

# Information Visualization

## Rules of Thumb

**Tamara Munzner**  
Department of Computer Science  
University of British Columbia

Lect 20/21, 19/24 Mar 2020

<https://www.cs.ubc.ca/~tmm/courses/436V-20>

2

### Upcoming

- Milestone 2: still due Wed Mar 25 11:59pm  
– (remember update announced w/ schedule status component)

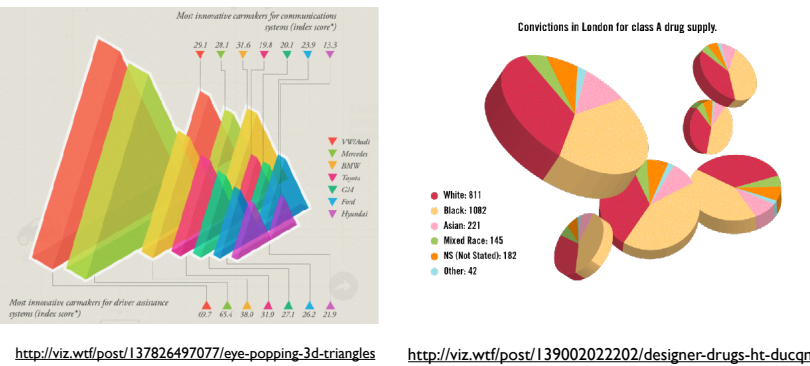
### Rules of Thumb Summary

- No unjustified 3D
- No unjustified 2D
- Eyes beat memory
- Resolution over immersion
- Overview first, zoom and filter, details on demand
- Responsiveness is required
- Function first, form next

3

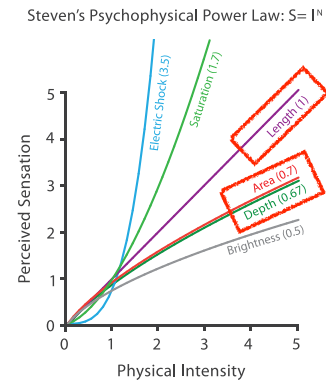
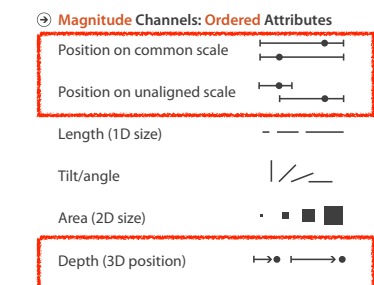
## Rules of Thumb

### Unjustified 3D all too common, in the news and elsewhere



### Depth vs power of the plane

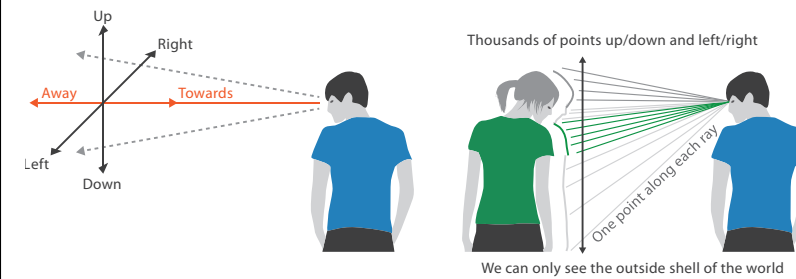
- high-ranked spatial position channels: **planar** spatial position  
– not depth!



4

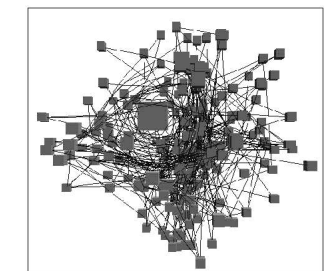
### No unjustified 3D: Danger of depth

- we don't really live in 3D: we **see** in 2.05D  
– acquire more info on image plane quickly from eye movements  
– acquire more info for depth slower, from head/body motion



### Occlusion hides information

- occlusion
- interaction can resolve, but at cost of time and cognitive load

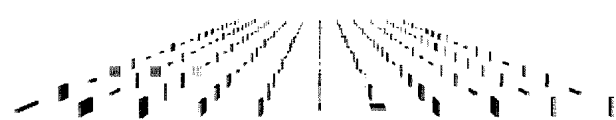


[Distortion Viewing Techniques for 3D Data. Carpendale et al. InfoVis 1996.]

5

### Perspective distortion loses information

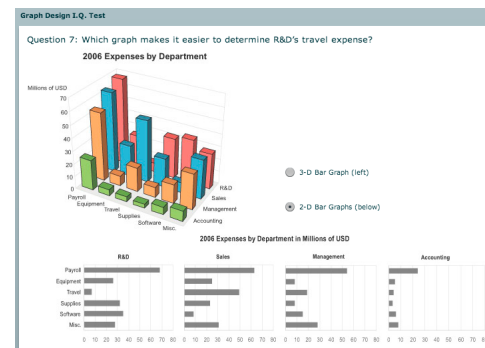
- perspective distortion  
– interferes with all size channel encodings  
– power of the plane is lost!



[Visualizing the Results of Multimedia Web Search Engines. Mukherjee, Hirata, and Hara. InfoVis 96]

### 3D vs 2D bar charts

- 3D bars very difficult to justify!  
– perspective distortion  
– occlusion
- faceting into 2D almost always better choice



[http://perceptualedge.com/files/GraphDesignIQ.html]

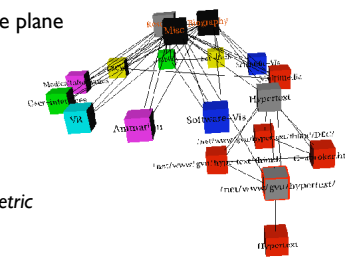
6

### Tilted text isn't legible

- text legibility  
– far worse when tilted from image plane

- further reading

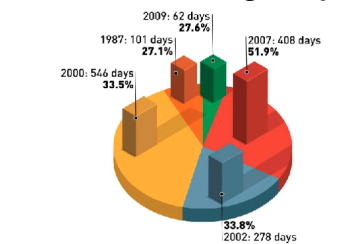
[Exploring and Reducing the Effects of Orientation on Text Readability in Volumetric Displays. Grossman et al. CHI 2007]



[Visualizing the World-Wide Web with the Navigational View Builder. Mukherjee and Foley. Computer Networks and ISDN Systems, 1995.]

### Socratic quiz: 3D pie charts++

#### Bear markets, how long do they last?

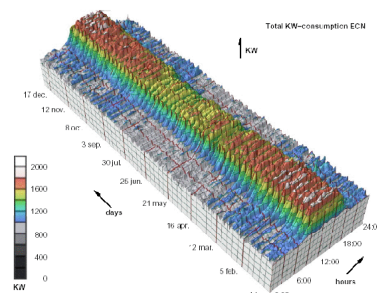


CIBC NEWS  
This chart shows the length and degree of the last bear market on the S&P 500 (not an index, but not the one you're calling for).  
<https://twitter.com/cmcsmc/status/1238215422530342912?>

7

### No unjustified 3D example: Time-series data

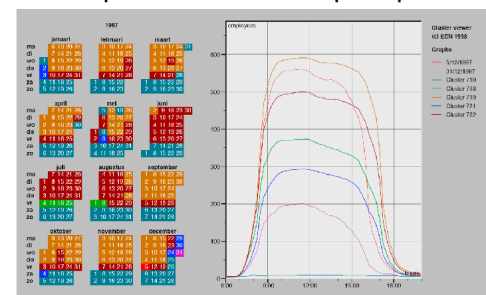
- extruded curves: detailed comparisons impossible



[Cluster and Calendar based Visualization of Time Series Data. van Wijk and van Selow, Proc. InfoVis 99.]

### No unjustified 3D example: Transform for new data abstraction

- derived data: cluster hierarchy
- juxtapose multiple views: calendar, superimposed 2D curves

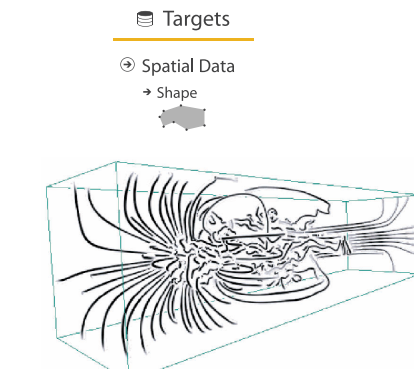


[Cluster and Calendar based Visualization of Time Series Data. van Wijk and van Selow, Proc. InfoVis 99.]

14

### Justified 3D: shape perception

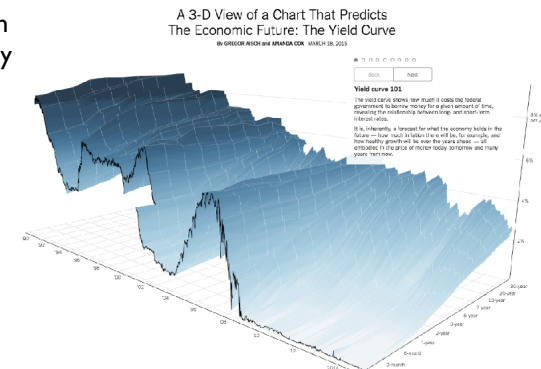
- benefits outweigh costs when task is shape perception for 3D spatial data  
– interactive navigation supports synthesis across many viewpoints



[Image-Based Streamline Generation and Rendering. Li and Shen. IEEE Trans. Visualization and Computer Graphics (TVCG) 13:3 (2007), 630-640.]

### Justified 3D: Economic growth curve

- constrained navigation steps through carefully designed viewpoints

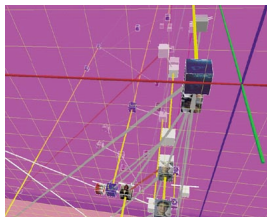


<http://www.nytimes.com/interactive/2015/03/19/upshot/3d-yield-curve-economic-growth.html>

15

## No unjustified 3D

- 3D legitimate for true 3D spatial data
- 3D needs very careful justification for abstract data
  - enthusiasm in 1990s, but now skepticism
  - be especially careful with 3D for point clouds or networks

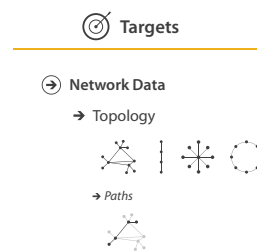


[WEBPATH-a three dimensional Web history. Frecon and Smith. Proc. InfoVis 1999]

17

## No unjustified 2D

- consider whether network data requires 2D spatial layout
  - especially if reading text is central to task!
  - arranging as network means lower information density and harder label lookup compared to text lists
- benefits outweigh costs when topological structure/context important for task
  - be especially careful for search results, document collections, ontologies



18

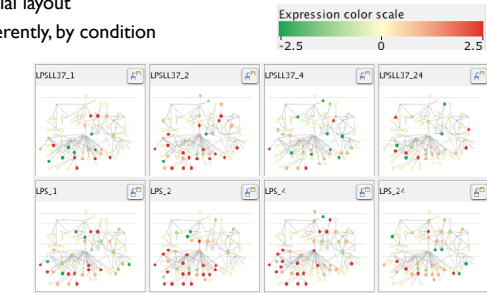
## Eyes beat memory

- principle: external cognition vs. internal memory
  - easy to compare by moving eyes between side-by-side views
  - harder to compare visible item to memory of what you saw
- implications for animation
  - great for choreographed storytelling
  - great for transitions between two states
  - poor for many states with changes everywhere
    - consider small multiples instead



## Eyes beat memory example: Cerebral

- small multiples: one graph instance per experimental condition
  - same spatial layout
  - color differently, by condition

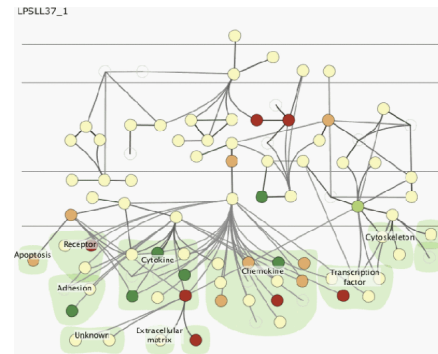


[Cerebral: Visualizing Multiple Experimental Conditions on a Graph with Biological Context. Barsky, Munzner, Gardy, and Kincaid. IEEE Trans. Visualization and Computer Graphics (Proc. InfoVis 2008) 14:6 (2008), 1253–1260.]

20

## Why not animation?

- disparate frames and regions: comparison difficult
  - vs contiguous frames
  - vs small region
  - vs coherent motion of group
- safe special case
  - animated transitions



21

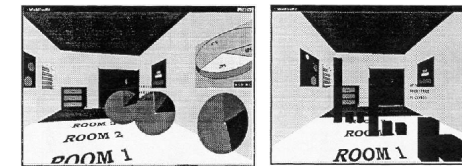
## Change blindness

- if attention is directed elsewhere, even drastic changes not noticeable
  - door experiment
- change blindness demos
  - mask in between images
  - [https://youtu.be/bh\\_9XFzbWV8](https://youtu.be/bh_9XFzbWV8)

22

## Resolution beats immersion

- immersion typically not helpful for abstract data
  - do not need sense of presence or stereoscopic 3D
  - desktop also better for workflow integration
- resolution much more important: pixels are the scarcest resource
- virtual reality for abstract data difficult to justify thus far
  - but stay tuned with second wave, AR (augmented reality) has more promise

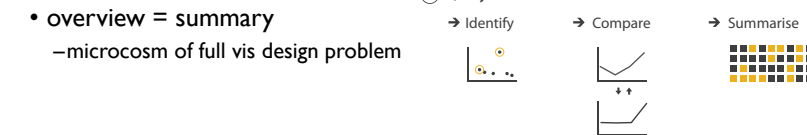


[Development of an information visualization tool using virtual reality. Kirner and Martins. Proc. Symp. Applied Computing 2000]

23

## Overview first, zoom and filter, details on demand

- influential mantra from Shneiderman
  - [The Eyes Have It: A Task by Data Type Taxonomy for Information Visualizations. Shneiderman. Proc. IEEE Visual Languages, pp. 336–343, 1996.]



- overview = summary
  - microcosm of full vis design problem

24

## Rule of thumb: Responsiveness is required

- visual feedback: three rough categories
  - 0.1 seconds: perceptual processing
    - subsecond response for mouseover highlighting - ballistic motion
  - 1 second: immediate response
    - fast response after mouseclick, button press - Fitts' Law limits on motor control
  - 10 seconds: brief tasks
    - bounded response after dialog box - mental model of heavyweight operation (file load)
- scalability considerations
  - highlight selection without complete redraw of view (graphics frontbuffer)
  - show hourglass for multi-second operations (check for cancel/undo)
  - show progress bar for long operations (process in background thread)
  - rendering speed when item count is large (guaranteed frame rate)

25

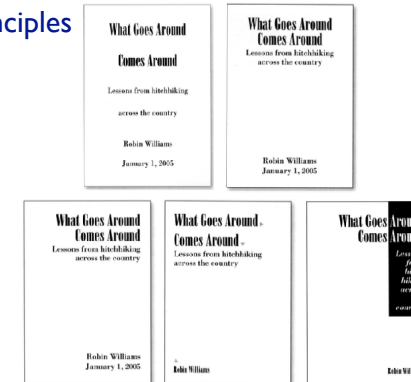
## Function first, form next

- start with focus on functionality
  - possible to improve aesthetics later on, as refinement
  - if no expertise in-house, find good graphic designer to work with
  - aesthetics do matter: another level of function
    - visual hierarchy, alignment, flow
    - Gestalt principles in action
      - (not covered in this class)
- dangerous to start with aesthetics
  - usually impossible to add function retroactively

26

## Form: Basic graphic design principles

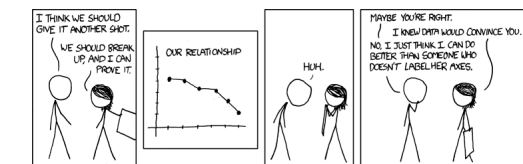
- proximity
    - do group related items together
    - avoid equal whitespace between unrelated
  - alignment
    - do find/make strong line, stick to it
    - avoid automatic centering
  - repetition
    - do unify by pushing existing consistencies
  - contrast
    - if not identical, then very different
    - avoid similar
- buy now and read cover to cover - very practical, worth your time, fast read!  
*The Non-Designer's Design Book, 4th ed. Robin Williams, Peachpit Press, 2015.*



27

## Best practices: Labelling

- make visualizations as self-documenting as possible
  - meaningful & useful title, labels, legends
    - axes and panes/subwindows should have labels
      - and axes should have good mix/max boundary tick marks
    - everything that's plotted should have a legend
      - and own header/labels if not redundant with main title
    - use reasonable numerical format
      - avoid scientific notation in most cases



[<https://xkcd.com/833/>]

28

## Rules of Thumb Summary

- No unjustified 3D
  - Power of the plane
  - Disparity of depth
  - Occlusion hides information
  - Perspective distortion dangers
  - Tilted text isn't legible
- No unjustified 2D
- Eyes beat memory
- Resolution over immersion
- Overview first, zoom and filter, details on demand
- Responsiveness is required
- Function first, form next

## Further reading

- Visualization Analysis and Design. Tamara Munzner. CRC Press, 2014.
  - Chap 6: Rules of Thumb
- Designing with the Mind in Mind: Simple Guide to Understanding User Interface Design Rules. Jeff Johnson. Morgan Kaufmann, 2010.
  - Chap 12: We Have Time Requirements
- The Non-Designer's Design Book. 3rd edition. Robin Williams. Peachpit Press, 2008.

30

## Credits

- Visualization Analysis and Design (Ch 6)

31

29