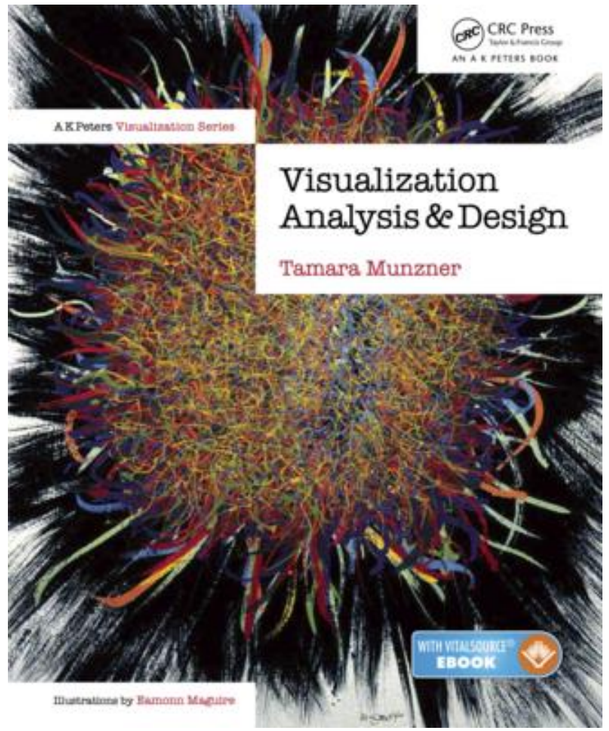
Information Visualization

Rules of Thumb

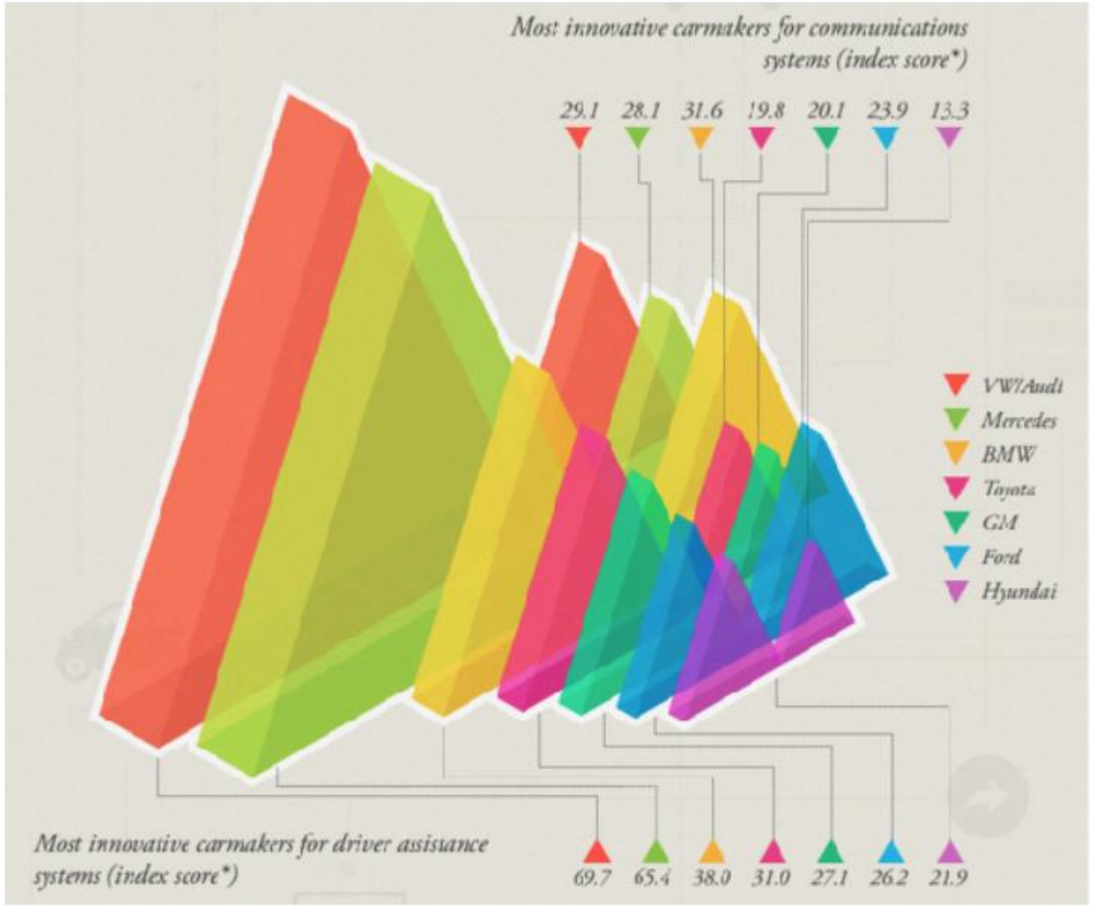


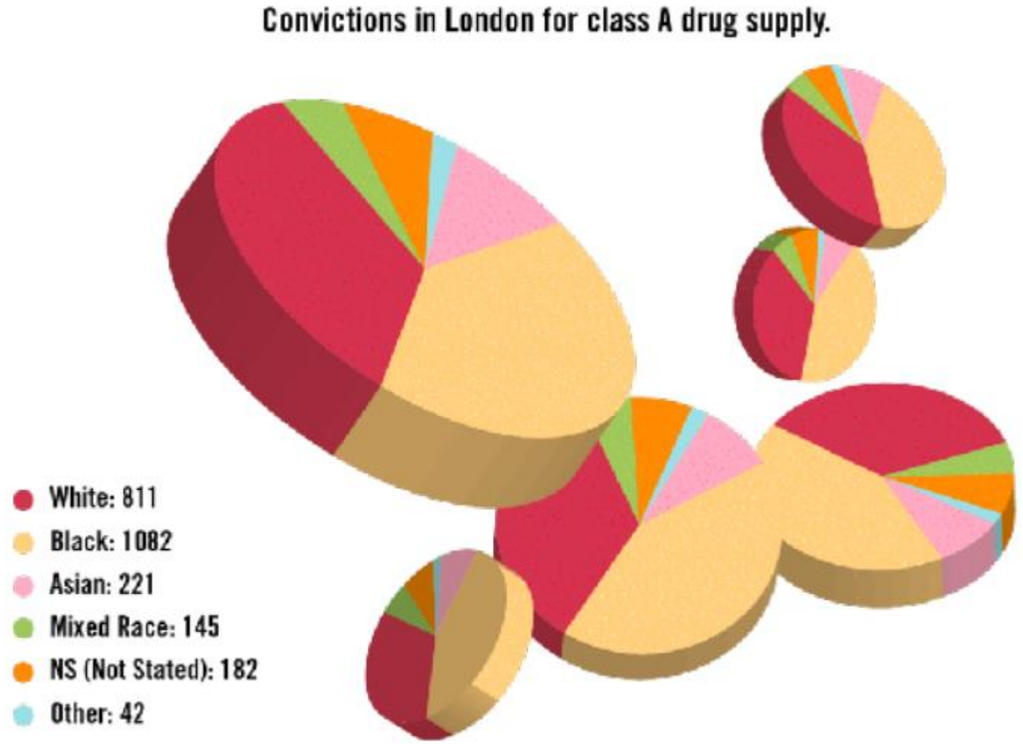
- Slides refer to https://www.cs.ubc.ca/~tmm/

Rules of Thumb

- 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

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



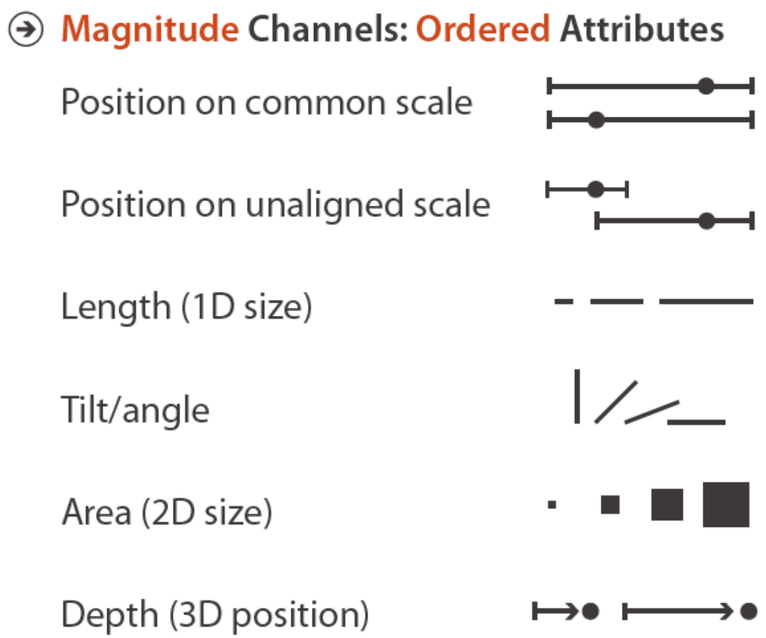


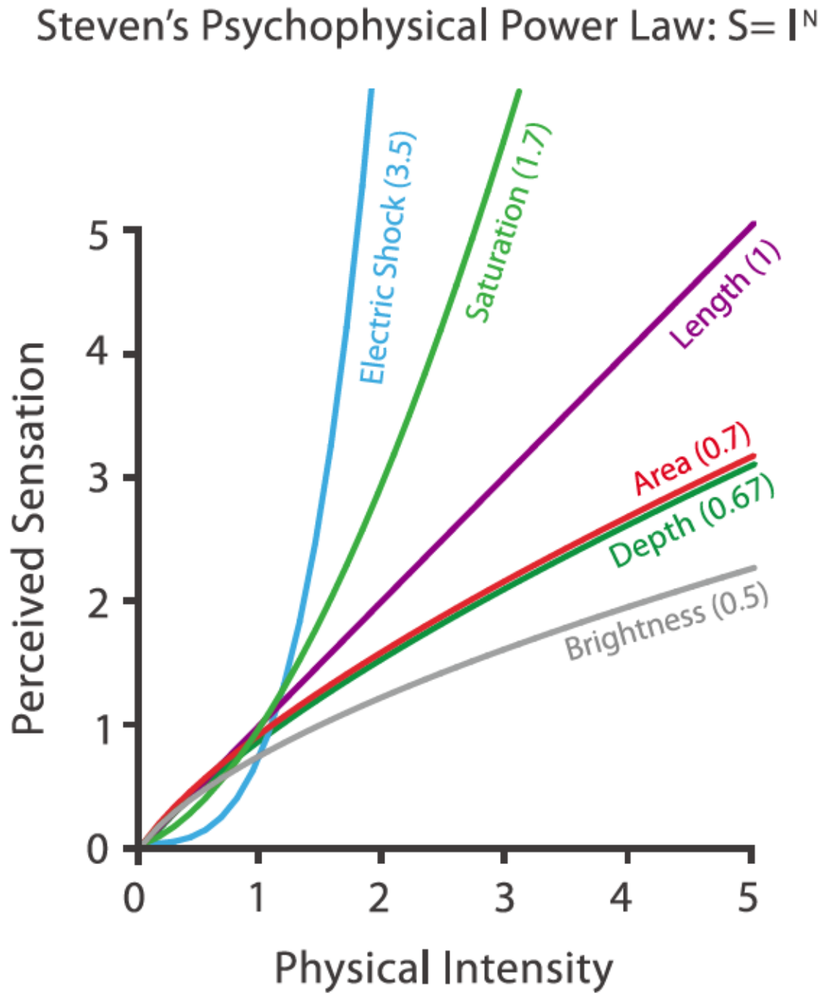
http://viz.wtf/post/137826497077/eye-popping-3d-triangles

http://viz.wtf/post/139002022202/designer-drugs-ht-ducqn

No unjustified 3D: Power of the plane

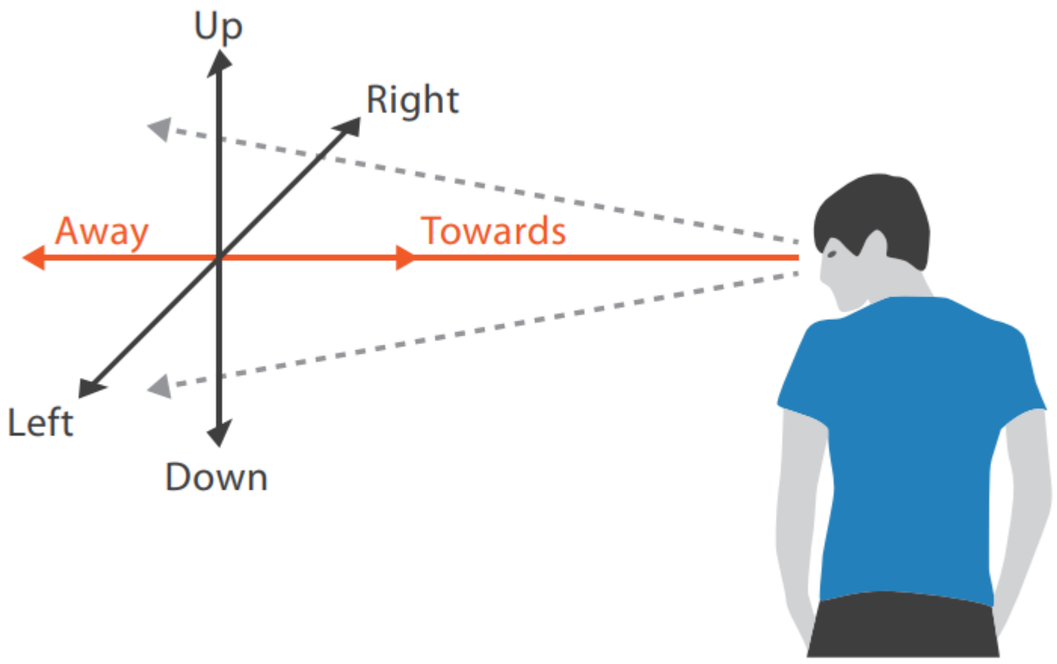
- high-ranked spatial position channels: planar spatial position
  - not depth!

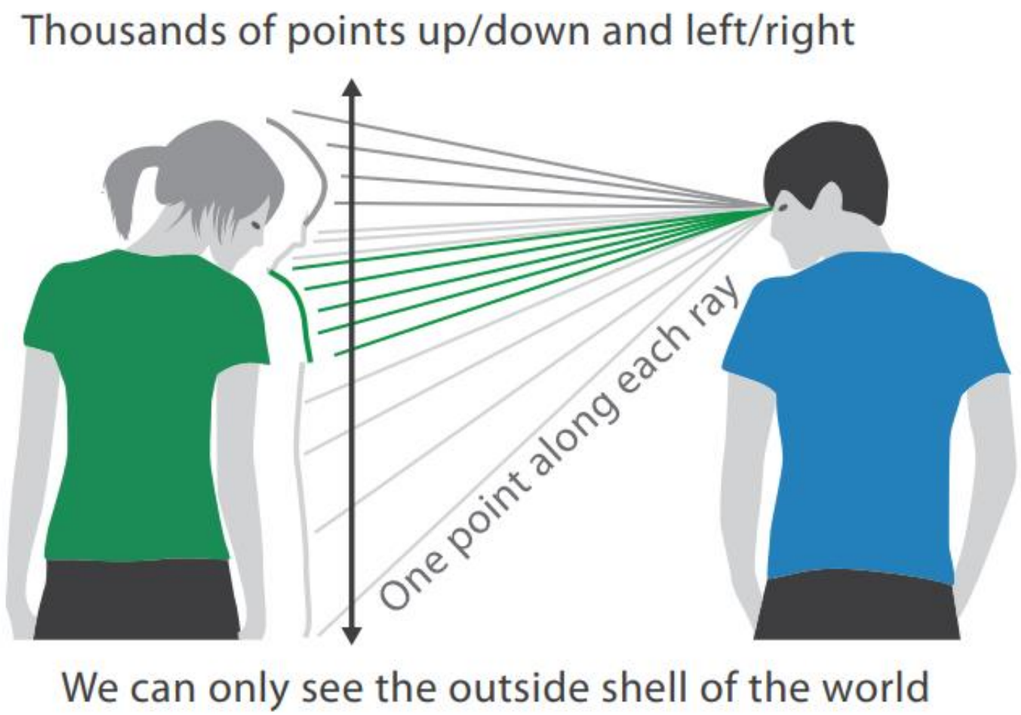




No unjustified 3D: Danger of depth

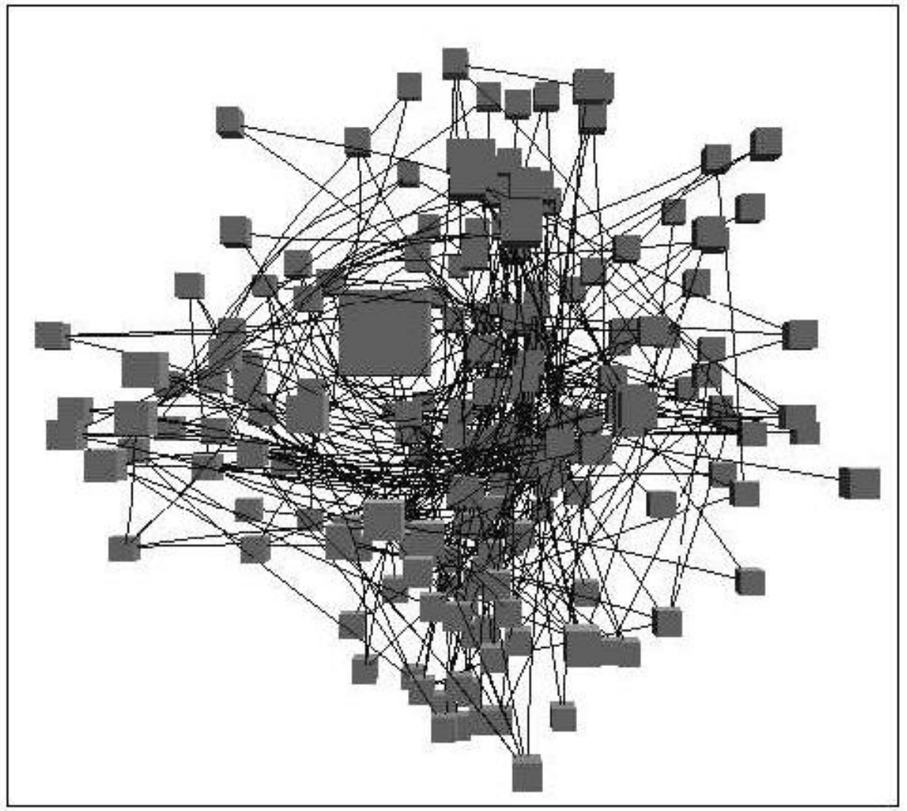
- we don't really live in 3D: we *see* in 2.05D
  - acquire more info on image plane quickly from eye movements
  - acquire more info for depth slower, from head/body motion





Occlusion hides information

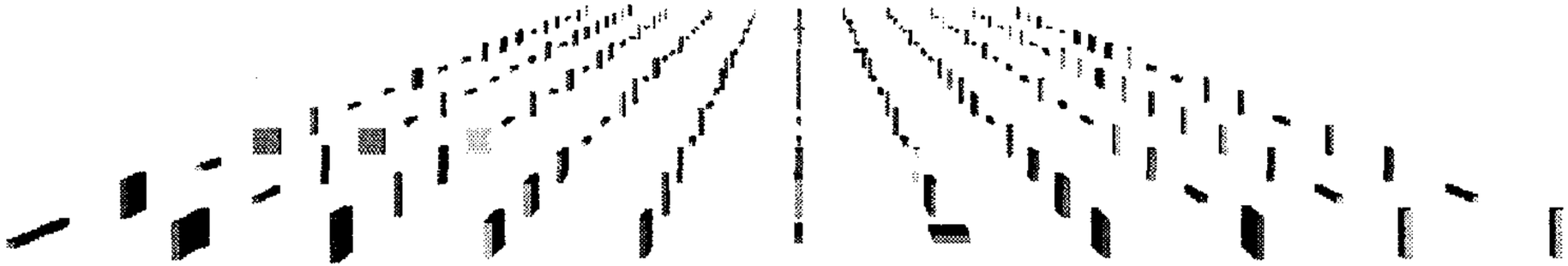
- occlusion
- interaction complexity



[Distortion Viewing Techniques for 3D Data. Carpendale et al. InfoVis1996.]

Perspective distortion loses information

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

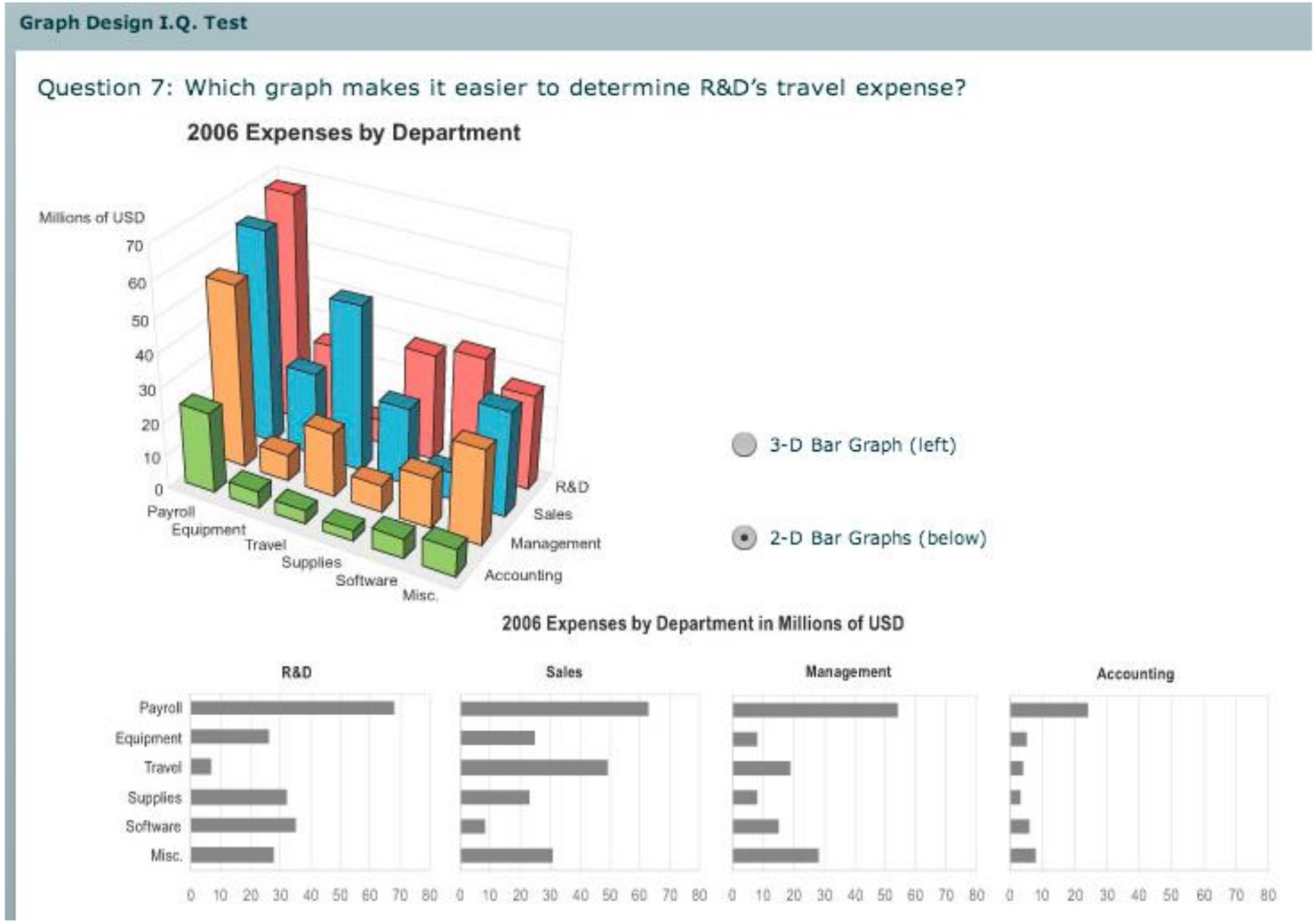


The cubes represent the documents and their colors represent the domains.
The width, height, and depth of the cubes are mapped to the frequency of the keywords “visualization”, “information” and “software” respectively.

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

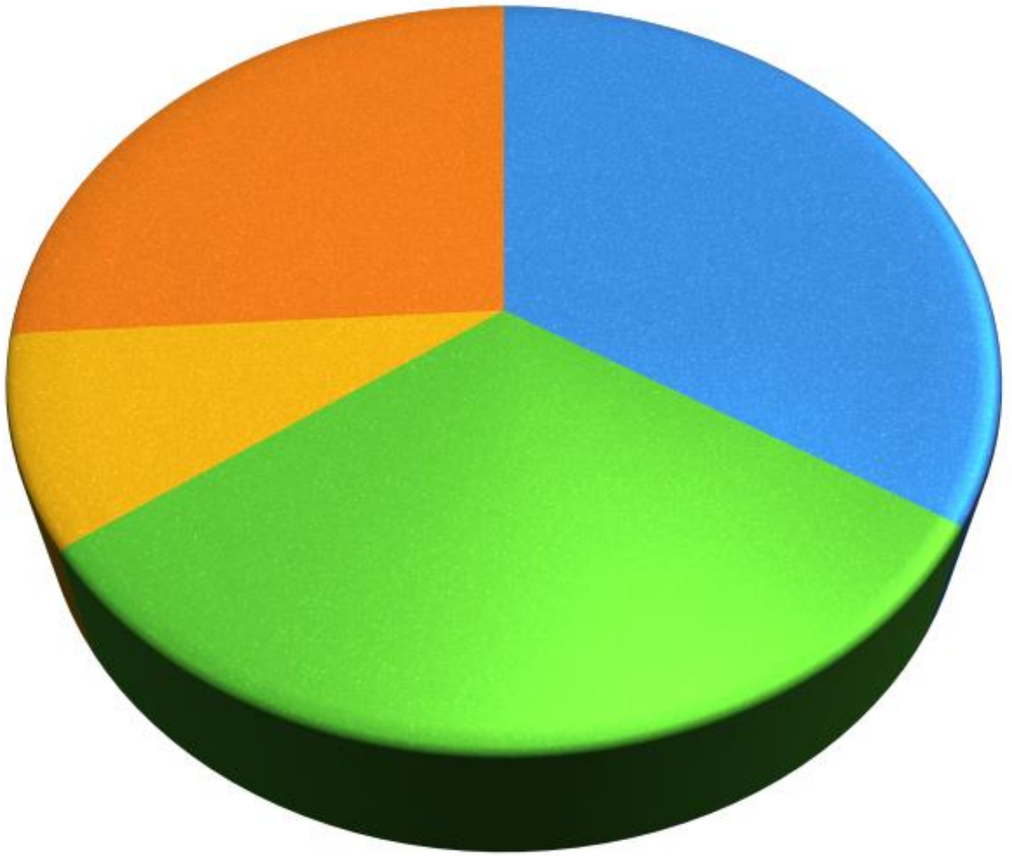
3D vs 2D bar charts

- 3D bars never a good idea!



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

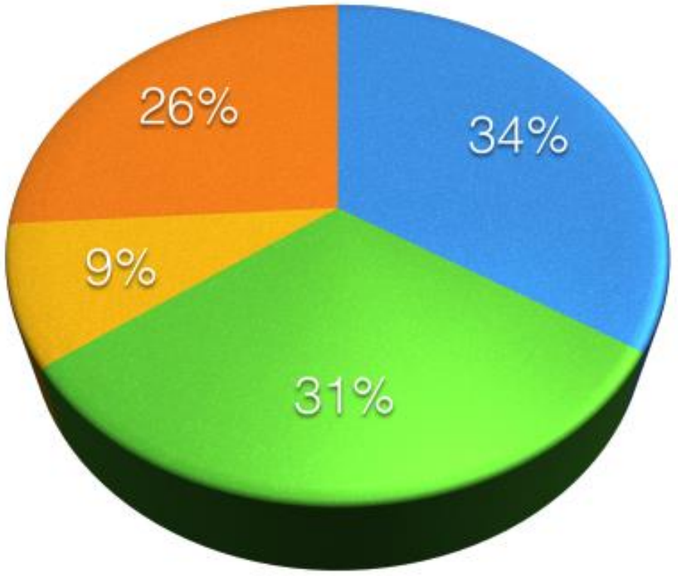
立體圓餅圖



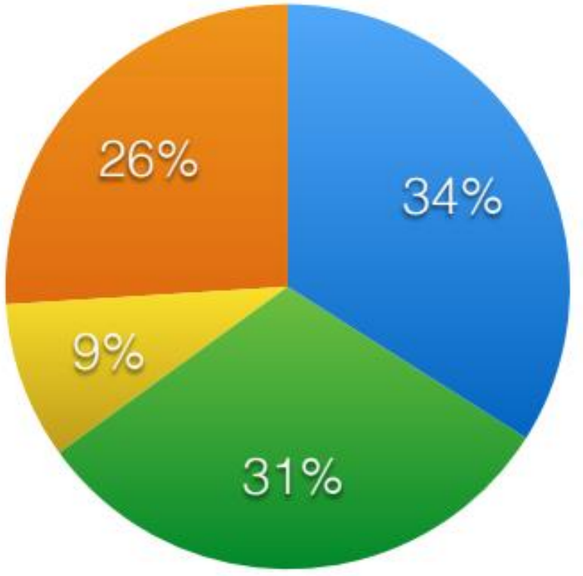
綠：藍：菊：黃=?

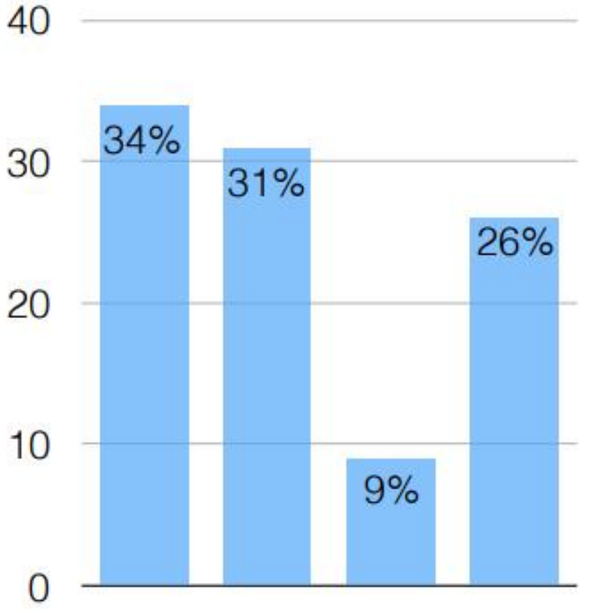
立體圓餅圖

立體圓餅圖，
近的比例會較大



善於表現與整體比例的關係，
不容易做分項比較

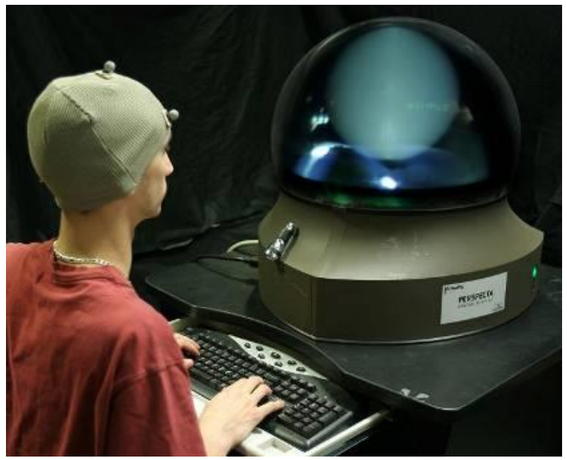


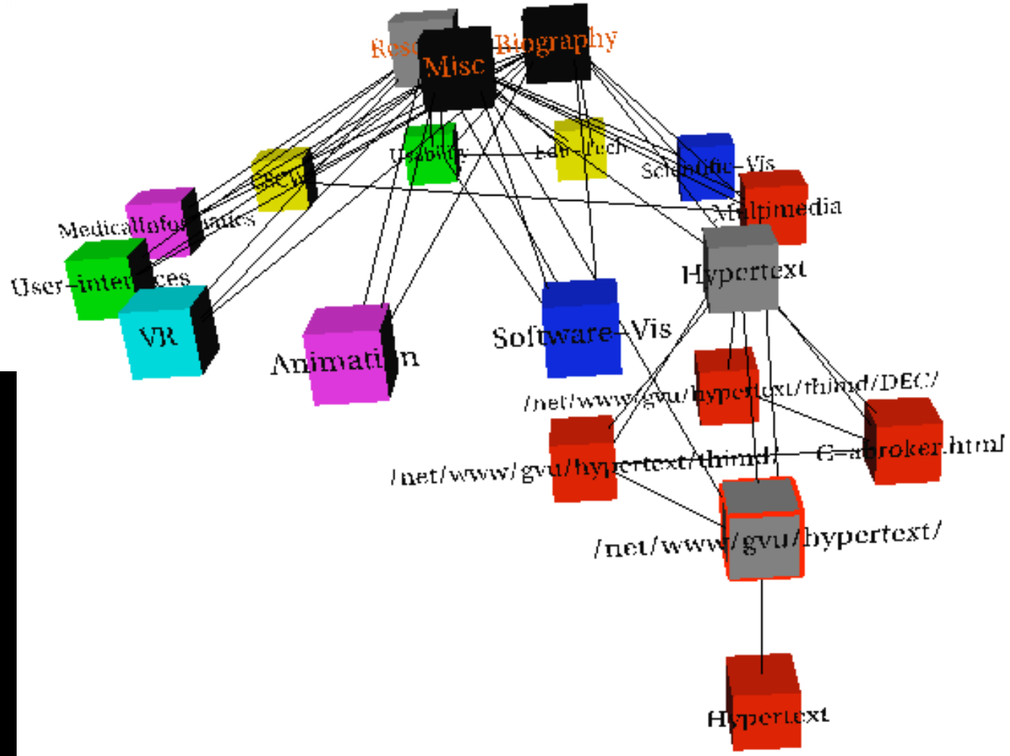


Tilted text isn't legible

- text legibility

  - far worse when tilted from image plane
- further reading



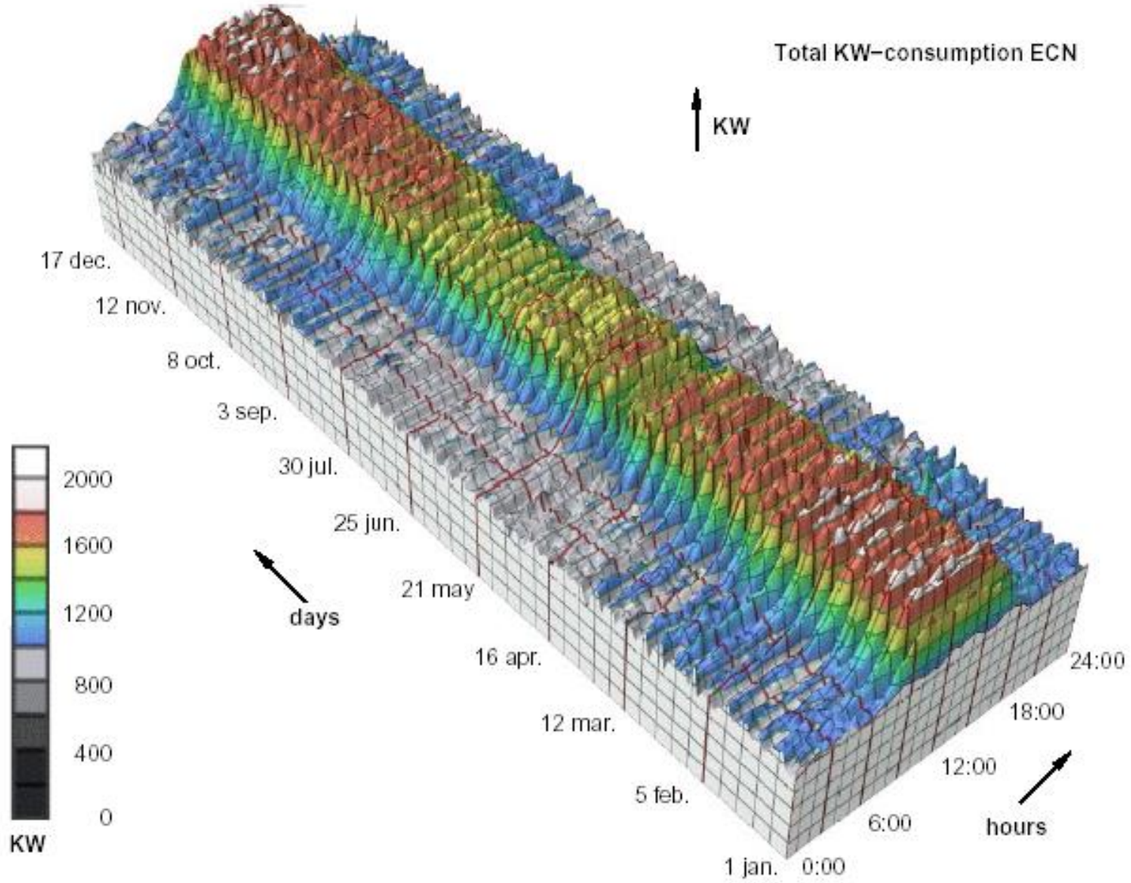


[*Exploring and Reducing the Effects of Orientation on Text Readability in Volumetric Displays*. *Grossman et al. CHI 2007]*

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

No unjustified 3D example: Time-series data

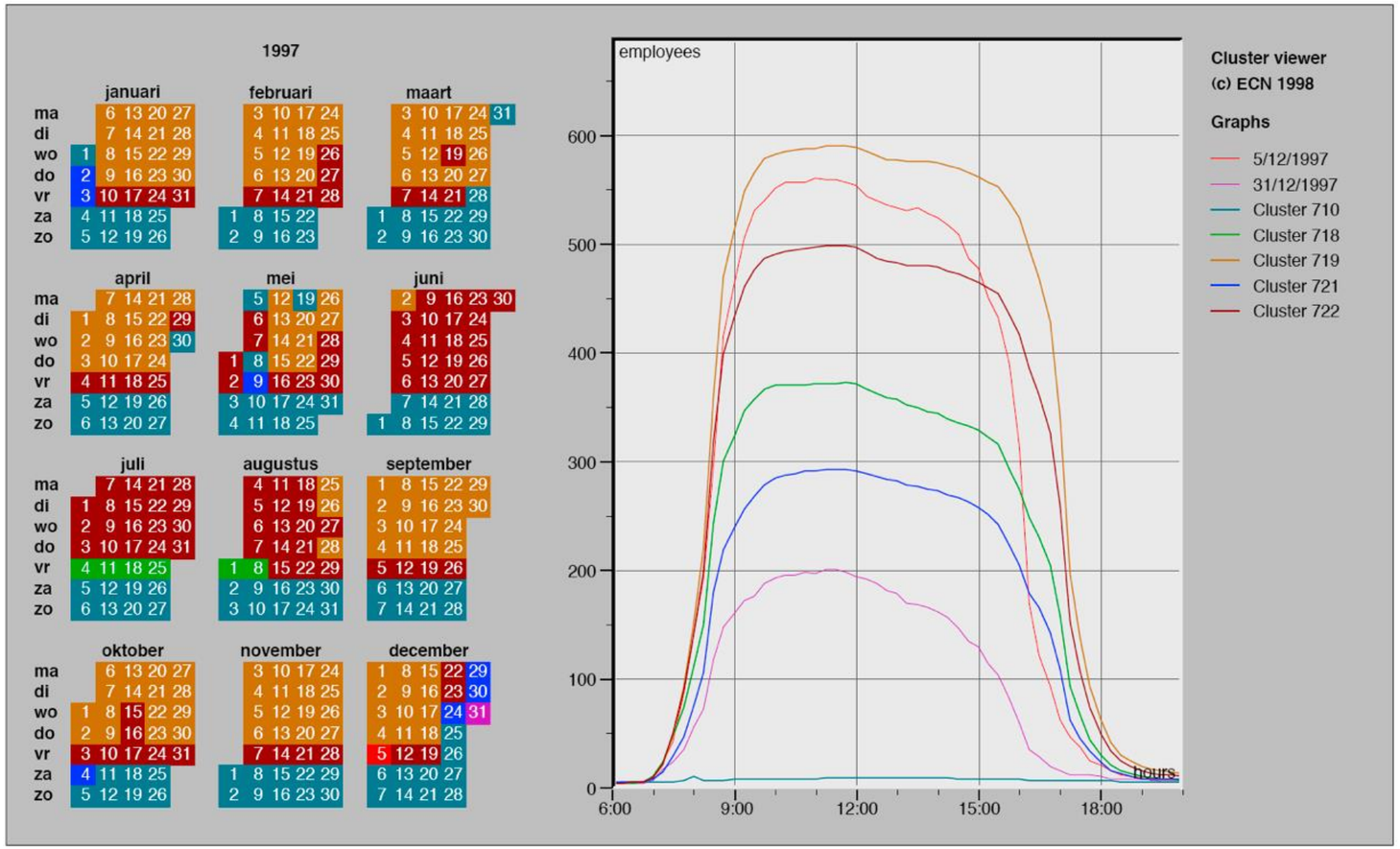
- extruded curves: detailed comparisons impossible



[Cluster and Calendar based Visualization of Time Series Data. van Wijk and van Selow, Proc. InfoVis 99.1

No unjustified 3D example: Transform for new data abstraction

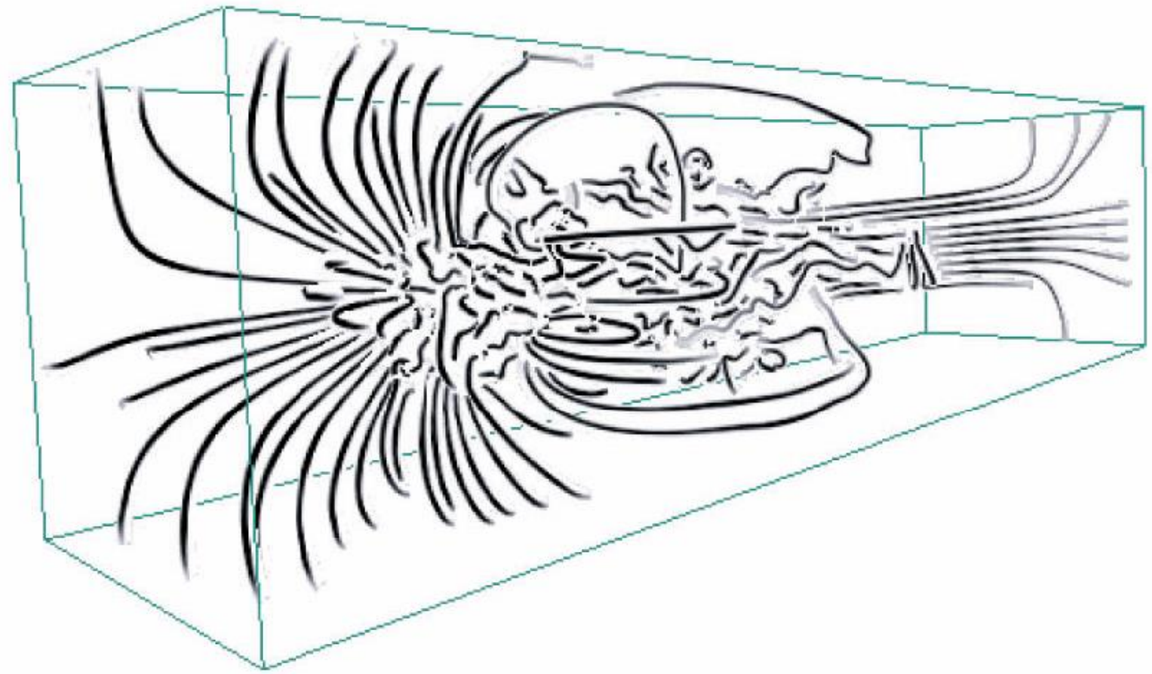
- derived data: cluster hierarchy
- juxtapose multiple views: calendar, superimposed 2D curves



[Cluster and Calendar based Visualization of Time Series Data. van Wijk and van Selow, Proc. InfoVis 99.1

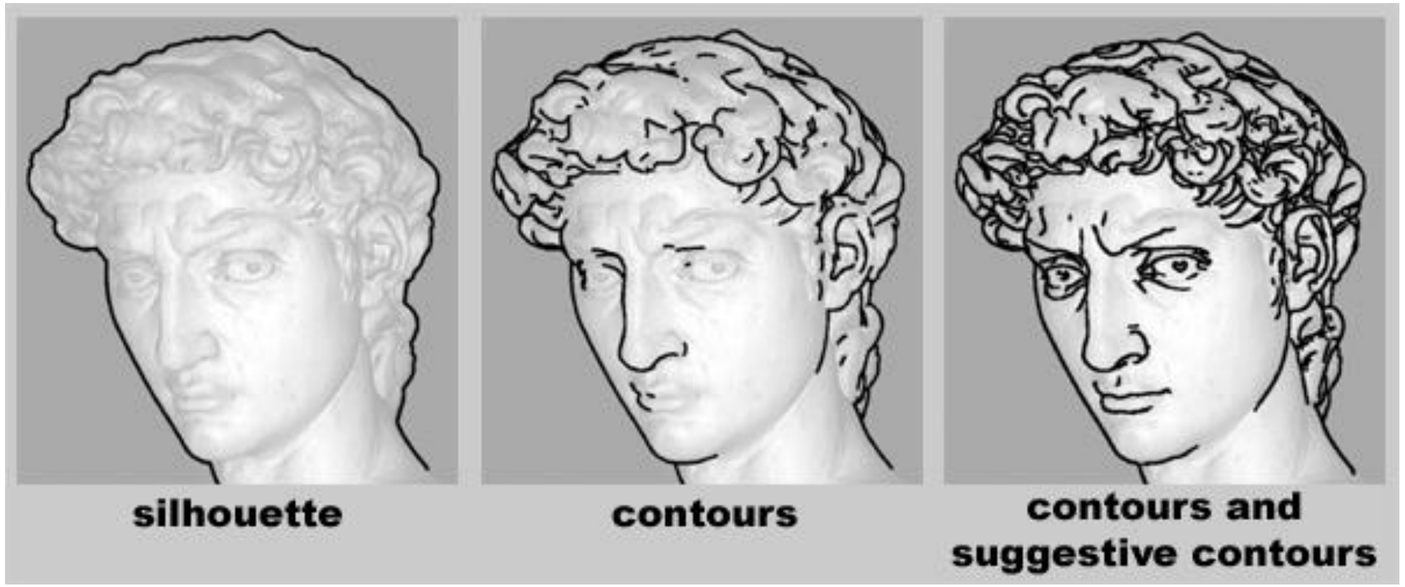
Justified 3D: shape perception

- 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

Suggestive Contours for Conveying Shape



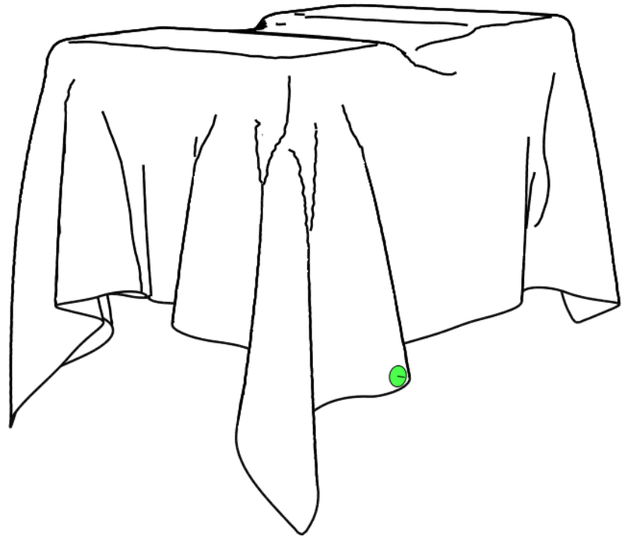
[Doug DeCarlo et al. 2003]

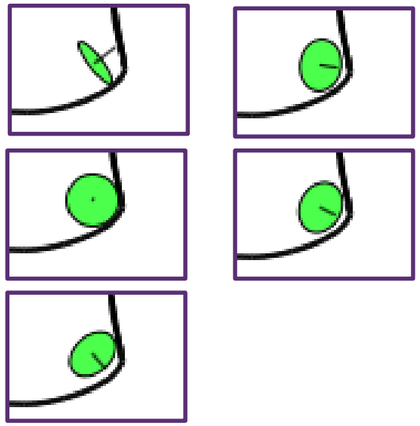
Apparent Ridges for Line Drawing [Tilke Judd et al. 2007]

Shaded View | Contours | Suggestive Contours | Ridges & Valleys | Apparent Ridges

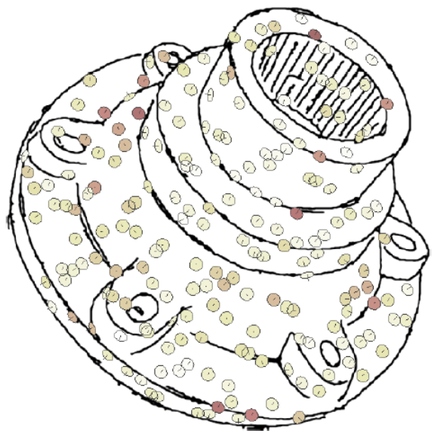
The maxima of the normal variation with respect to the viewing plane.

How Well Do Line Drawings Depict Shape? [Forrester Cole et al. 2009]

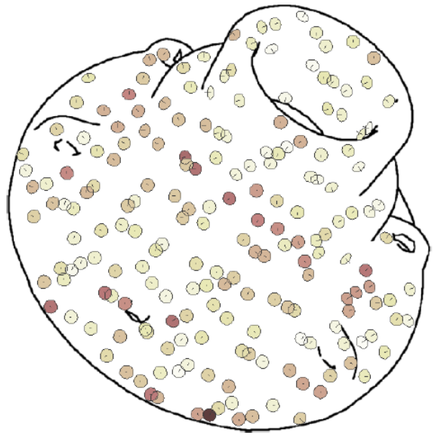




(a) shaded image



(b) human drawing

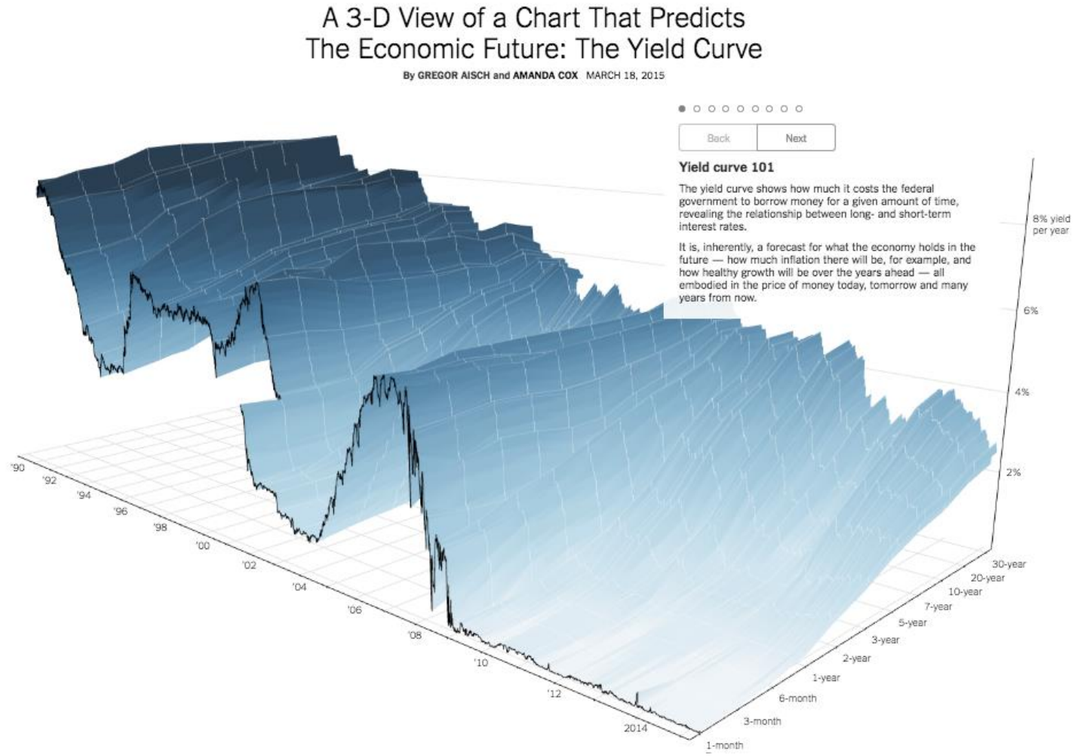


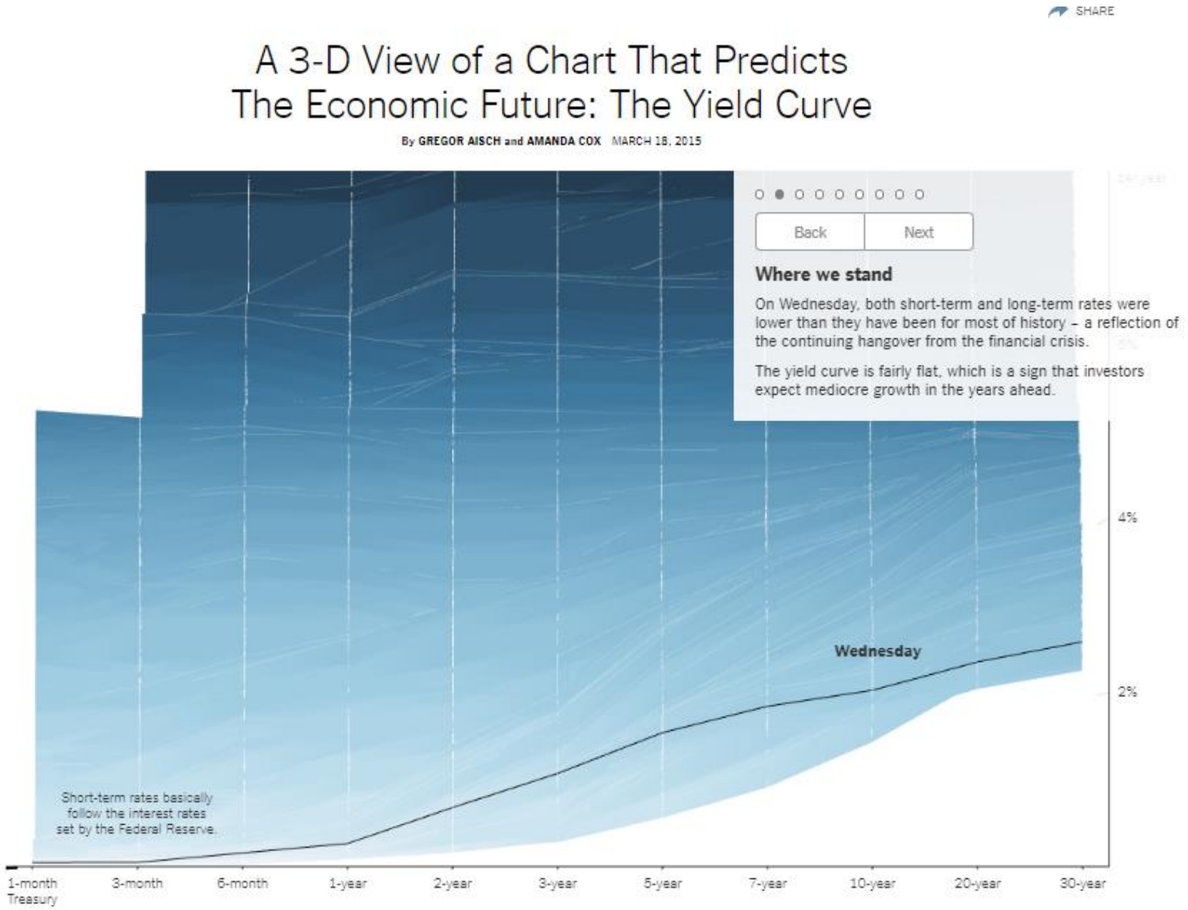
(c) contours

(d) apparent ridges

Justified 3D: Economic growth curve

constrained navigation steps through carefully designed viewpoints

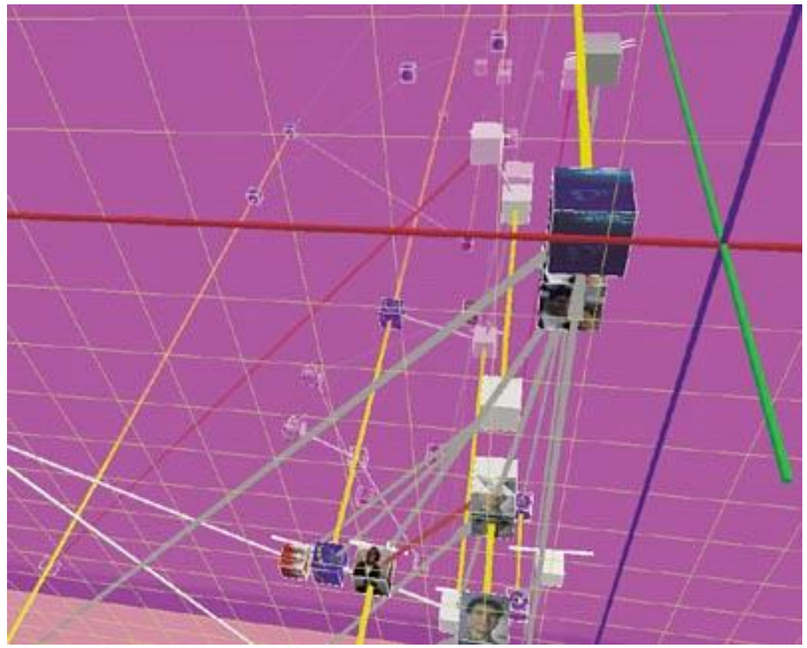




http://www.nytimes.com/interactive/2015/03/19/upshot/3d-yield-curve-economic-growth.html

No unjustified 3D

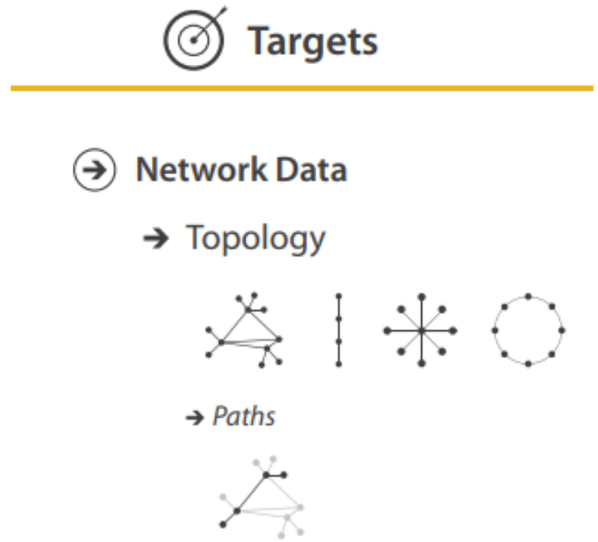
- 3D legitimate for true 3D spatial data
- 3D needs very careful justification for abstract data
  - enthusiasm in 1990s, but now skepticism
  - be especially careful with 3D for point clouds or networks



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

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

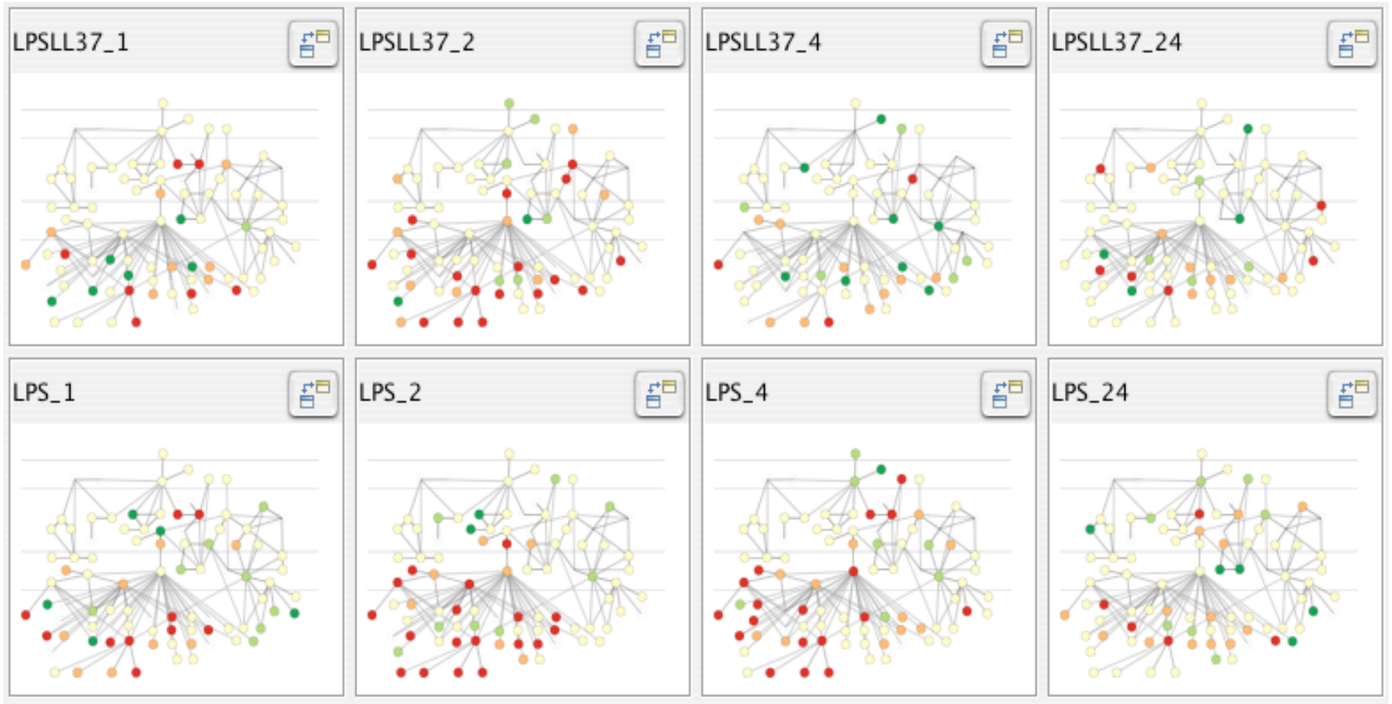


Eyes beat memory

- 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



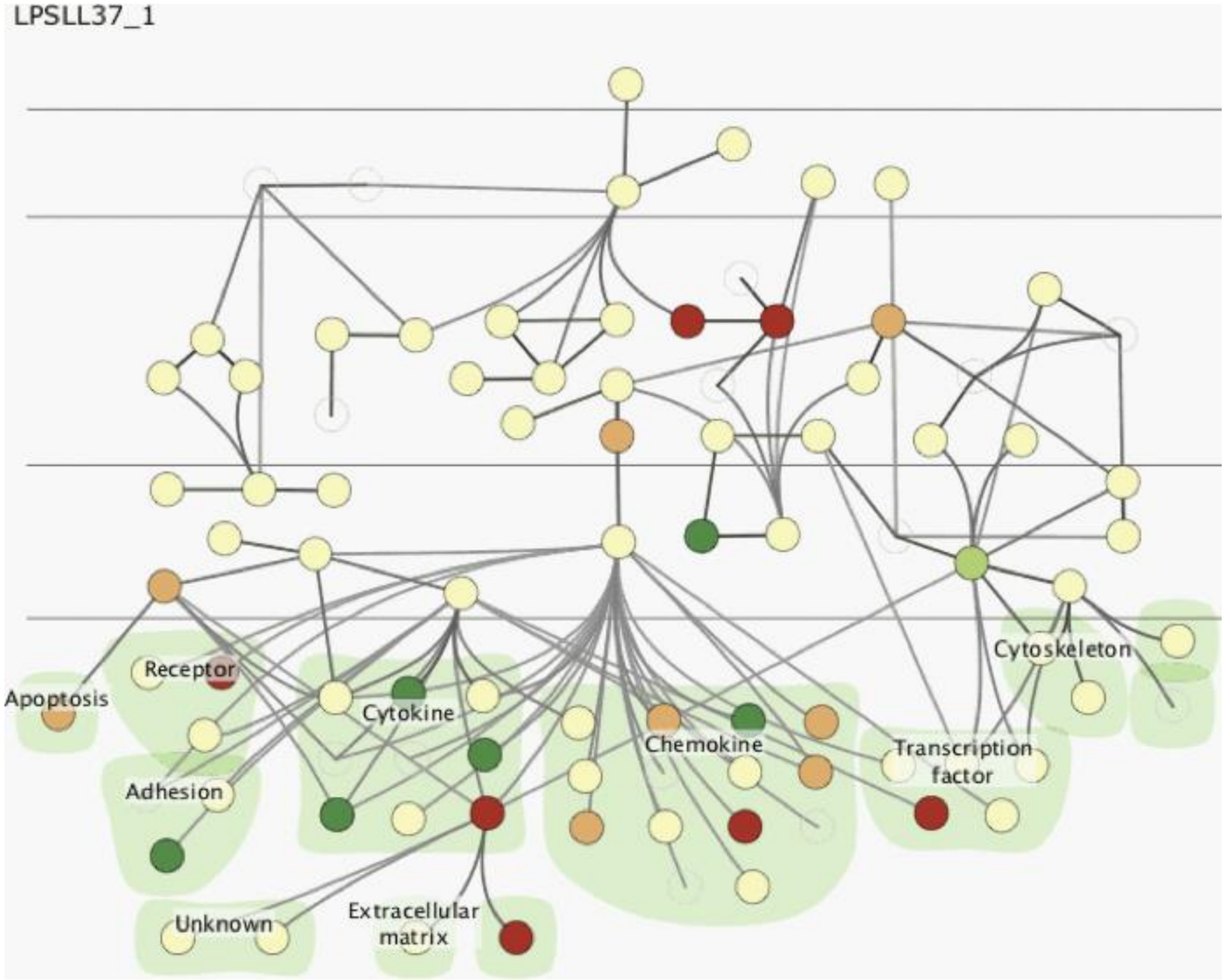
video

[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.]

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



Change blindness (改變視盲，變盲)

- if attention is directed elsewhere, even drastic changes not noticeable
  - door experiment (video 1998)

- change blindness demos
  - mask in between images (video)

Motion-Induced Blindness (動盲)

動盲是1990年代才普遍被心理學家所研究。

- 動盲是在動態的背景下，注視特定的點位，會造成在不特定的時間，忽略一些明顯的特徵。
- 動盲和變盲一樣，都與注意力有些相關，大腦 往往在處理動態資訊時，都會遵循『贏者通吃』的法則。都會選擇性的注意，而忽略其他明顯的變化。

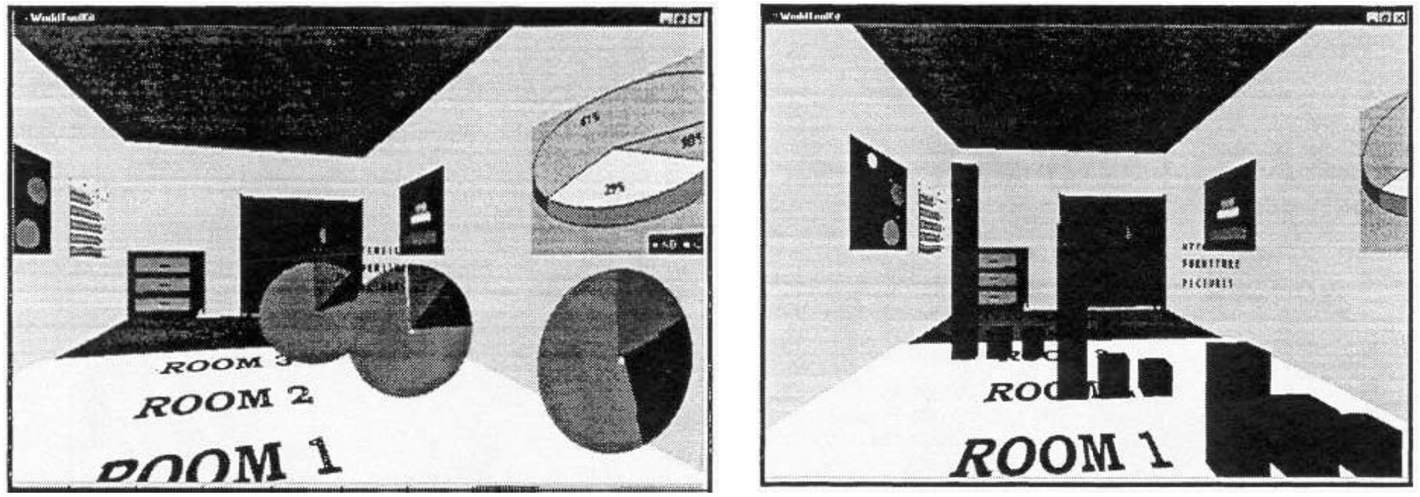
Attension and Working memory

- 注意力是一個複雜的認知機制，讓我們的腦在 複雜環境中，能選擇地專注在某件比較重要的 事物上，而暫時忽略了其他事物。

- 工作記憶是大腦暫時地記住數個目標，並在心 理做運算的能力。工作記憶和個人的能力以及 專注力都有相關，影片中要求默計傳球數量，就需要使用到工作記憶。

Resolution beats Immersion

- immersion typically not helpful for abstract data
  - do not need sense of presence or stereoscopic 3D
- resolution much more important
  - pixels are the scarcest resource
  - desktop also better for workflow integration
- virtual reality for abstract data very difficult to justify



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

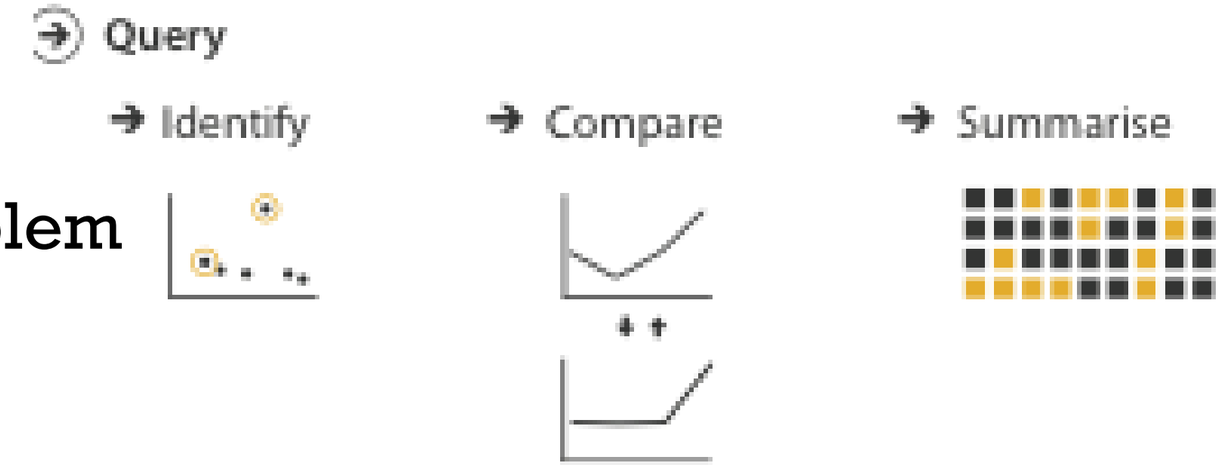
DataHop: Spatial Data Exploration in Virtual Reality(UIST 2020)

Overview first, zoom and filter, details on demand

- influential mantra from Shneiderman

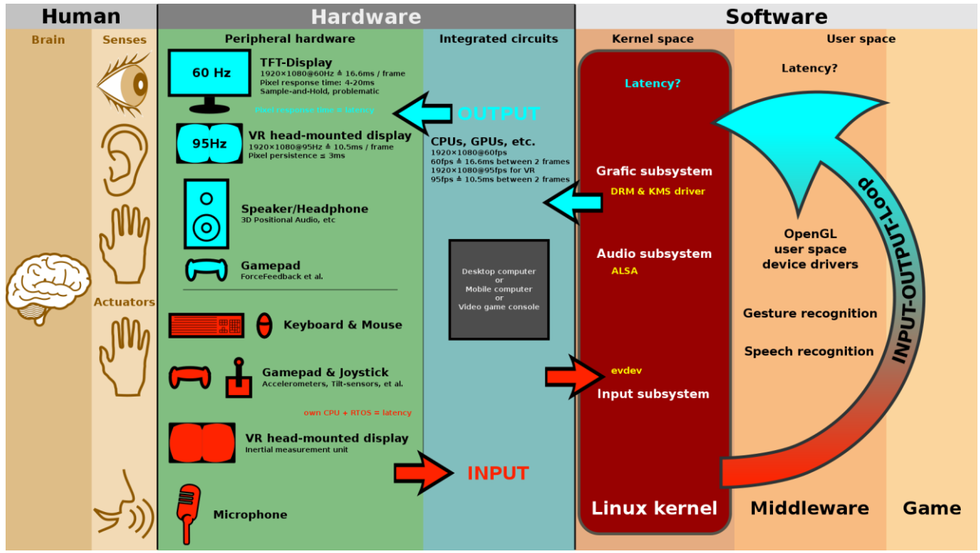
[The Eyes Have It: A Task by Data Type Taxonomy for Information Visualizations. Shneiderman. Proc. IEEE Visual Languages, pp. 336–343, 1996.]

- overview = summary
  - microcosm of full vis design problem



Responsiveness is required

- three major categories
  - 0.1 seconds: perceptual processing
  - 1 second: immediate response
  - 10 seconds: brief tasks
  - Jacob Nielsen's Response Times: The Three Important Limits:



- importance of visual feedback
  - How is Nintendo doing in interactive feedback(video)

Get if Right in Black and White

Color2Gray: Salience-Preserving Color Removal

Amy A. Gooch Sven C. Olsen Jack Tumblin Bruce Gooch

Northwestern University *

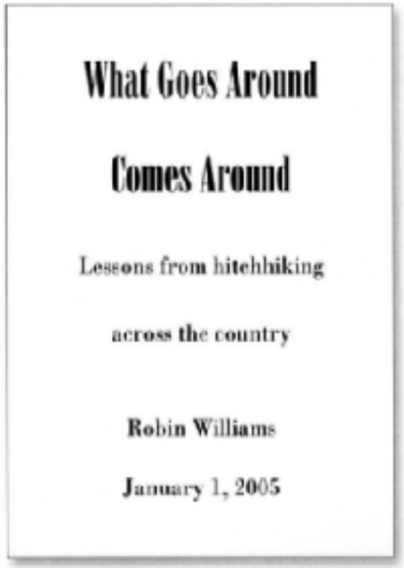
Function first, Form next

- start with focus on functionality
  - straightforward to improve aesthetics later on, as refinement
  - if no expertise in-house, find good graphic designer to work with

- dangerous to start with aesthetics
  - usually impossible to add function retroactively

Form: Basic graphic design ideas

- 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 not quite the same



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

Rules of Thumb (recap)

- 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*