You're in the right classroom.
Today is a guest lecture!

CONCEPTUAL MODEL

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CS-270 Fundamentals of Human-Computer Interaction
CS-570 Introduction to Human-Computer Interaction

WISCONSIN
UNIVERSITY OF WISCONSIN–MADISON

OUTLINE

Conceptual model

Hands-on activity

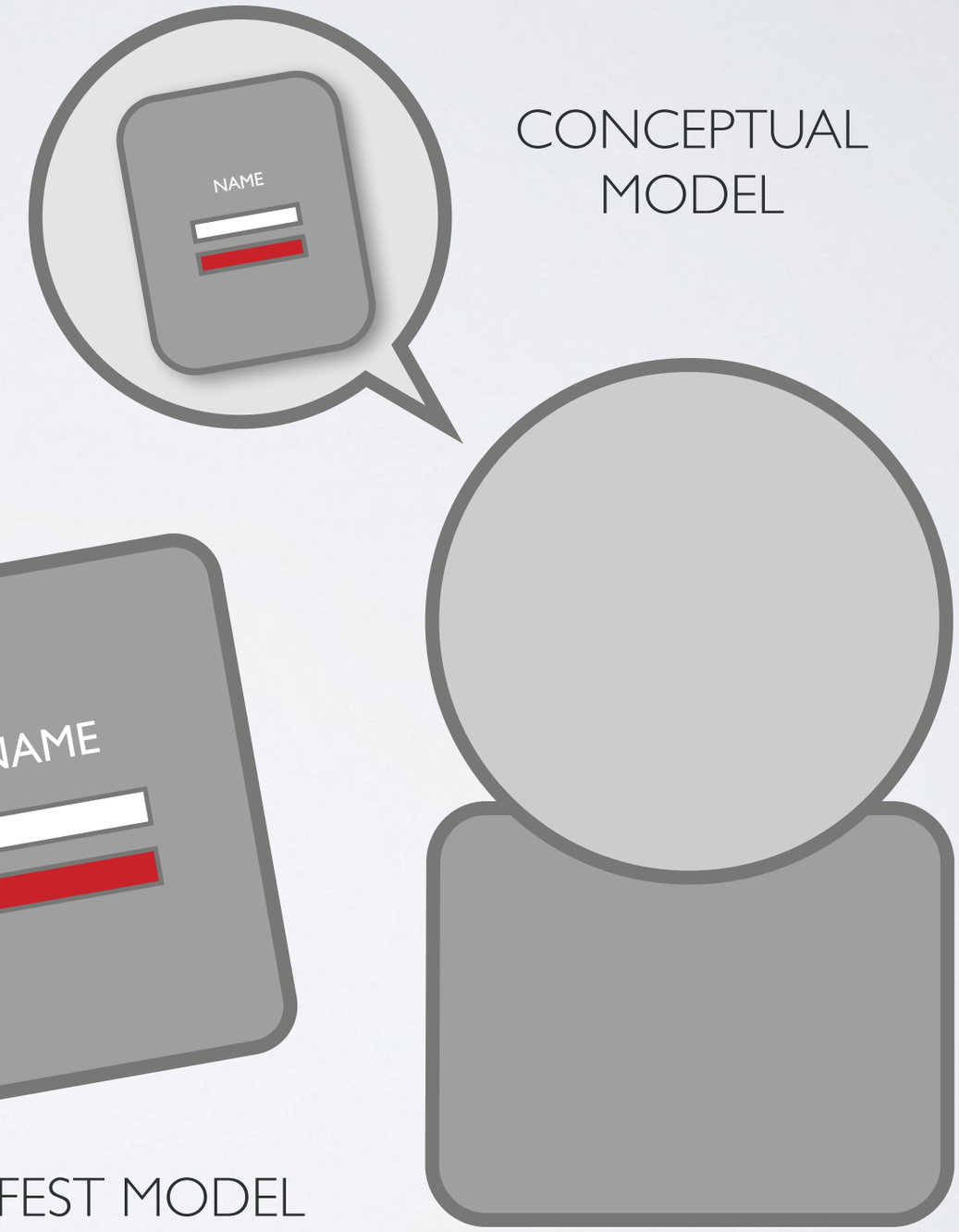
My own research on human-robot interaction

CONCEPTUAL MODEL

CONCEPTUAL MODEL

A user's **conceptual model** (also called a **mental model**) is his or her view of a system as s/he *believes it to be*, especially concerning how s/he can act upon it and what the system's responses mean.

MODEL MATCHING



CONCEPTUAL MODEL

```
formInput(form f){
    new String() n;
    n=textField.getName();
    f.submit(n);
}
```

IMPLEMENTATION MODEL

MANIFEST MODEL

MODEL FORMATION

As a user interacts, his/her conceptual model is revised whenever s/he must **explicitly revisit it**, usually because of a **breakdown** such as unfulfilled expectations or unclear representations.

During a breakdown, the conceptual model is revisited as the system with which we interact goes from **ready-to-hand** to **present-at-hand**.

MODEL FORMATION

According to Heidegger

Ready-to-hand (*zuhanden*)

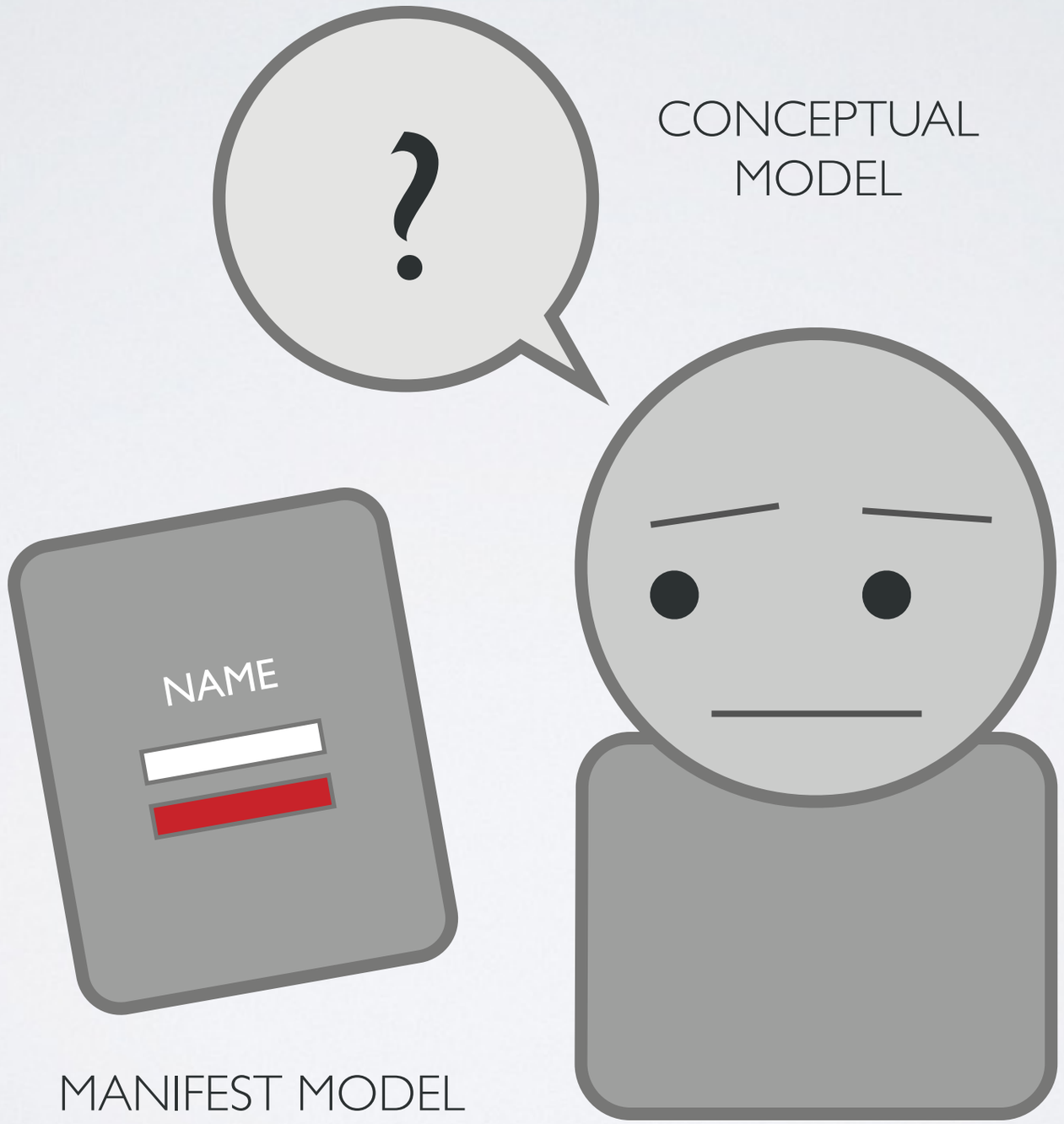
Our normal involvement with tools, where we neither notice them nor theorize about them and instead regard them casually or not at all as we attempt to achieve something.

Present-at-hand (*vorhanden*)

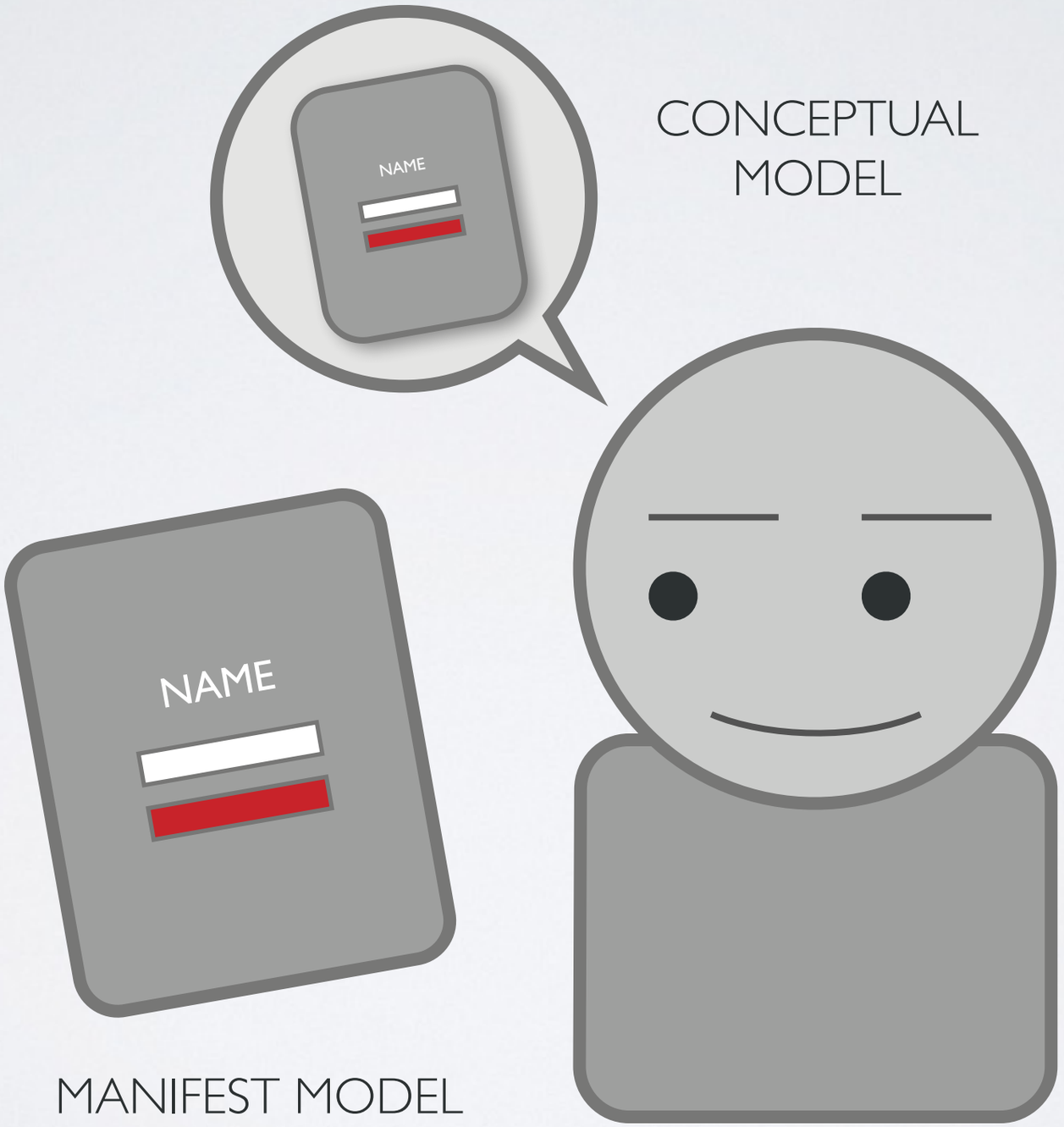
The moment we truly notice something as it leaps into view, standing apart from any utility or purpose, just as a thing in itself.

This often occurs during a "breakdown" in use.

PRESENT-AT-HAND



READY-TO-HAND



MODEL FORMATION

Users will struggle until their **mental model matches the manifest model** of the system.

Constantly revising one's conceptual model can be painful.

Pay close attention next time you start using a technology that is new to you.

MODEL FORMATION

Best designs instantly form conceptual models using:

- Consistency
- Predictability
- Visibility
- Matching the system to the task
  - To the way people think about doing a thing.
- User-centered concepts, not system-centered ones

HOW CAN WE FACILITATE THE FORMATION OF CONCEPTUAL MODEL?

CONCEPTUAL MODELS

Conceptual models are informed by many things:

- Metaphors
- Modes
- Affordances
- Constraints
- Mappings
- Prior experiences
  - Expectations

DESIGN ELEMENTS

Metaphors

Modes

Affordances

Constraints

Mappings

Prior experiences

METAPHORS

METAPHORS

Metaphors help "**jump start**" users' conceptual models by pre-populating them with ideas.

Great, but how do we apply metaphors?

Often new technologies begin as metaphors of old ones.

Can you think of some?

METAPHORS

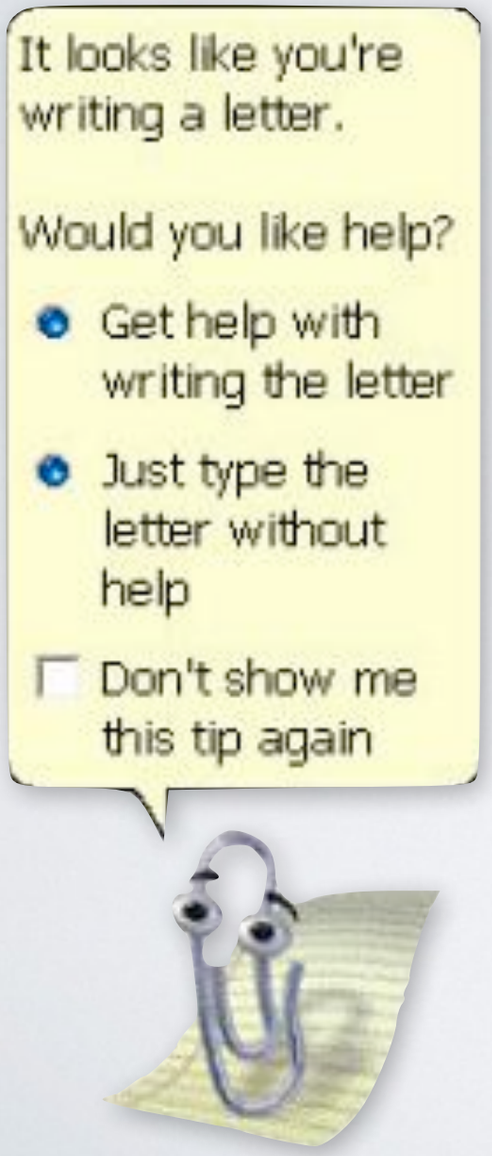
Cars were "horseless carriages."

Trains were "iron horses."

Radio was called "wire-less."

The first word processor was called "**the Electric Pencil**."

INAPPROPRIATE METAPHORS



Paper clips are not necessarily good at English!

Cats don't fetch!

CLIPPY RIP

MIXED METAPHOR

When two or more different metaphors coexist with some supposed relation.

In Windows, you have both the **desktop** metaphor (folders, files, etc.) and **windows** (separate views through which you can see things).

But no real desk has windows in them!

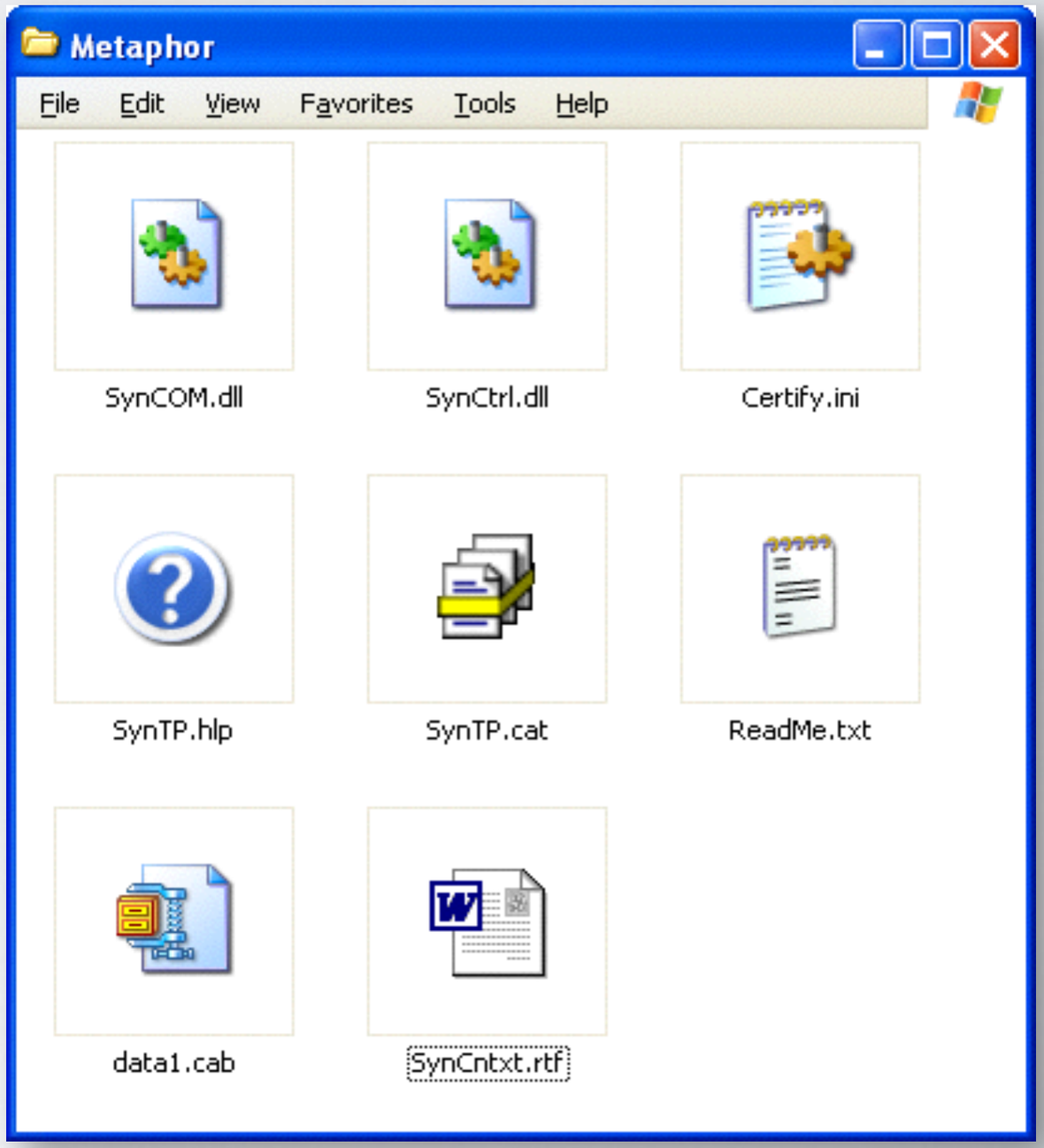
DESKTOP METAPHOR

Files

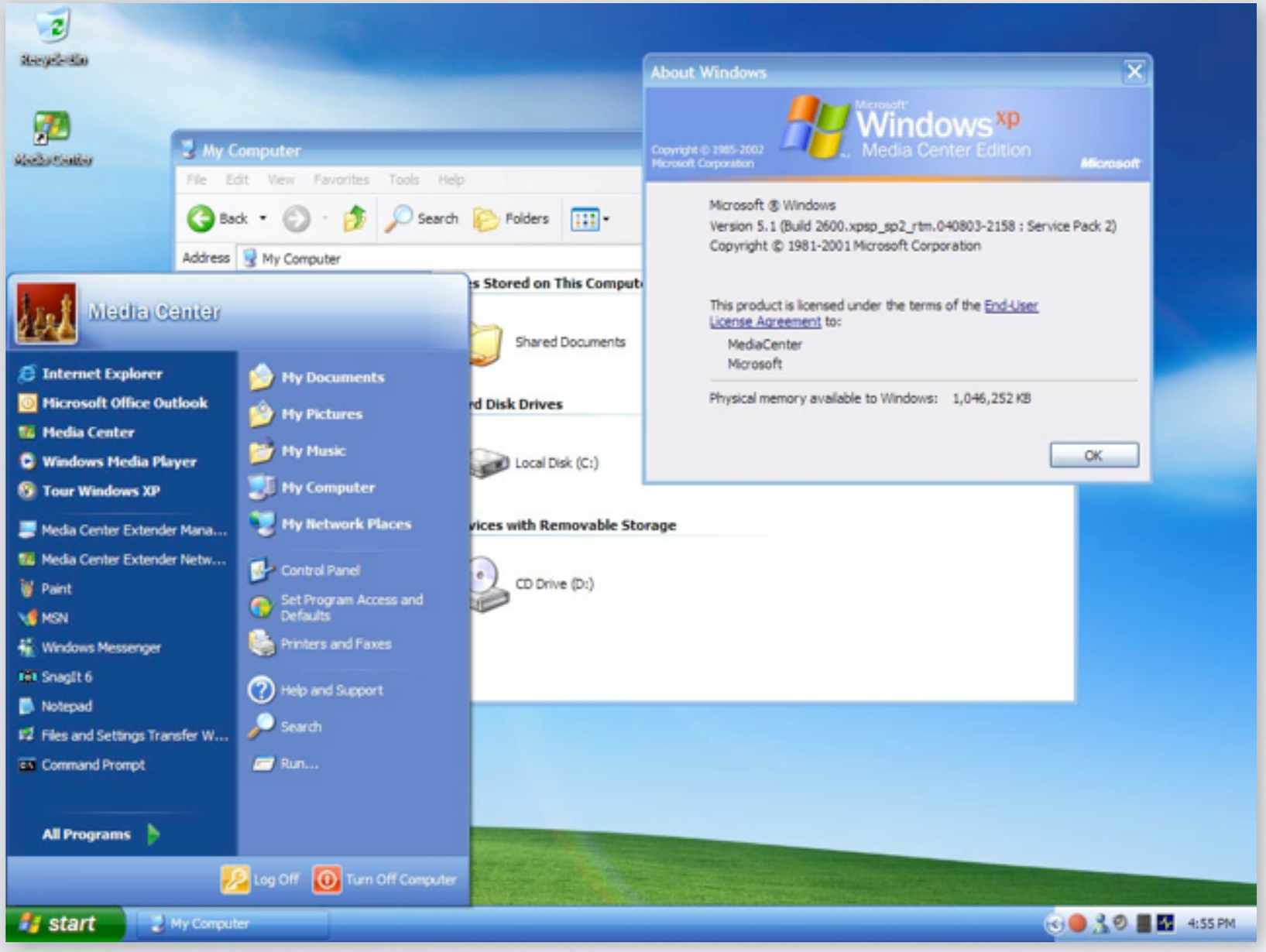
Documents

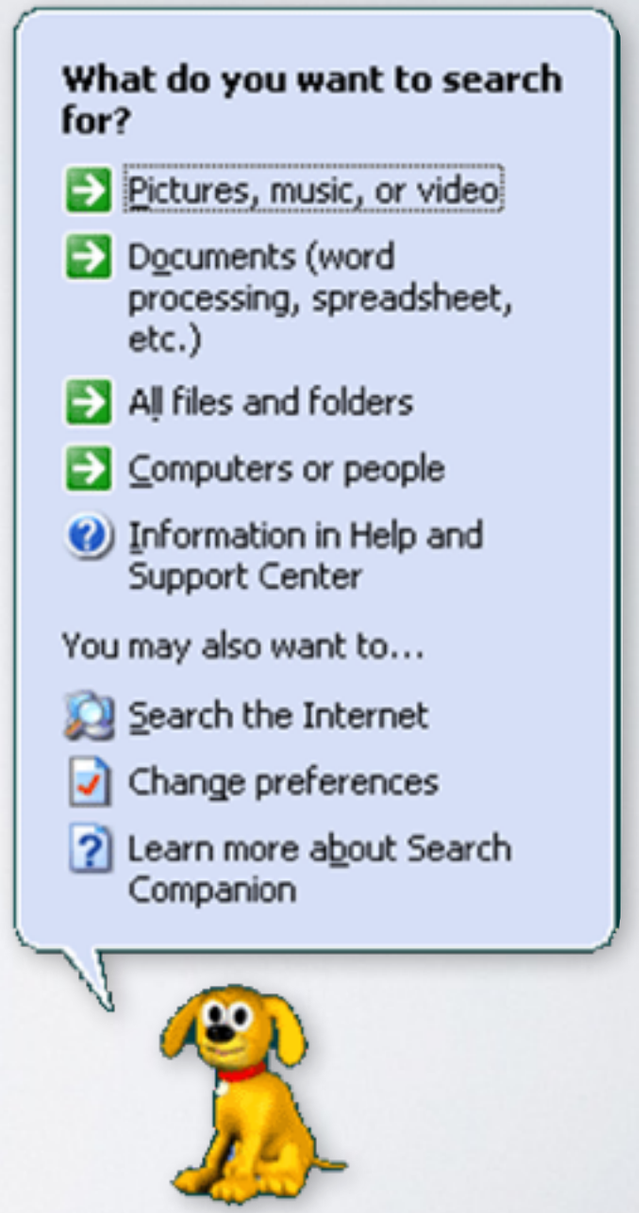
Folders

Cabinets



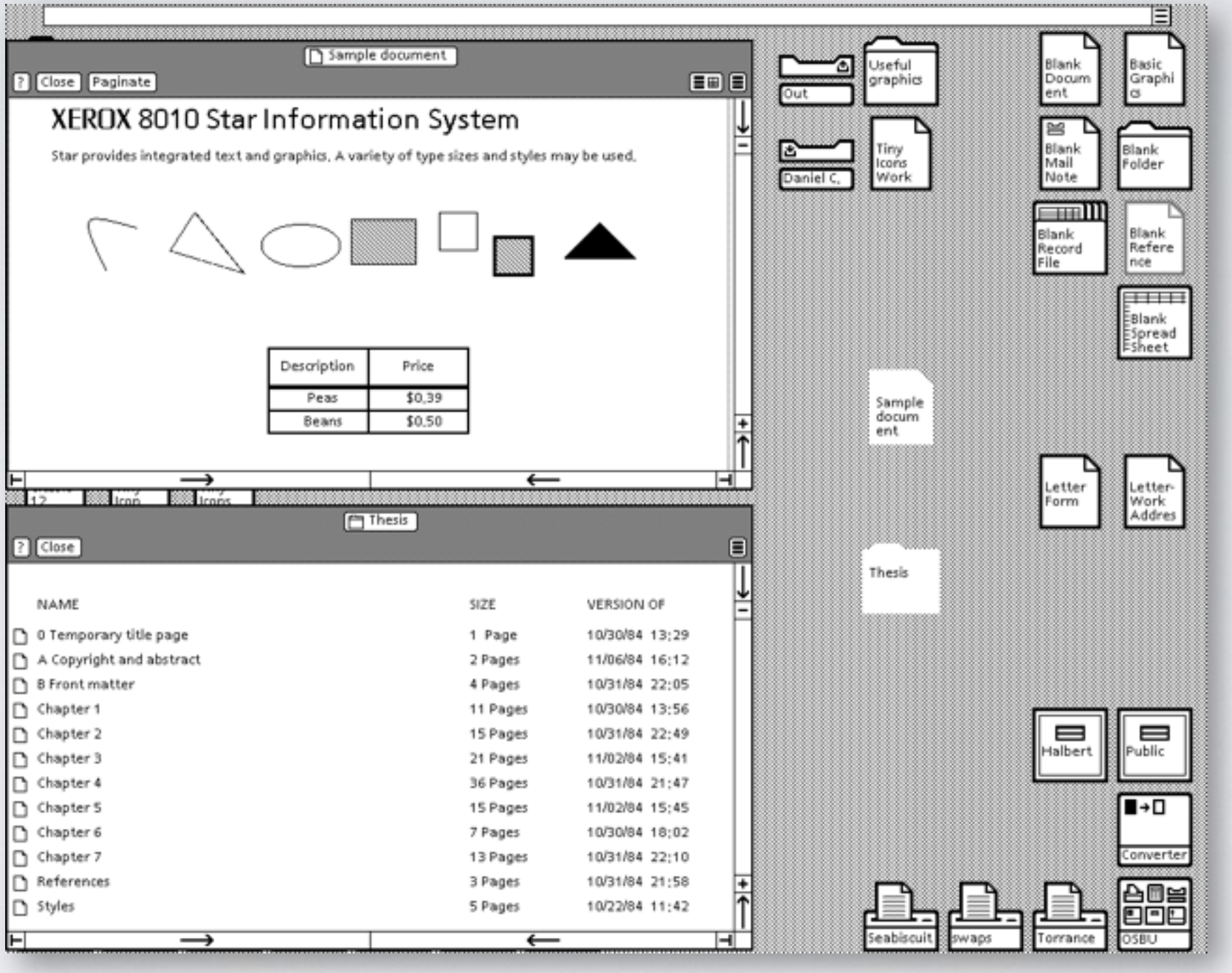
MIXED METAPHOR



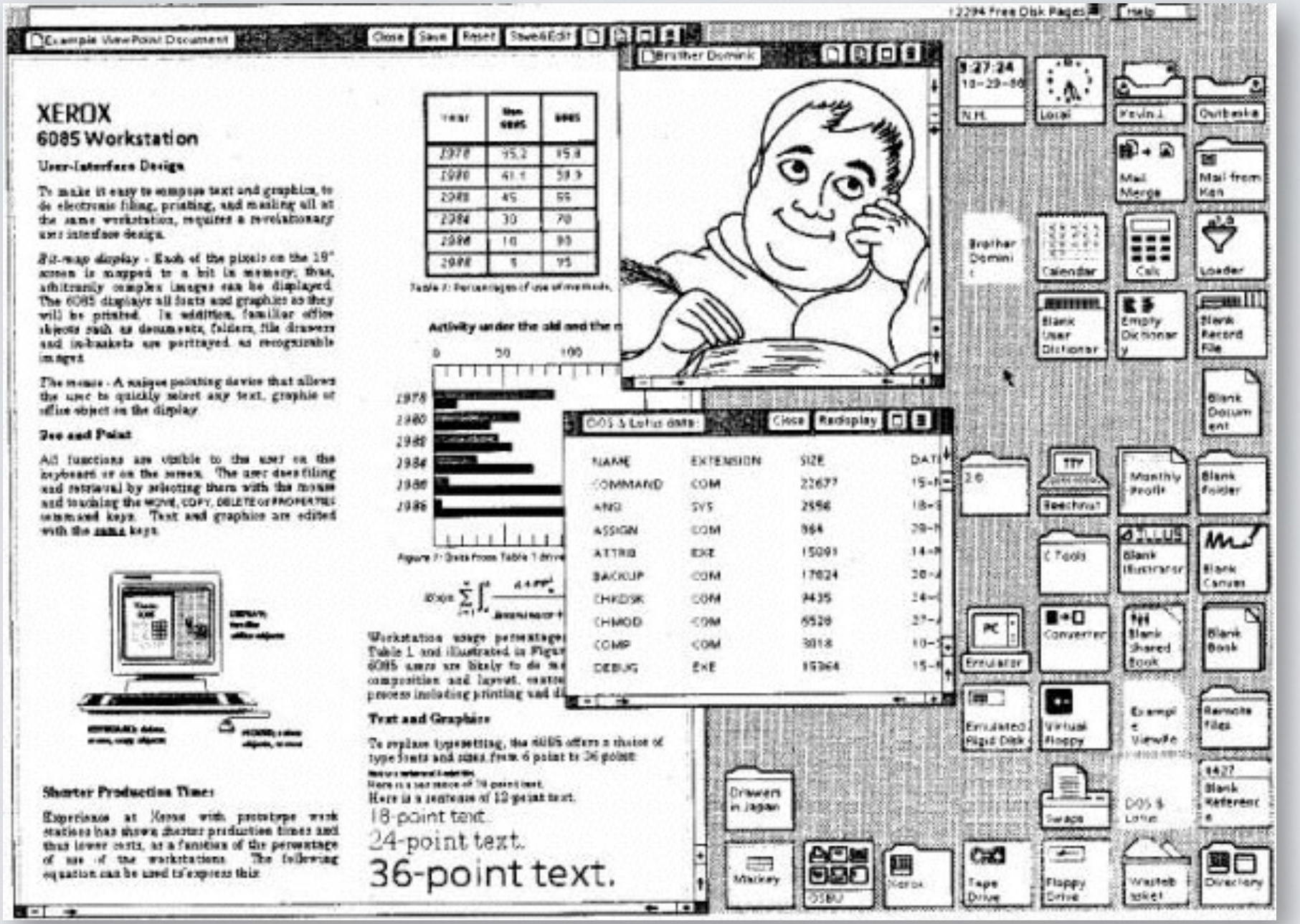


XEROX STAR (1979)

STAR SCREEN

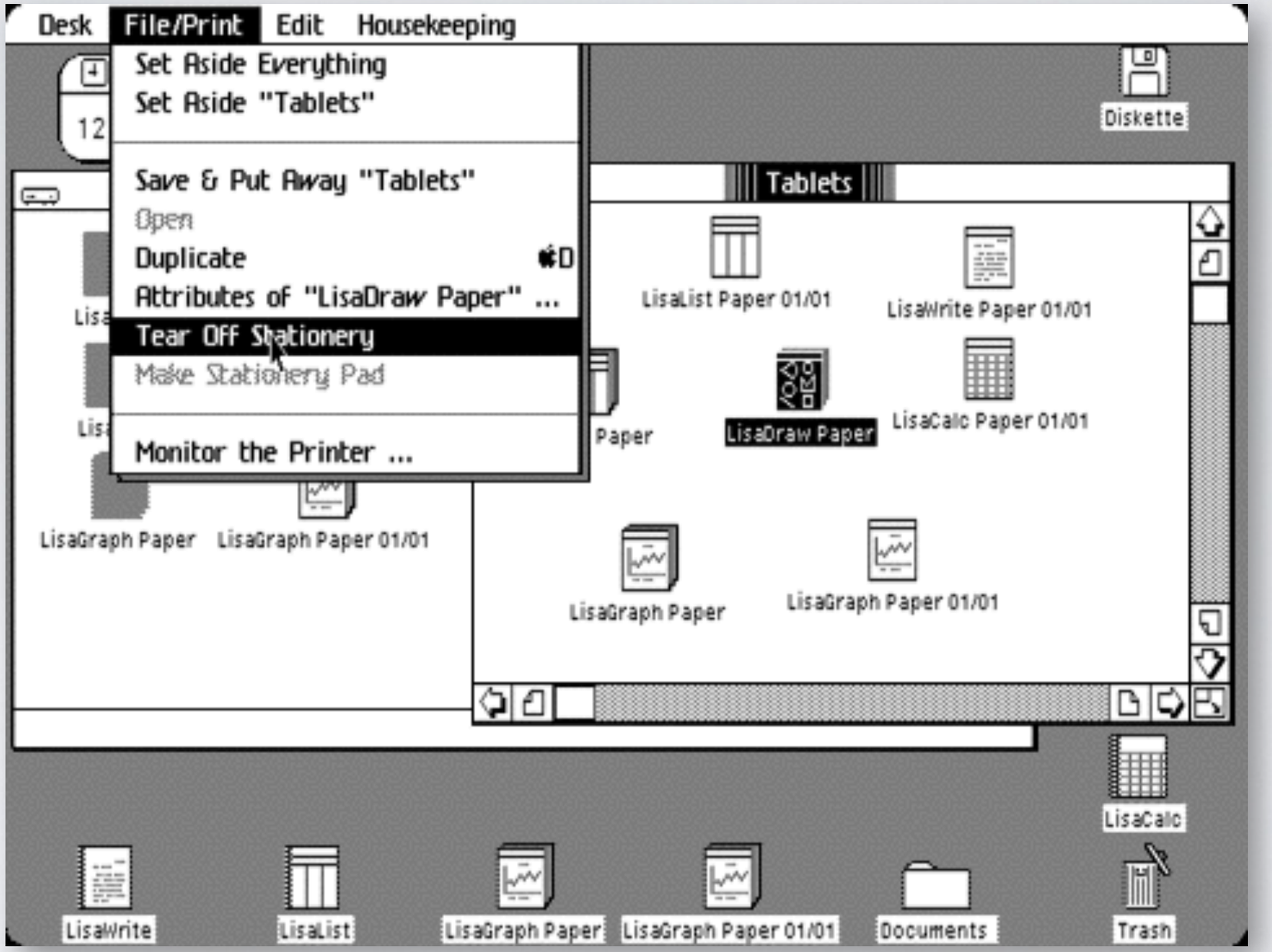

Sample document
? Close Paginate
XEROX 8010 Star Information System
Star provides integrated text and graphics. A variety of type sizes and styles may be used.
Description
Price
Peas
$0.39
Beans
$0.50
Thesis
? Close
NAME
SIZE
VERSION OF
0 Temporary title page
1 Page
10/30/84 13:29
A Copyright and abstract
2 Pages
11/06/84 16:12
B Front matter
4 Pages
10/31/84 22:05
Chapter 1
11 Pages
10/30/84 13:56
Chapter 2
15 Pages
10/31/84 22:49
Chapter 3
21 Pages
11/02/84 15:41
Chapter 4
36 Pages
10/31/84 21:47
Chapter 5
15 Pages
11/02/84 15:45
Chapter 6
7 Pages
10/30/84 18:02
Chapter 7
13 Pages
10/31/84 22:10
References
3 Pages
10/31/84 21:58
Styles
5 Pages
10/22/84 11:42
Out
Useful graphics
Daniel C.
Tiny Icons Work
Blank Document
Basic Graphics
Blank Mail Note
Blank Folder
Blank Record File
Blank Reference
Blank Spread Sheet
Sample document
Letter Form
Letter-Work Addres
Thesis
Halbert
Public
Converter
Seabiscuit
swaps
Torrance
OSBU

STAR SCREEN

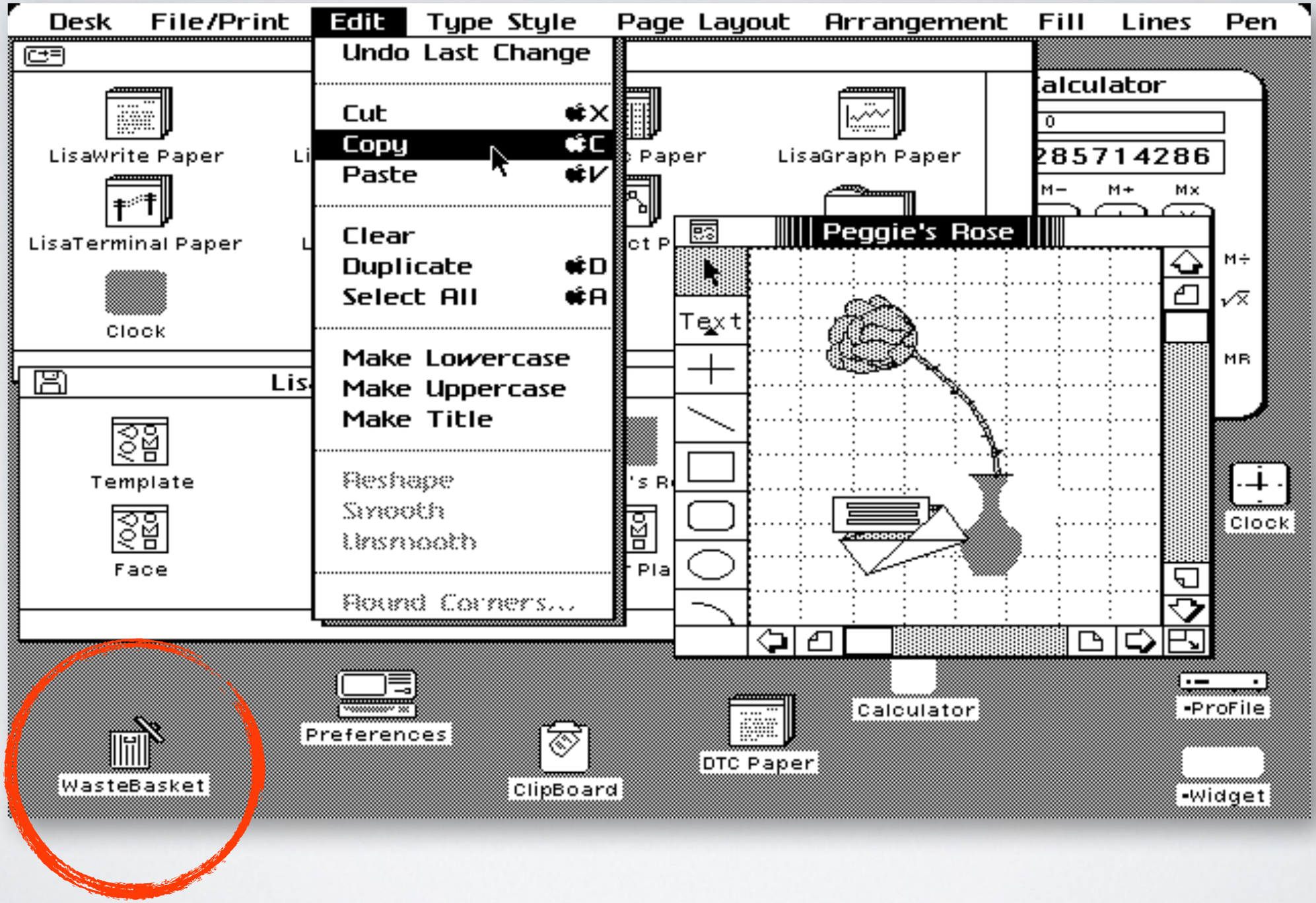

Example ViewPoint Document
Close
Save
Reset
Shell&Edit
XEROX
6085 Workstation
User-Interface Design
To make it easy to compose text and graphics, to do electronic filing, printing, and mailing all at the same workstation, requires a revolutionary user interface design.
Bit-map display - Each of the pixels on the 19" screen is mapped to a bit in memory; thus, arbitrarily complex images can be displayed. The 6085 displays all fonts and graphics as they will be printed. In addition, familiar office objects such as documents, folders, file drawers and in-baskets are portrayed as recognizable images.
The mouse - A unique pointing device that allows the user to quickly select any text, graphic or office object on the display.
See and Point
All functions are visible to the user on the keyboard or on the screen. The user does filing and retrieval by selecting them with the mouse and touching the MOVE, COPY, DELETE or PROPERTIES command keys. Text and graphics are edited with the same keys.
Shorter Production Times
Experience at Xerox with prototype work stations has shown shorter production times and thus lower costs, as a function of the percentage of use of the workstations. The following equation can be used to express this:
Text and Graphics
To replace typewriting, the 6085 offers a choice of type fonts and sizes from 6 point to 36 point:
Here is a sentence of 12-point text.
18-point text.
24-point text.
36-point text.
Brother Domini
DOS & Lotus data:
Close
Redisplay
NAME
EXTENSION
SIZE
COMMAND
COM
22677
ANG
SYS
2598
ASSIGN
COM
984
ATTRIB
EXE
15091
BACKUP
COM
17824
CHKDSK
COM
9435
CHMOD
COM
6528
COMP
COM
9818
DEBUG
EXE
16364
12294 Free Disk Pages
Help
Local
Kevin J.
Outbasks
Mail Merge
Mail from Ken
Calendar
Calc
Loader
Blank User Dictionar
Empty Dictionar y
Blank Record File
Blank Docum ent
Monthly Profit
Blank Folder
C Tools
Blank Illustrator
Blank Canvas
Converter
Blank Shared Book
Blank Book
Emulated Rigid Disk
Virtual Floppy
Remote files
Drawers in Japan
Swaps
Blank Referenc e
Tape Drive
Floppy Drive
Wastebasket
Directory

APPLE LISA (1983)

LISA SCREEN

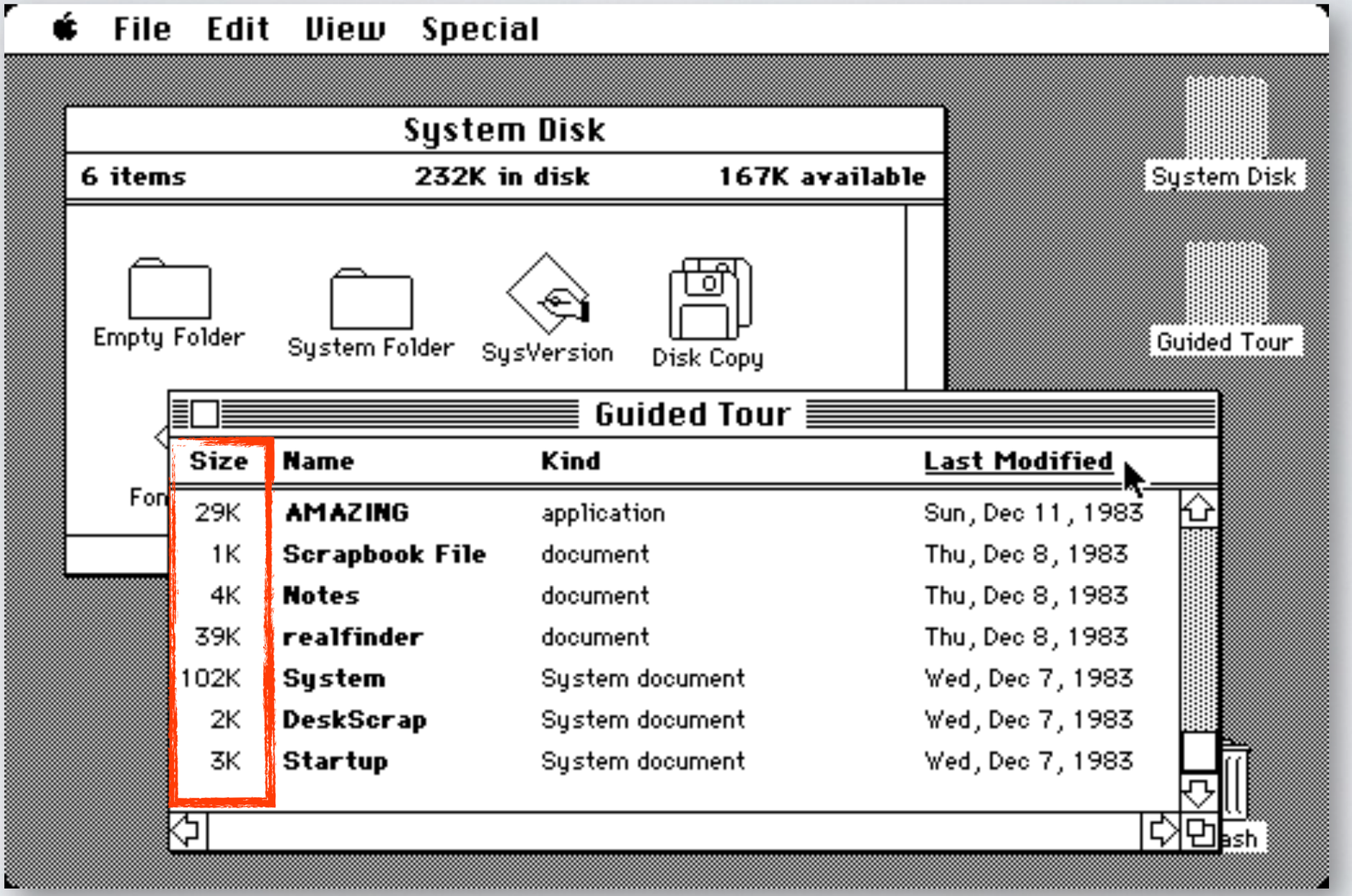

Desk
File/Print
Edit
Housekeeping
Set Aside Everything
Set Aside "Tablets"
Save & Put Away "Tablets"
Open
Duplicate ⌘D
Attributes of "LisaDraw Paper" ...
Tear Off Stationery
Make Stationery Pad
Monitor the Printer ...
Diskette
Tablets
LisaList Paper 01/01
LisaWrite Paper 01/01
LisaDraw Paper
LisaCalc Paper 01/01
Paper
LisaGraph Paper
LisaGraph Paper 01/01
LisaGraph Paper
LisaGraph Paper 01/01
LisaCalc
LisaWrite
LisaList
LisaGraph Paper
LisaGraph Paper 01/01
Documents
Trash

LISA DRAW

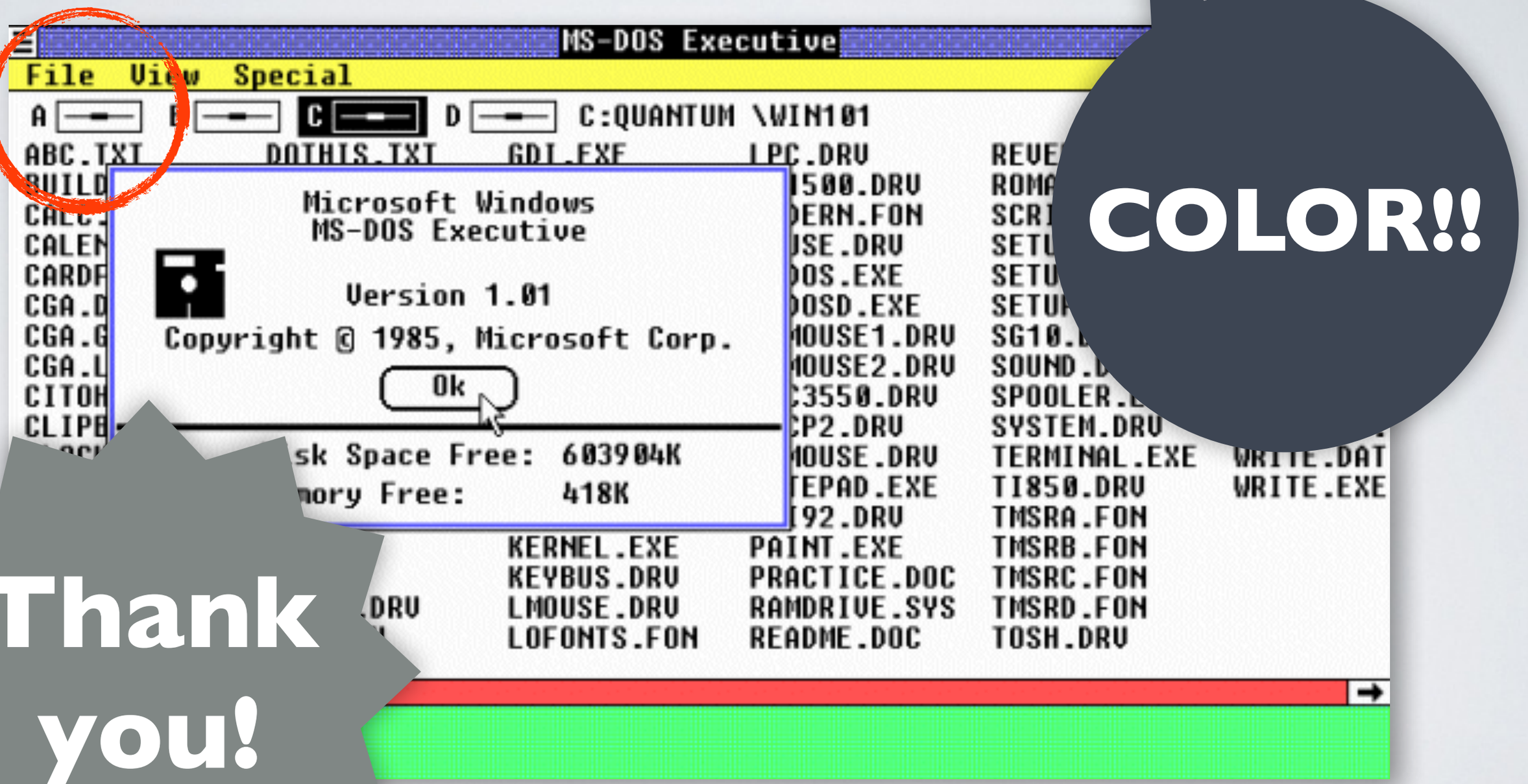

Desk
File/Print
Edit
Type Style
Page Layout
Arrangement
Fill
Lines
Pen
Undo Last Change
Cut ⌘X
Copy ⌘C
Paste ⌘V
Clear
Duplicate ⌘D
Select All ⌘A
Make Lowercase
Make Uppercase
Make Title
Reshape
Smooth
Unsmooth
Round Corners...
LisaWrite Paper
LisaTerminal Paper
Clock
Template
Face
LisaGraph Paper
Peggie's Rose
Text
Calculator
0
285714286
M−
M+
Mx
M÷
√x
MR
Clock
WasteBasket
Preferences
ClipBoard
DTC Paper
Calculator
ProFile
Widget

MACINTOSH (1984)

MACINTOSH SCREEN



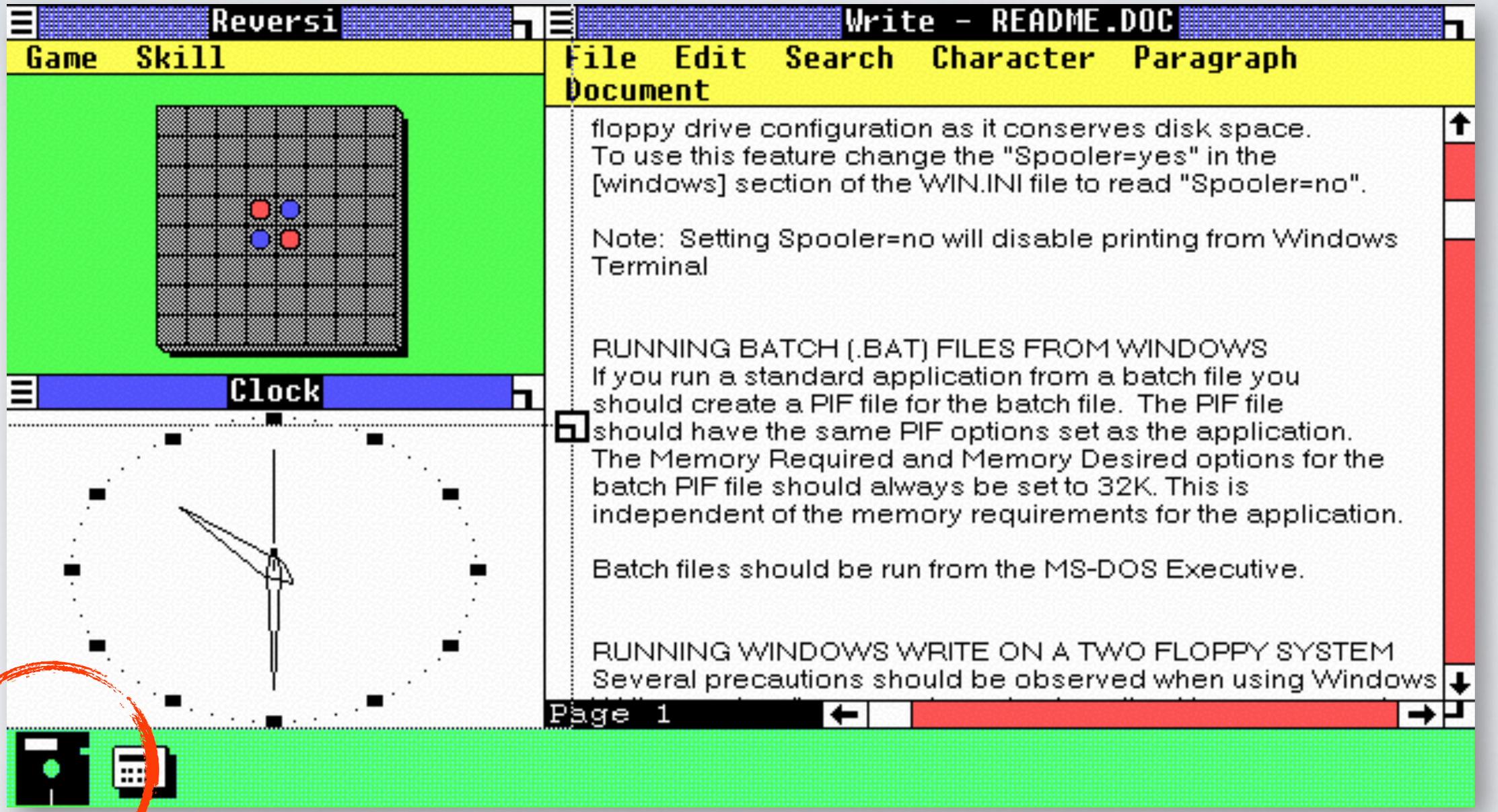
WINDOWS 1.0 (1985)



COLOR!!

Thank you!

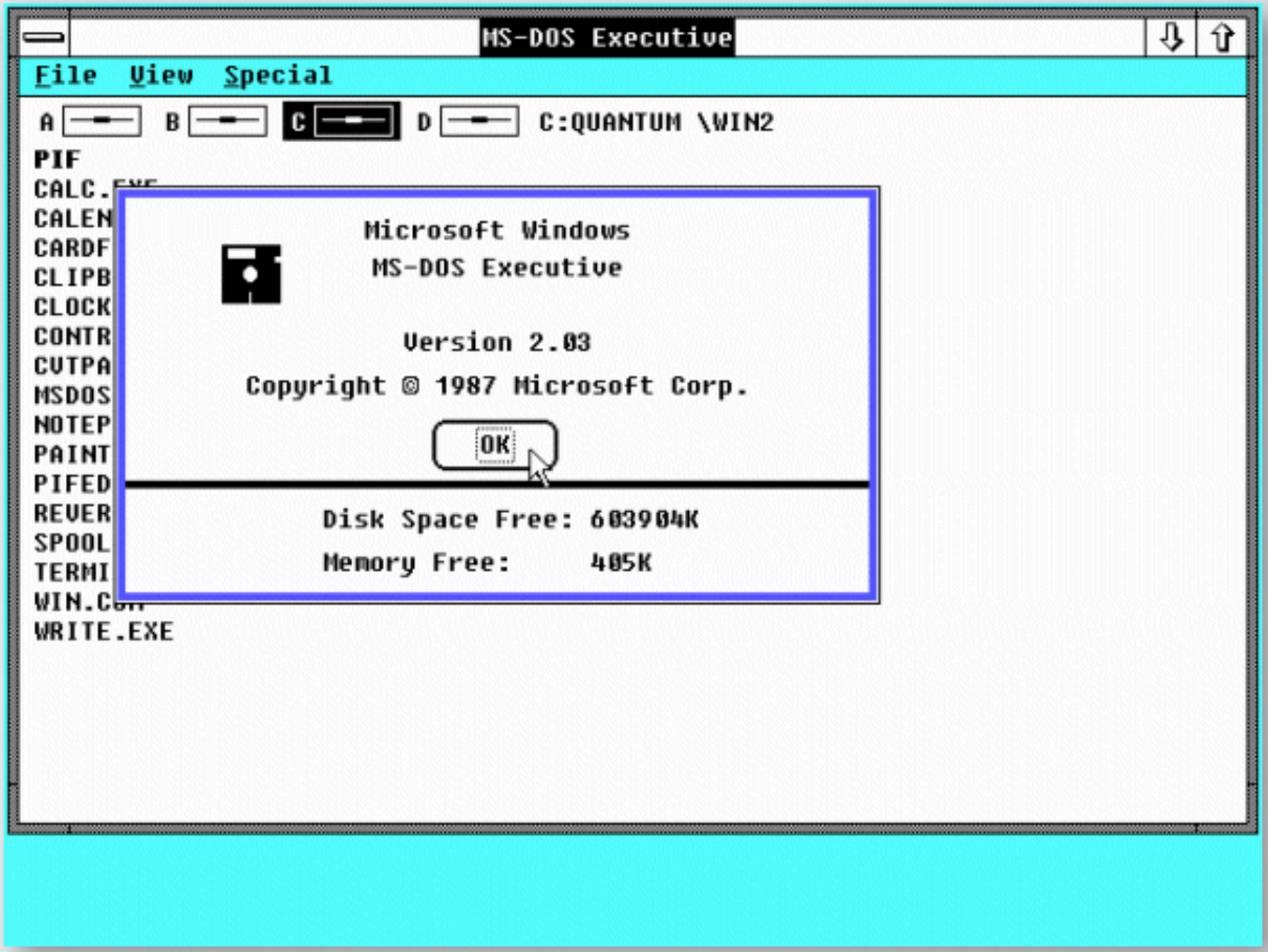
WINDOWS 1.0


Reversi
Game Skill
Clock
Write - README.DOC
File Edit Search Character Paragraph Document
floppy drive configuration as it conserves disk space.
To use this feature change the "Spooler=yes" in the
[windows] section of the WIN.INI file to read "Spooler=no".
Note: Setting Spooler=no will disable printing from Windows Terminal
RUNNING BATCH (.BAT) FILES FROM WINDOWS
If you run a standard application from a batch file you should create a PIF file for the batch file. The PIF file should have the same PIF options set as the application. The Memory Required and Memory Desired options for the batch PIF file should always be set to 32K. This is independent of the memory requirements for the application.
Batch files should be run from the MS-DOS Executive.
RUNNING WINDOWS WRITE ON A TWO FLOPPY SYSTEM
Several precautions should be observed when using Windows
Page 1

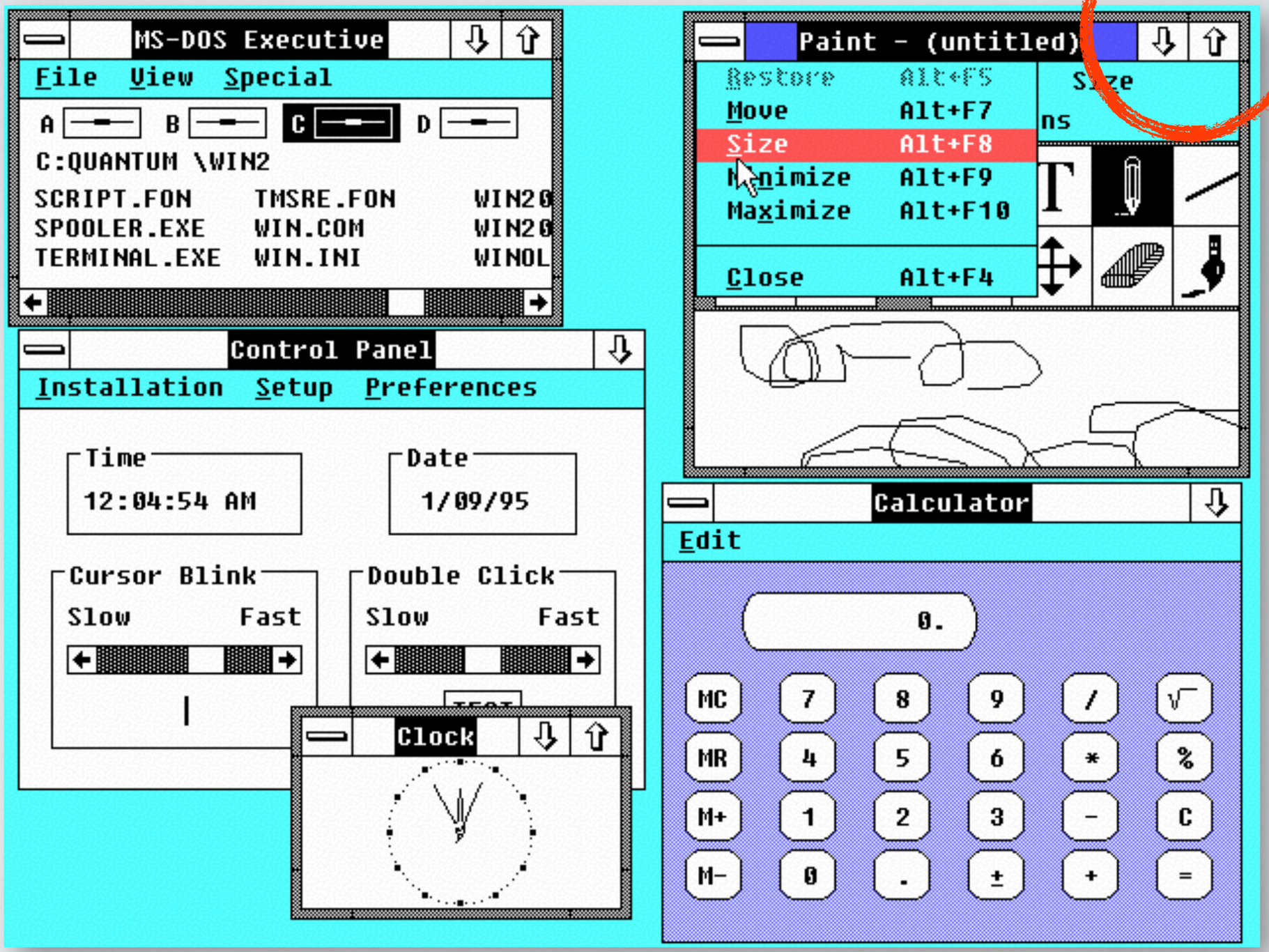
WINDOWS 1.0

Clipboard
Text
56339
Calculator
Edit
Copy F2
Paste Ins
56339
MC 7 8 9 / √
MR 4 5 6 * %
M+ 1 2 3 - C
M- 0 . ± + =

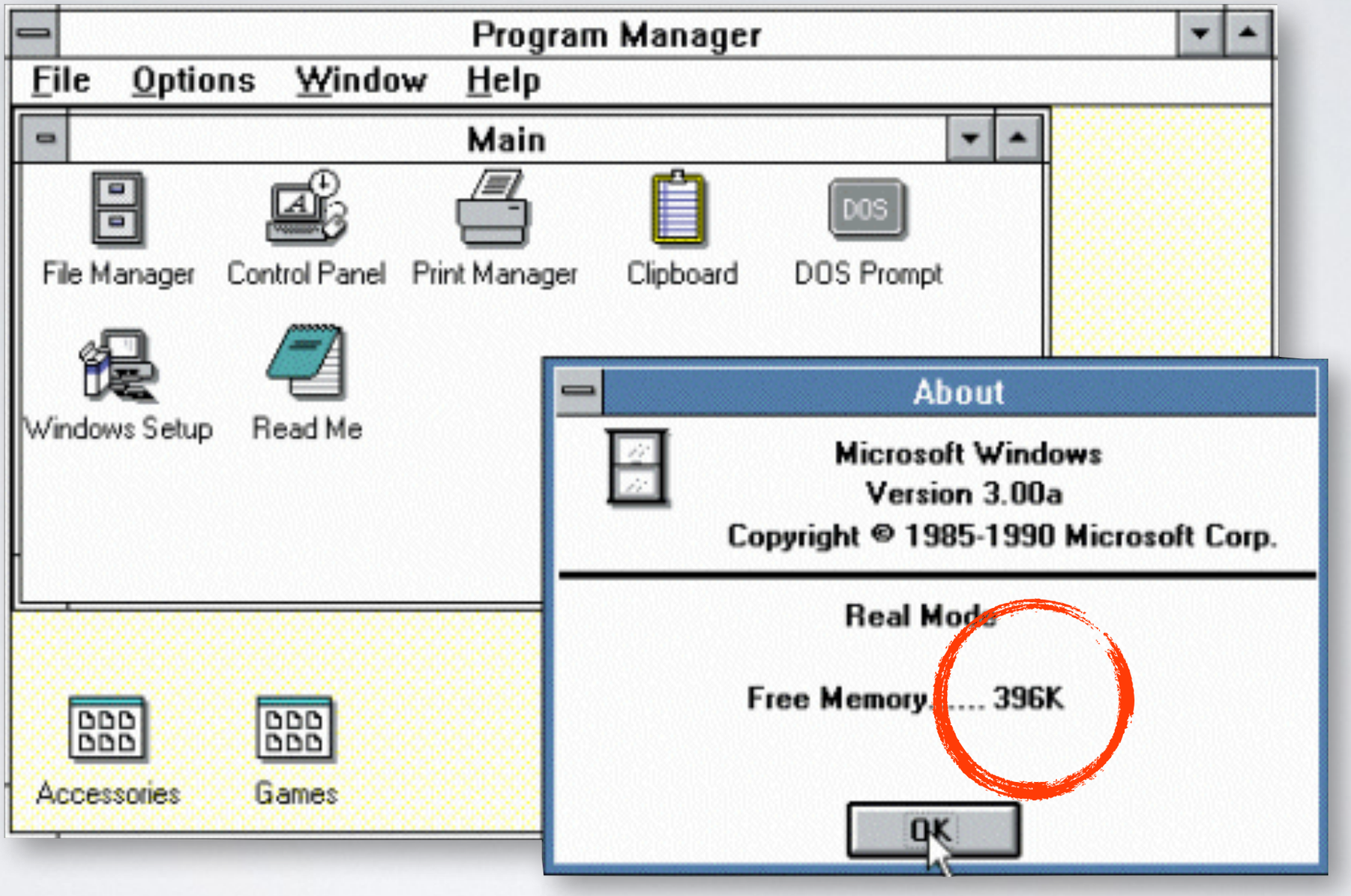
WINDOWS 2.0 (1987)



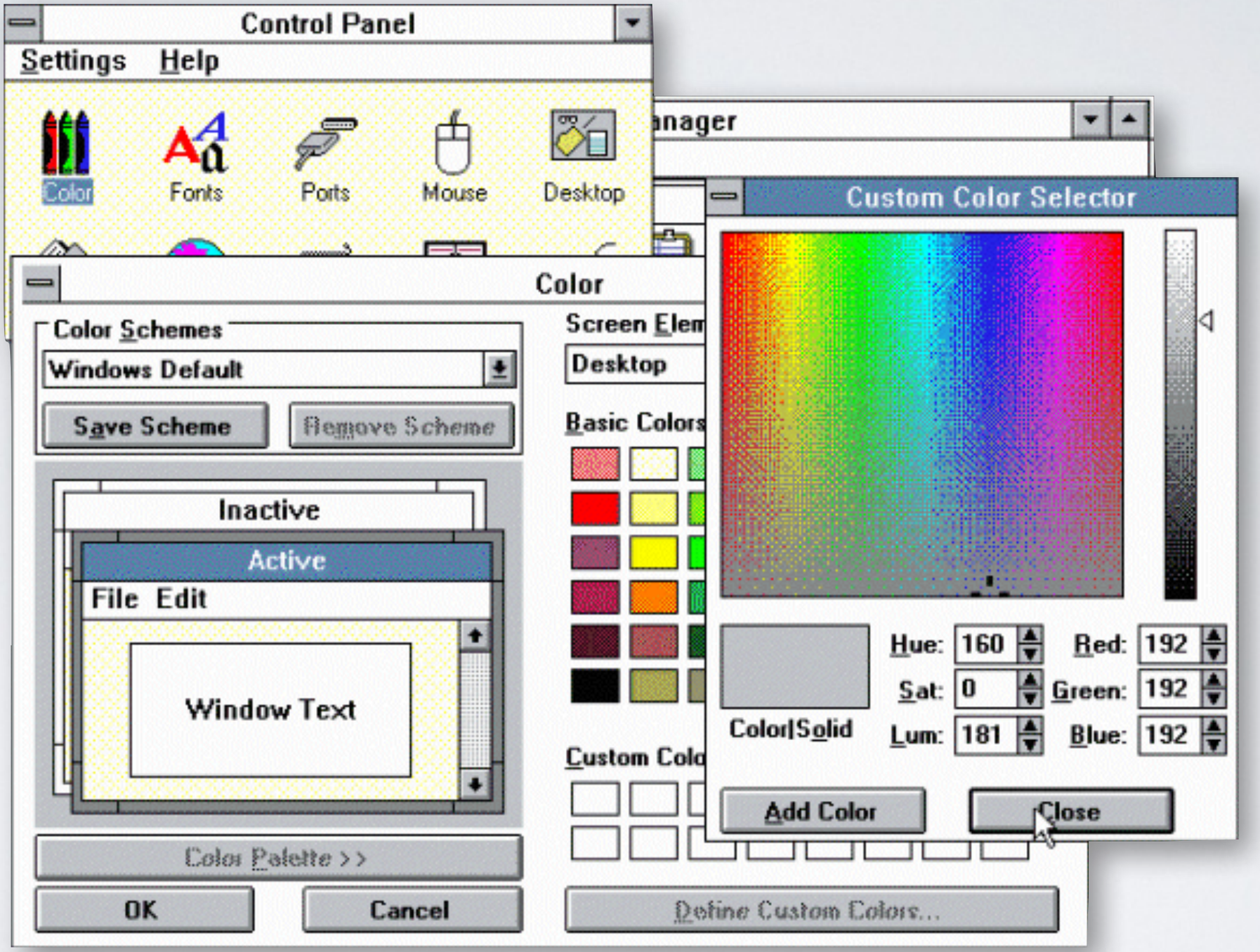
WINDOWS 2.0


MS-DOS Executive
File View Special
A B C D
C:QUANTUM \WIN2
SCRIPT.FON TMSRE.FON WIN20
SPOOLER.EXE WIN.COM WIN20
TERMINAL.EXE WIN.INI WINOL
Control Panel
Installation Setup Preferences
Time
12:04:54 AM
Date
1/09/95
Cursor Blink
Slow Fast
Double Click
Slow Fast
Clock
Paint - (untitled)
Restore Alt+F5
Move Alt+F7
Size Alt+F8
Minimize Alt+F9
Maximize Alt+F10
Close Alt+F4
Calculator
Edit
0.
MC 7 8 9 / √
MR 4 5 6 * %
M+ 1 2 3 - C
M- 0 . ± + =

WINDOWS 3.0 (1990)



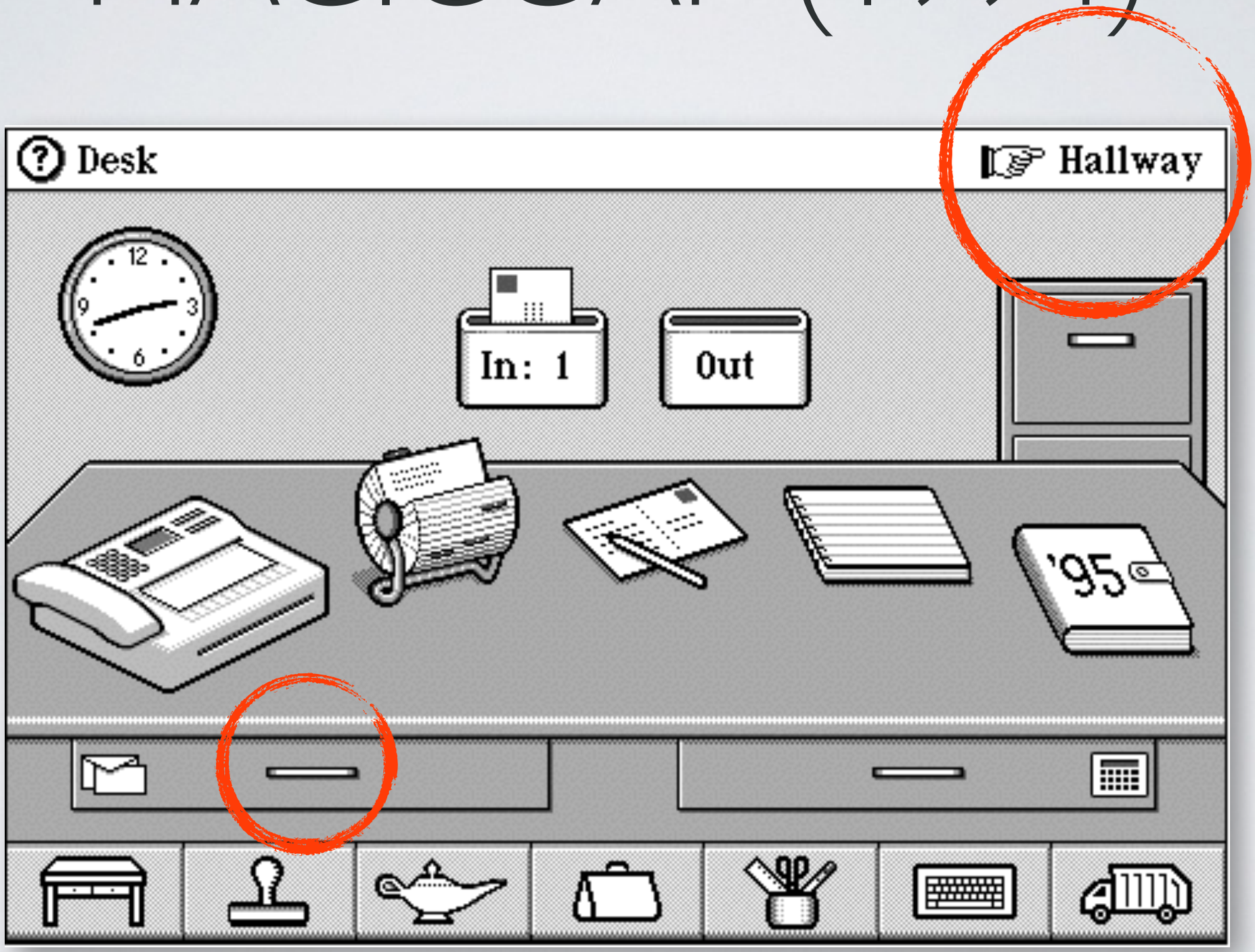
WINDOWS 3.0


Control Panel
Settings Help
Color
Fonts
Ports
Mouse
Desktop
anager
Color
Color Schemes
Windows Default
Save Scheme
Remove Scheme
Screen Elem
Desktop
Basic Colors
Inactive
Active
File Edit
Window Text
Custom Colo
Color Palette >>
OK
Cancel
Define Custom Colors...
Custom Color Selector
Color|Solid
Hue: 160
Sat: 0
Lum: 181
Red: 192
Green: 192
Blue: 192
Add Color
Close

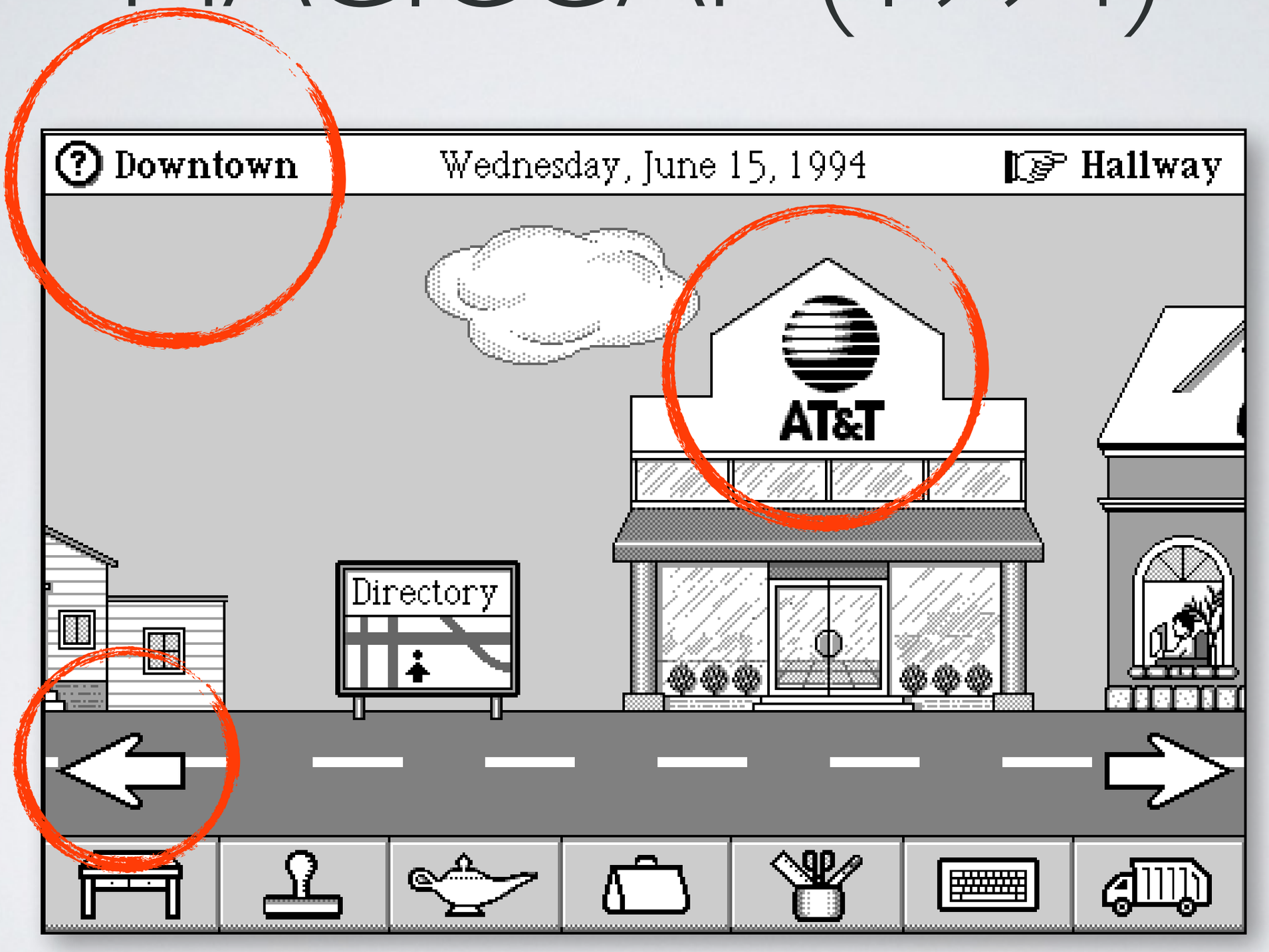
WINDOWS 3.0

Solitaire
Game Help
Reversi
Game Skill Help
Program Manager
1:21:25
Thank you!

MAGICCAP (1994)



MAGICCAP (1994)



MICROSOFT BOB (1995)

PROBLEMS W/ METAPHORS

Metaphors can be powerful and make interfaces easier to learn, but . . .

They can **limit designers' creativity**.

They can reduce the advantages of software.

If they are shallow, inappropriate, or mixed they can be **misleading** more than helpful.

They can be overly "cute" at the expense of functional.

They can be **culturally specific**.

They can result in **slower interactions or performance**.

DESIGN ELEMENTS

Metaphors √

Modes

Affordances

Constraints

Mappings

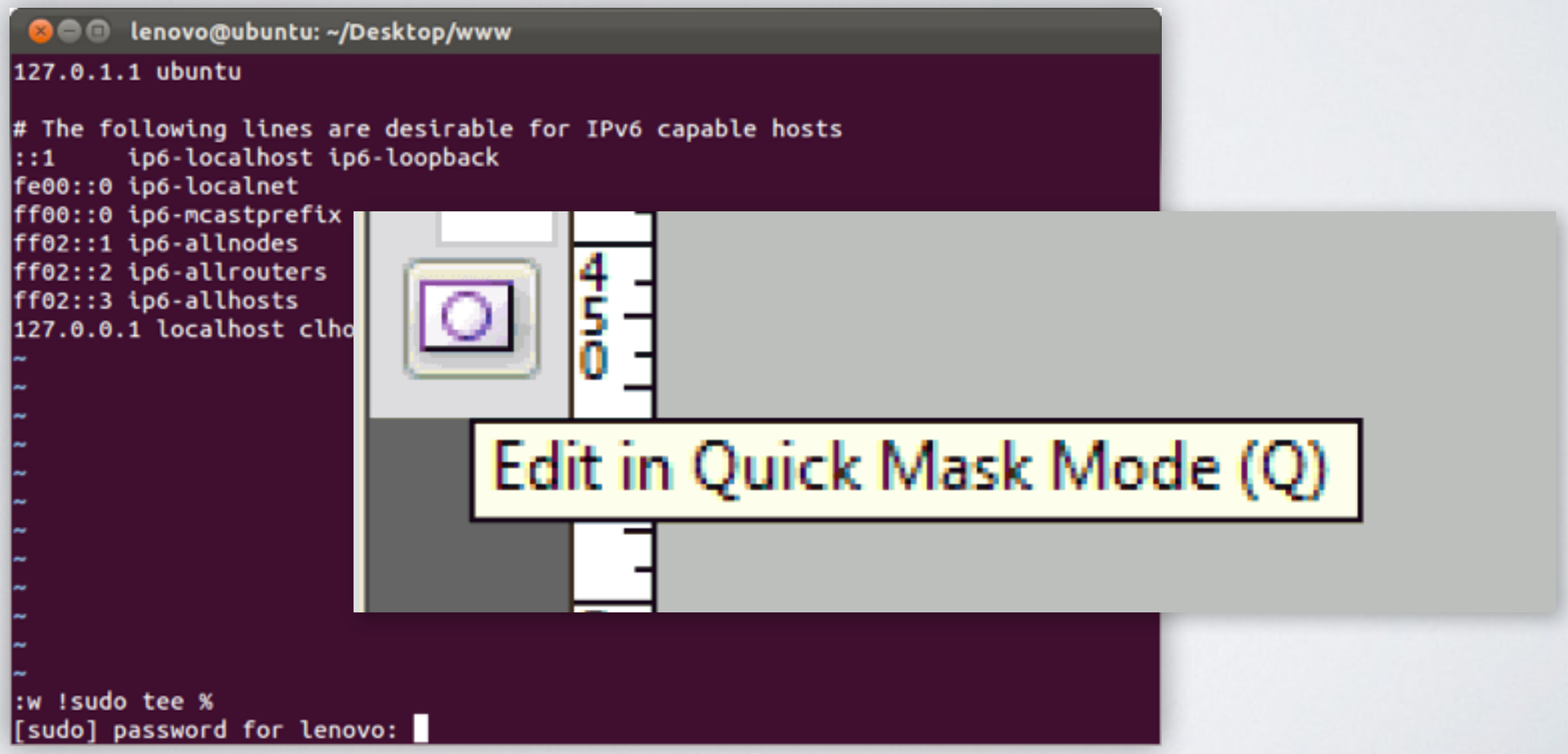
Prior experiences

MODES

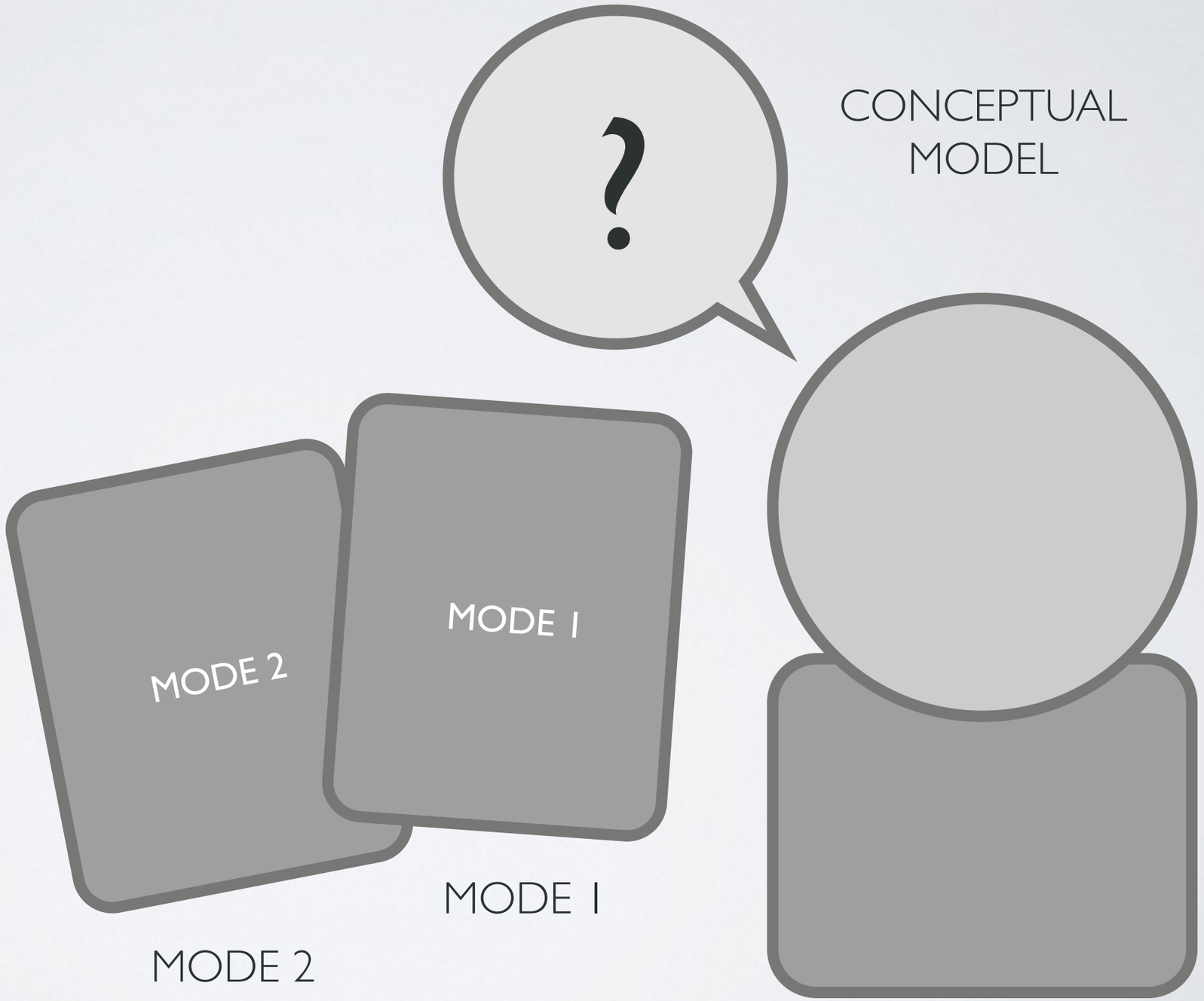
WHAT ARE MODES?

Modes are "**switches**" that change the state of an interactive system such that the same actions have different effects.

What are some examples?



MODES & MODELS



EXAMPLES

CAPS LOCK

“Why is it needed? I'm always hitting it by accident… The keyboard is the most bizarre, ridiculous, non-designed monstrosity foisted on the American public. We've put huge amounts of effort into the design of things you see on the screen, but the keyboard seems handed down by God – and it's an evil god.”

— *Don Norman*

ACTIVE VS. PASSIVE MODES

An **active mode** is one that requires constant action to maintain. Once that action has retired, so does the mode.

E.g., Shift.

A **passive mode** is one that requires action to set, and requires a separate action to unset, or to set again.

E.g., CAPS LOCK.

Generally, active modes are preferred. Why?

What are drawbacks of passive modes?

What are drawbacks of active modes?

USE OF MODES

Modes are often discouraged. But when are they useful?

When the means for control are outnumbered by the number of necessary outcomes.

Imagine a keyboard with distinct keys for lowercase and capital letters.

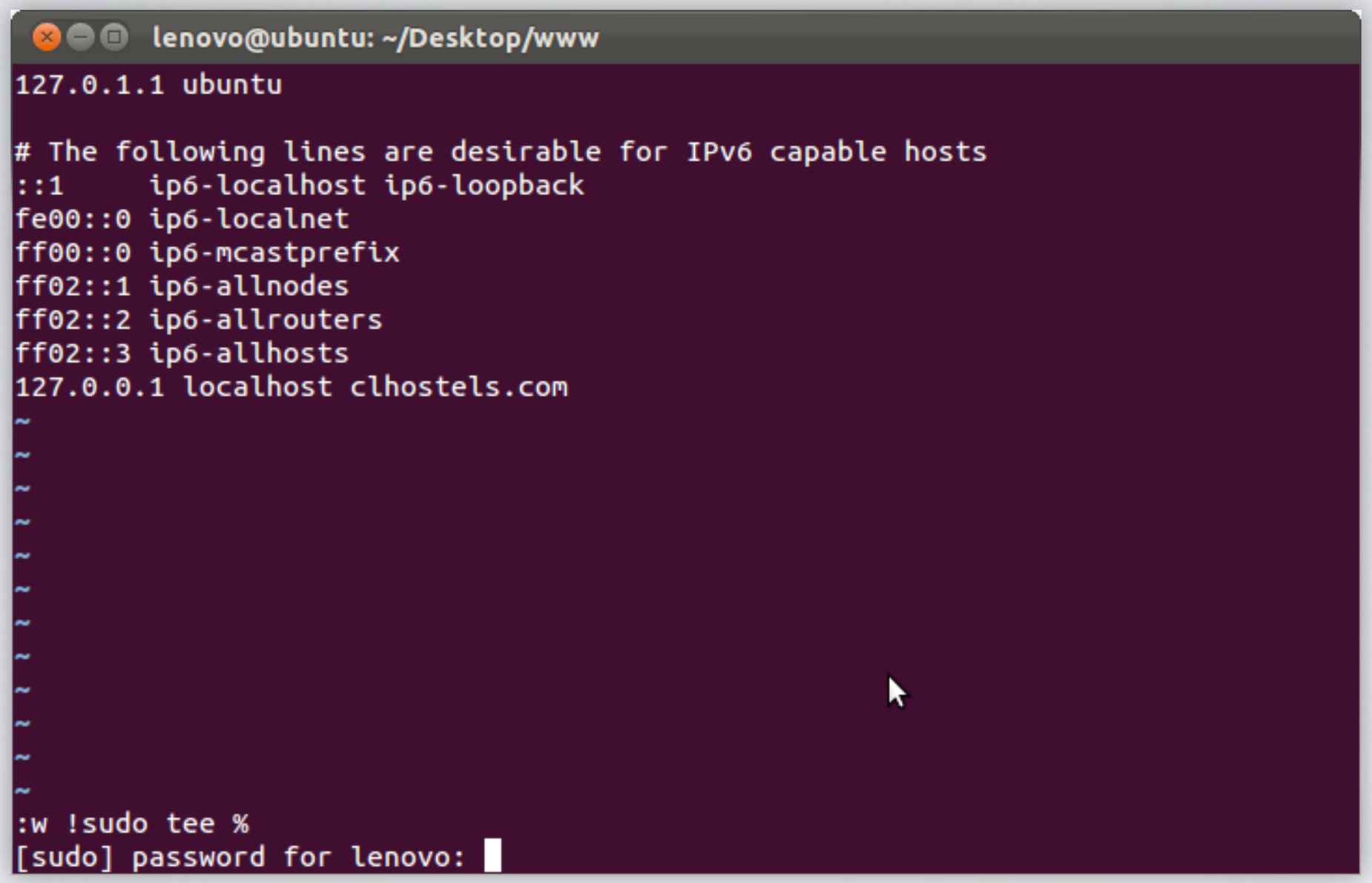
If you are going to have a mode, it is imperative that its status and activation are **visible**.

Modes in command line interfaces are dangerous for this reason.

Modes should be **invertible**.

If I can get to mode B from mode A, I should be able to get back to mode A from mode B, ideally with the same action (e.g., toggle).

VI


lenovo@ubuntu: ~/Desktop/www
127.0.1.1 ubuntu
The following lines are desirable for IPv6 capable hosts
::1 ip6-localhost ip6-loopback
fe00::0 ip6-localnet
ff00::0 ip6-mcastprefix
ff02::1 ip6-allnodes
ff02::2 ip6-allrouters
ff02::3 ip6-allhosts
127.0.0.1 localhost clhostels.com
:w !sudo tee %
[sudo] password for lenovo:

VI

Thank you!

VI "Cheat" Sheet
ACNS Bulletin ED–03
February 1995

vi Editor "Cheat Sheet"

Invoking vi: vi *filename*

Format of vi commands: *[count][command]* (count repeats the effect of the command)

Command mode versus input mode

Vi starts in command mode. The positioning commands operate only while vi is in command mode. You switch vi to input mode by entering any one of several vi input commands. (See next section.) Once in input mode, any character you type is taken to be text and is added to the file. You cannot execute any commands until you exit input mode. To exit input mode, press the escape (**Esc**) key.

Input commands (end with Esc)

a	Append after cursor
i	Insert before cursor
o	Open line below
O	Open line above
:r *file*	Insert *file* after current line

Any of these commands leaves vi in input mode until you press **Esc**. Pressing the **RETURN** key will not take you out of input mode.

File management commands

:w *name*	Write edit buffer to file *name*
:wq	Write to file and quit
:q!	Quit without saving changes
ZZ	Same as :wq
:sh	Execute shell commands (<ctrl>d)

Window motions

<ctrl>d	Scroll down (half a screen)
<ctrl>u	Scroll up (half a screen)
<ctrl>f	Page forward
<ctrl>b	Page backward
/string	Search forward
?string	Search backward
<ctrl>l	Redraw screen
<ctrl>g	Display current line number and file information
n	Repeat search

DESIGN ELEMENTS

Metaphors √

Modes √

Affordances

Constraints

Mappings

Prior experiences

Time to wake up!

Important

AFFORDANCES

AFFORDANCES

Ecological approach to psychology

> "The affordances of the environment are what it offers animals, what it provides or furnishes, for good or ill."

— J. J. Gibson (1977)

> "The term 'affordance' refers to **the perceived and actual properties** of the thing, primarily those fundamental properties that determine just **how the thing could possibly be used.**"

— Don Norman (1988)

IN OTHER WORDS

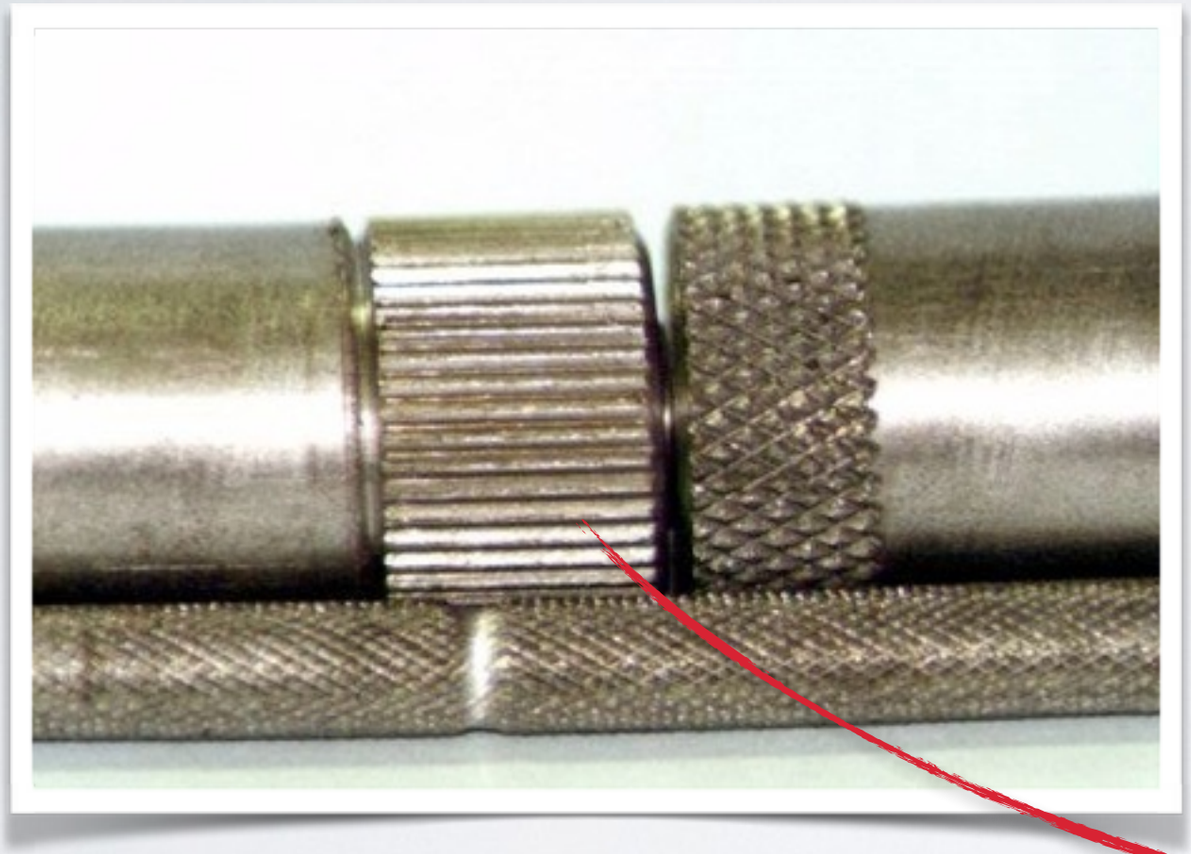
What does a thing communicate to people regarding how it can be used?

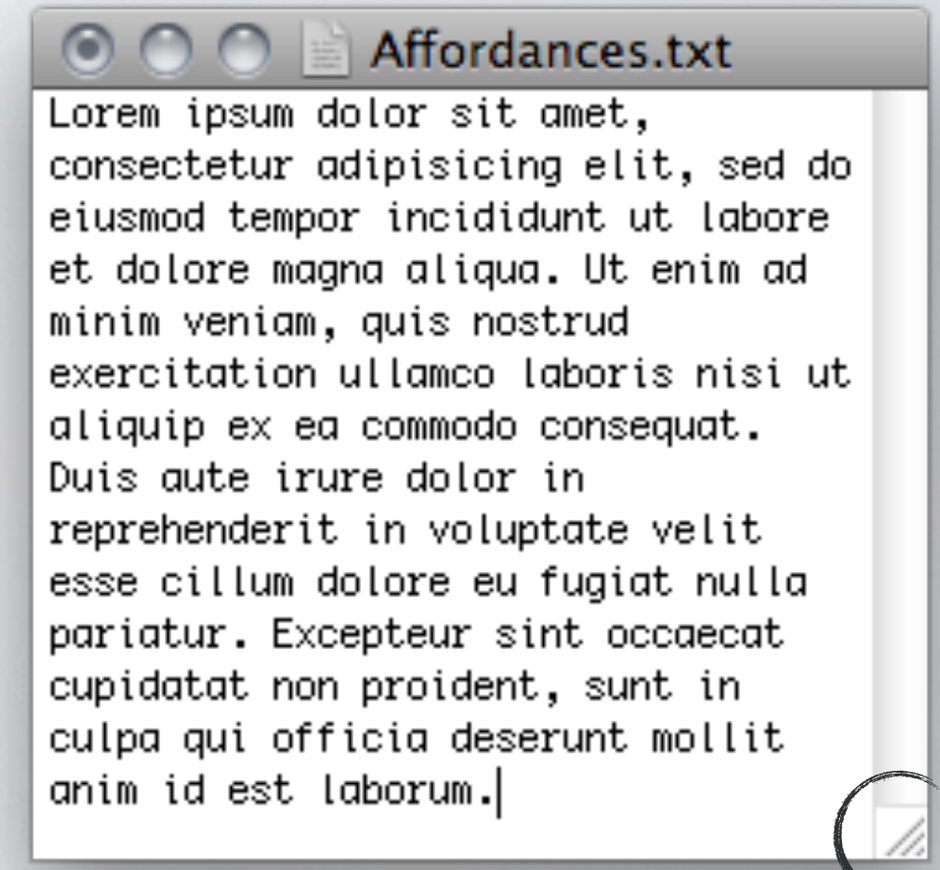
Often by **visual appearance**.

How a thing seems should tell us how the thing can be used.

Whether how it ***seems*** it can be used and how it ***actually*** must be used match is a design question.

AN EXAMPLE





Knurling provides a visual affordance for "gripping."

MORE DEFINITIONS

"People perceive the environment directly in terms of its **potentials for action**."

"An affordance of an object … refers to attributes of both the object and the actor."

"In general, **when the apparent affordances of an artifact matches its intended use, the artifact is easy to operate**. When apparent affordances suggest different actions than those for which the object is designed, errors are common."

— William Gaver (1991)

METAPHORS VS. AFFORDANCES

Metaphors are meant to "jump start" a user's conceptual model for a system.

Affordances are meant to "jump start" a user's conceptual model for interaction with an artifact in the environment.

I.e., "Metaphors" for low-level interaction.

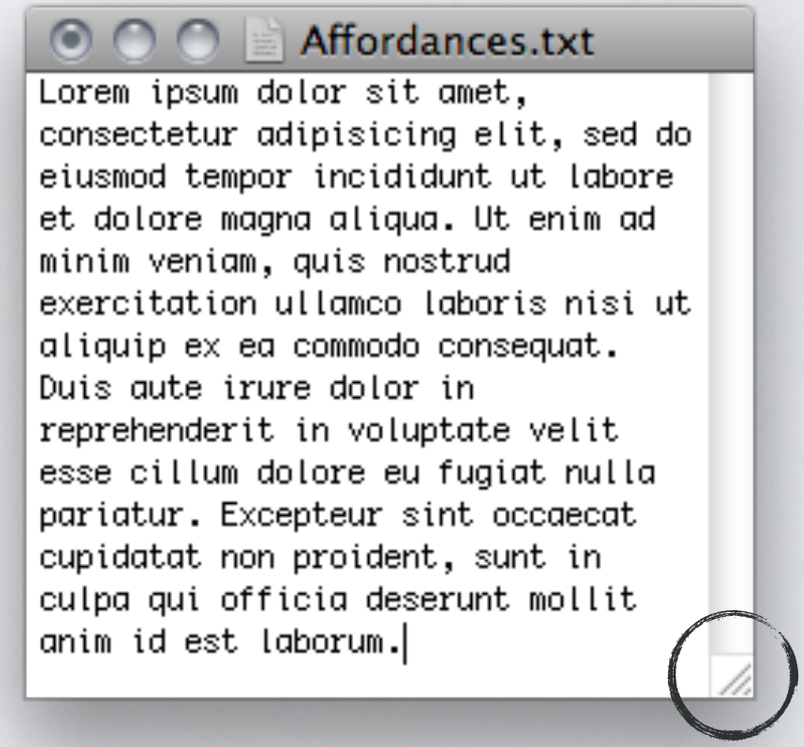
As with metaphors, if affordances are designed poorly, they can be damaging to a correct conceptual model.

DIFFERENT TYPES OF AFFORDANCE

PERCEPTIBLE AFFORDANCE

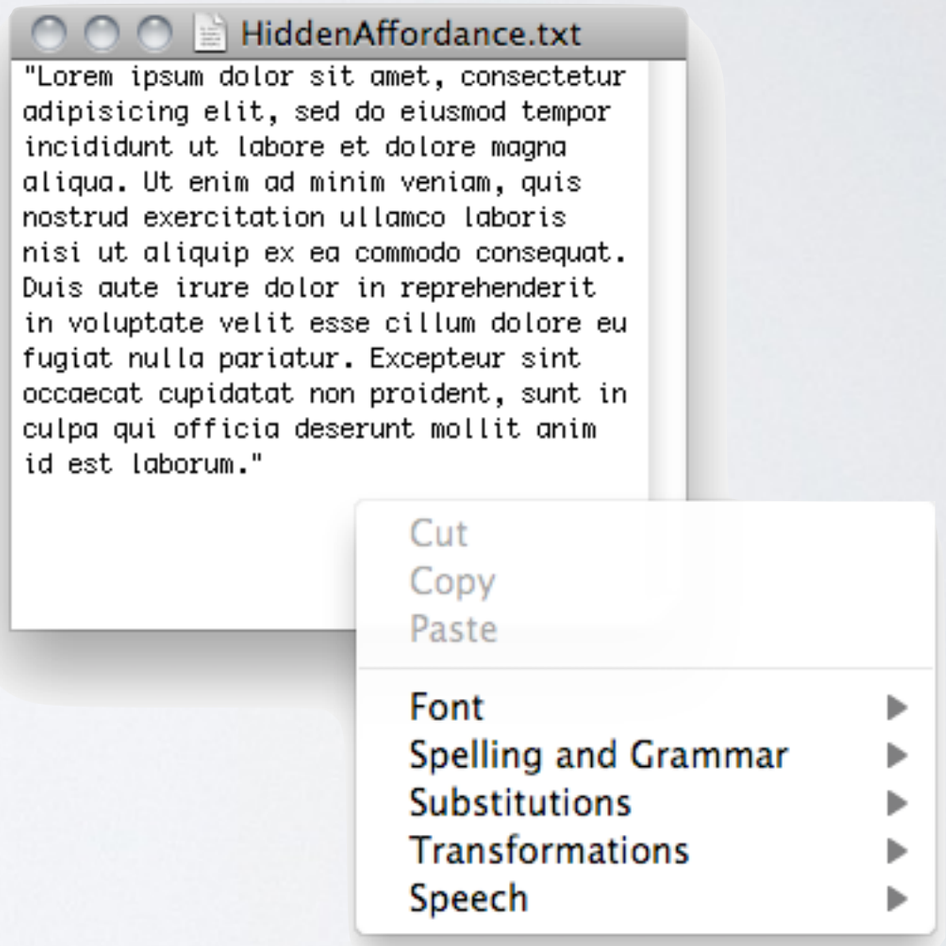
When there is perceptual information for an existing affordance.

Knurling in an example, assuming you can actually move and resize the window with it.



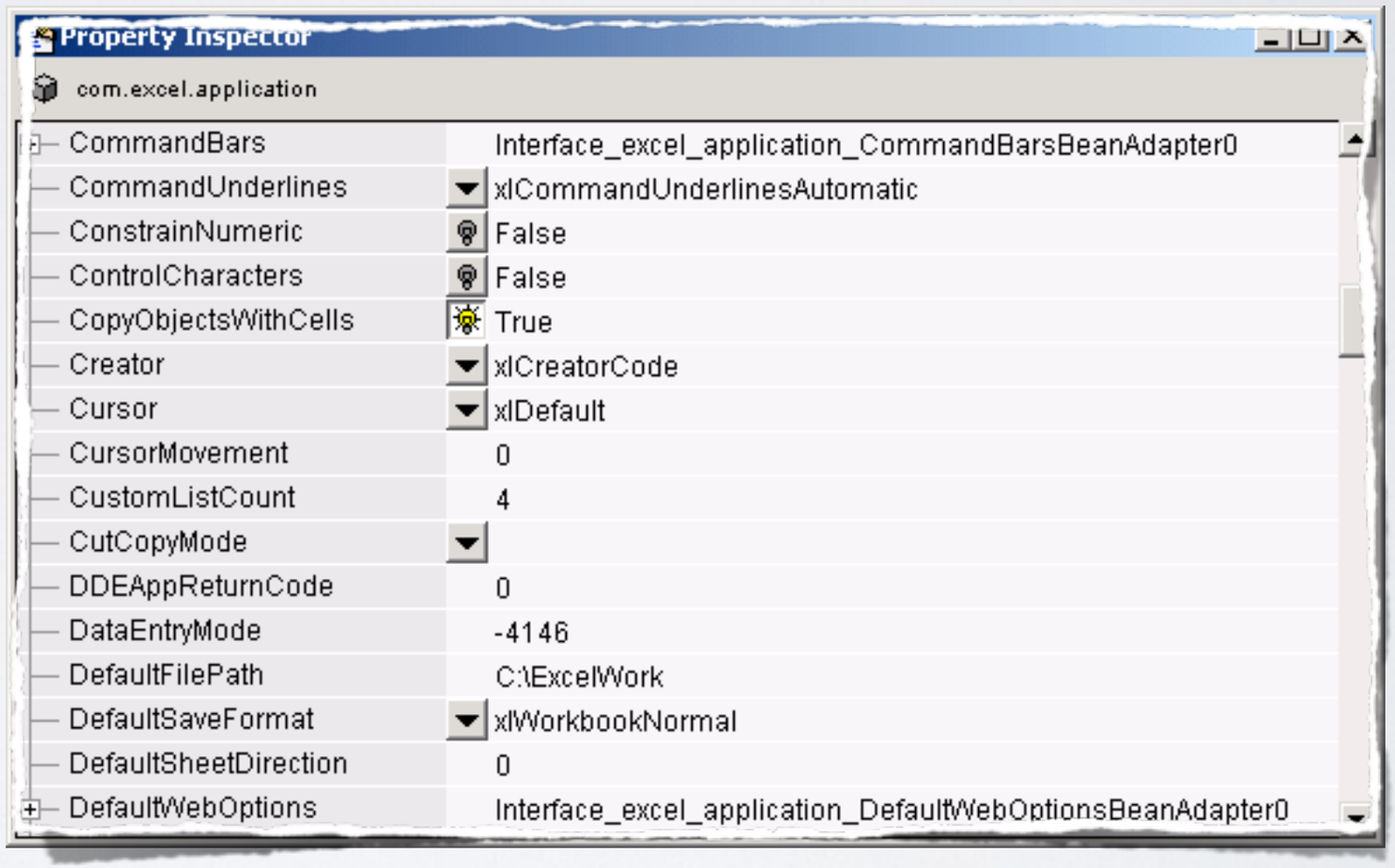
HIDDEN AFFORDANCE

When there is **not** perceptual information for an existing affordance.



FALSE AFFORDANCE

When there is perceptual information for an affordance that does not exist.



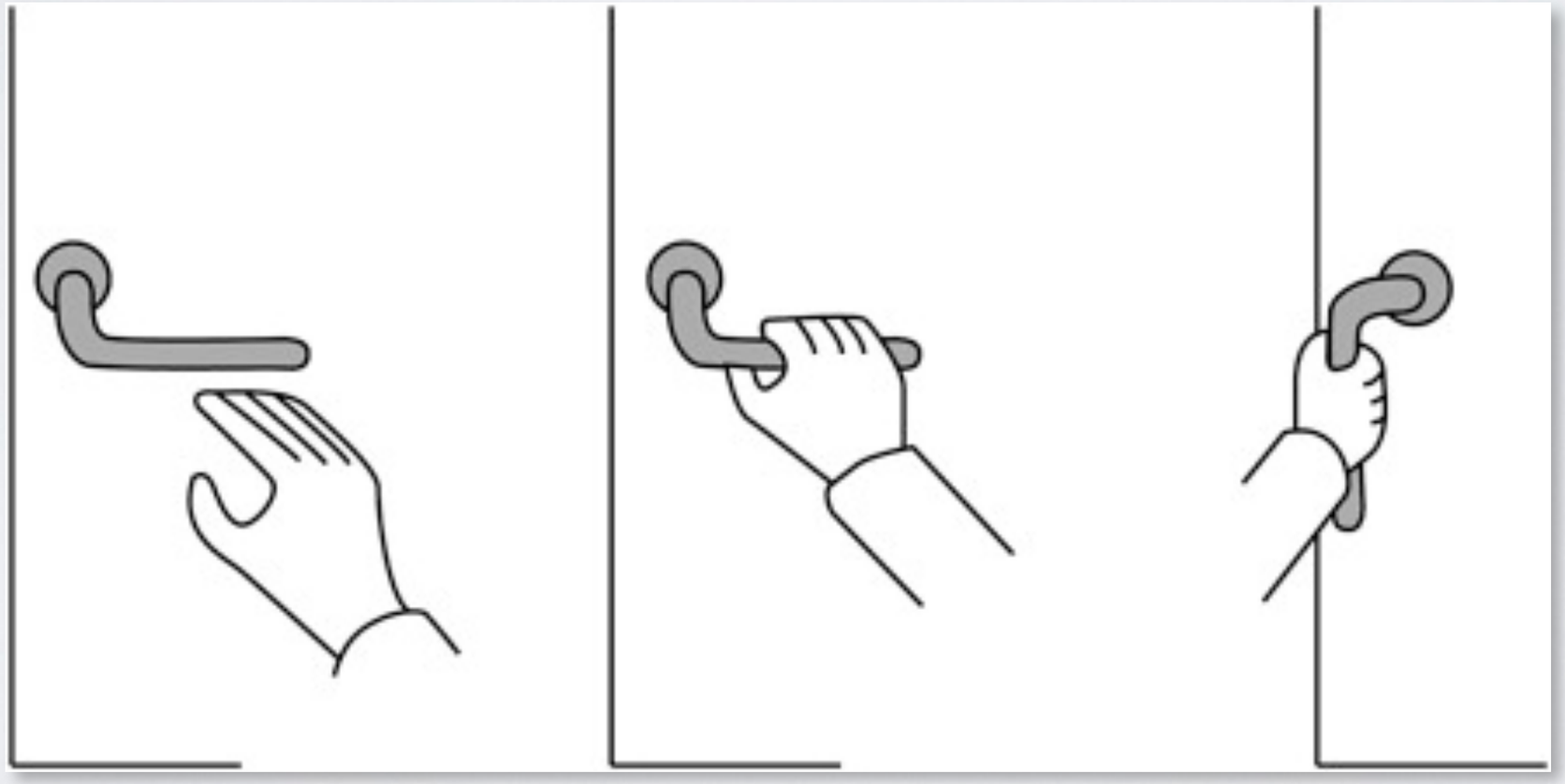
FALSE AFFORDANCES

FALSE AFFORDANCES

CONSISTENT AFFORDANCES

SEQUENTIAL AFFORDANCE

Acting on a perceptible affordance leads to information indicating new affordances.



NESTED AFFORDANCES

Affordances due to **spatial** relationships reveal what actions can be done.

Affordances that combined reveal a specific associated action

AFFORDANCES & CONVENTIONS

"Note also that affordances are not intrinsic, but depend on the background and culture of users. Most computer-literate user will click on an icon. This is not because they go around pushing pictures in art galleries, but because they have **learned that this is an affordance** of such objects in a computer domain…"

— Dix et al. (2004)

"Designers sometimes will say that when they put an icon, cursor, or other target on the screen, they have added an 'affordance' to the system. This is a misuse of the concept. … It is wrong to claim that the design of a graphical object on the screen 'affords clicking' … Yes, the object provides a target and it helps the user know where to click and maybe even what to expect in return, but those aren't affordances, those are conventions, and feedback, and the like. … **Don't confuse affordances with conventions**."

— Norman

Icons do not afford "pushing" or "clicking." Icons do not communicate "pushability" by their attributes. They do not give an indication of their intended use, except by convention.

VISIBILITY & FEEDBACK

Two sides of the execution/evaluation coin.

Visibility — Can I see what I need to in order to take appropriate action?

Feedback — Do I receive appropriate information about actions that I am taking or have taken?

Crucial pieces of direct manipulation interfaces.

Visibility of objects.

Feedback for all actions.

Most affordances depend on visibility.

Most metaphors depend on visibility.

THREE KINDS OF VISIBILITY

Must have visibility:

1. Of objects of interest.
2. Of available actions.
3. Of system status.

Affordances address the first two.

Feedback addresses the third.

FEEDBACK

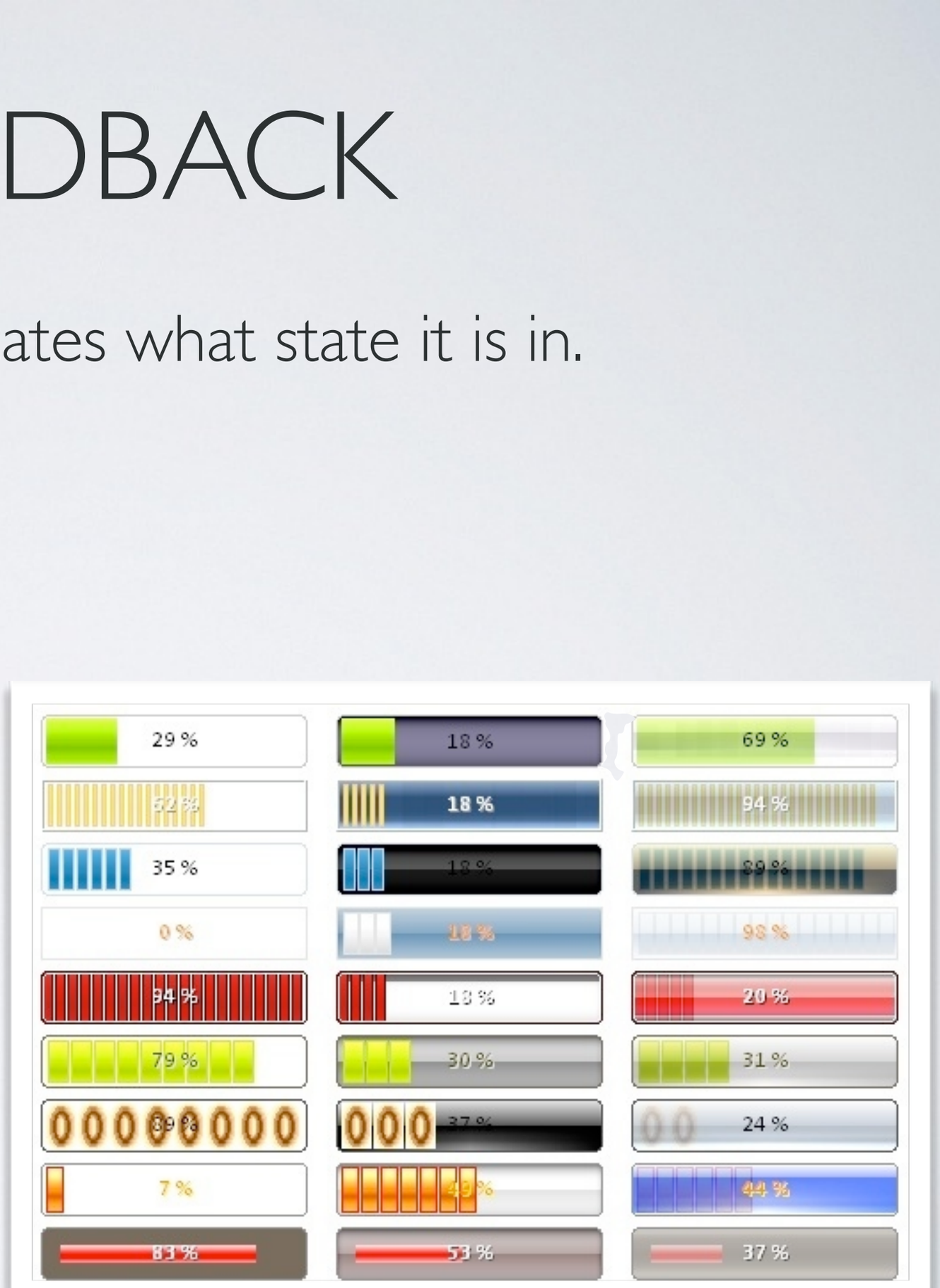
At all times, the system indicates what state it is in.

Examples:

Hourglass icon

Progress bars

Chimes and sound alerts



DESIGN ELEMENTS

Metaphors √

Modes √

Affordances √

Constraints

Mappings

Prior experiences

CONSTRAINTS

CONSTRAINTS

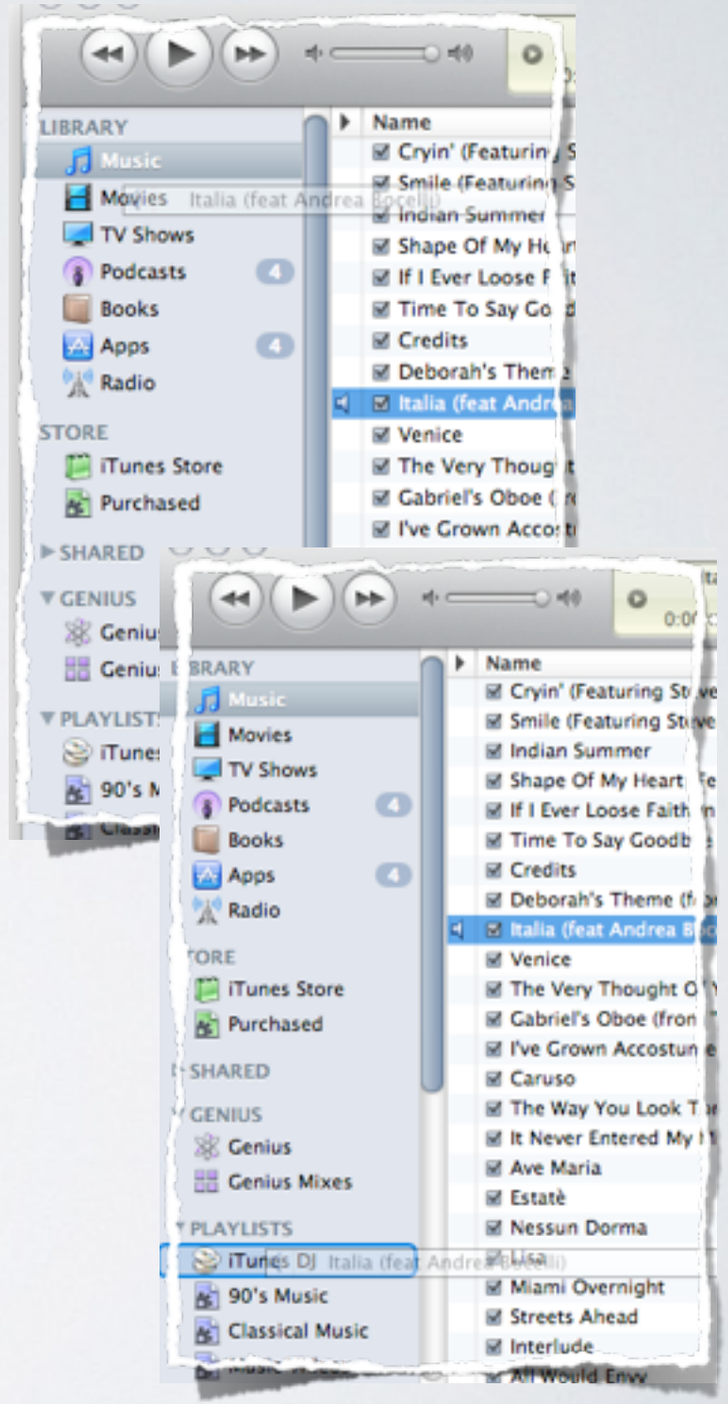
Constraints prevent some actions while allowing others.

Direct manipulation interfaces should employ these, permitting legal actions while making illegal ones visible through feedback.

Prevent errors before they can happen.

Disruptive error messages are a last resort. Instead, use constraints to prevent wrong behavior in the first place.

E.g., Windows cannot be dragged to where you cannot retrieve them.



DESIGN ELEMENTS

Metaphors √

Modes √

Affordances √

Constraints √

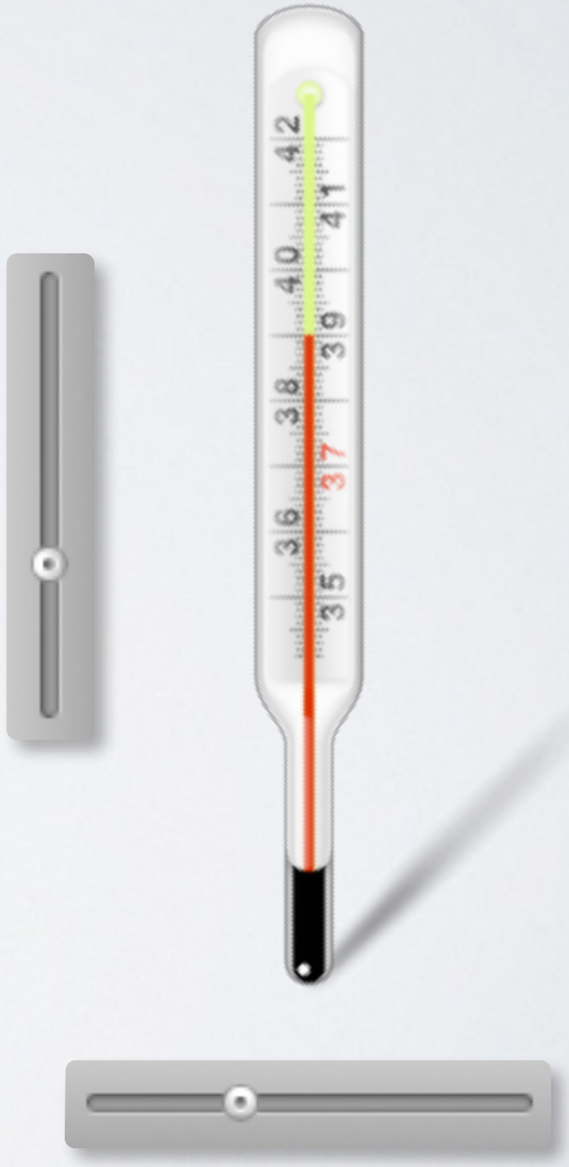
Mappings

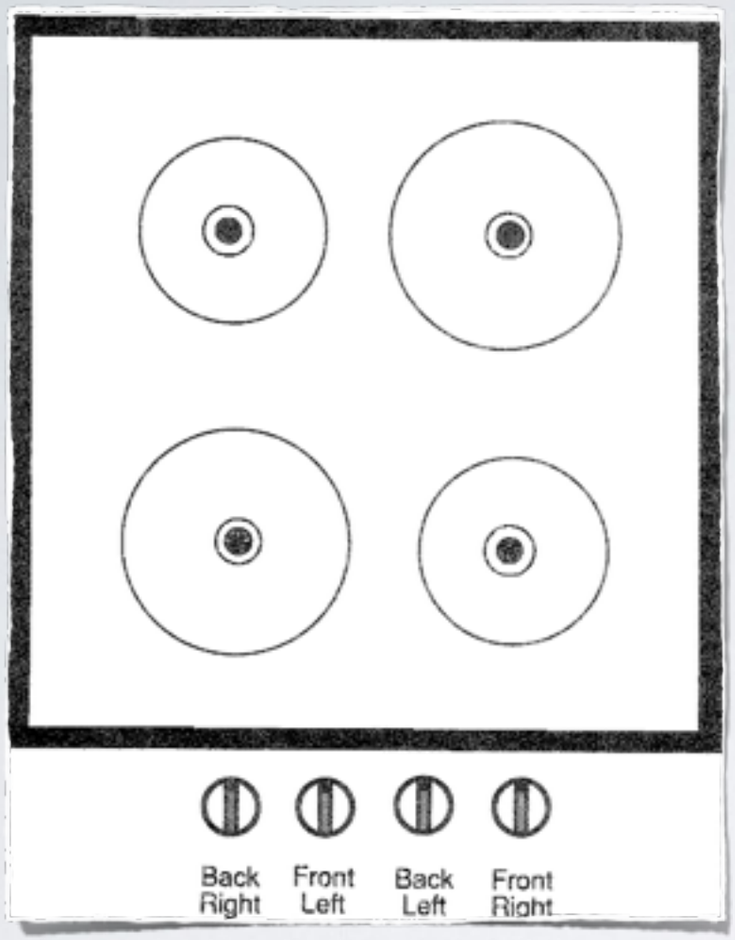
Prior experiences

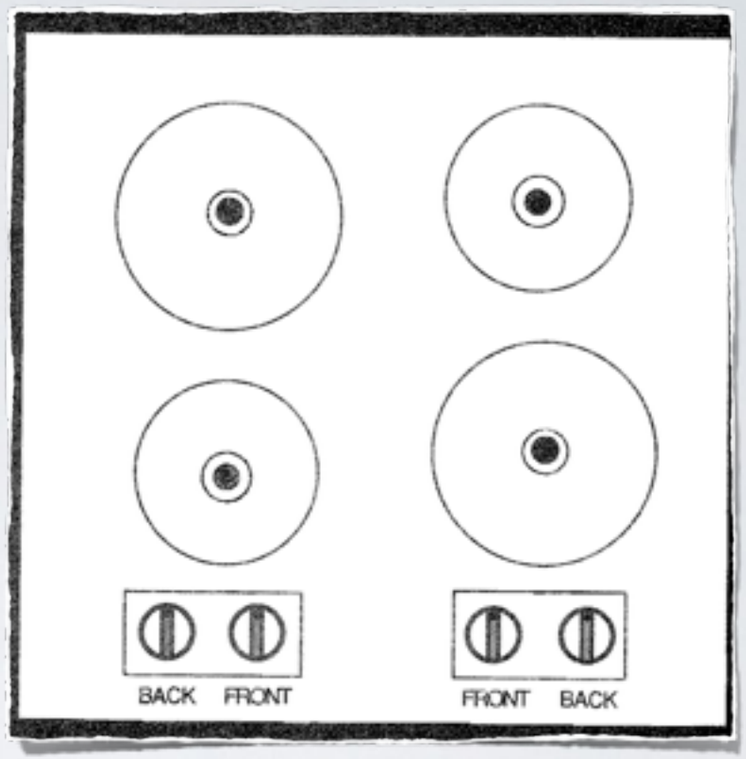
MAPPINGS

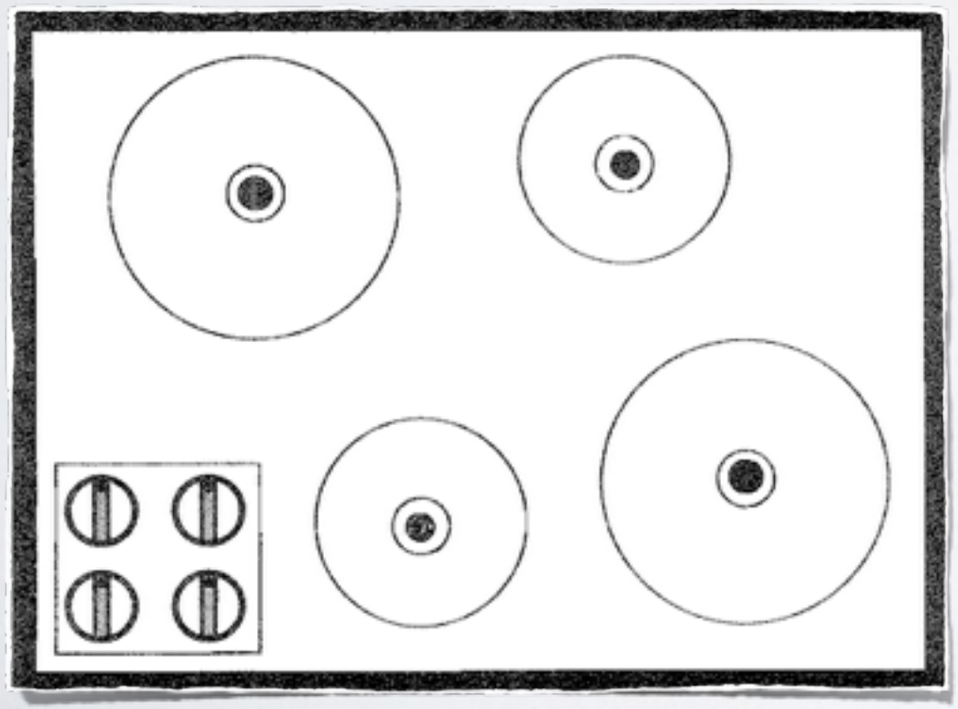
NATURAL MAPPINGS

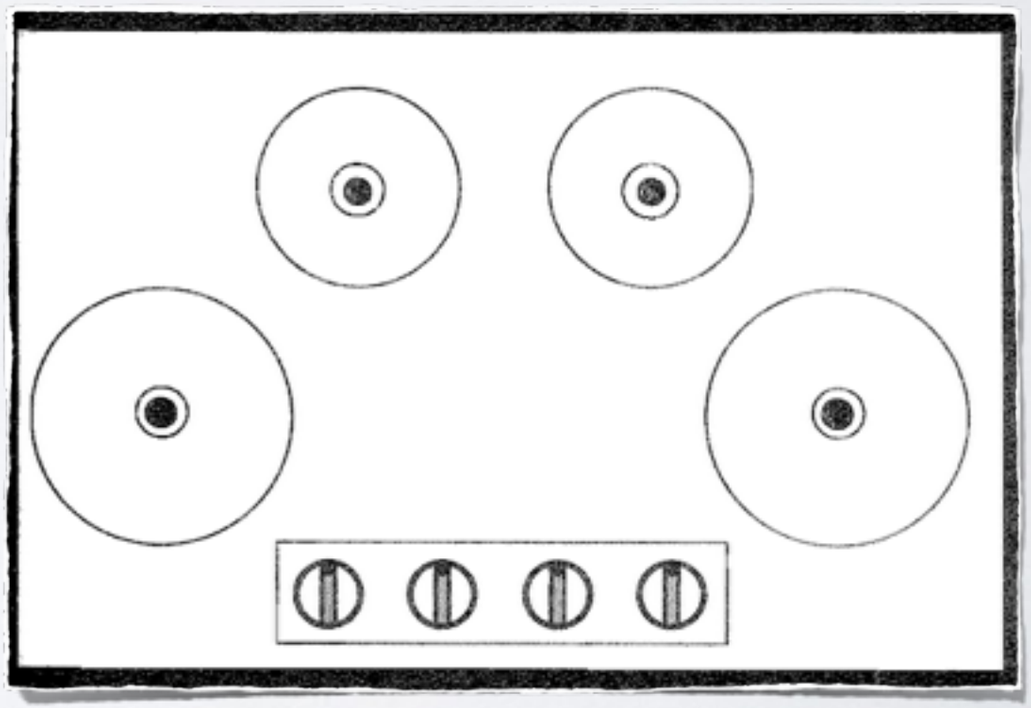
Use physical, spatial, or other analogies to draw the connection between a control and the display or manipulation of an object.

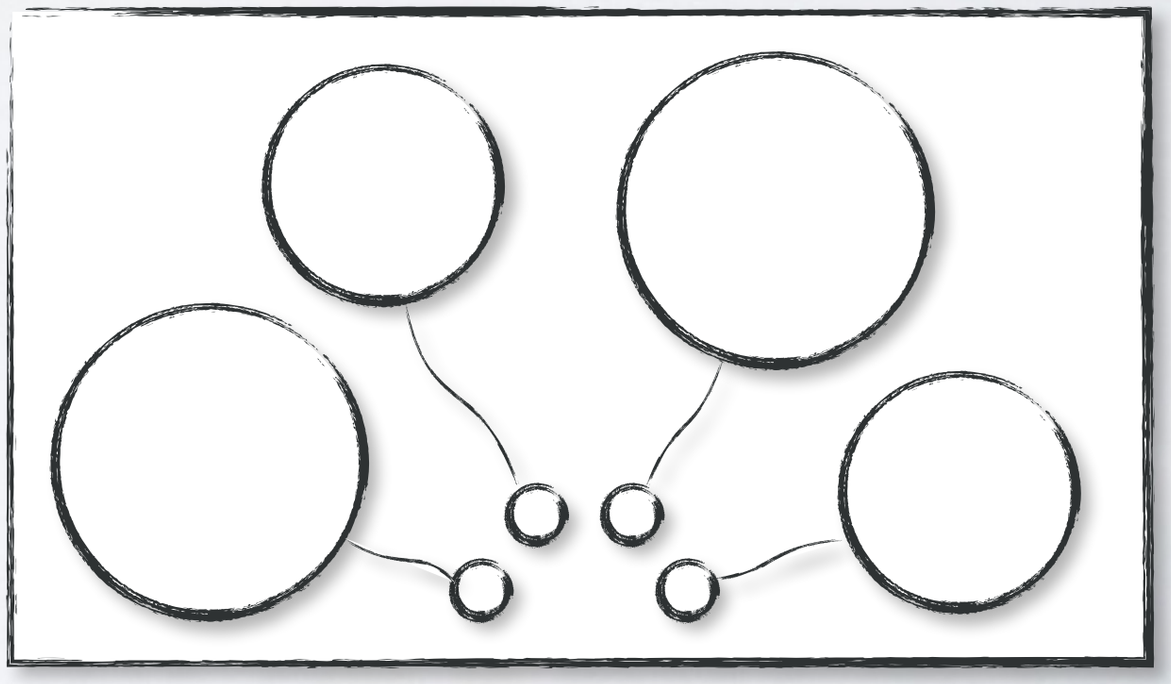



Back Right
Front Left
Back Left
Front Right


BACK
FRONT
FRONT
BACK







NATURAL MAPPINGS

Minimize the number of cognitive steps to transform action into effect, or perception into comprehension.

Applicable to both action and displays (execution and evaluation).

Minimize the need for labels, instructions, help systems.

DESIGN ELEMENTS

Metaphors √

Modes √

Affordances √

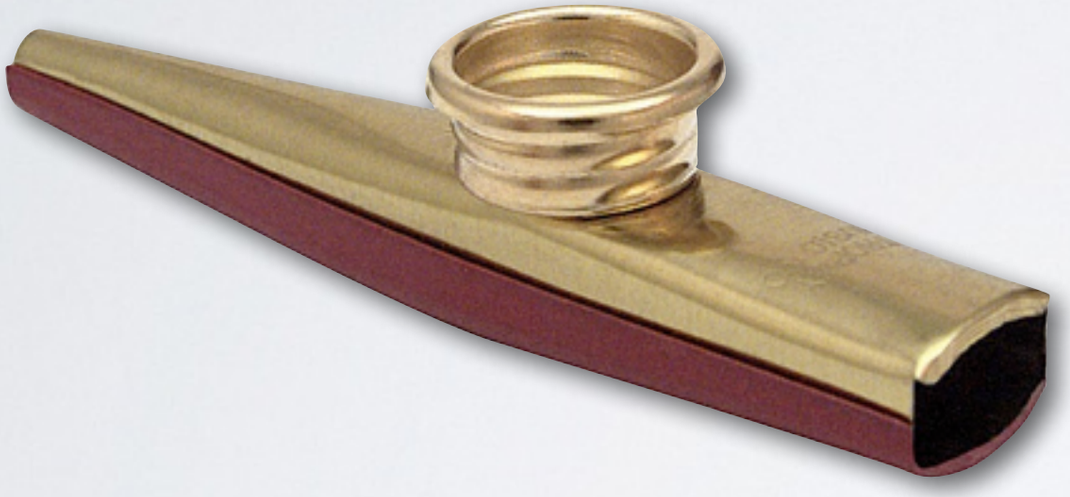
Constraints √

Mappings √

Prior experiences

EXPERTS & NOVICES

WHAT IS MORE USABLE?



A kazoo

A violin

NOVICES

Unfamiliar with the system.

Possibly unfamiliar with the context and domain.

Often apprehensive about technology.

Often unwilling to explore interfaces for fear of inflicting permanent damage.

Confidence develops slowly at first.

Errors tend to be mistakes, not slips.

EXPERTS

Familiar with the system, context, and domain.

Usually comfortable with technology.

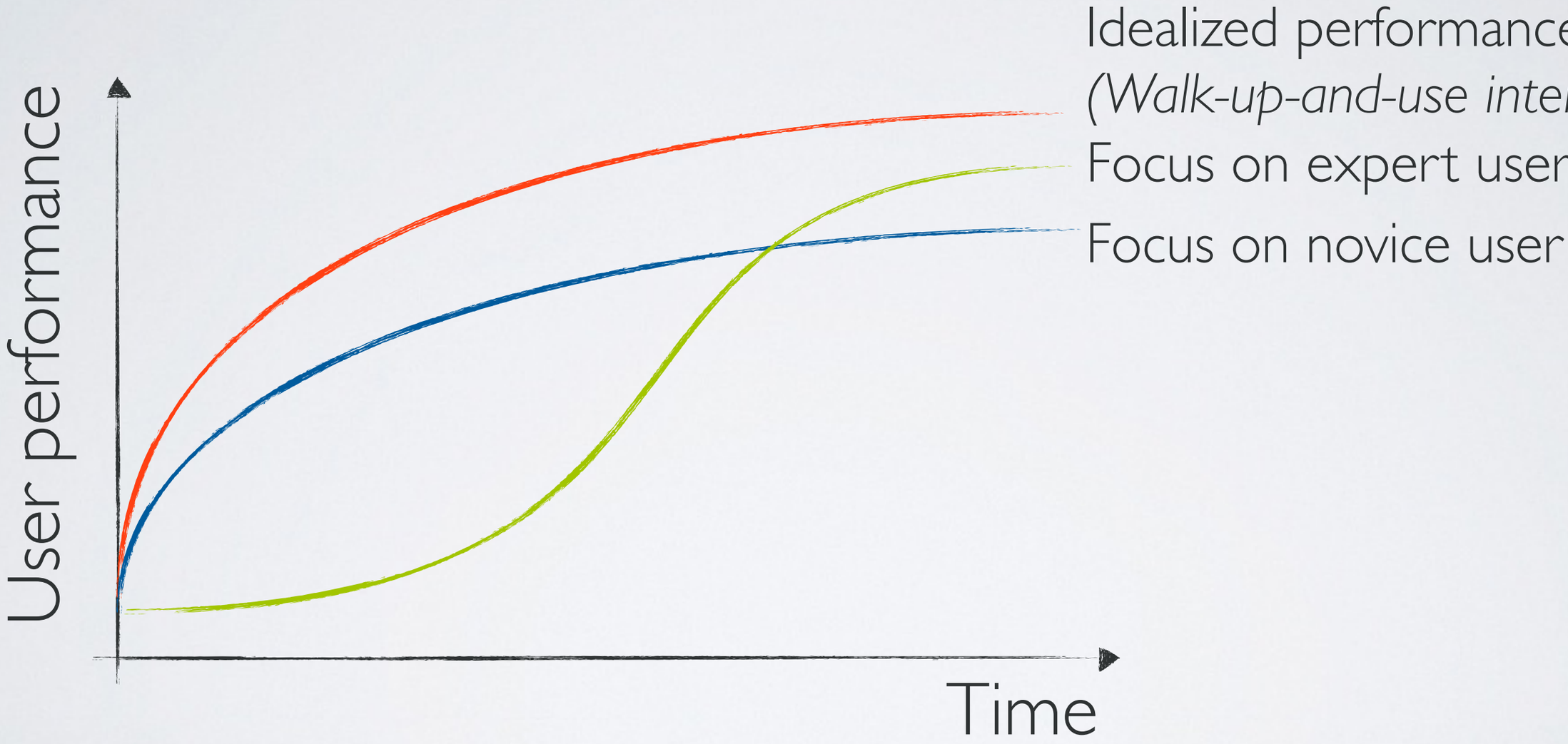
Willing to explore interfaces, try new things, teach themselves.

- Rely heavily on undo.

Confidence develops quickly.

Errors tend to be slips, not mistakes.

EXPERTISE & PERFORMANCE



CAN WE ACCOMMODATE BOTH?

How can we smoothly transition from novice to expert use in the same system?

E.g., ShapeWriter

Can we include both novice and expert functionality in the same space?

E.g., Keyboard shortcuts, menu accelerators

Can adaptive user interfaces change dynamically over time?

We have to be careful that users still feel in contro

DESIGN ELEMENTS

Metaphors √

Modes √

Affordances √

Constraints √

Mappings √

Prior experiences √

HOA

IDENTIFY AFFORDANCES

Examples of good affordance, false affordance, sequential affordance, and nested affordance.

MOBILE METAPHORS

Devise a task on mobile phone and apply a metaphor to the context.