

#6 Human-Computer Interaction



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Outline

- Previous Lectures
 - What is HCI & HCI framework
 - Design, HCI artifacts, design thinking, and design methodologies
 - Modeling: cognition, mental, conceptual, activities, prototyping
 - Design principles
 - Semiotics & representations: role in design & cognition
- This lecture
 - The Frame Problem, Kurt Gödel, & David Hume
 - Metaphors and role in HCI artifacts

The Frame Problem

- A comprehends, fully, all programming languages and is a well-educated, sophisticated, competent developer. A only has knowledge of programming languages.
- B says to A: “write me a program”.
- What program should A write?
- A hello-world? Why not a calculator? Snake game? An online shop? A chatbot? A firmware?
- Doesn't A know how to write “a program”?
- What is wrong here?
- How is it that with all the knowledge, facts, StackOverflow answers, and all proper mental models of the task, A cannot figure out **what to do**?

The Frame Problem

- “How to act?” cannot be answered by **solely** relying on “the facts”.
 - Which facts are relevant?
 - Which should be disregarded?
- By only relying on knowledge of programming, how can A determine which facts are relevant, and which are not, to write “a program”?
- “Relevance Realization” (RR) is at the heart of The Frame Problem and is concerned with what is **relevant**.
- RR cannot be accomplished without a frame of interpretation.
- <https://plato.stanford.edu/entries/frame-problem/>
- <https://folk.idi.ntnu.no/gamback/teaching/TDT4138/dennett84.pdf>
- <https://www.youtube.com/watch?v=JgHcd9G33s0>
- <https://www.youtube.com/watch?v=IHE63fxpHCg>
- <https://www.youtube.com/watch?v=EVAKG6Y2uIg>

Kurt Gödel's Incompleteness Theorem

- Consider the following conjecture:
 - “Every even number is the sum of two primes.”
- How would you prove it?
- Kurt Gödel’s theorem says there is an inner limit to the provability of formal axiomatic logical systems / theories.
- <https://plato.stanford.edu/entries/goedel-incompleteness/>
- <https://www.youtube.com/watch?v=I4pQbo5MQOs>

IS / OUGHT

- Is/Ought distinction raised by British philosopher David Hume (circa 1739):
 - Claims of what *ought*, or *ought not*, to be cannot be solely based on what *is*, or *is not*, true.
 - Put plainly: one cannot draw a *why/how* only from a *what*.
- <https://www.youtube.com/watch?v=eT7yXG2aJdY>
- Is there a value structure/system according to which facts ("is"es) are being interpreted?
- What is the nature of those value systems? What determines the priority of a *fact* over another?
- "It's all relative."?! What say ye?

The Frame Problem: AI Meets David Hume

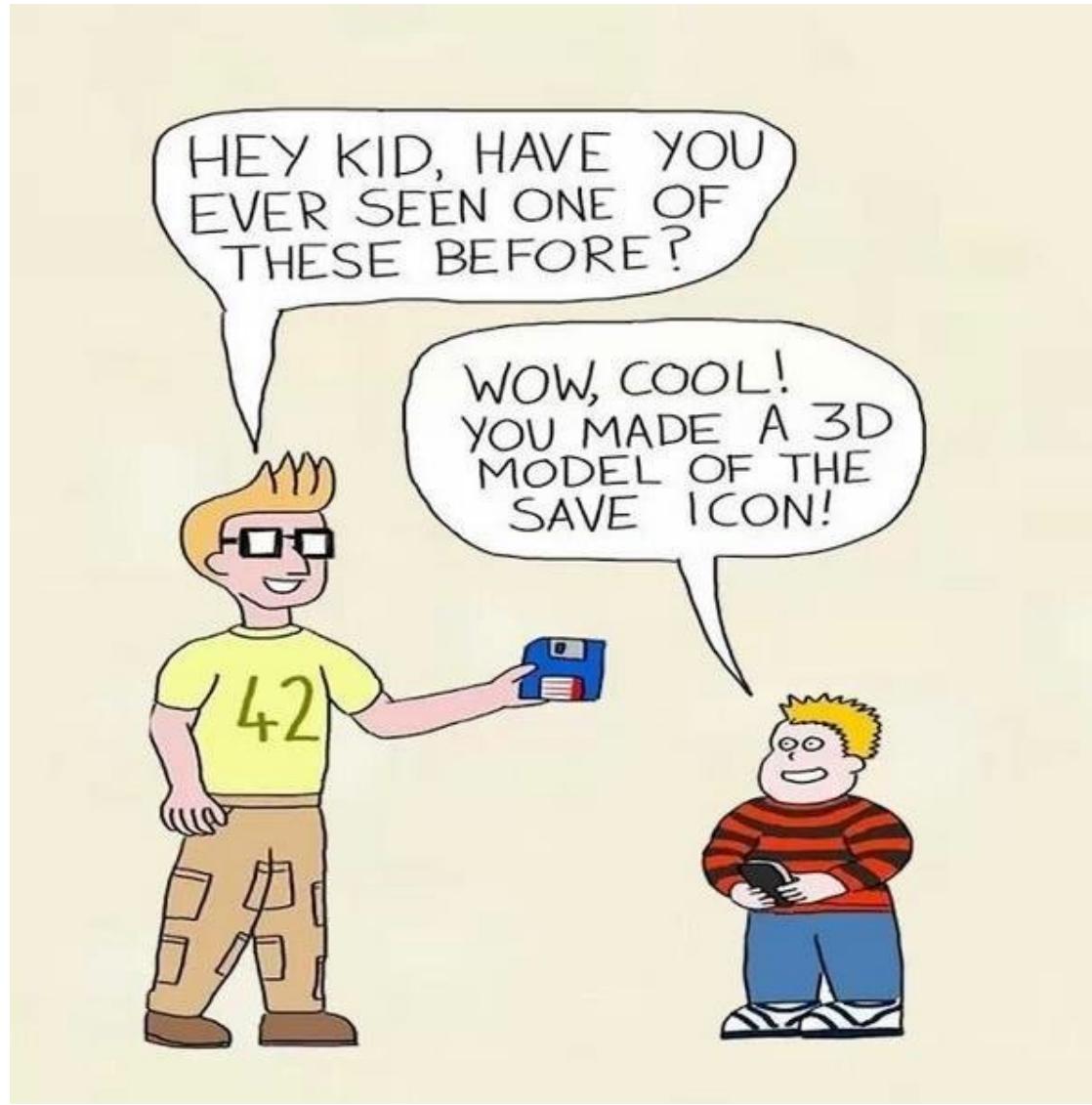
- Sciences are, fundamentally, concerned with questions of “what is” regarding a phenomenon.
 - A scientific discipline **cannot** guarantee answers to questions of “so what?”
 - Computer sciences are no different.
 - Ethics is the study of “so what?” questions.
- So what? What is the implication for HCI practitioners?

Analogies & Metaphors

Back to HCI artifacts

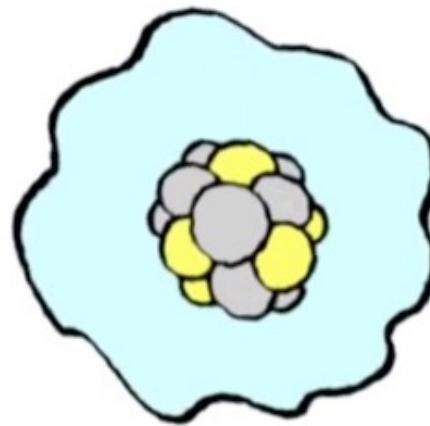
- How do you create a fit between the fundamental mental models of users and HCI artifacts?
- How do you reduce complexity of design for designers?
- Through familiarity and similarity

Familiarity



How analogies shape thinking

- A comparison between two things, typically for the purpose of explanation or clarification



https://www.youtube.com/watch?v=twwd_LLVmDM

Metaphor

- What is a metaphor?
- Do designers need to know anything about metaphors?
- What is the difference between metaphor and analogy?

Metaphors and human thought

“Metaphor is pervasive in everyday life, not just in language but in thought and action. Our ordinary conceptual system, in terms of which we think and act, is fundamentally metaphorical in nature. ... Metaphor is as much a part of our functioning as our sense of touch, and as precious.”

- George Lakoff

“Our cognitive ability to interpret the world around us is largely based on metaphor and metonymy. Both of them let us see relations between unknown and known, remote and near, invisible and visible, based essentially on similarity and contiguity between concepts.”

- Wolfgang Raible

Role of Metaphor

- Our thoughts and thinking processes are fundamentally grounded in metaphor
- How do we think about an 'argument'?
 - The metaphor is **war/fighting**
 - your claims are *indefensible*
 - he *attacked* my weak points
 - he *shot down* my arguments

Metaphor is mapping

- A metaphor is a mapping from one system/domain to another

Source —————→ **Target**

e.g., Building —————→ Argument

*We need to **butress** the argument with more evidence*

*Your argument has a **strong foundation***

e.g., War —————→ Argument

*We need to **defeat** their argument*

*One of the classic ways to **attack** an argument*

How metaphors work

From ancient Greek *metaphora* — “to transfer”

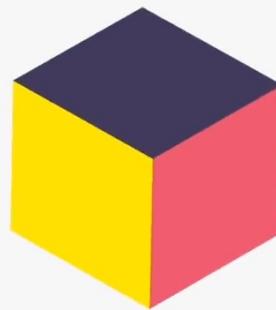


Extracted from: 1:14 to 4:00
<https://www.youtube.com/watch?v=iEu2zQ7ZCTs>

Role of Metaphor

- Looking at previous metaphor, we don't just *talk* about arguments in terms of war
 - we actually *win* or *lose* arguments ...
 - we *defend* positions ...
 - we *gain* or *lose* ground ...
- NOTE how these metaphors **structure thought, action, and feelings**
 - Three main concepts related to HCI artifacts and good design
 - They affect usability as well as experience design
- Ask yourself: Does your thinking change with different metaphors for time or argument? How would you feel? How would you act?

Notice effect of metaphors



<https://www.youtube.com/watch?v=Sf-NpKIzF9Q>

Role of Metaphor

- Metaphors function as **natural models**, allowing us to take our knowledge of the familiar, concrete, known objects and experiences and use it to give more structure to more abstract, unknown domains.

Remember skeuomorphism?

"When virtual objects & actions in an application are metaphors for objects & actions in the real world, users quickly grasp how to use the app."

—Apple's Human Interface Guidelines

Can you think of any metaphors used in computing?

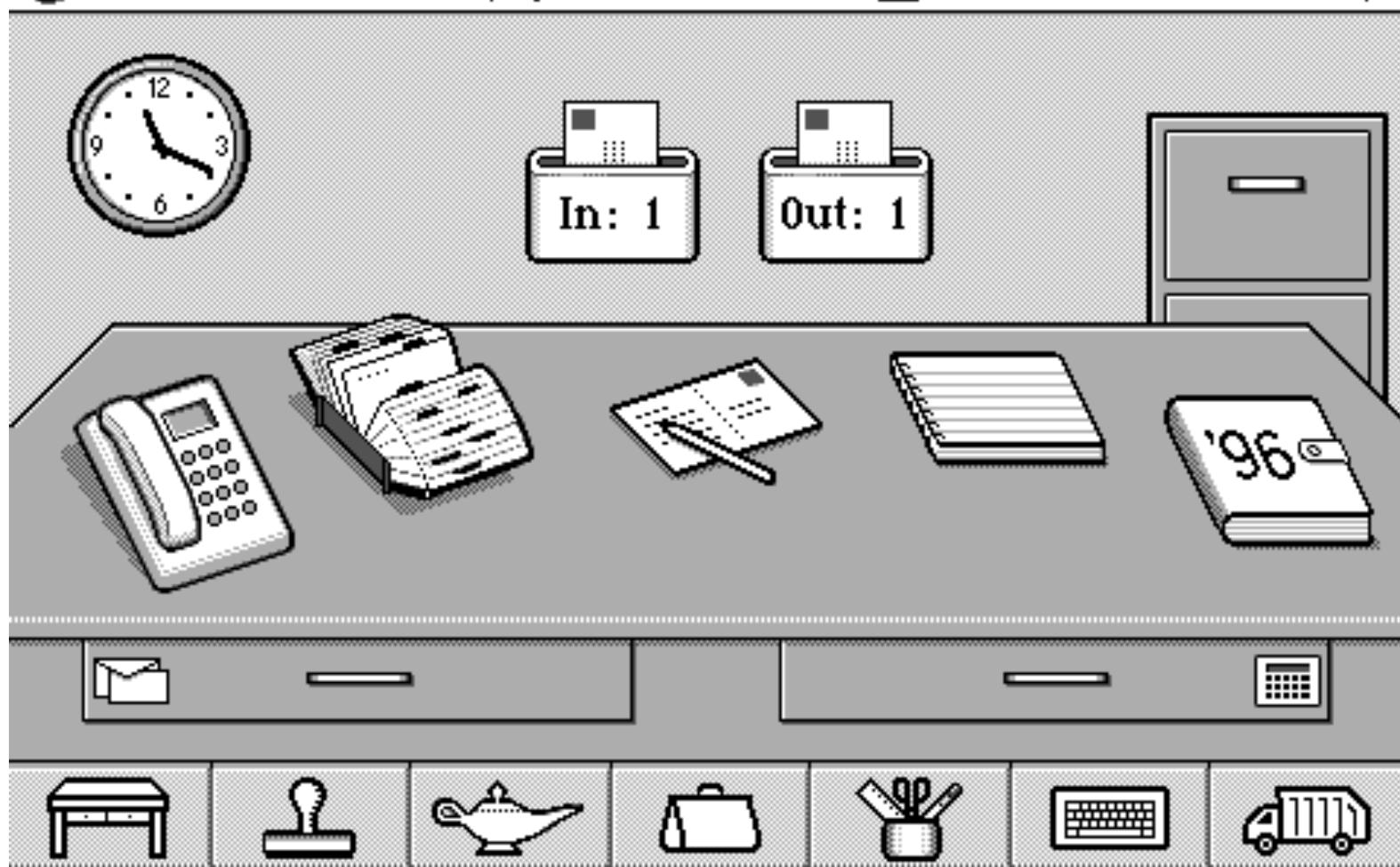
A desktop metaphor

① Desk

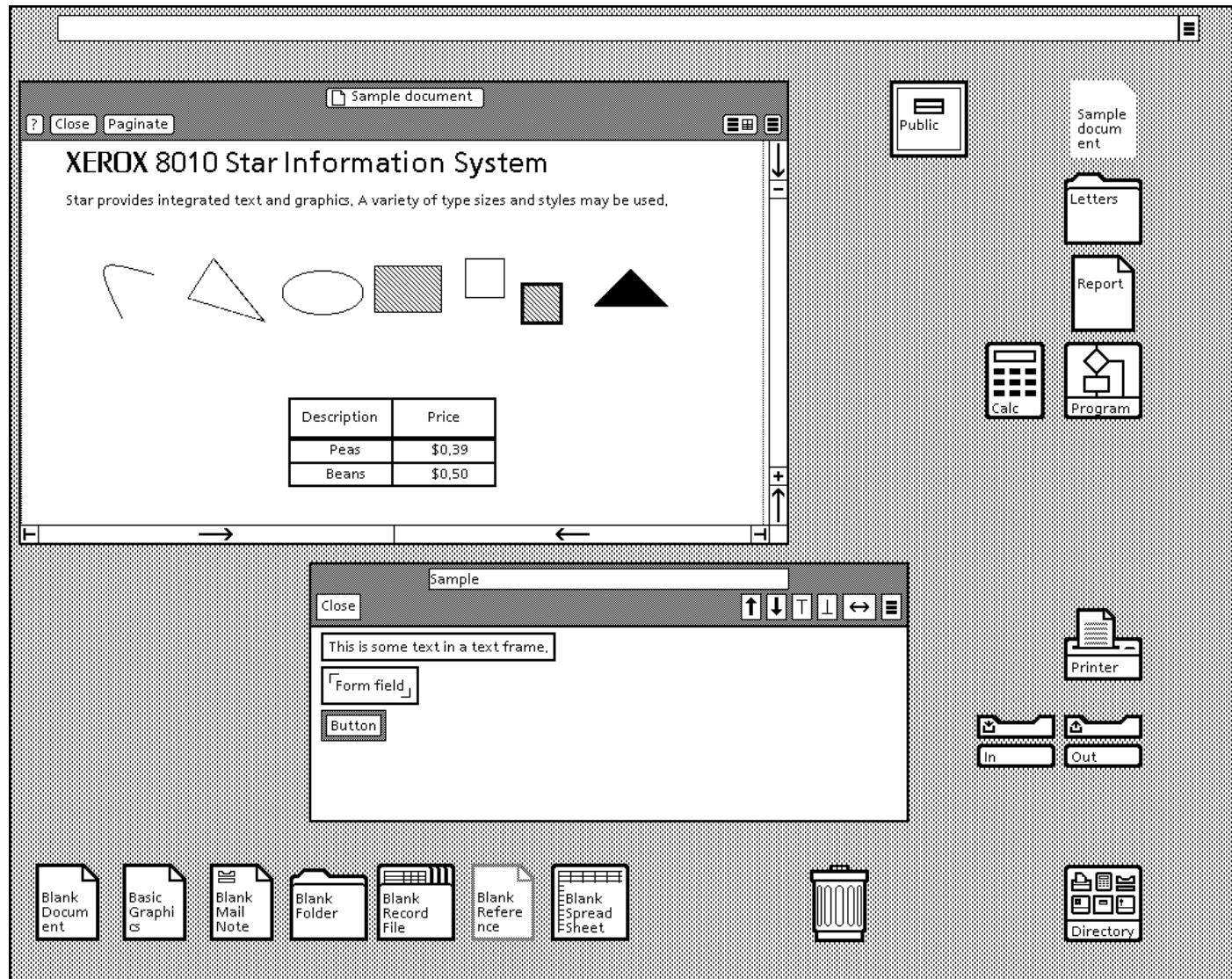
Monday, June 17, 1996



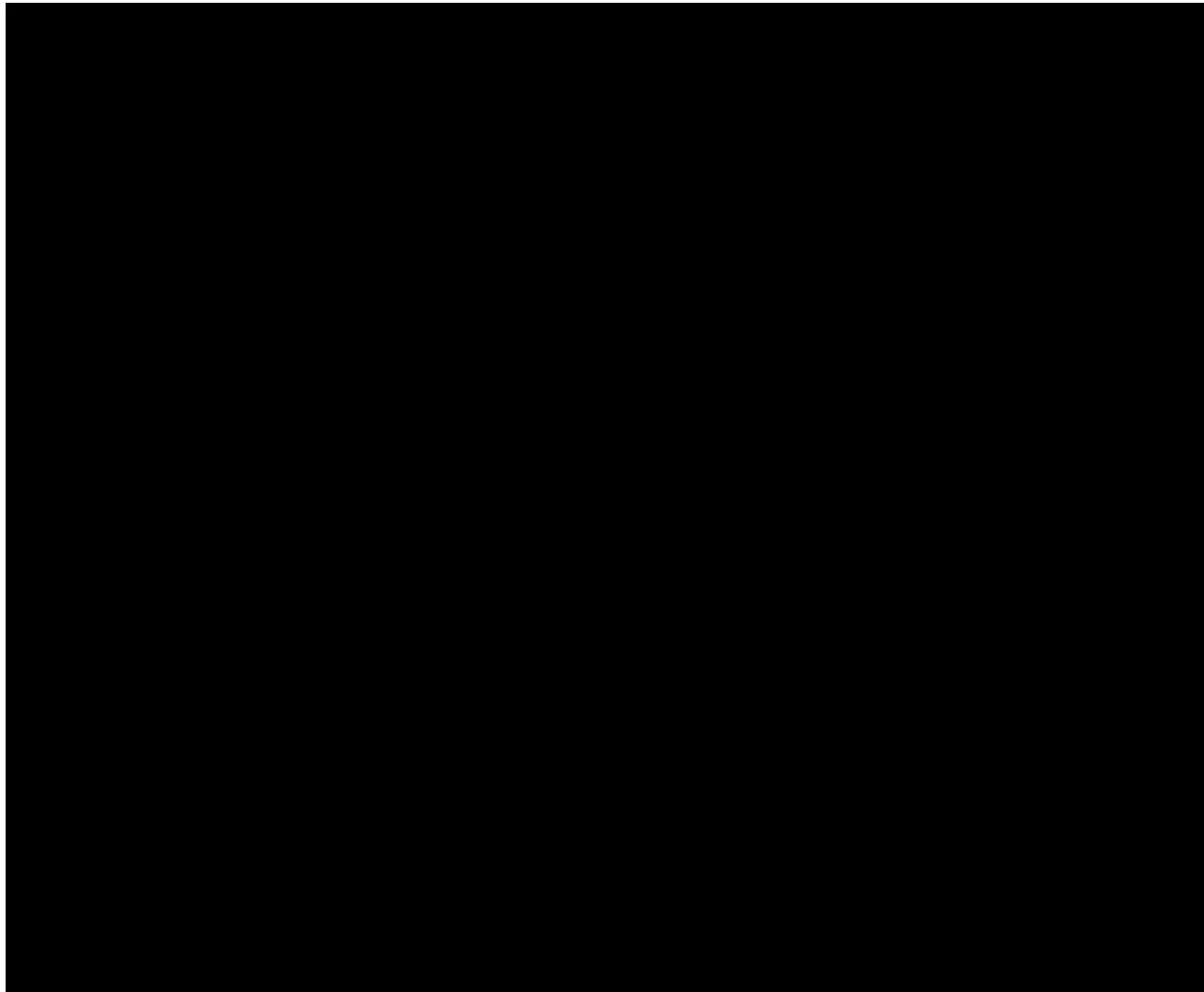
Hallway



Desktop metaphor of Xerox 8010 Star



Apple Macintosh



<https://www.youtube.com/watch?v=1UtI0gkOGy4>

Exploring metaphors

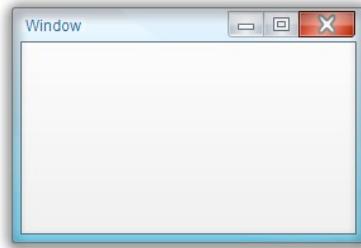


<https://www.youtube.com/watch?v=MzLMg-fXgY&list=PLipfmLASdpKebHQWdfxVQ4i3yWuYqRzth&index=18>

Metaphors in computing

- Obvious ones:
 - desktop, windows, folders, trash can, bookmarks
- Not as obvious:
 - memory, pointer, bus, port, stack, queue, zip, unzip
- We use metaphors heavily in computing
- We may even forget that they are metaphors

Other interface (sign) metaphors



| Name | Size |
|----------------------------|----------|
| example.net | 4 KB |
| Screenshot from 2016-05-13 | 307.04 K |
| Download | 27 |
| View | 27 |
| Edit | 27 |
| Code Edit | 27 |
| Move | 16 |
| Copy | |
| Rename | |
| Change Permissions | |
| Delete | |
| Compress | |



Why care about metaphors?

- Metaphors are closely linked to conceptual models
 - Humans think metaphorically
 - Metaphor implies a model
 - Models cannot be easily understood without a metaphor
 - **Remember the *time* and *argument* metaphors**
- Metaphors do not eliminate complexity, but
 - **They help highlight what we should pay attention to and what to suppress**
 - i.e., they support cognitive functions and processes such as attention and forming mental models
- But, they do reduce complexity **relatively**

Metaphors in computing

- Used to control and reduce complexity of new situations
- Interface actions (or higher-level tasks) are mapped to the elements of an already-understood and familiar concept
- Prior knowledge of the concept helps the user with a novel or unfamiliar situation
- Metaphors create expectations and/or allow users to predict how a system is supposed to behave
- Metaphors suggest or induce feelings – i.e., have connotative and emotive residual effects

Famous analogies for computers

- computer as vast library -- Memex, 1945
- computer as giant calculator -- ENIAC, 50s
- computer as intelligent assistant -- Licklider, 1957
- computer as sketchpad -- Sutherland, 1962
- computer as tool or typewriter -- Engelbart, 1963
- computer as human pretender -- Weizenbaum, '60s
- computer as network -- Taylor, 1968
- computer as book -- Allan Kay
- computer as desktop/windows -- Xerox PARC, '70s
- computers as public device -- Apple, 1984

- Do you notice the term “as”?

Word and text processing software

- Metaphor?
 - Typewriting
- Familiar knowledge domain
 - Typewriting
 - Only one character can be hit at any one time
 - Hitting a character key will result in a letter being displayed on a visible medium
 - <https://www.youtube.com/watch?v=wgZZmLPXGe8>

Metaphors in interaction design

CONCEPTUAL MODELS

- High level description of a system
- Helps you communicate your ideas
- Helps you determine important components of your design

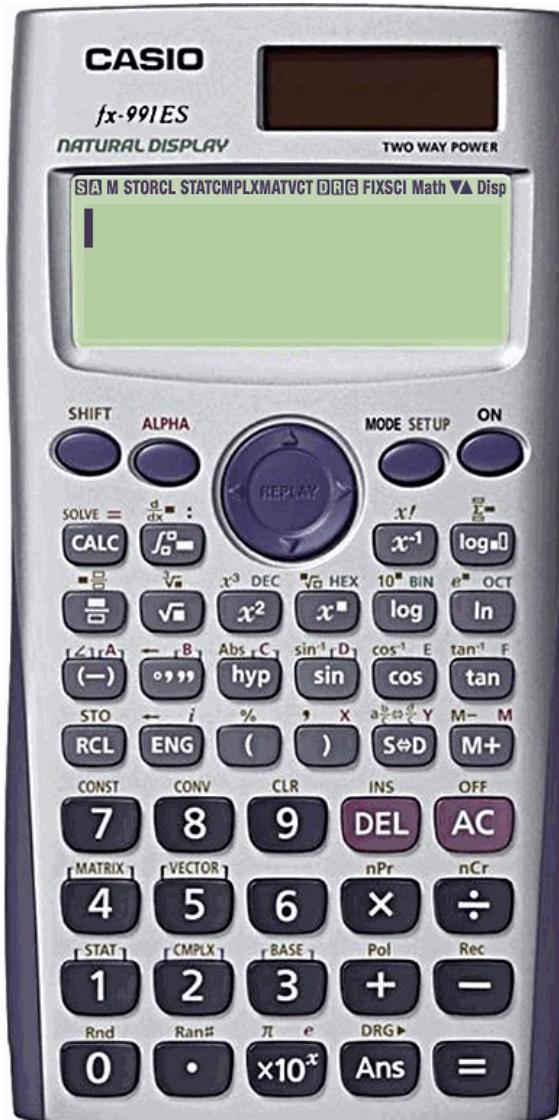


<https://www.youtube.com/watch?v=gLjeW5rWMb8>

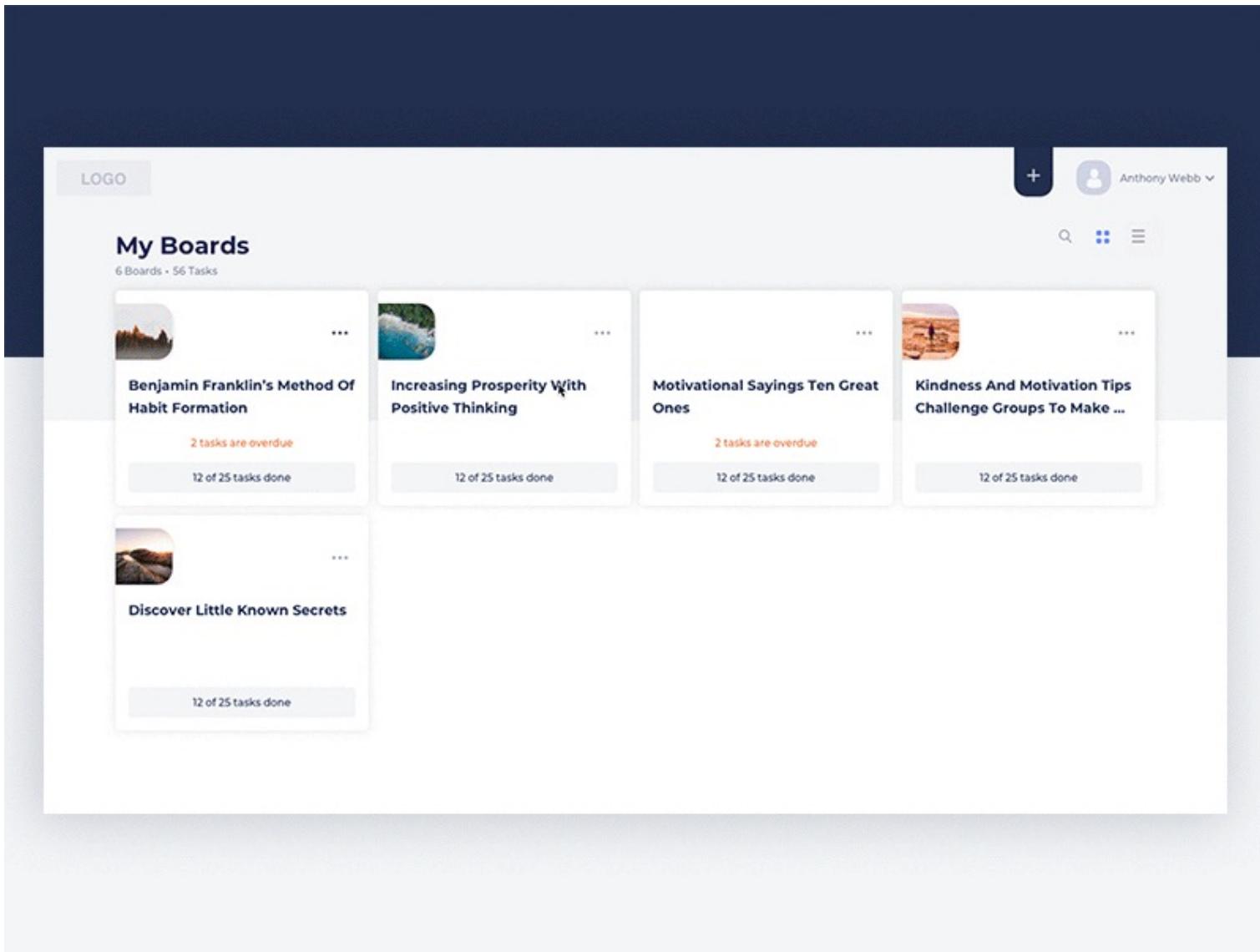
Types of metaphors in computers

- Skeuomorphic metaphor
 - Straightforward mapping
 - E.g., Typewriter to keyboard
- Virtual metaphor
 - Different from physical; adds strange behavior to physical
 - E.g., picking up and moving physically becomes select and drag-and-drop with a mouse cursor
- Composite metaphor
 - Adds new things to the above two
 - E.g., desktop metaphor (containing tools such as calendar, calculator, ...) now has added metaphoric structures such as windows (not a natural part of desktops) and menus (not a natural part of desktops)

Skeuomorphic metaphor



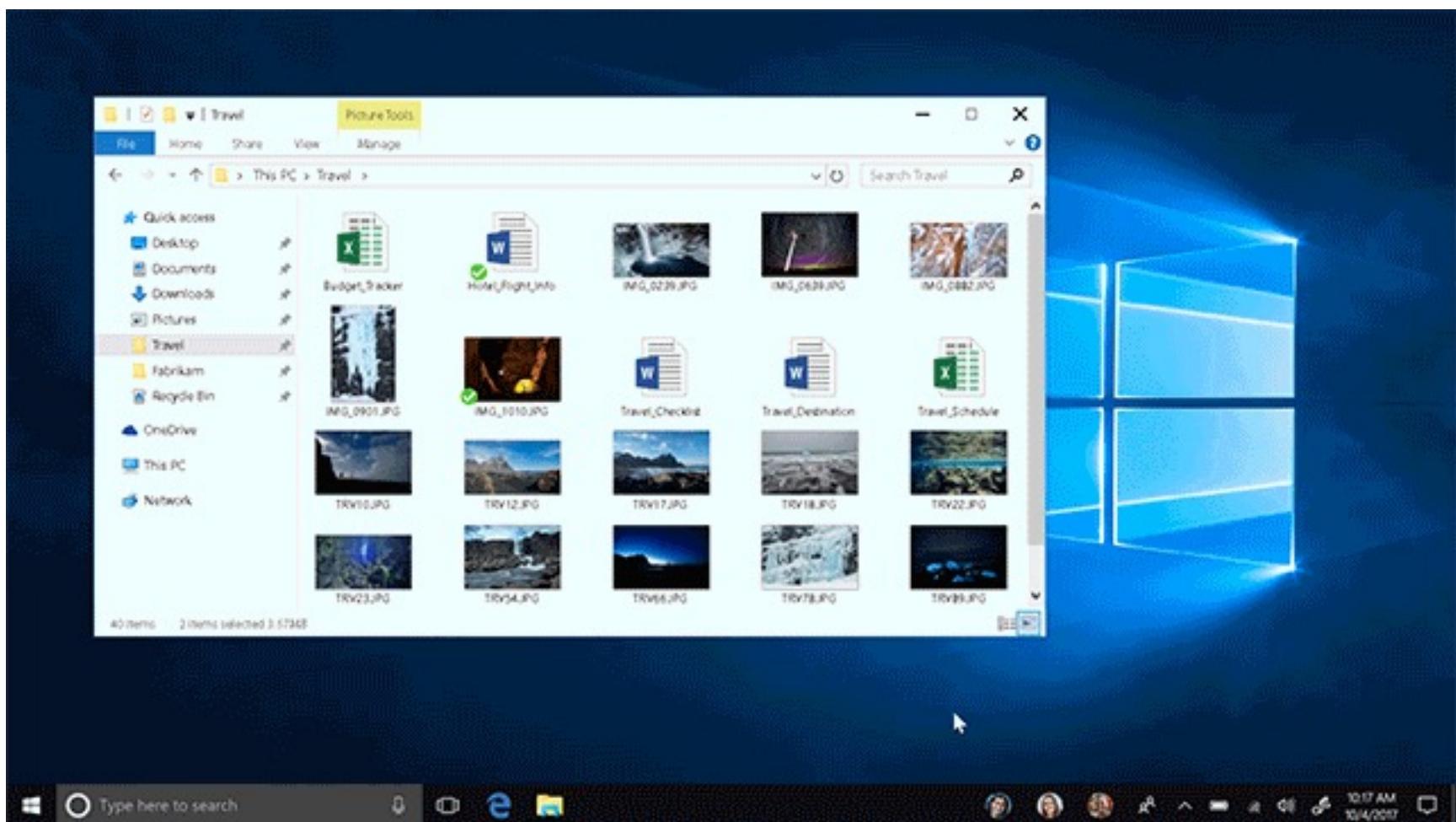
Virtual metaphor: Drag and drop



Composite metaphors

- Mixing two or more metaphors
 - E.g., desktop interfaces
 - Metaphors combined together
 - Desktop: files, folders
 - Accessory tools: calendar, clipboard
- Complementary, heterarchical metaphors divide up interface function at a single level
 - E.g., MS Office
 - Separate metaphor for each constituent application

Composite metaphor



Metaphor Genres

- A metaphoric design structure can give us a genre
 - Each has a breakthrough ancestor that established the genre
 - Each new innovation influences and refines the underlying genre

- The **desktop metaphor has become a genre** with many expressions
 - Initially: Xerox Star
 - Now: Windows, Mac, Linux, ...
 - Details vary, but underlying metaphor is the same
 - Remember abstract vs. concrete



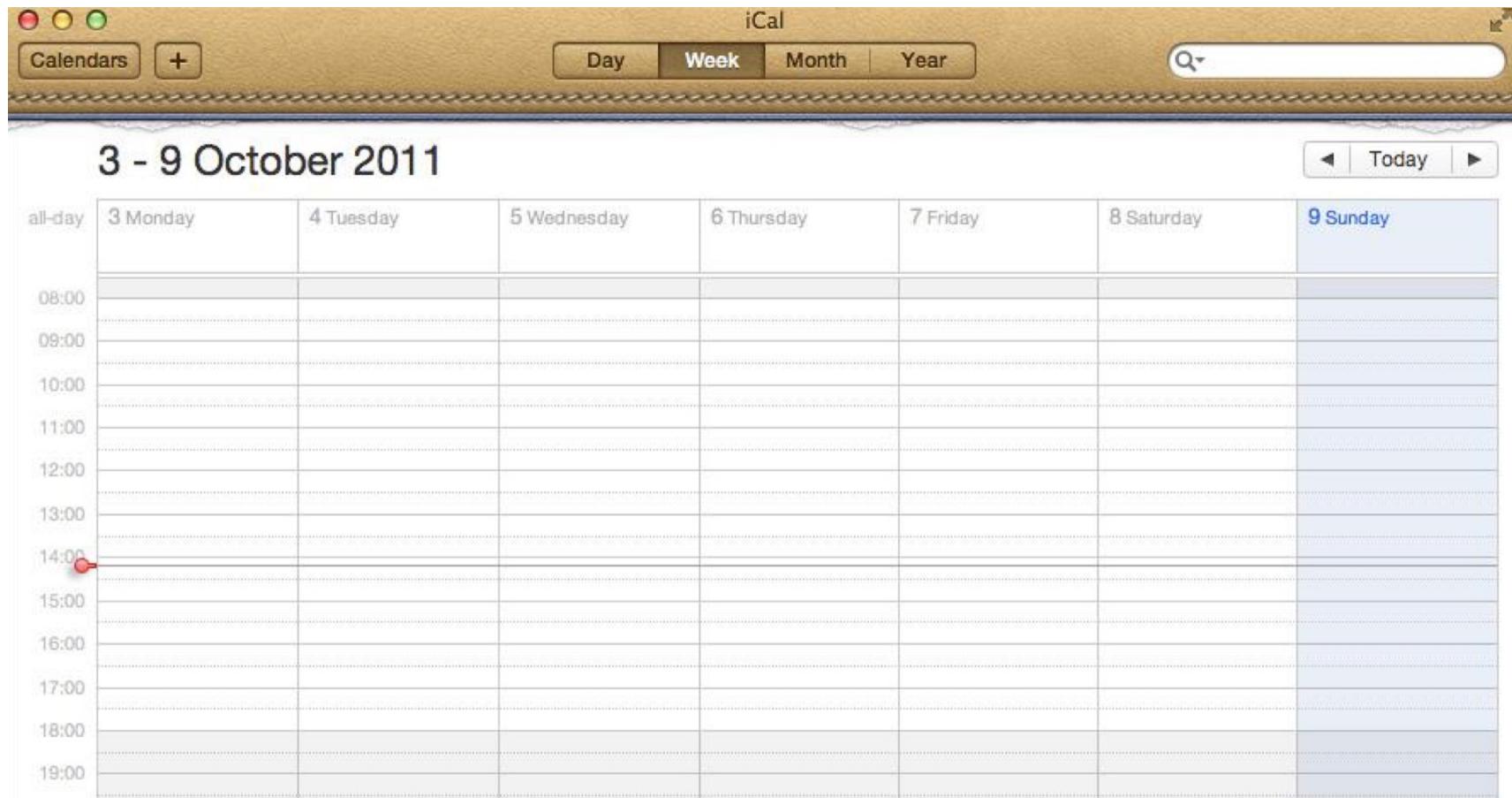
Metaphor and Consistency: Microsoft Bob

- Should metaphorical representations try to copy the real world exactly?



<https://www.youtube.com/watch?v=5teG6ou8mWU>

Skeuomorphic metaphors can limit design



Document aging

- In the real world, documents become yellowish when they age
- If you were to use color as metaphor to signify age of documents, what would you do?

Metaphors and color coding

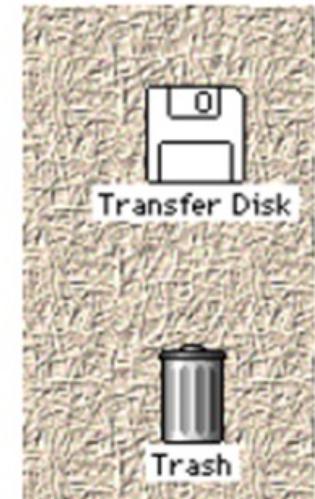
- “age of document” metaphor
 - Problem
 - Oldest item (deep yellow) leaps out of screen and dominates white
 - Alternative
 - Progress from yellow to duller shades of brown
 - Lesson
 - Exact replication of real-world metaphor does not always work
 - **Use metaphor to help develop ideas but be careful it doesn't end up confusing users**

Metaphor and Consistency

Usefulness of metaphors depends on how well they allow users to **understand and predict** system behavior, not on how literally they copy the real world

Poor Metaphors

- To delete files, drag them to the trash
- To eject a disk, drag it to the trash
- Problems:
 - Counter-intuitive
 - Some users get nervous and confused
 - Extending the metaphor too far
 - Incompatible with the initial association



<http://homepage.mac.com/bradster/architect/shame.htm>

Poor Metaphors



- Broken metaphor
- Did you use it?

My Briefcase

- Supposed to be a "briefcase", where you put files to take home
 - But when you took the files home, you still had to put them on a floppy disk
 - So, do you put them in the briefcase or on a floppy disk?

Poor Metaphors

- VCR controls for a printer?
- What does “rewind” do?



Memetics & Mimesis

- Metaphors spread like wildfire
- We are often unaware of the underlying metaphors that anchor and shape our thought processes; neither do users
- Most often, metaphors get picked up by mimesis (imitation) without explicit thinking
 - If you are not careful enough, you can copy poor metaphors
 - **Due diligence** is crucial in adoption of your metaphors
 - Both for design and thinking

Factors in choosing metaphors

1. Structure

- How much structure does the metaphor provide?
- e.g., “link” metaphor does not provide much structure
 - one-way or two-way?
 - data flow or mere connection?

2. Applicability of structure

- How much of the metaphor is relevant to the functionality of the artifact?
- What aspects may raise false expectations?
 - Remember *context* in semiotics

Factors in choosing metaphors

3. Representability

- How easily can you represent the metaphor visually, auditorily,?

4. Suitability to users

- Will users understand the metaphor?

5. Extensibility

- How much will the metaphor or the implementation of it allow for further expansion?

High-level organizing metaphors

- Machine/mechanism
 - Production, rationality, functioning, predictability, purpose, automation
- Environment/architecture
 - Space (void/mass)
- Sports
 - Competition, rules, win/lose
- Nervous system
 - Information, communication, distribution
-

Old, classic video on interface metaphors

DESIGN METAPHORS (computer objects)

Info Hierarchies

- File cabinet and folders
- Encyclopedia with articles
- Shopping mall with stores

Books with chapters

Info Environments

- Library with doors, rooms or collections
- City of Knowledge with multiple gates and landmarks

Support tools

- Maps and overviews
- History stack
- Communications tools (email, b-boards, listservs...)

Help and tours

Guides with introductions

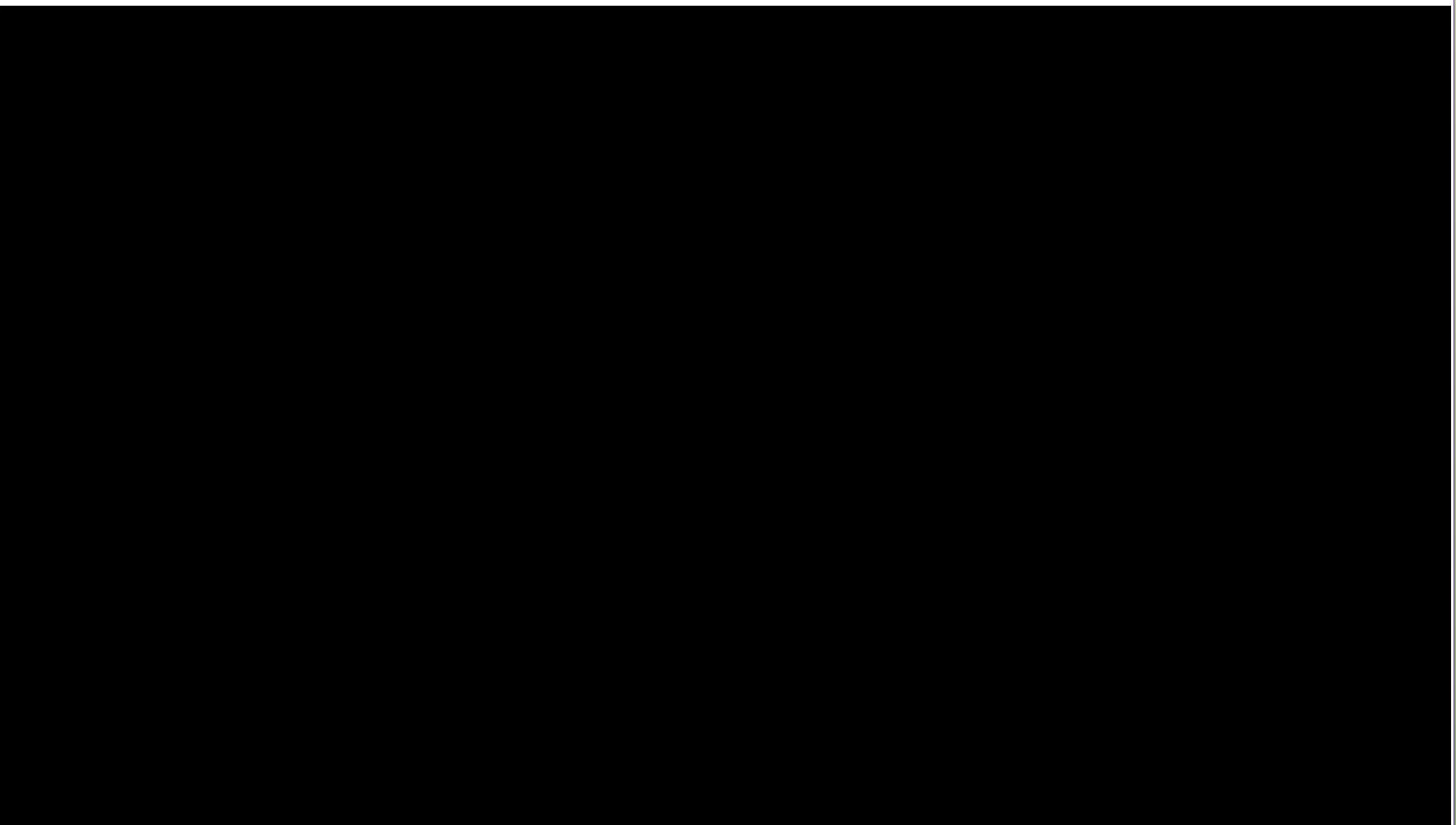
https://www.youtube.com/watch?v=qkP_GEewQz8

How can you make use of a “lens”-based metaphor in your design?

Should we use metaphors in design?

- Metaphors are the most basic approaches to thinking, learning, and feeling
- Whether explicit or not, **people will generate metaphoric comparisons on their own.**
 - Ask a novice user to explain to you how a computer works
 - I went *into* this, then it brought me *over* here, then it *opened* ...
- Metaphor mismatches may be inevitable
 - HCI designers must learn all they can about metaphors
 - How they function and affect thinking, action, and feelings
 - How they can be systematically incorporated into design

Searching for new metaphors?



<https://www.youtube.com/watch?v=f3qTEpHTQyg>

Watch these videos

- How to Learn Faster #25 Create a Lively Visual Metaphor or Analogy
 - <https://www.youtube.com/watch?v=yk1RSiO3yK8>
- Mac Spoofed: Metaphors
 - https://www.youtube.com/watch?v=_EFODz8bkVs&
- WIRED By Design: How Metaphors Make Us Love Some Designs and Not Others
 - https://www.youtube.com/watch?v=QET0r_naPjw
- Organizational Metaphors
 - Not directly related to interfaces, but important for understanding how metaphors structure ideas
 - https://www.youtube.com/watch?v=Xt_1qCHH_Qk

Summary of Metaphors

- Metaphors are **critical** in HCI
- Metaphors enable the transfer of knowledge, feelings, and actions
 - We think using metaphors and act accordingly
 - Metaphors are used for modeling computer systems
- Metaphors can be
 - Helpful (e.g., opening a file)
 - Misleading (e.g., rewind the printer?)
 - Part of a genre (e.g., the desktop genre)
- Not everything has an underlying metaphoric structure
 - e.g., Undo function
- Selection of one metaphor over another should be based on how well they allow users to correctly predict an HCI artifact's behaviour and function
 - Not on how well it models the real world