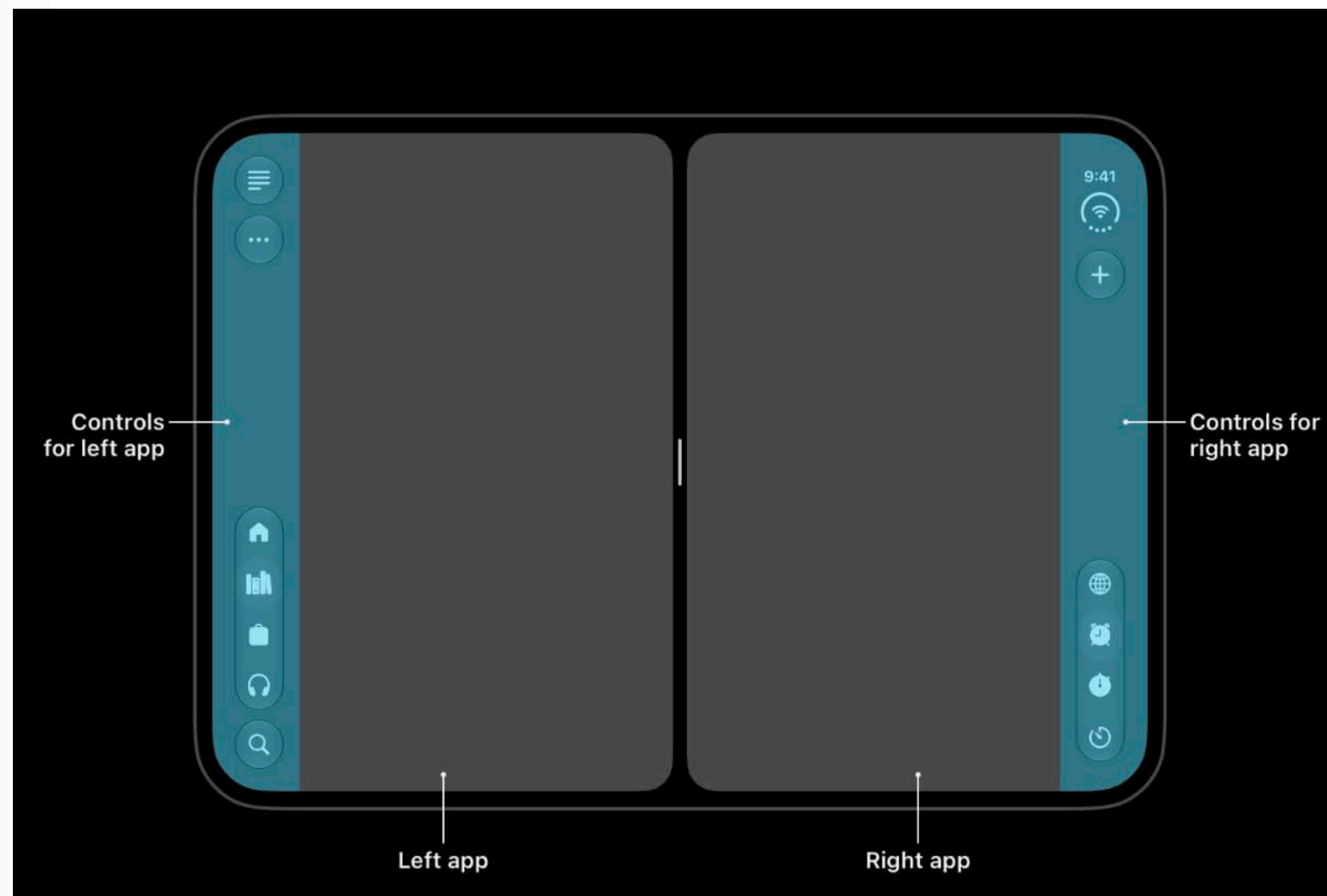




**Hey did you see that cool 3D Touch
feature?**

**Oh, you mean another implementation of a
quasi-mode (spring loaded mode) which
takes advantage of Fitts Law. Yea saw it
(again).**







**Hey did you see the new iPhone Duo
controls on the right side?**

**Oh, you mean another
implementation of Fitts Law.
Yea saw it (again).**

