SWE 632 - Design & Development of User Interfaces

Class will start in:

20:00

George Mason University

Instructor:
Dr. Kevin Moran

Teaching Assistant:
David Gonzalez Samudio

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SWE 632 - Design & Development of User Interfaces

Fall 2020

George Mason University

Dr. Kevin Moran

Week 15:

Final Exam Review & Project Presentations

Administrivia

- Project Checkpoint 7 - *Due Today*
- Final Project Presentation - Today!
- Final Exam - Take Home, Out on Dec 9th, Due on Dec 15th
- Discussion Question This Week *- Final Exam Review*
- Course Evaluations*- Out Now, Available until Dec. 6th*

Final Exam

- Free response, essay questions
- Will include definitions, key ideas & concepts, how to use methods
  - May link multiple ideas together in applying them to a scenario
- Lectures, assigned readings, tech talks
- Will include 5-7 questions
- ***Exam will be Take-Home***
  - The Final Exam will be released on ***December 9th***, and due on ***December 15th***.

Final Exam Review

Week 8 - Site Design

Challenges in Site Design

- Sometimes large space for users to navigate to find information.
- No spatial sense of scale. 50 pages? 500 pages? 50,000 pages?
- No sense of direction. Which way did I just go?
- No sense of location. No spatial anchoring of where I am now and how that relates to where I could go.
- No place to check if something is *not* present or supported.

Site Design

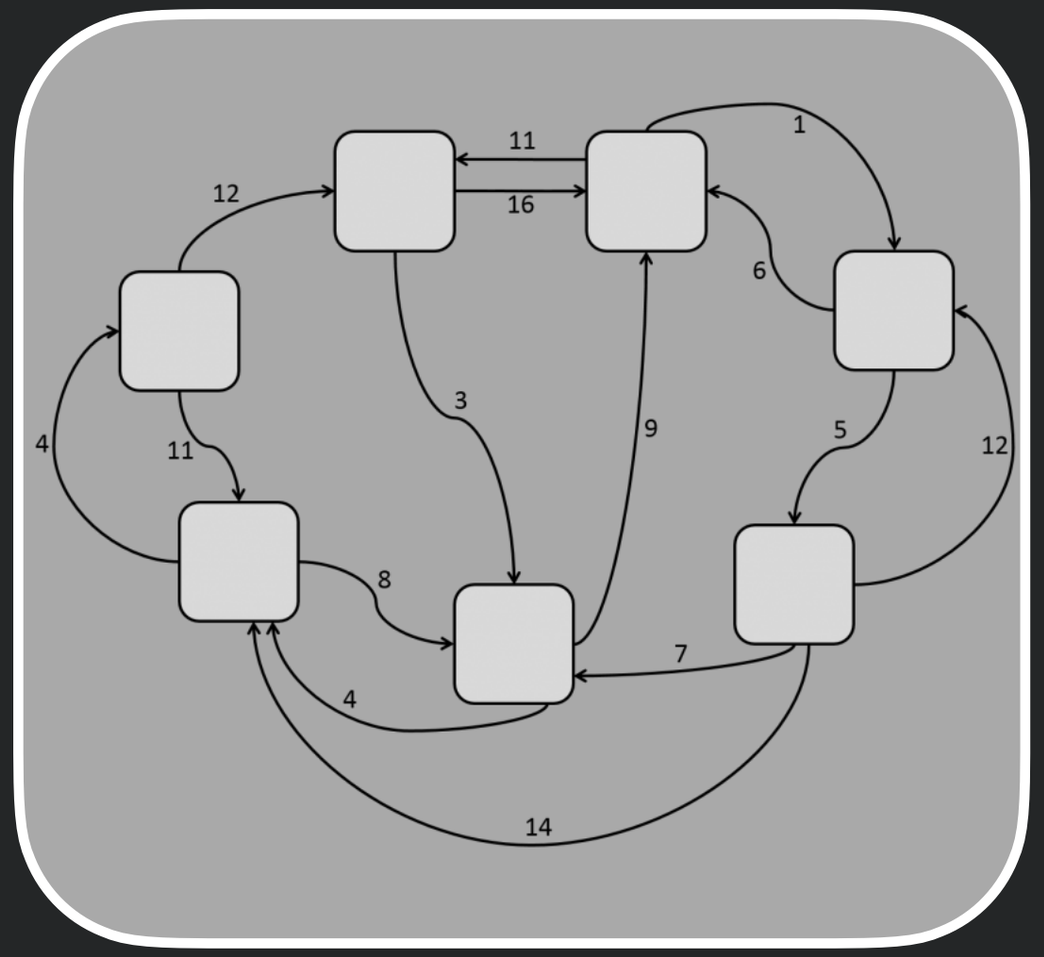
- Some key design dimensions
  - Organization of content into pages / screens
  - Organization of content within pages / screens
  - Ways in which users navigate between pages / screens
- Key design goals
  - Reduce the time / cost for users to reach content
  - Reduce the irrelevant information users must read

Information Foraging

- Mathematical model describing navigation
- Analogy: animals foraging for food
  - Can forage in different patches (locations)
  - Goal is to maximize chances of finding **prey** while minimizing time spent in hunt
- Information foraging: navigating through an information space (patches) in order to maximize chances of finding prey (information) in minimal time

Information environment

- Information environment represented as ***topology***
  - Information ***patches*** connected by traversable ***links***
- Examples
  - Web pages, connected by links
  - Menu options & dialogs connected by commands
  - Locations on map, connected by search, scroll, move interactions with map



Traversing Links

- Patch - a space in the environment where a user is located (e.g., a page, a dialog)
- Links - connection between patch offered by the information environment
- Cues - information features associated with outgoing links from patch
  - E.g., text label on a hyperlink
- User must choose which, of all possible links to traverse, has best chance of reaching prey

Simplified mathematical model

- Users make choices to maximize ***possibility*** of reaching prey per cost of interaction
- Predators (idealized) choice = max [V / C]
  - V - value of information gain, C - cost of interaction
- Don’t usually know ground truth, have to estimate
- Predator’s desired choice = max [E[V] / E[C]]

Hierarchy

- Information in sites is hierarchical
  - Different pages at different levels of hierarchy
  - May be different navigation elements that lead into different subtrees
- Important to signal
  - what are hierarchies are present
  - which navigation elements are part of the same hierarchy
  - where the user currently is on each hierarchy

Web navigation conventions

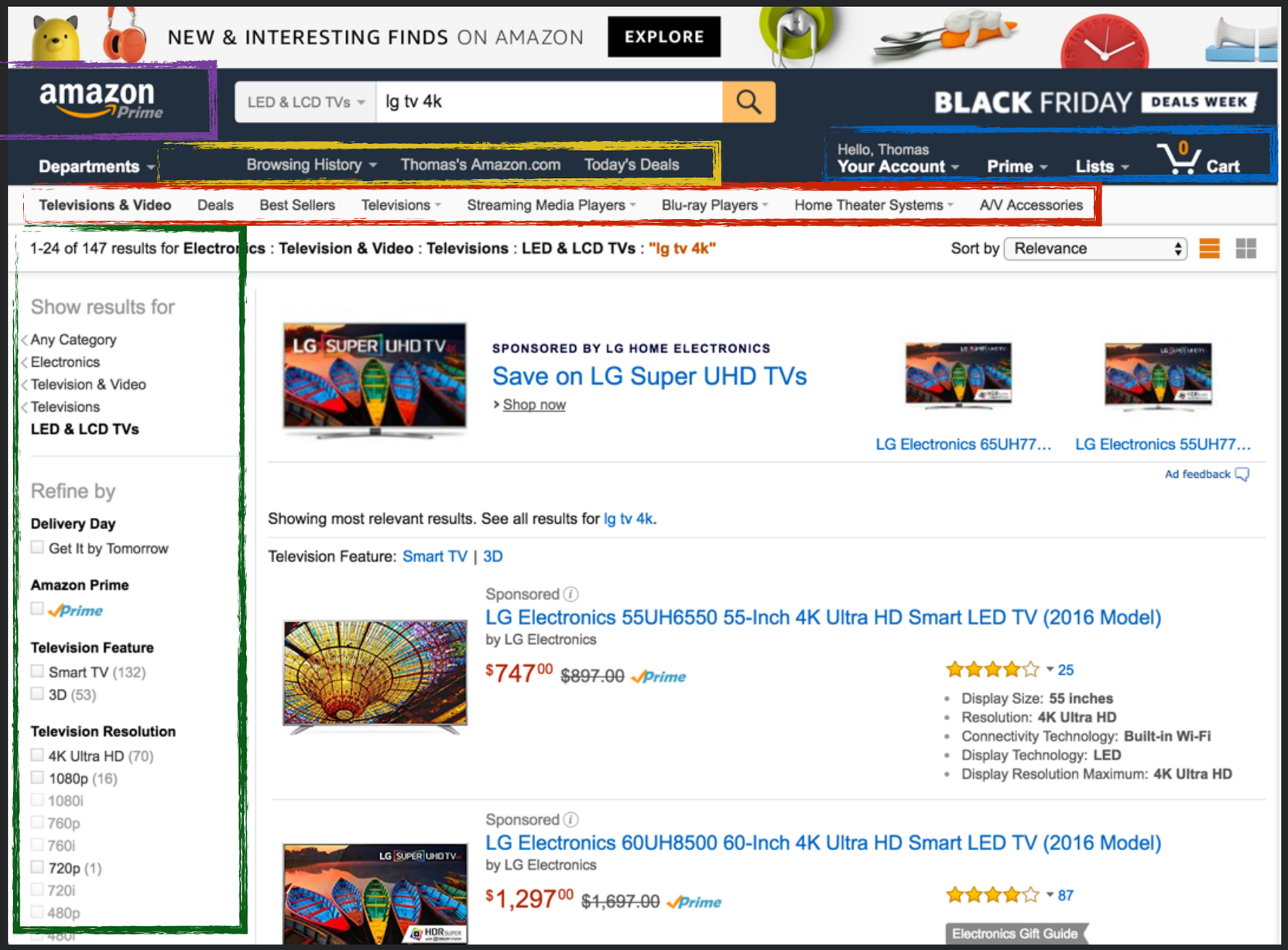
Site ID

You are here

Local navigation

Utilities

Sections



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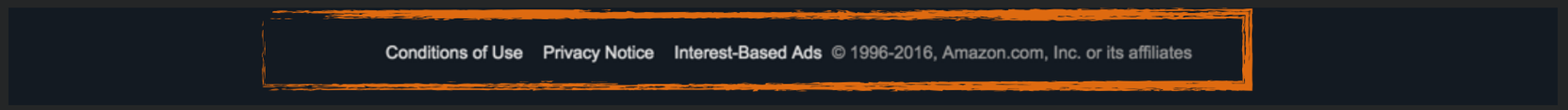
Footer navigation

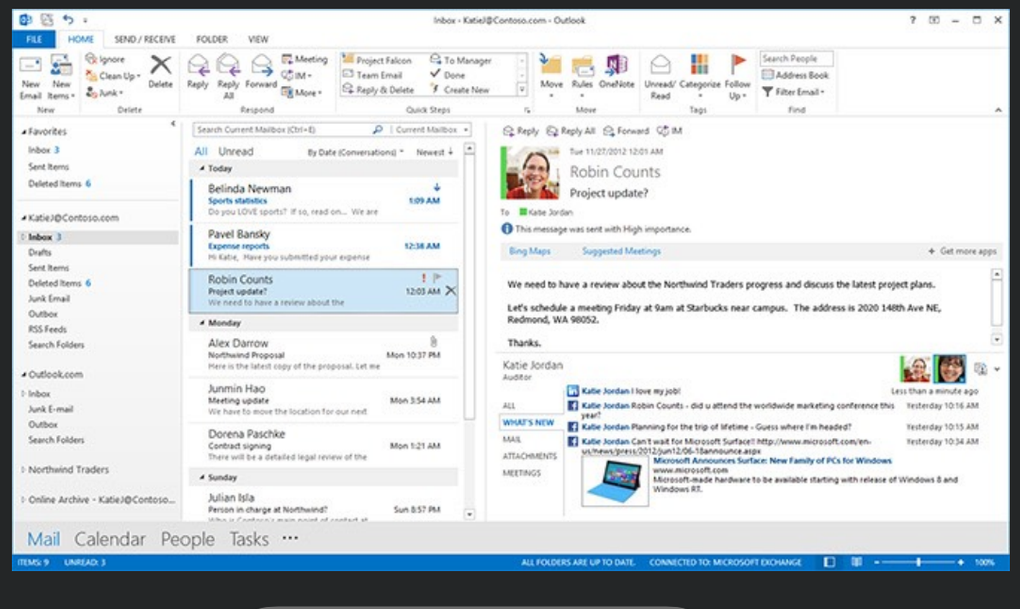


Alternative - Idioms

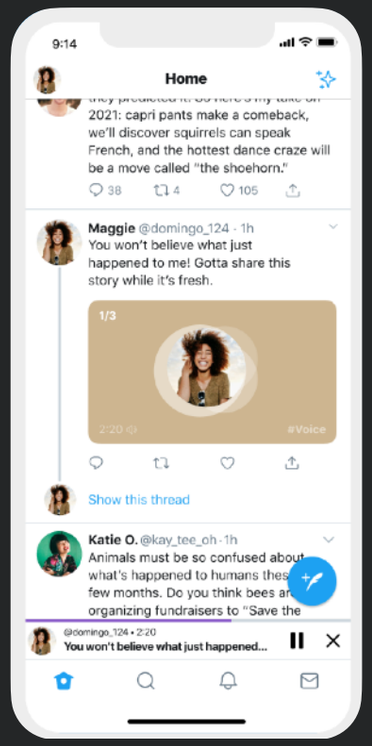
- A consistent mental model of how something works
  - e.g., Files: open / close / save / save as
- Offers intuitive understanding of affordances & interactions
- Provides consistent vocabulary for describing interactions
- Only have to learn it ***once***
- Might have originated in real world, but thought of in terms of mental model for UI interactions

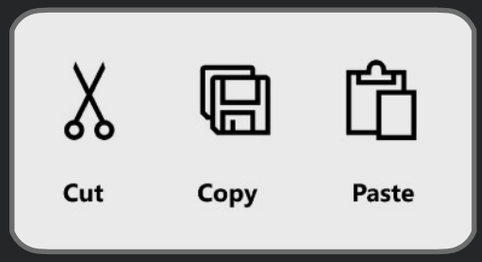
Examples of Idioms

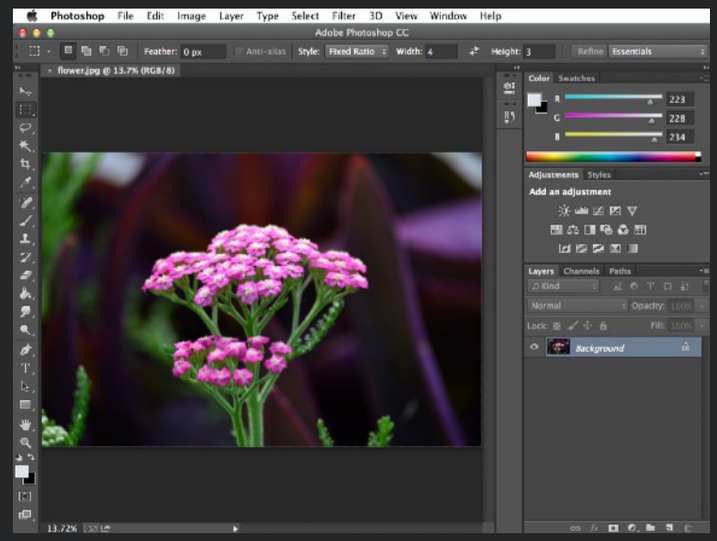
- Email
- Clipboard: cut / copy / paste
- Format painter



- Newsfeed
- Follow item







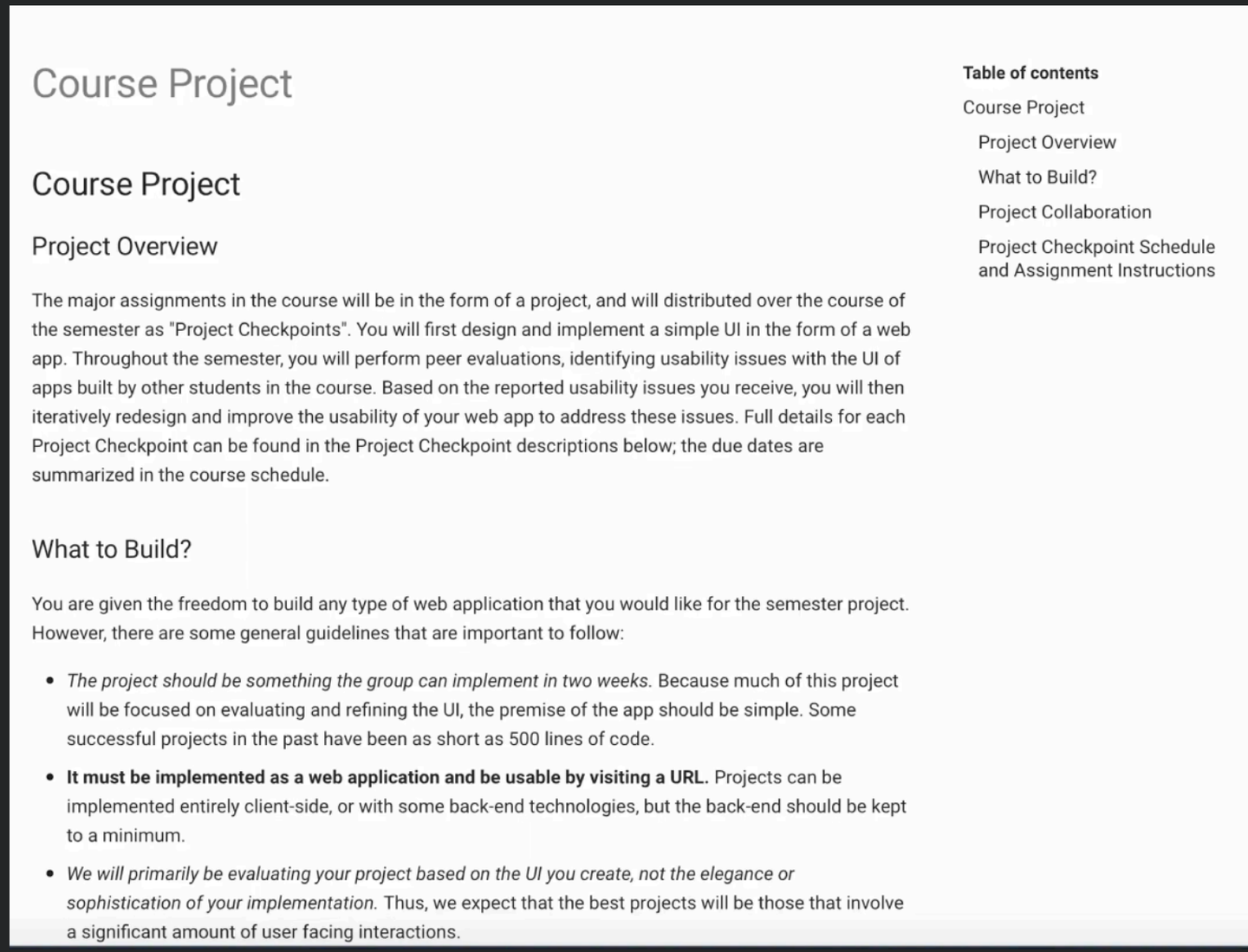
Interaction Flow Guidelines

- Don’t use dialogs to report normal behavior
- Separate commands from configuration
- Don’t ask questions, give users choices
  - Give users default input, show possible options
- Make dangerous choices hard to reach
- Design for the probable, provide for the possible

Week 9 - Interaction Design

Hinting

- Indicate which UI elements can be interacted with
- Possible visual indicators
  - ***Static hinting*** - distinctive look & feel
  - ***Dynamic hinting*** - rollover highlights
  - ***Response hinting*** - change visual design with click
  - ***Cursor hinting*** - change cursor display



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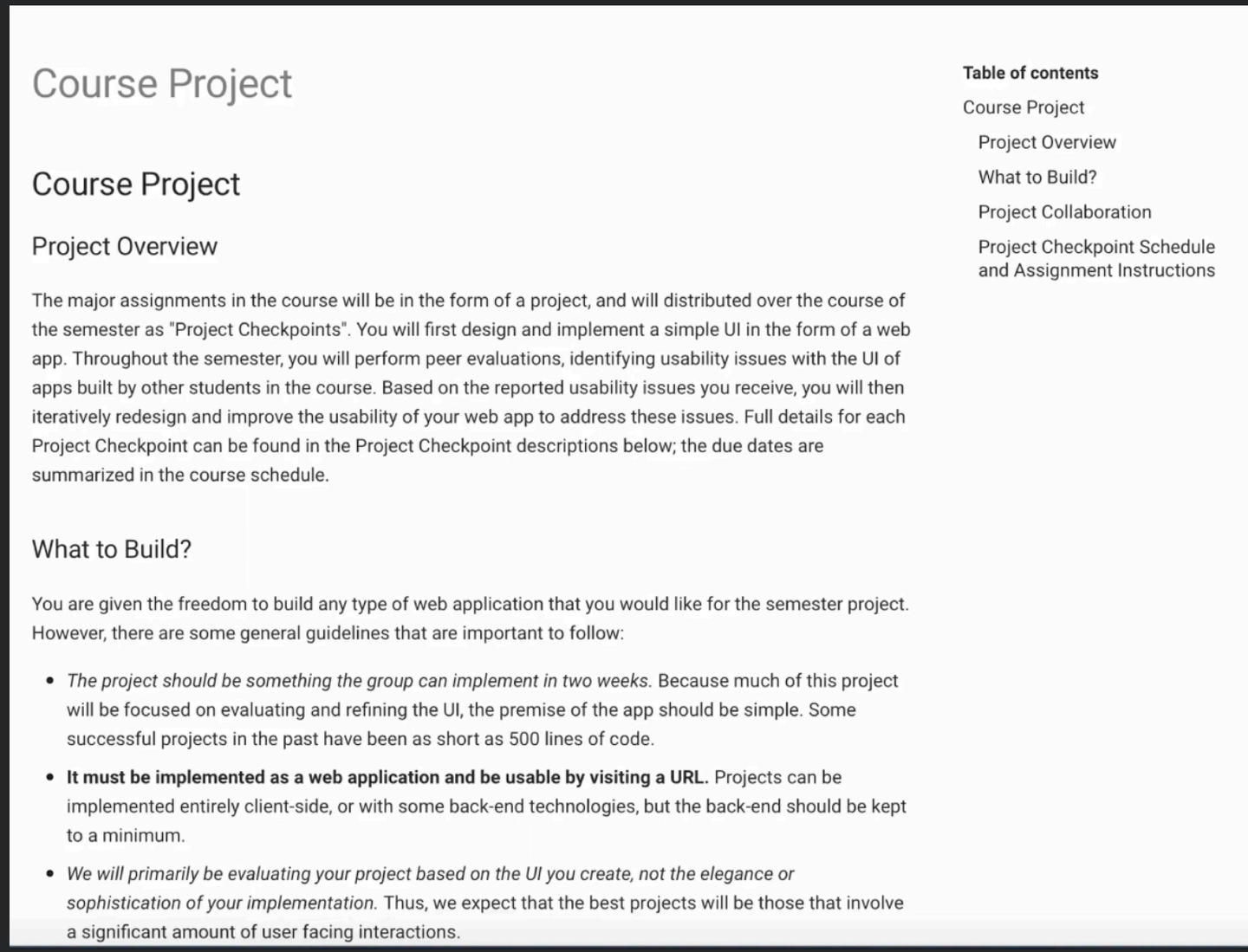
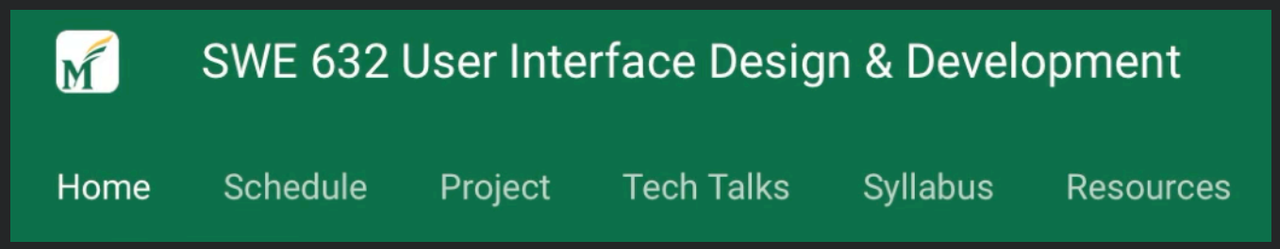


Command Interactions

- How can a user invoke a command?
- Common examples
  - Menus
  - Buttons
  - Toolbar
  - Dialog box
  - Keyboard shortcut
  - Gesture
- What are some advantages and disadvantages of each approach?

Moving the Mouse



- After a user has (1) realized that a region is interactable, (2) decided that it will cause the desired action to be invoked
- How long does it take for a user to move the cursor to click on it?
- What factors might influence this time?

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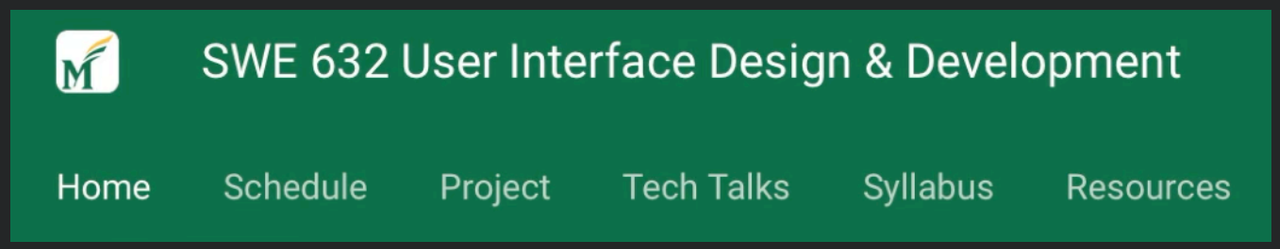

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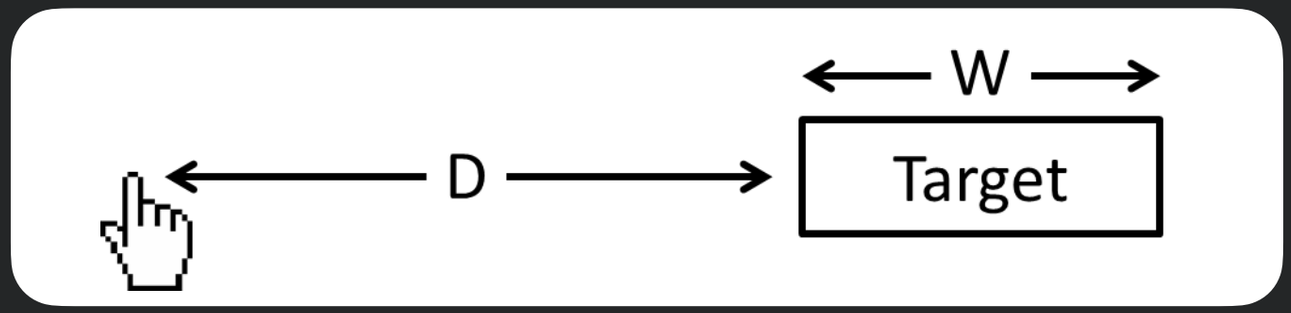
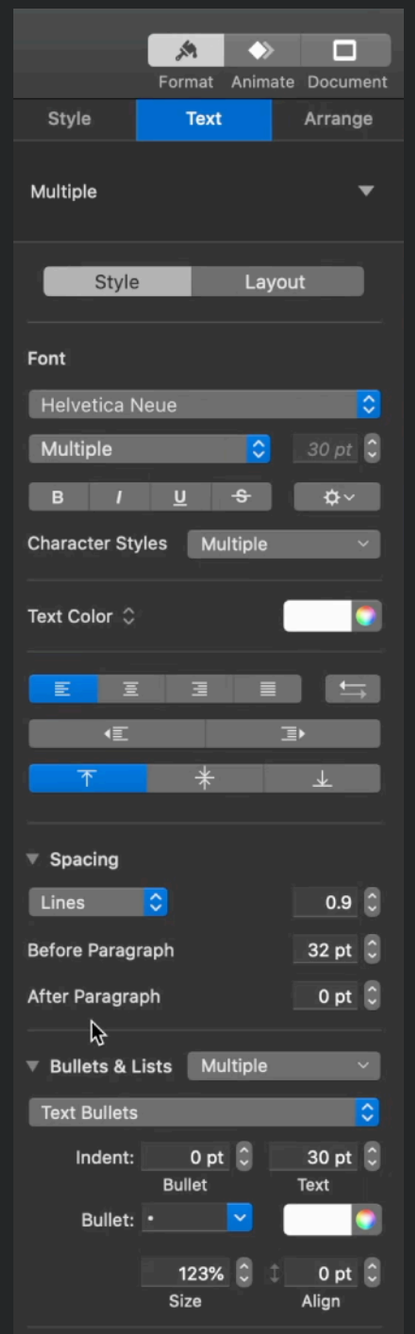
Fitt's Law



- Time required to move to a target ***decreases*** with target ***size*** & ***increases*** with ***distance*** to the target
- Movements typical consist of
  - one large quick movement to target (***ballistic*** movement)
  - fine-adjustment movement (***homing*** movements)
- Homing movements generally responsible for most of movement time & errors
- Applies to rapid pointing movements, not slow continuous movements



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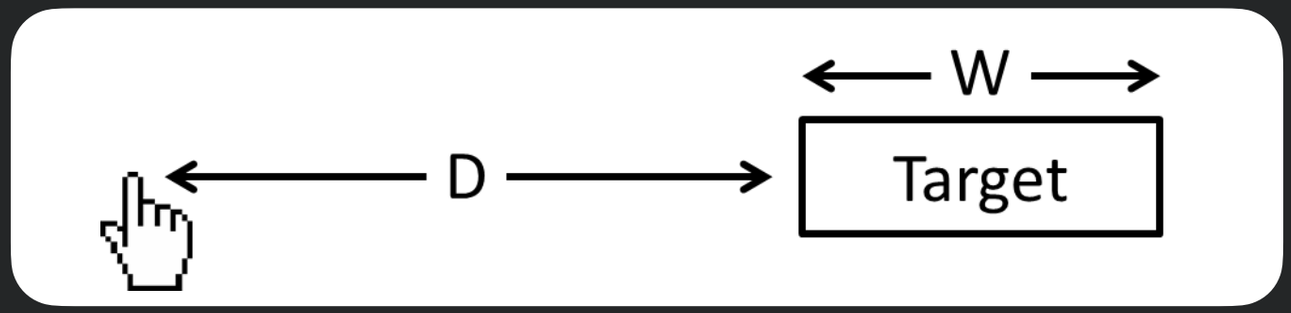

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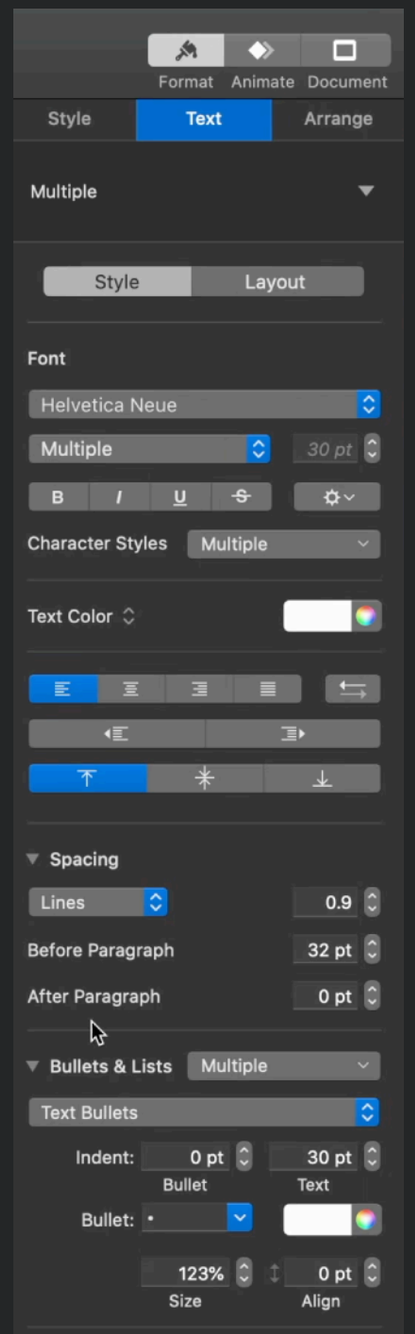

Responsive Design

- Mobile devices often have smaller form factor than desktop / laptop OS
- Can design a separate UI
- Or may build a ***fluid*** UI that rescales for different display sizes

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Supporting Users with Disabilities

- **Perception** - visual & auditory impairments
  - Blindness or visual impairments
  - Color blindness
  - Deafness & hearing limitations
- **Motion** - muscle control impairments
  - Difficulties with fine muscle control
  - Weakness & fatigue
- **Cognition** - difficulties with mental processes
  - Difficulties remembering
  - Difficulties with conceptualizing, planning, sequencing actions

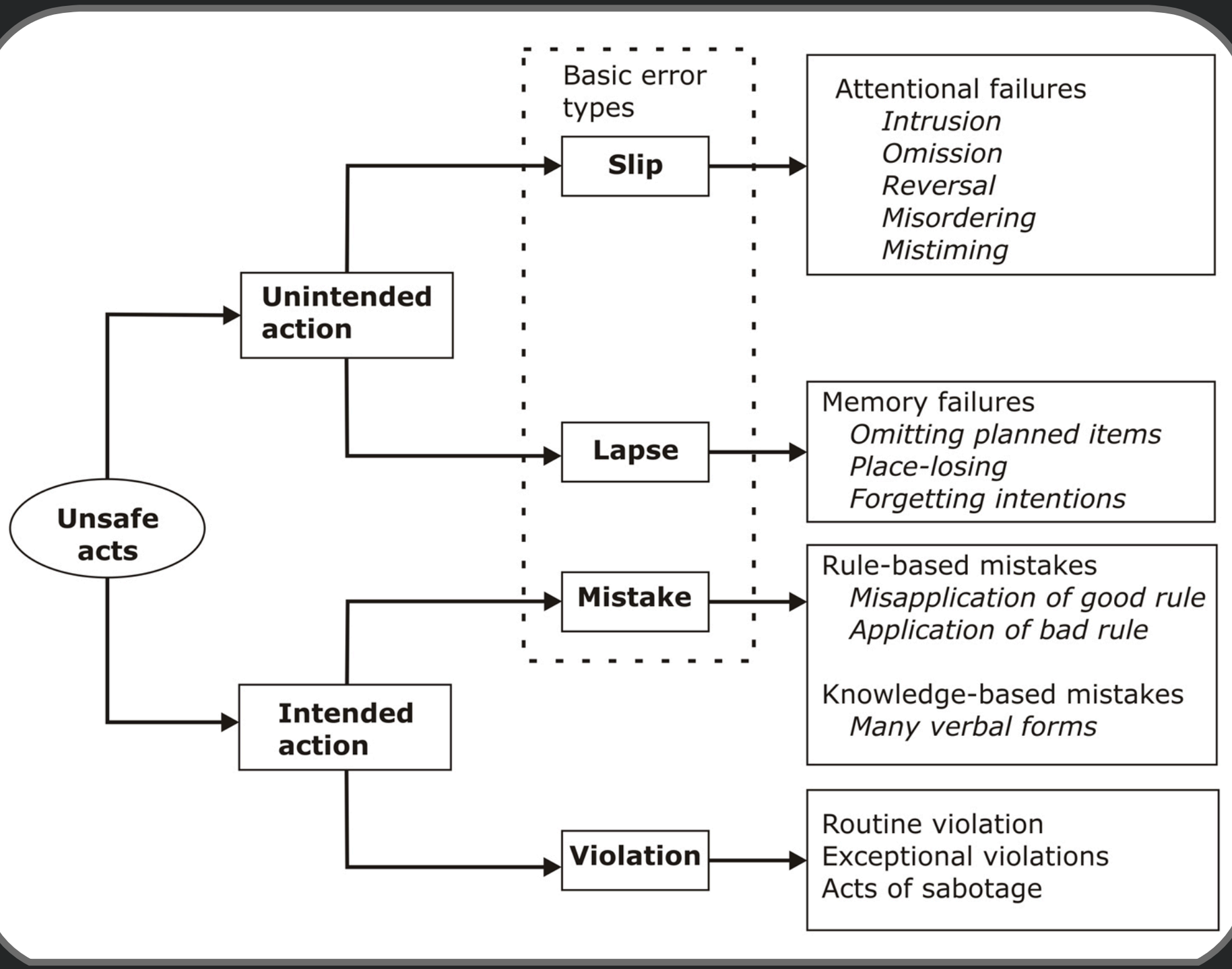
7 Principles of Universal Design

- ***Equitable use:*** The design is useful and marketable to people with diverse abilities
- ***Flexibility in use:*** The design accommodates a wide range of individual preferences and abilities
- ***Simple and intuitive:*** Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level
- ***Perceptible information:*** The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities
- ***Tolerance for error:*** The design minimizes hazards and the adverse consequences of accidental or unintended actions
- ***Low physical effort:*** The design can be used efficiently and comfortably and with a minimum of fatigue
- ***Size and space for approach and use:*** Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility

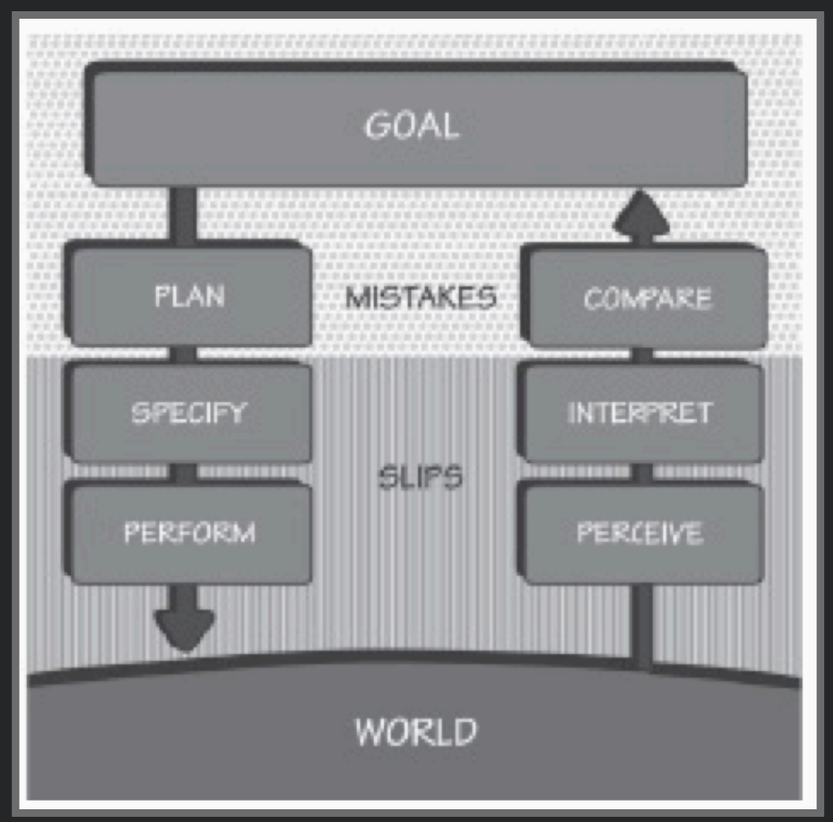
http://universaldesign.ie/What-is-Universal-Design/The-7-Principles/

Week 10 - Preventing Error

Psychological Types of Unsafe Acts



Error & the Seven Stages of Action



- ***Novices*** *are more likely to make mistakes than slips, and* ***experts*** *are more likely to make slips.*

Some Strategies for Designing for Errors

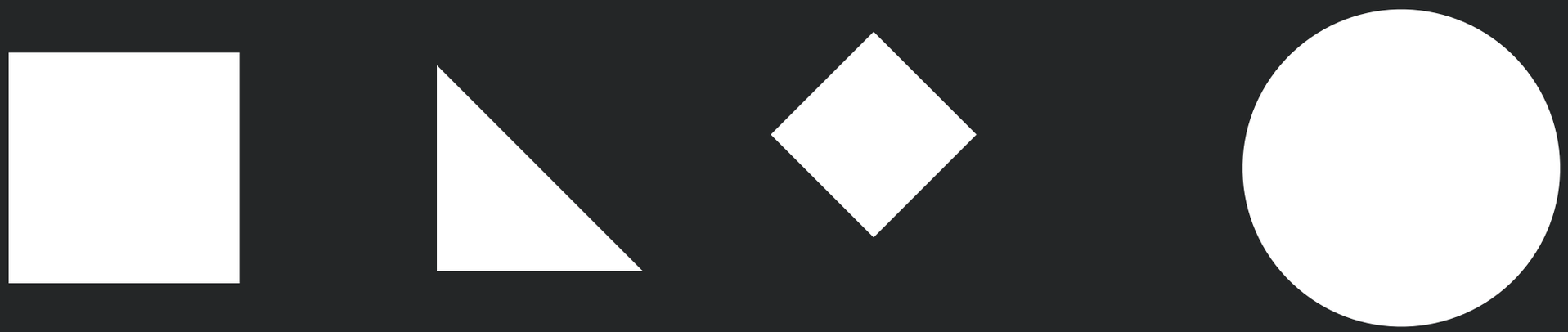
- Understand the cause, and fix it
- Make it possible to reverse errors
- Offer feedback that enables users to discover and correct errors
- Don't treat actions as errors, but as manipulations

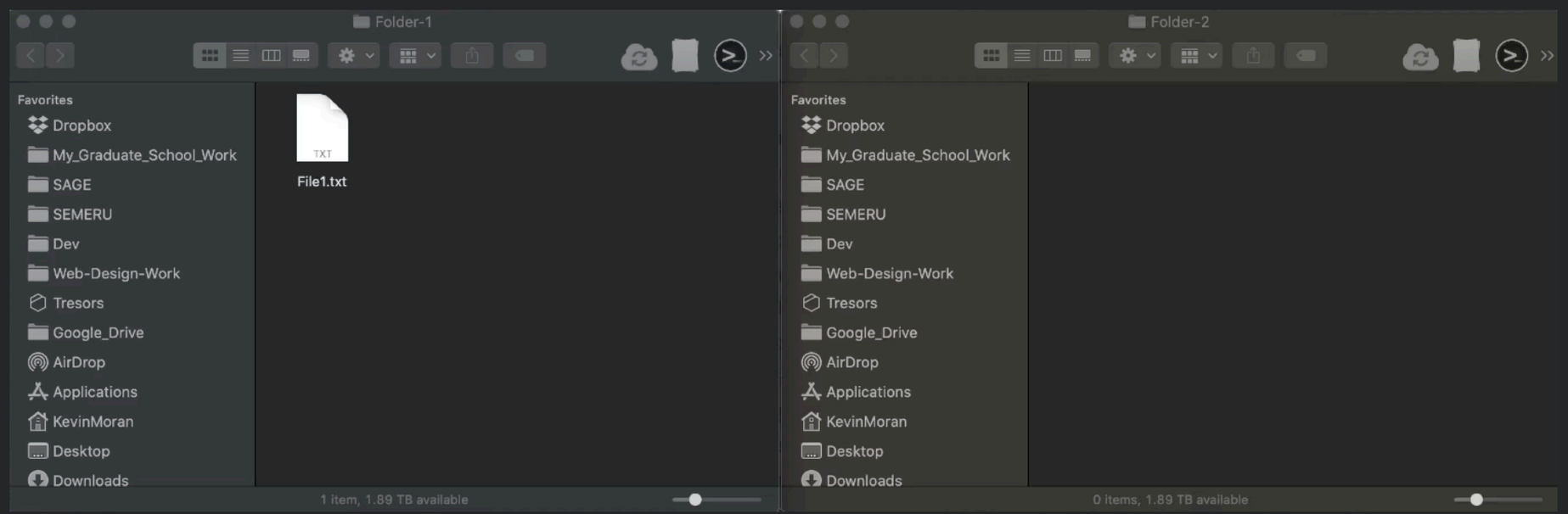
Norman's Key Design Principles

1. Put the knowledge required to to operate the technology in the world
2. Use the power of natural and artificial constraints
3. Bridge the two Gulfs: the Gulf of Execution and the Gulf of Evaluation
    - Execution: Make options readily available
    - Evaluation: Provide Feedback

Direct Manipulation

- “Rapid incremental reversible operations whose impact on the objects of interest is immediately visible” (Shneiderman, 1982)





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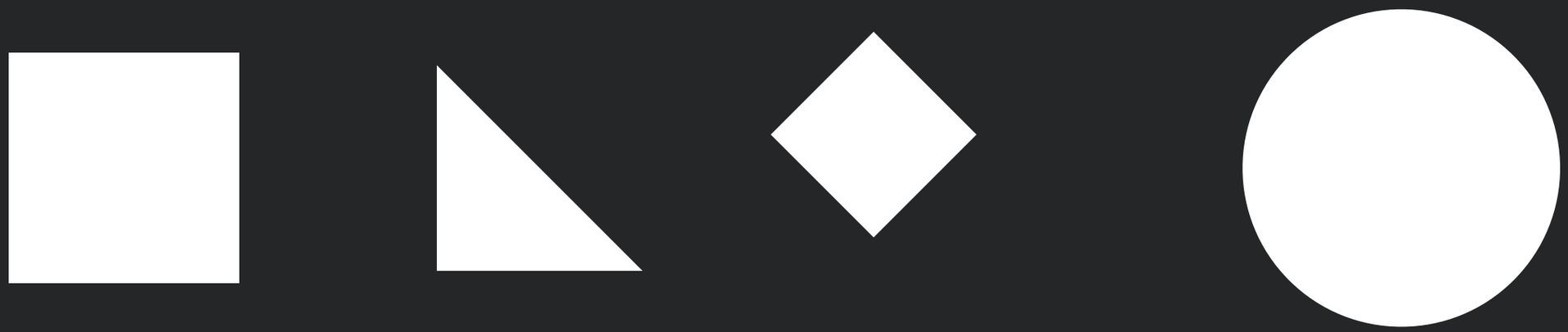
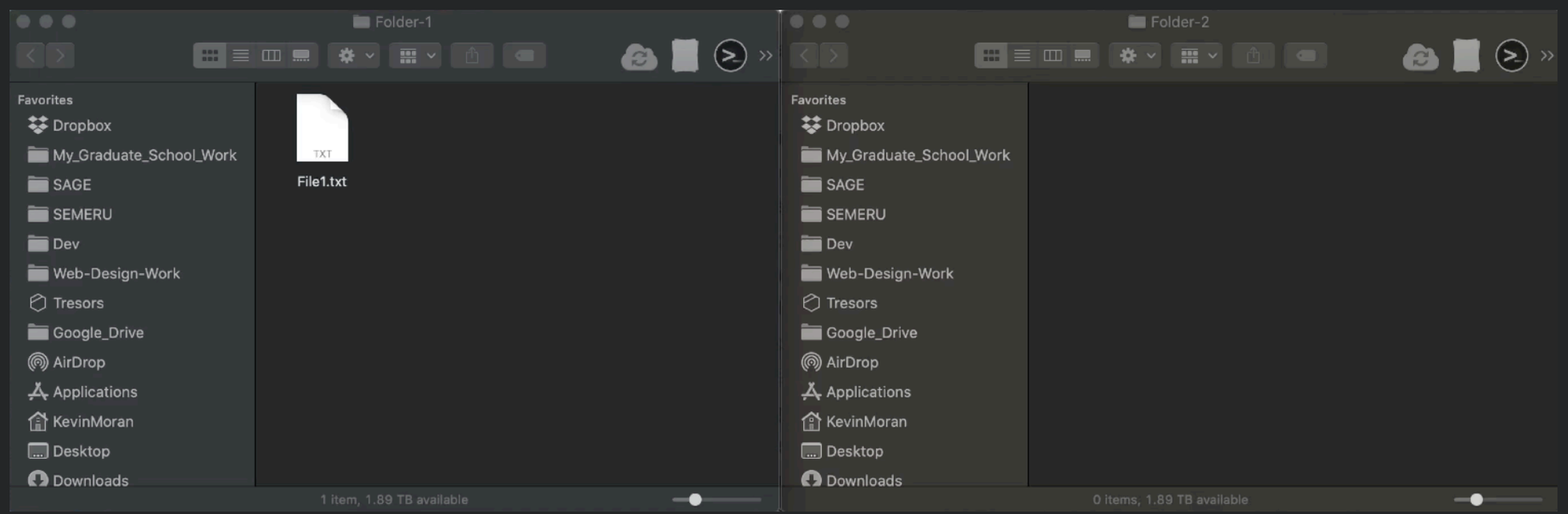




Direct Manipulation Characteristics

- Continuous Representation of the Object of Interest
- Physical Actions instead of complex syntax
- Continuous feedback and reversible, incremental actions

Benefits

- Supports exploration
  - Don’t plan long sequence of actions: pick an action, try it, can change mind if want to do something else instead
- Provides immediate feedback
  - Can quickly see what outcome of actions are in manipulating the world
  - Easy to compare desired state of the world to actual state of the world

Drawbacks

- Only a small Number of Objects on screen at once
- It can be physically demanding on the user
- Can be relatively slow
  - If the user needs to perform a large number of actions, it may be impractical
- Repetitive tasks are not well supported
  - e.g. can be better for novices to learn, but harder to experts to exploit
- Some gestures can be error prone

Week 12 -Visual Design

Visual Design

- *Solving **communications problems** in ways that are both functionally effective and aesthetically pleasing.*

- Creating a visual language containing a vocabulary of design elements characterized by

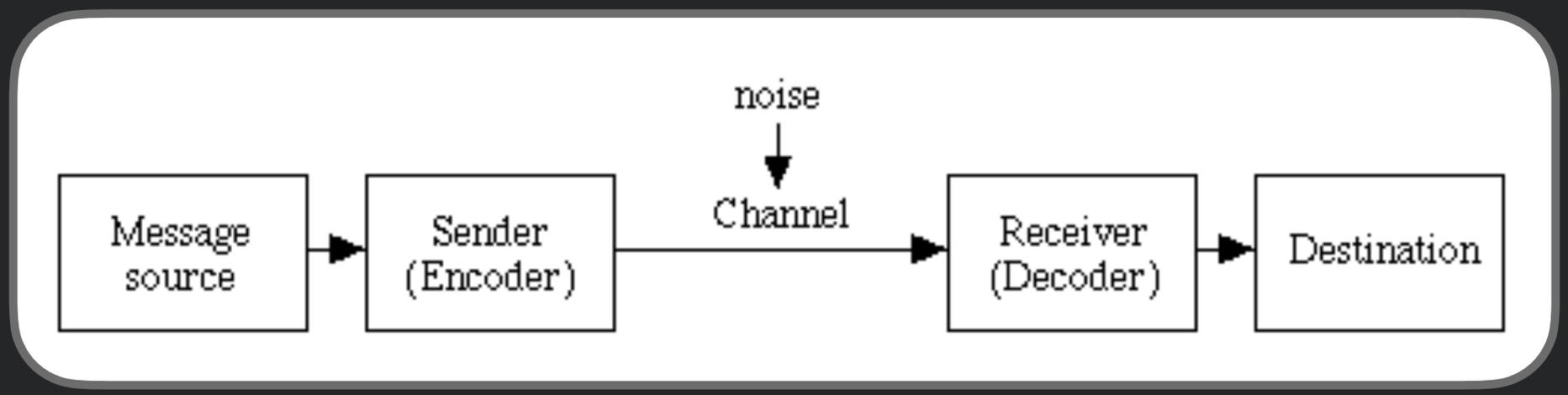
  - Visual variables—shape, size, position, orientation, color, texture, …

  - Organizational relations between elements—balance, structure, proportion, …

  - Visual syntax—rules for assembling elements w/in design language

Visual Design as Communication

- Goal: ***efficiently*** & ***accurately*** transmit information from system to user
- Visual variables & organization encode information



Goals for Visual Design

- Successfully ***transmit*** information
- Present coherent & consistent design that reduces ambiguity and potential confusion
- Reduce visual ***search*** time through layout & organization
- Create desired ***emotional*** reactions through aesthetic choices

Elegance & Simplicity

- ***Elegance*** — derives from Latin eligere, to “select carefully”
- ***Judicious*** selection of elements and economy of expression revealing an intimate understanding of problem
- Removing & combining superfluous elements until only the necessary remains

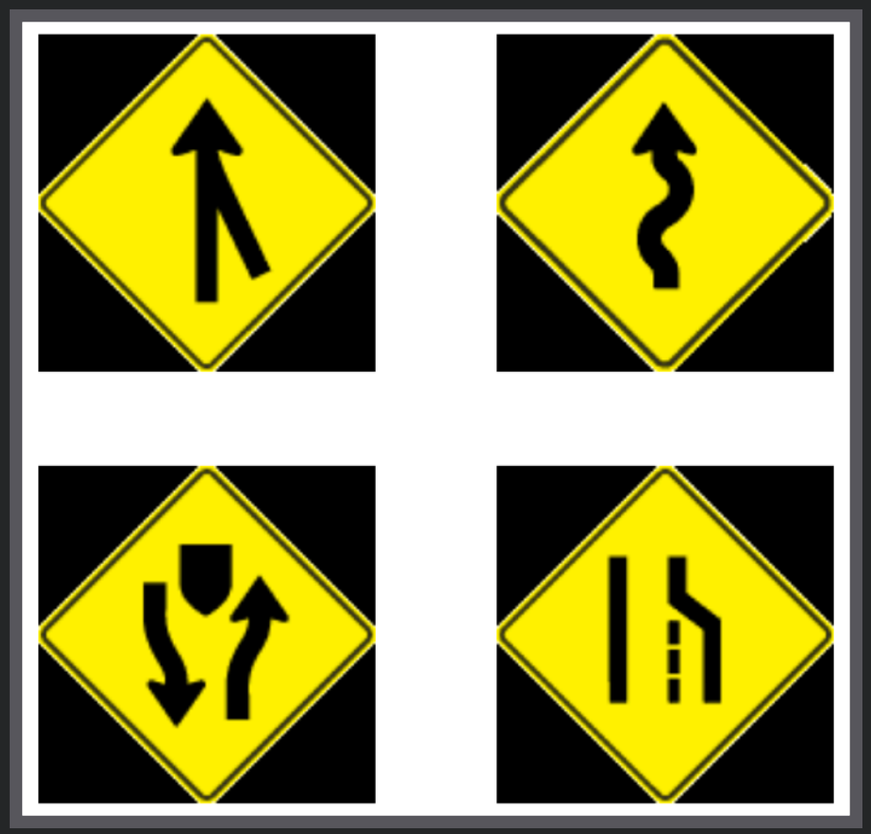
Benefits of Simplicity

- ***Approachability*** - rapidly understood affordances, allowing glanceable understanding of possible interactions

- ***Immediacy*** - greater emotional impact because interactions can be quickly understood

Marc Berthier. Tykho Radio. 1997. Synthetic rubber and other materials, 5 1/2 x 5 1/2 x 1 5/8″ (14 x 14 x 4.1 cm). Manufactured by Lexon, France. The Museum of Modern Art, New York. Gift of the manufacturer.

Reducing a Design to its Essence



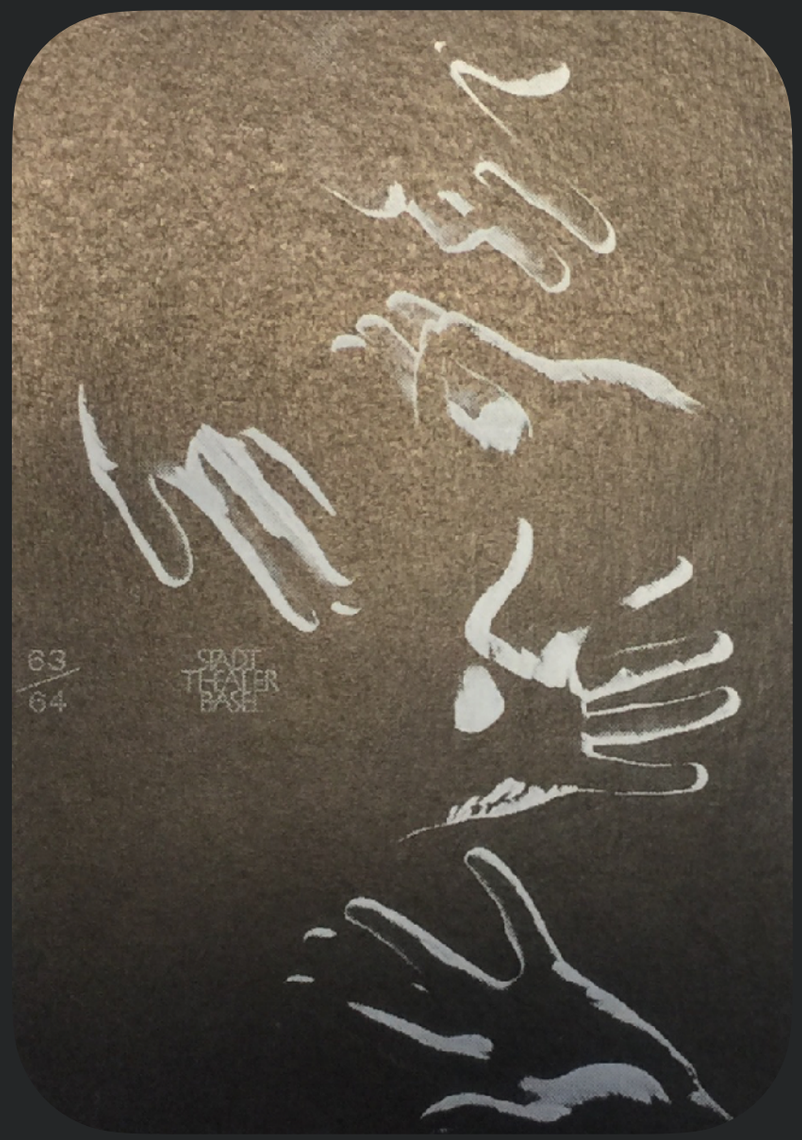
- Make design simple, bold, and direct by removing inessential details & elements
  - Even essential elements may be suggested

1. *Determine essential qualities & information to be conveyed*

2. *Critically examine each element & ask how design would suffer without it.*

3. *Try removing elements. What happens?*

Terminology



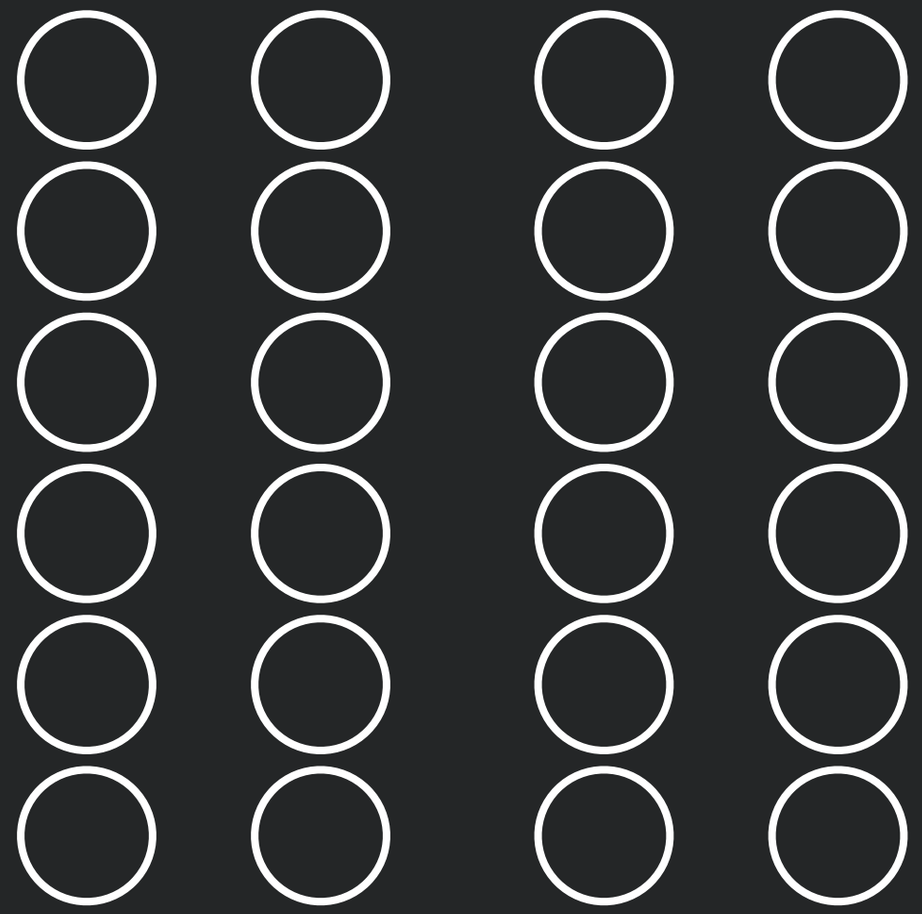
- Scale - ***relative*** size or magnitude of element in comparison to related elements
- Contrast - visually noticeable ***distinctions*** along a common visual dimension
- Proportion - ratio and ***balance*** between elements
- Emphasis - contrasts can emphasize important elements or areas & add visual ***interest*** by creating tension & drama

Principles

- ***Clarity*** - contrasts should be clear and easily differentiated, not slight and subtle
- ***Harmony*** - proportions and ratios should be harmonious
- ***Activity*** - use contrasts to maintain orientation & context within design
- ***Restraint*** - contrasts should be conscious, strong, few in number, and never overwhelming

Gestalt Principle - Proximity

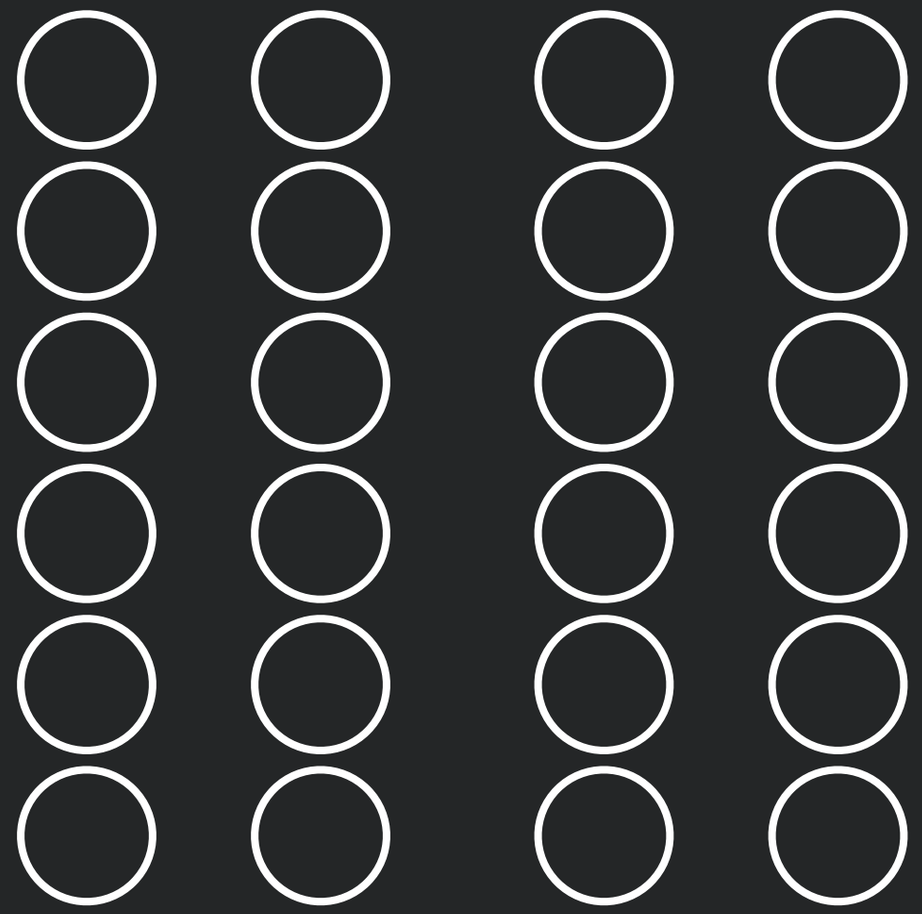
- Elements associated ***most*** strongly w/ nearby elements



Gestalt Principle - Proximity

- Elements associated ***most*** strongly w/ nearby elements

parsed as 4 columns based on close vertical spacing
then parsed as two sets of two columns based on spacing



Gestalt Principle - Similarity

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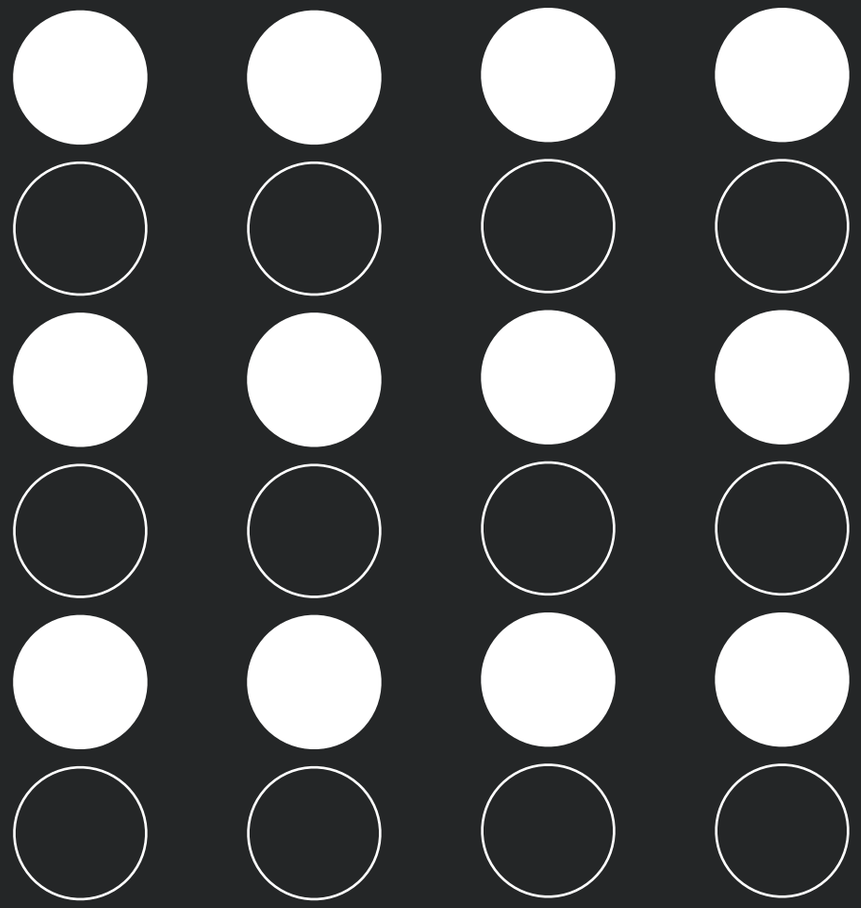

Gestalt Principle - Similarity

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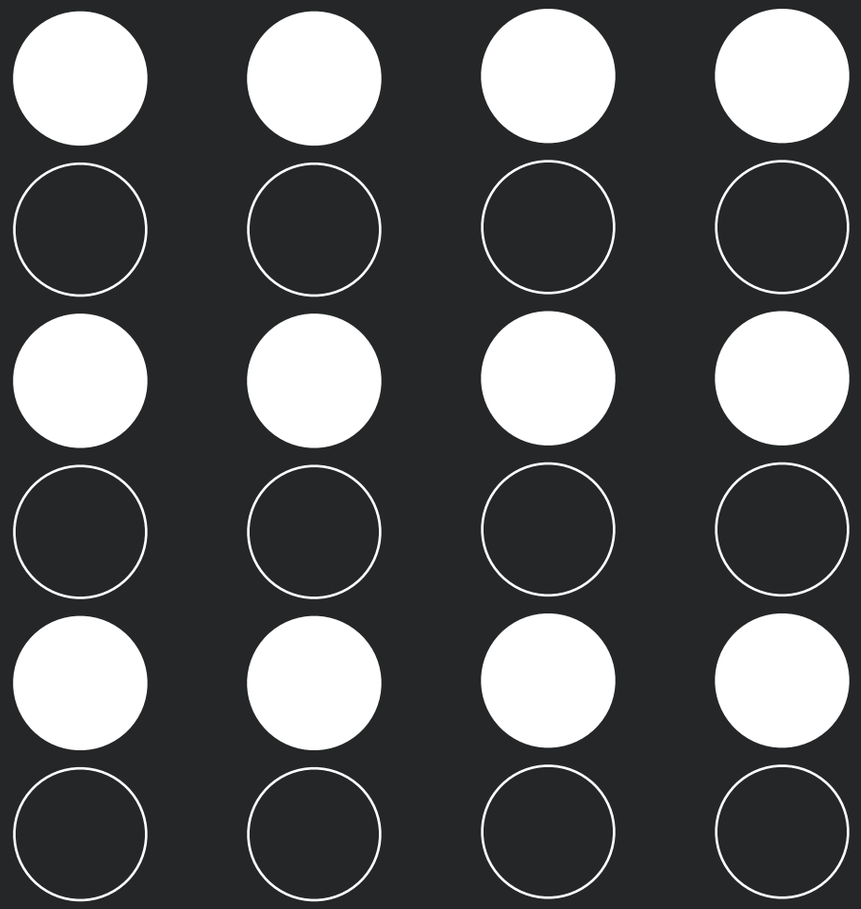
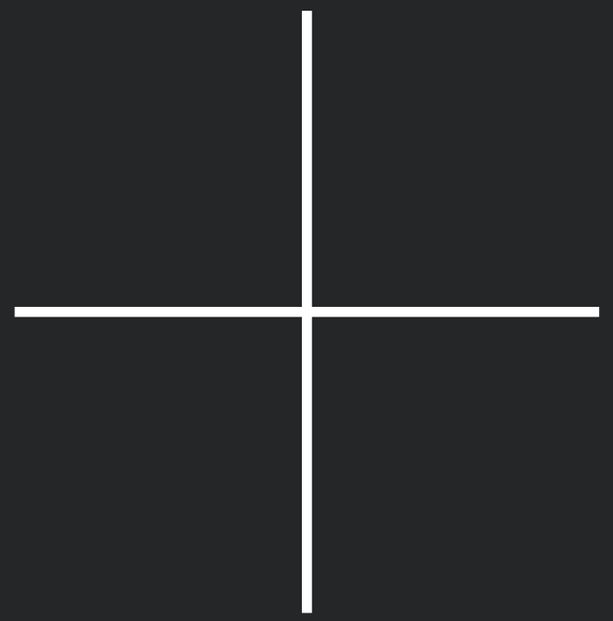
parsed as rows based on fill similarity,
despite closer column spacing



Gestalt Principle - Continuity

- Preference for ***simplest*** physical explanation of complex figure



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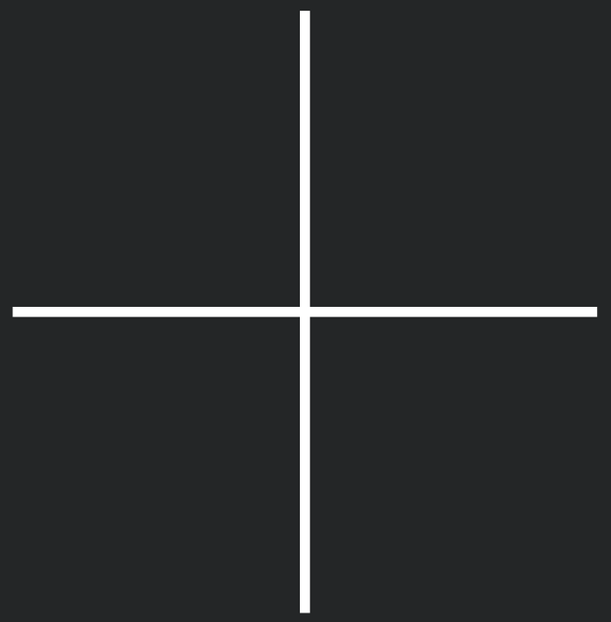
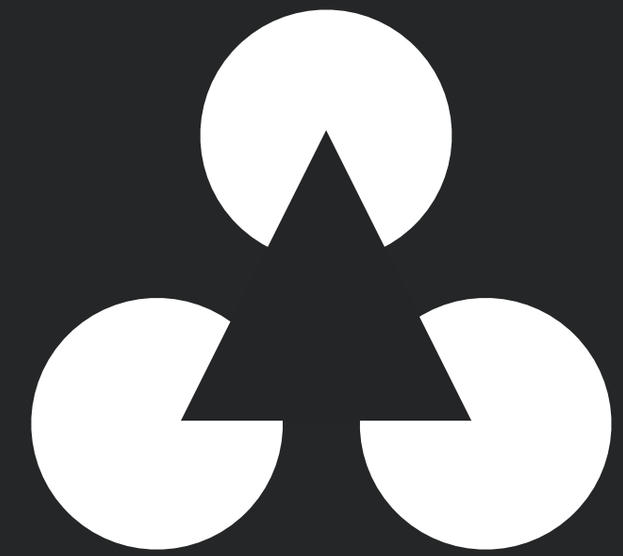
parsed as two lines, rather than 4 separate lines or 4 opposing angles



Gestalt Principle - Closure

- Preference to interpret figures as complete, even when missing information



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Parsed as triangle superimposed on 3 complete circles, even though none of these is actually present

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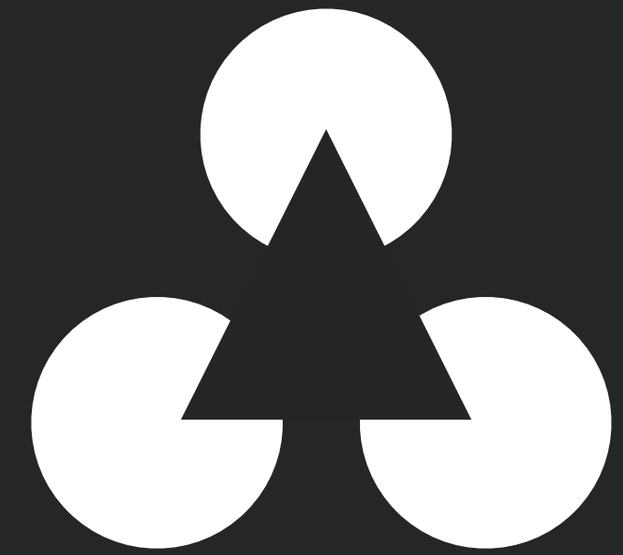

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Gestalt Principle - Area

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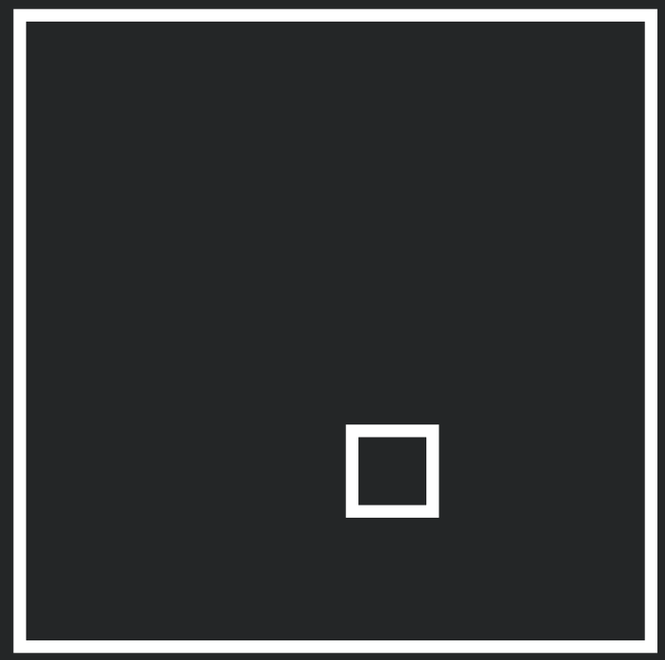

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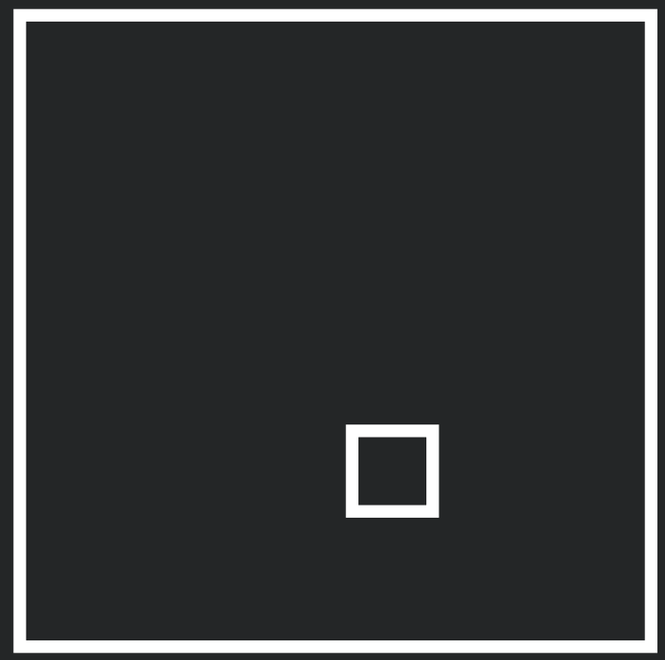

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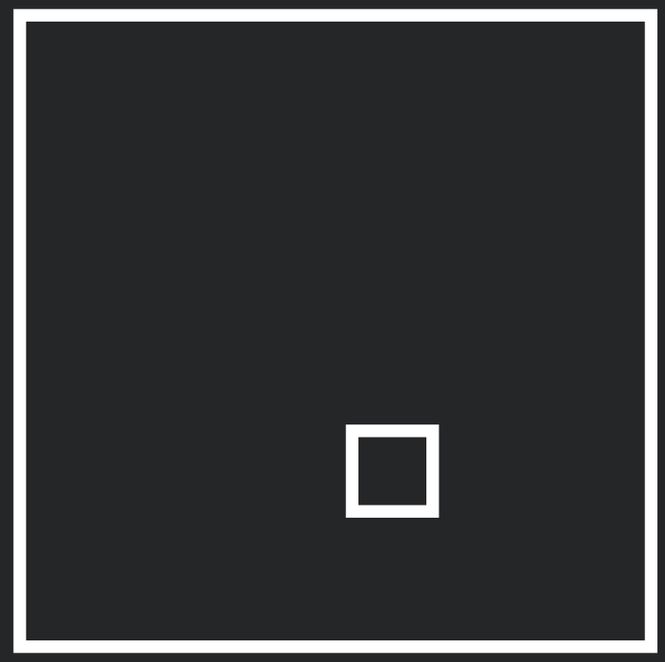
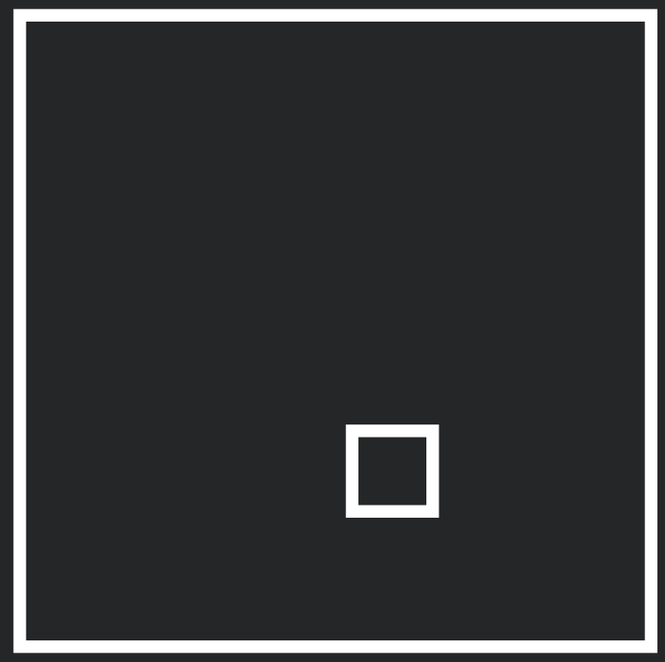


Gestalt Principle - Area

- Preference to interpret smaller overlapping elements as figure, larger as ground

Small rectangle parsed as small rectangle on top of larger, rather than hole



Gestalt Principle - Symmetry

- Preference to interpret ambiguous form as multiple symmetric elements

Parsed as two overlapping objects rather than 3 separate shapes

Hierarchy

Order groups based on perceptual prominence corresponding to intended reading sequence

Can help solve “skimming” problems

Structure can help people focus attention on key parts

Key points might **get lost though.**

Hierarchy

Order groups based on perceptual prominence corresponding to intended reading sequence

Can help solve “skimming” problems

Structure can help people focus attention on key parts

Key points might **get lost though.**

But bolding helps! Plus this obnoxious red arrow and text in a totally different font!

Types of Iconic Representation

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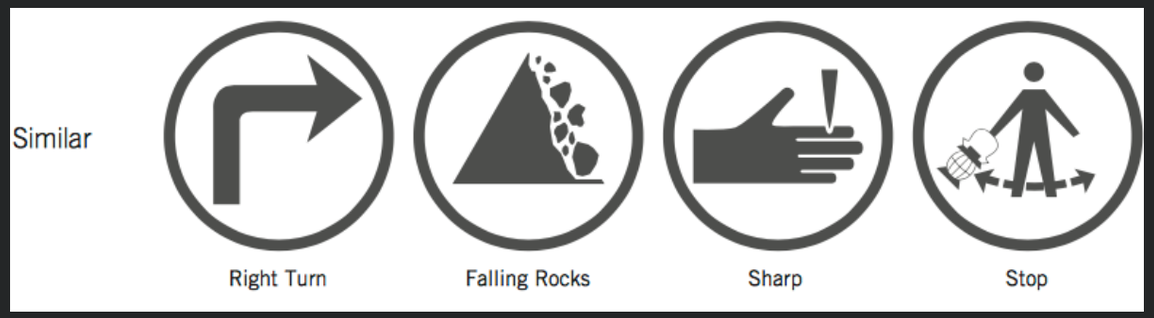
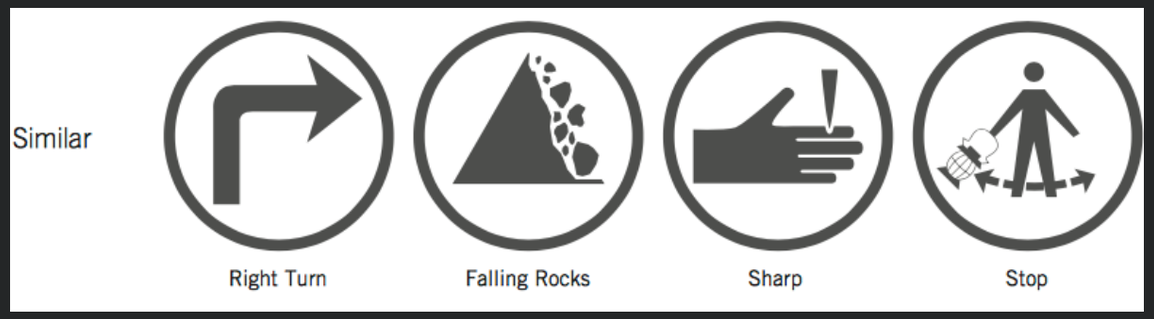
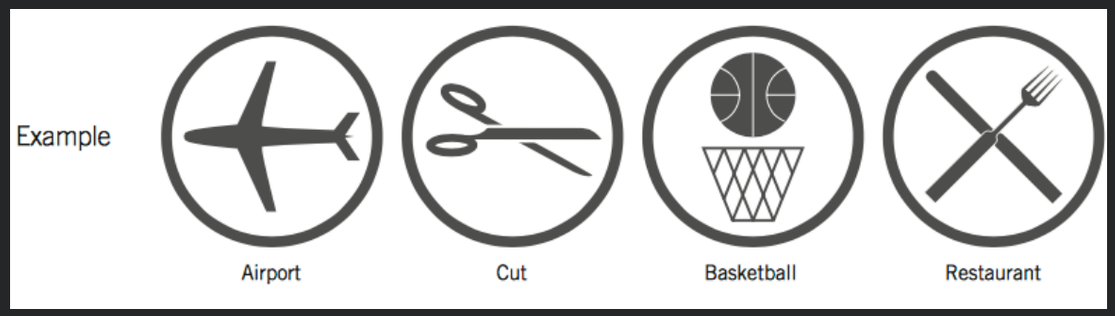
- Similar - visually ***analogous*** to action, object, concept



Types of Iconic Representation

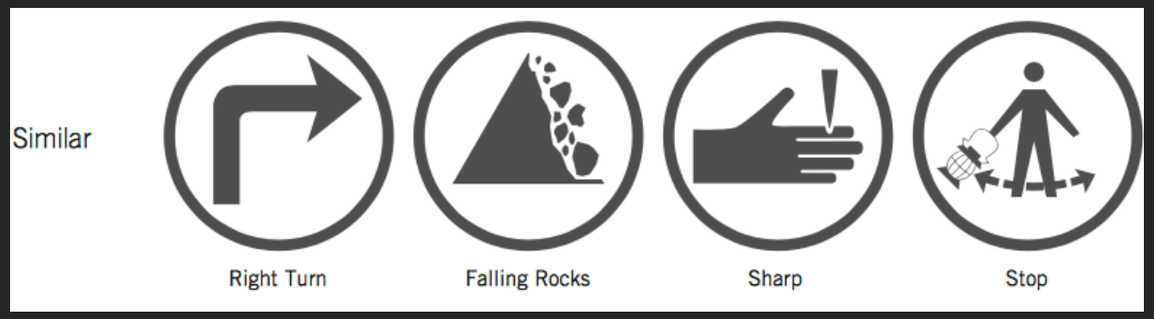
- Similar - visually ***analogous*** to action, object, concept
    - Example - things that exemplify or are commonly associated

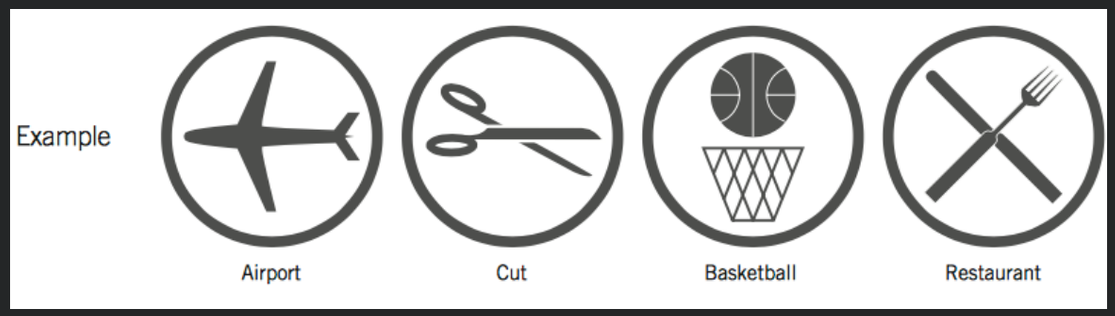


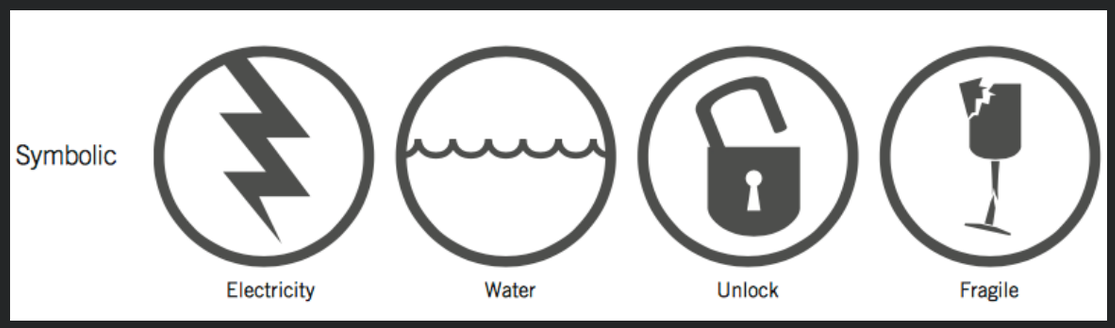


Types of Iconic Representation

- Similar - visually ***analogous*** to action, object, concept
  - Example - things that exemplify or are commonly associated
- Symbolic - represent concept at higher level of ***abstraction***

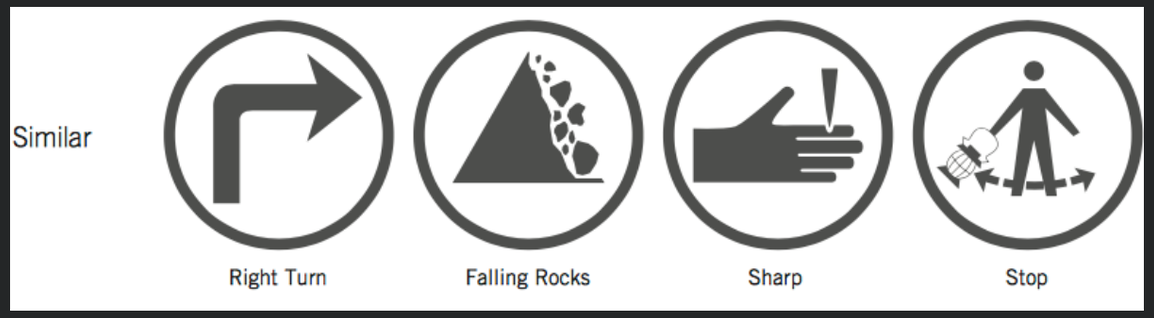


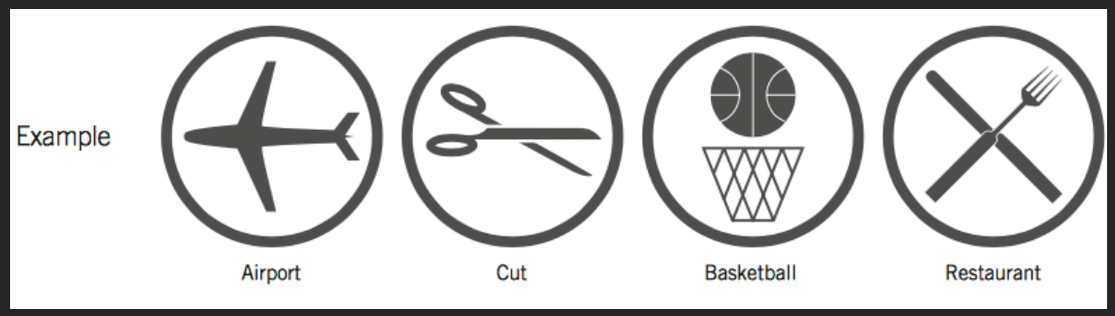


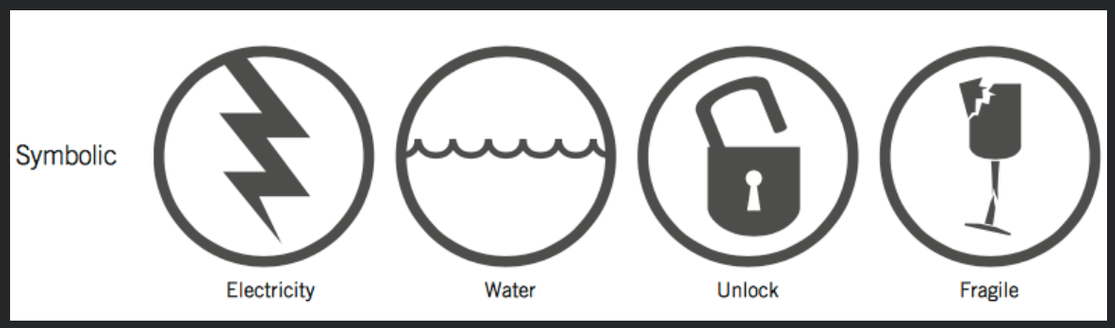


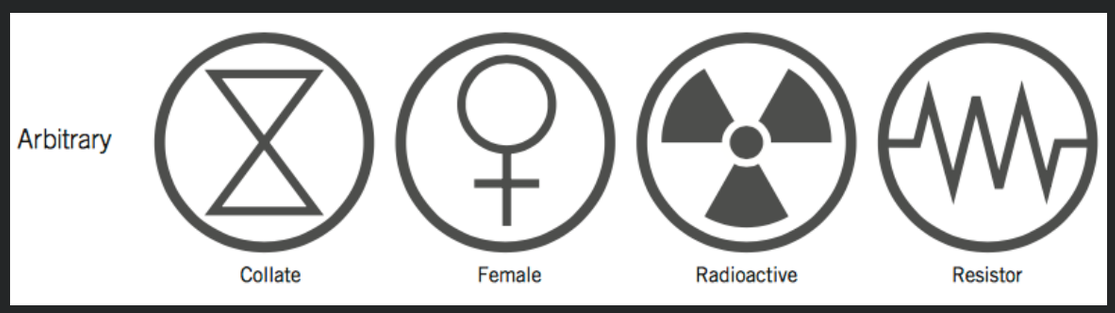
Types of Iconic Representation

- Similar - visually ***analogous*** to action, object, concept
  - Example - things that exemplify or are commonly associated
- Symbolic - represent concept at higher level of ***abstraction***
- Arbitrary - little or no relationship to concept, must be learned through ***standard***



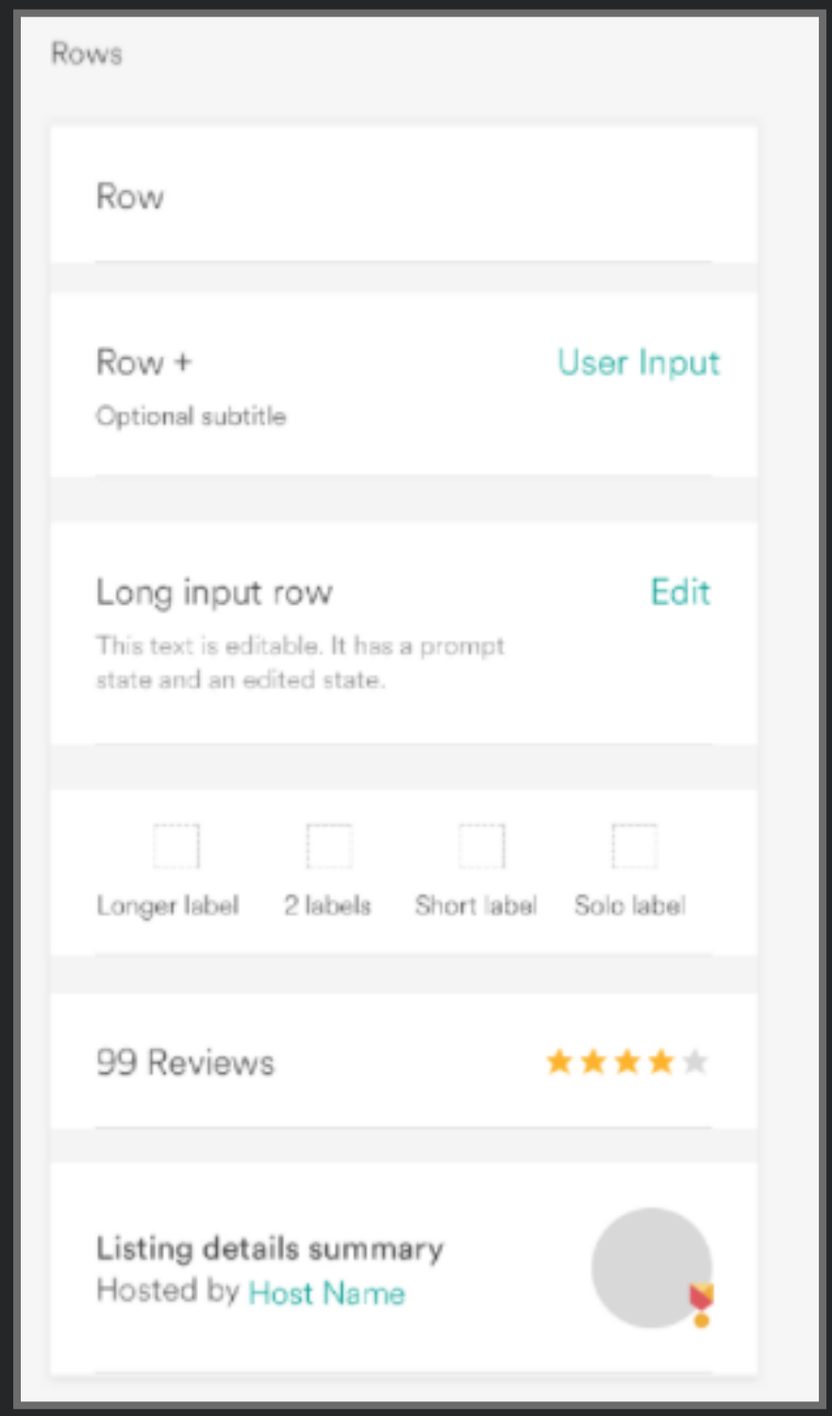






Design Languages

- Many, ***many*** choices about visual variables and syntax of composition
  - How do you ensure choices are made consistently across web app?
- Solution: design language
  - Describes how to express ideas and concepts in the interface
  - May be communicated through Human Interface Guideline documentation
  - (Example of consistency and standards)



Goals in Designing a Design Language

- Offer guidance and options on
  - Colors: examples of color palettes
  - Typography: justification, sizes, fonts, different heading levels
  - Organization
- Support different resolutions, devices
- Support universal design
  - Visually impaired, color blind users

Week 13 - Information Visualization

Amplifying Cognition

Amplifying Cognition

- Information Visualization can amplify cognition by:

Amplifying Cognition

- Information Visualization can amplify cognition by:

  1. Increasing the memory and processing resources available to users

Amplifying Cognition

- Information Visualization can amplify cognition by:

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  2. Reducing the search for information

Amplifying Cognition

- Information Visualization can amplify cognition by:

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  5. Using perceptual attention mechanisms for monitoring

Amplifying Cognition

- Information Visualization can amplify cognition by:

  1. Increasing the memory and processing resources available to users

  2. Reducing the search for information

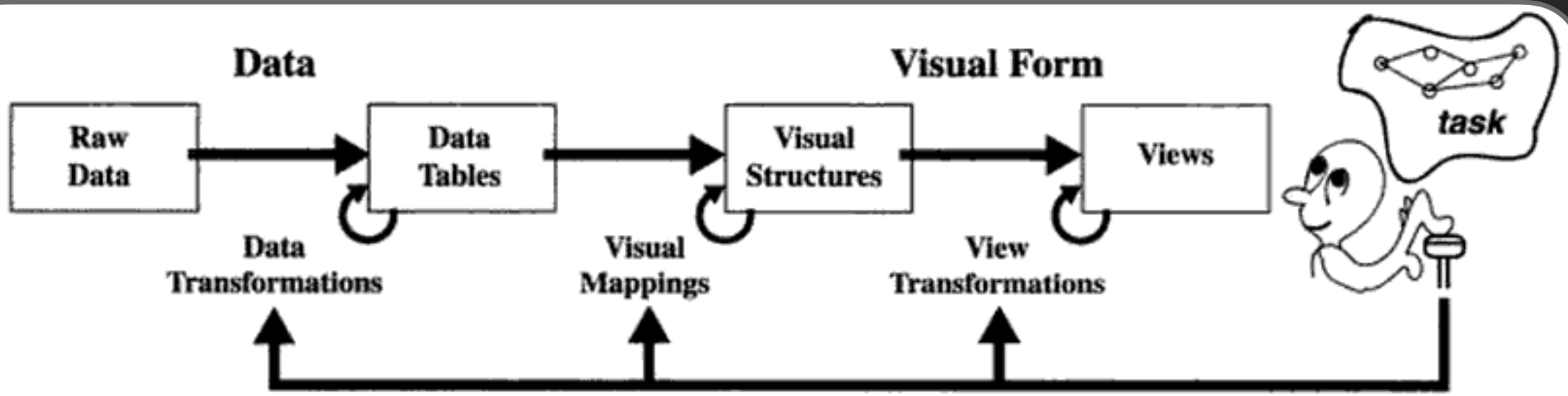
  3. Using visual representations to enhance the detection of patterns

  4. Enabling perceptual inference

  5. Using perceptual attention mechanisms for monitoring

  6. Encoding Information in a manipulable medium

Designing an Information Visualization



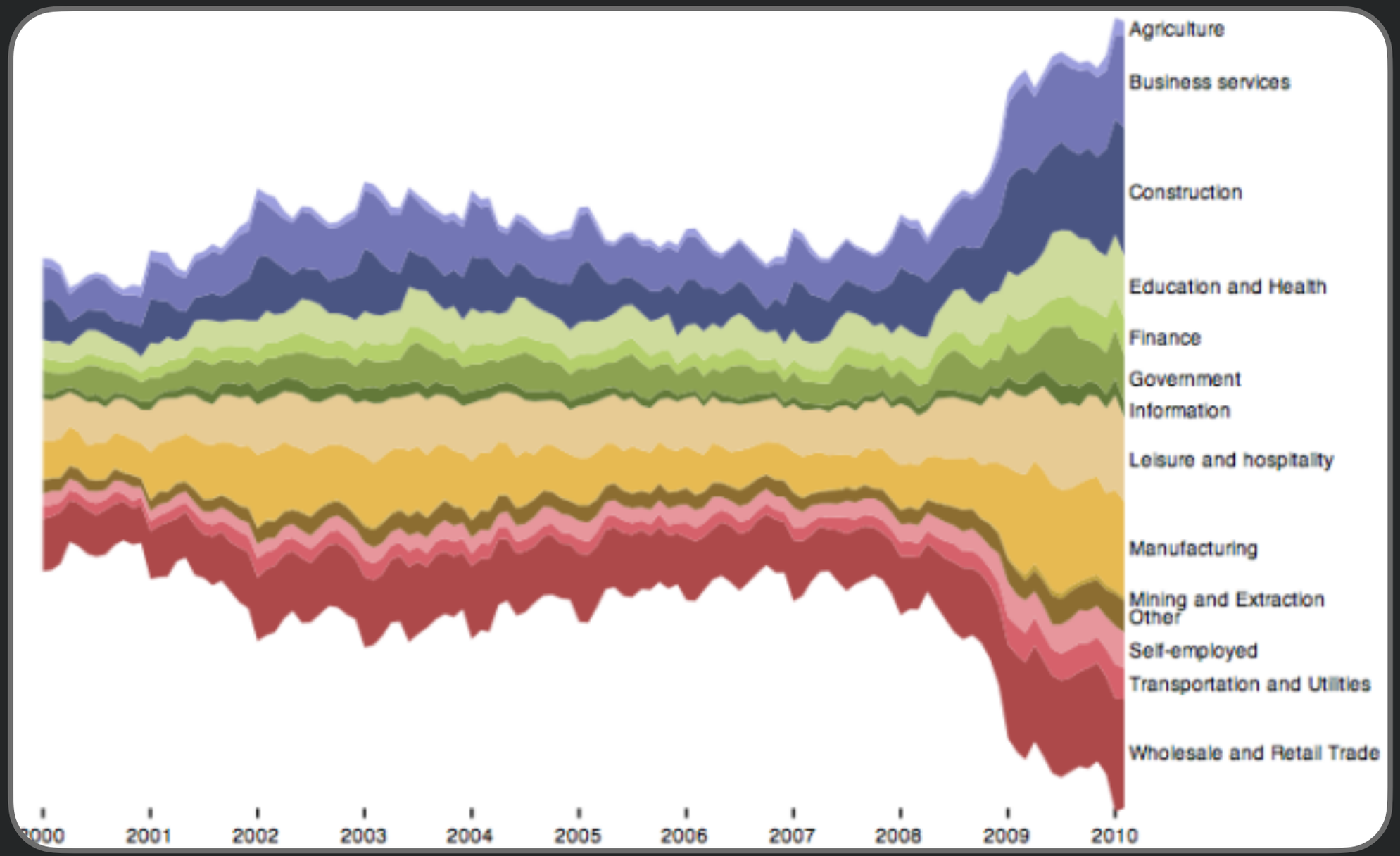
Raw Data: idiosyncratic formats
Data Tables: relations (cases by variables) + metadata
Visual Structures: spatial substrates + marks + graphical properties
Views: graphical parameters (position, scaling, clipping. . . .)

Visual Structures

- 3 components
  - spatial substrate
  - marks
  - marks' graphical properties

Examples of Visualizations for Different Data

- Supports visual summation of multiple components



Tufte's principles of graphical excellence

- Show the ***data***
- Induce the viewer to think about the substance rather than the methodology
- Avoid distorting what the data have to say
- Present ***many*** numbers in a small space
- Make large data sets ***coherent***
- Encourage the eye to ***compare*** different pieces of data
- Reveal data at several levels of detail, from overview to fine structure
- Serve reasonable clear ***purpose***: description, exploration, tabulation, decoration

Data-ink

- Data-ink - non-redundant ink encoding data information

$$\textbf{Data-ink ratio} = \frac{\textbf{Data-ink}}{\textbf{Total ink used to print the graphic}}$$

= **proportion of a graphic's ink devoted to the non-redundant display of data-information**

= **1.0 − proportion of a graphic that can be erased**

Information Visualization Tasks

- ***Overview:*** gain an overview of entire collection
- ***Zoom:*** zoom in on items of interest
- ***Filter:*** filter out uninteresting items
- ***Details on Demand:*** select an item or group and get details
- ***Relate:*** view relationships between items
- ***History:*** support undo, replay, progressive refinement
- ***Extract:*** allow extraction of sub-collections through queries

Week 14 - Community Design

Online Communities

- Online communities are virtual spaces where people come together to converse, exchange information or resources, learn, play [Kraut & Resnick]

- Supported by technology platforms, such as email, wikis, comments, social networks, automated feedback

- May be ***public***, open community or an ***internal*** community inside a company

- Break barriers of time, space, ***scale*** that limit offline interactions

Community Design

- Most of course: designing for ***task*** performance
  - Methods & principles derived from underlying ***cognitive*** psychology of user interactions with interfaces
- Community design: designing for successful ***community behavior***
  - Methods & principles derived from ***social*** psychology of how humans interact with other humans

Dimensions of Socio-technical System Design

- Community structure
  - Size of community
  - Homogeneity of member interests
  - Presence of subgroup structures
  - Relationship of membership to existing social ties

Dimensions of Socio-technical System Design

- Content, tasks, activities, external communication
  - Presence of self disclosure (e.g., user profiles) vs anonymity; visibility internally or externally
  - Presence of professional generated content, imported / exported from other communities
  - Welcoming activities & safe spaces for exploration
  - Tasks that are independent or interdepend, embedded in social experiences
  - Ability to invite friends & share content

Dimensions of Socio-technical System Design

- Feedback, rewards, sanctions
  - Feedback telling members how to behave may be informal or structured (e.g., ratings)
  - Give or take away something valuable such as intangible (approval, status) or tangible (community privileges, prizes)

Dimensions of Socio-technical System Design

- Roles, rules, access control, & visibility
  - Members may have specialized roles as welcomers for newcomers or dispute handlers
  - May be rules & guidelines for behaviors
  - May be procedures for decision-making & conflict resolution
  - May be access controls which limit who can join & actions that can be taken; might require money to perform certain actions
  - May be moderators regulating behavior
  - Communication choices on visibility of bad behavior & punishment

Challenges in Community Design

- Starting a new community
  - Dealing with newcomers
- Encouraging commitment
- Encouraging contribution
- Regulating behavior

7 Minute Break

Acknowledgements

- Slides adapted from Dr. Thomas Latoza's SWE 632 course