Rules of Thumb

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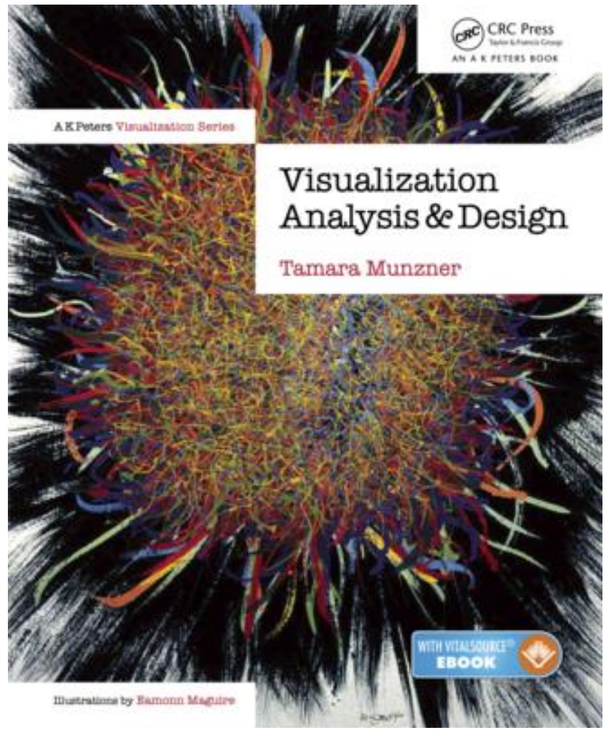


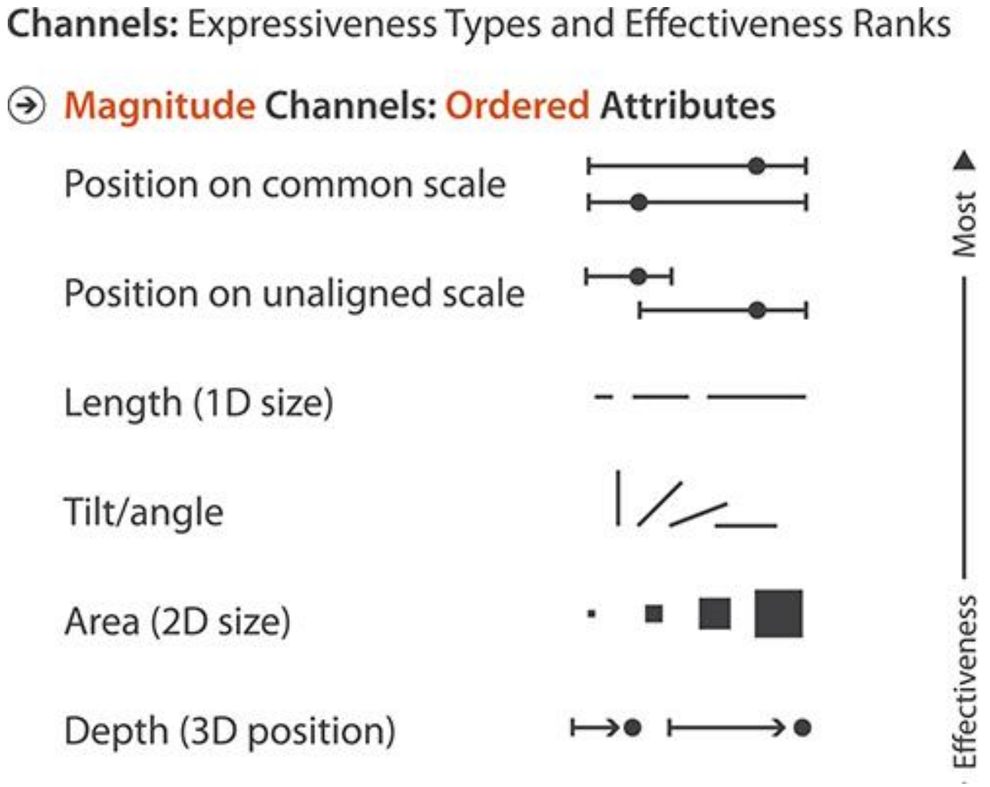
- Slides refer to https://www.cs.ubc.ca/~tmm/

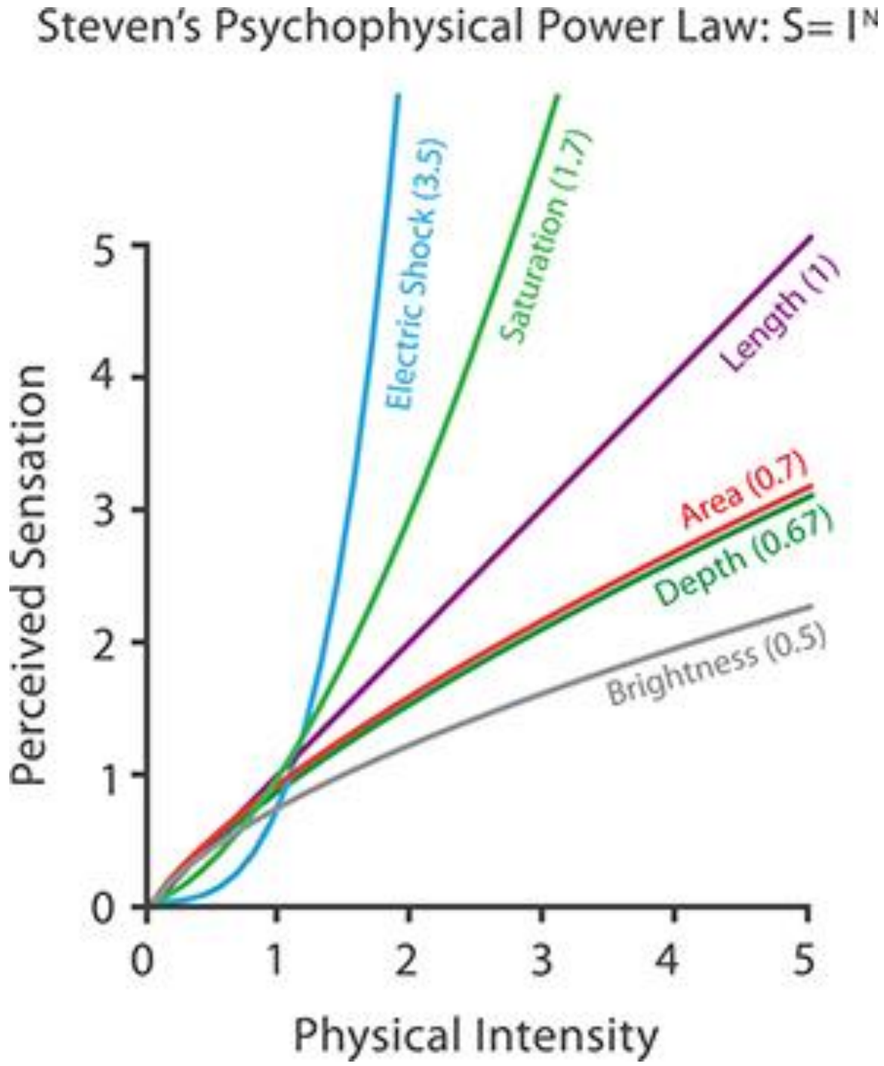
Rules of Thumb

- 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

No unjustified 3D: Power of the plane

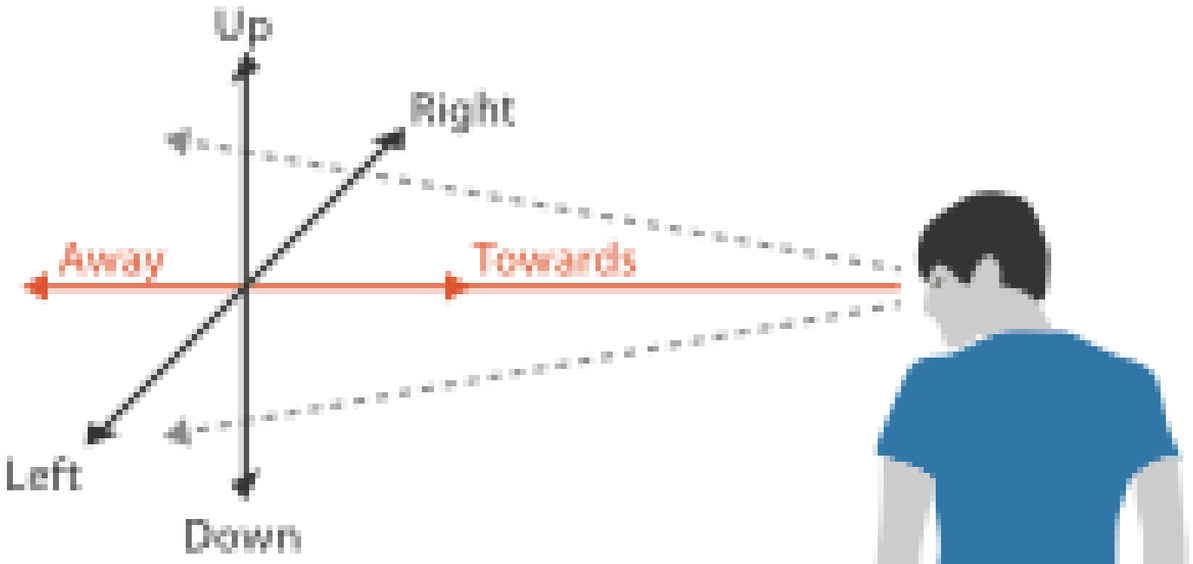
- high-ranked spatial position channels: planar spatial position
  - not depth!

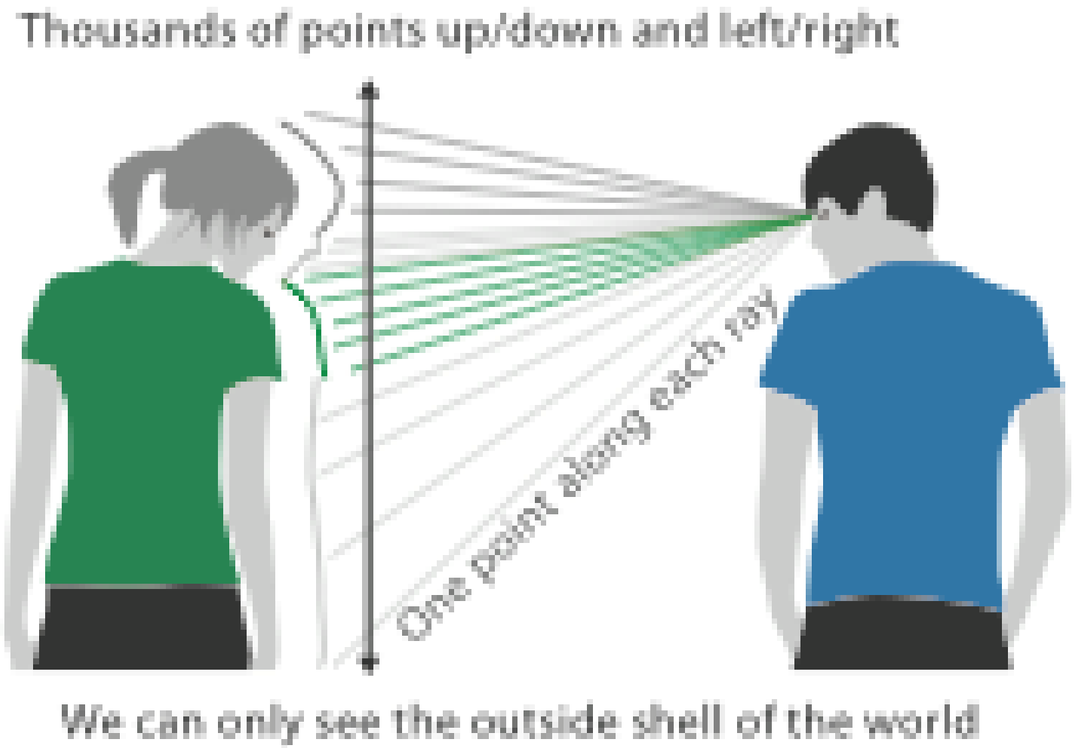




No unjustified 3D: Danger of depth

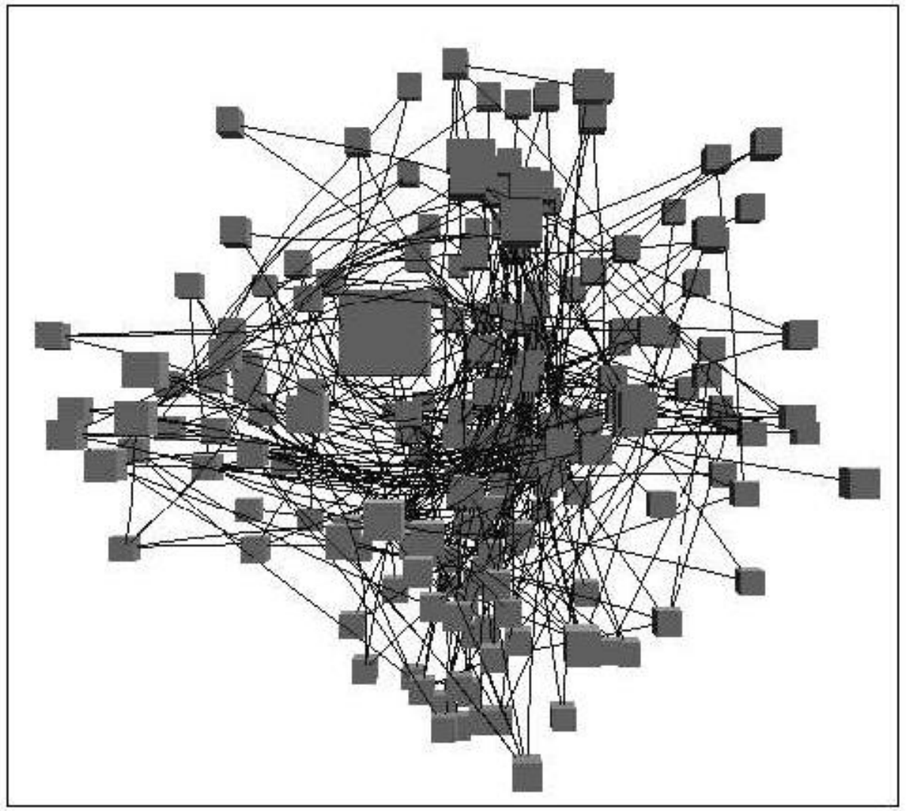
- we don’t really live in 3D: we *see* in 2.05D
  - acquire more info on image plane quickly from eye movements
  - acquire more info for depth slower, from head/body motion





Occlusion hides information

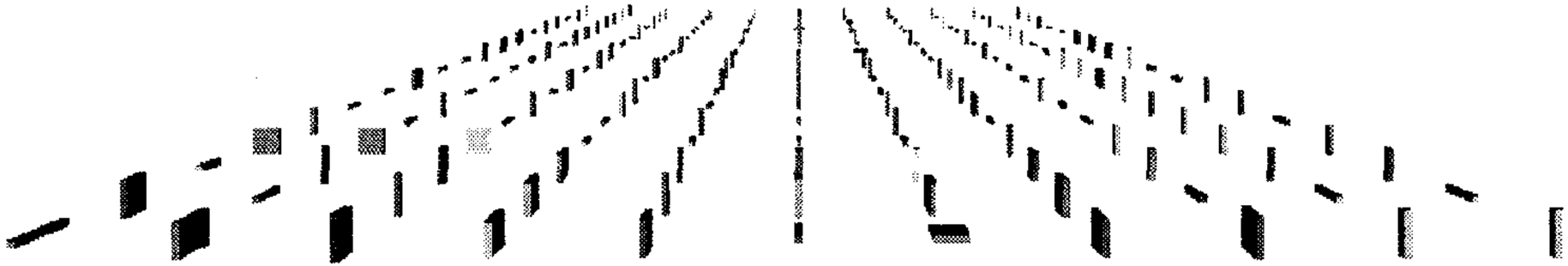
- occlusion
- interaction complexity



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

Perspective distortion loses information

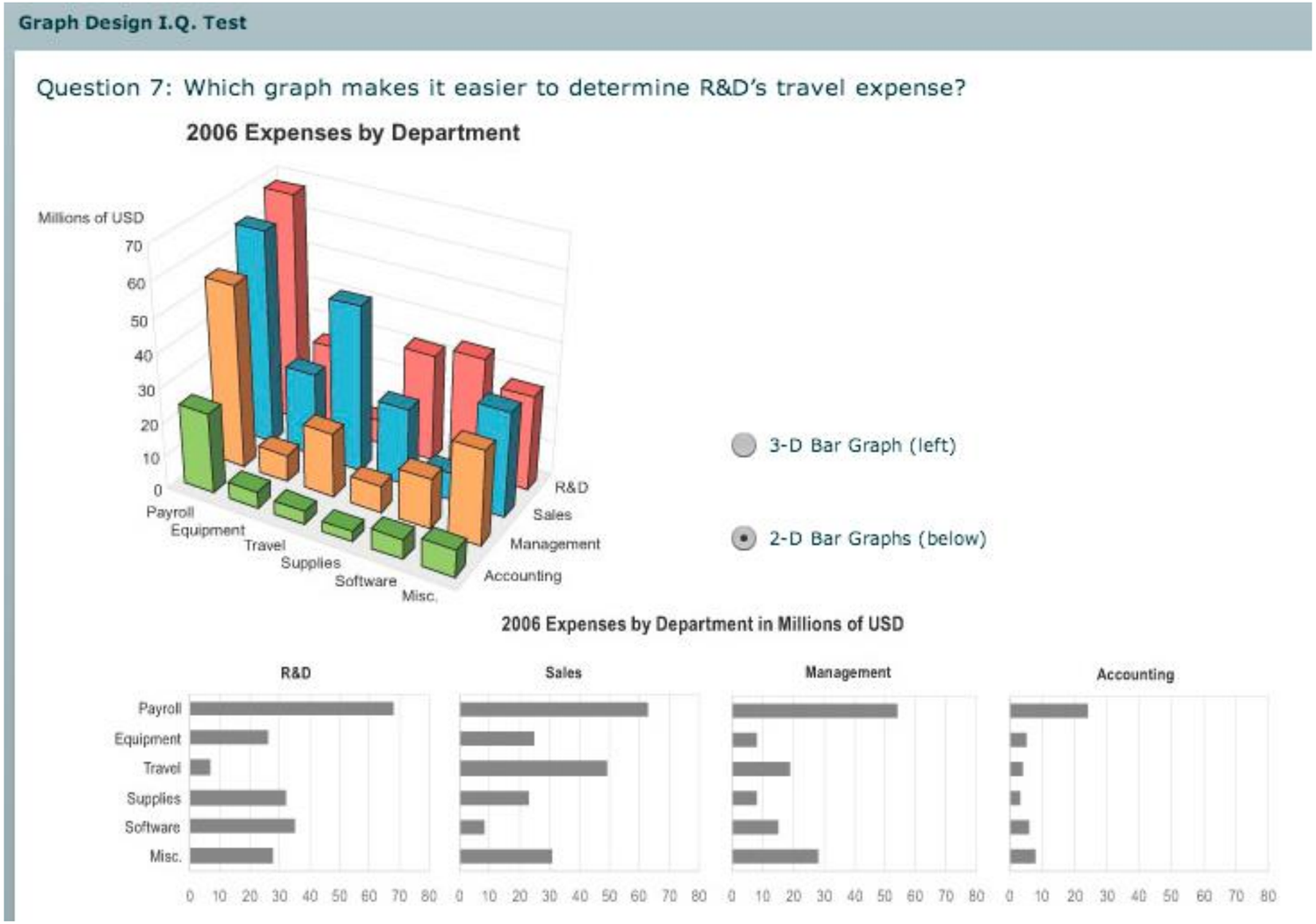
- perspective distortion
  - interferes with all size channel encodings
  - power of the plane is lost!



[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!

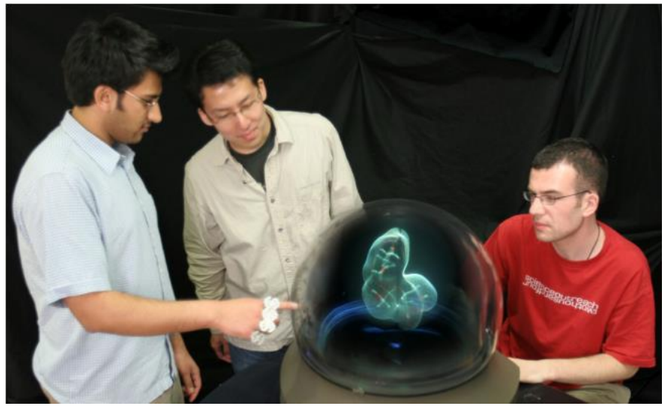


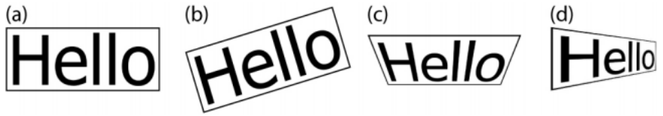
[http://perceptualedge.com/files/GraphDesignIQ.html]

Tilted text isn't legible

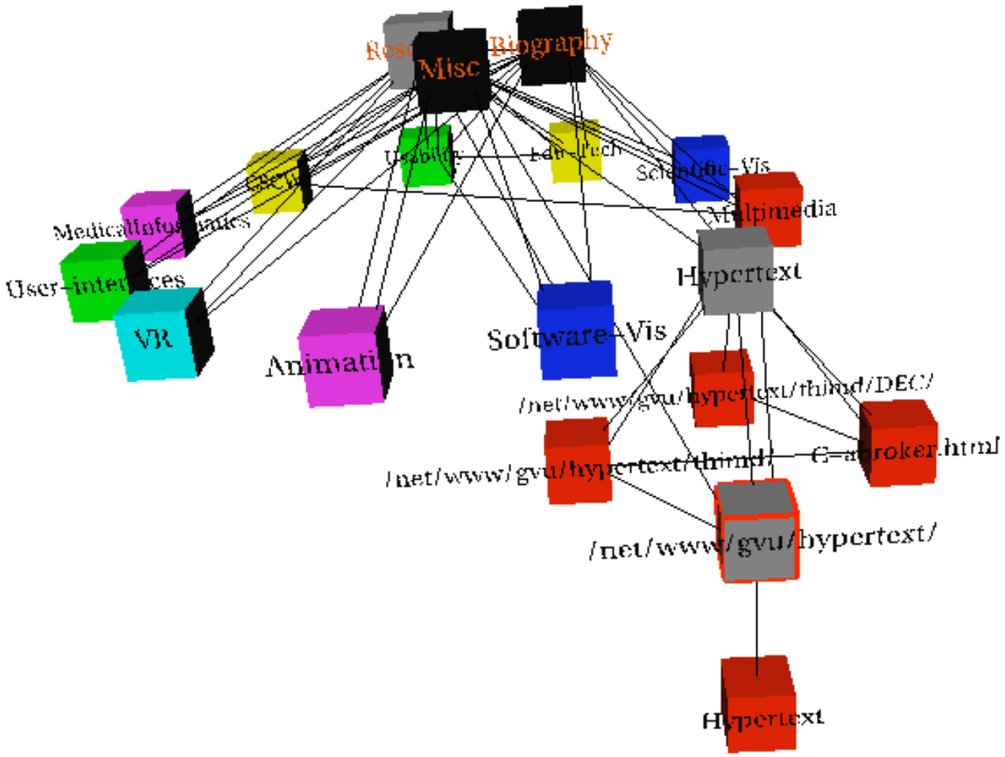
- Text legibility
  - far worse when tilted from image plane

- Further reading





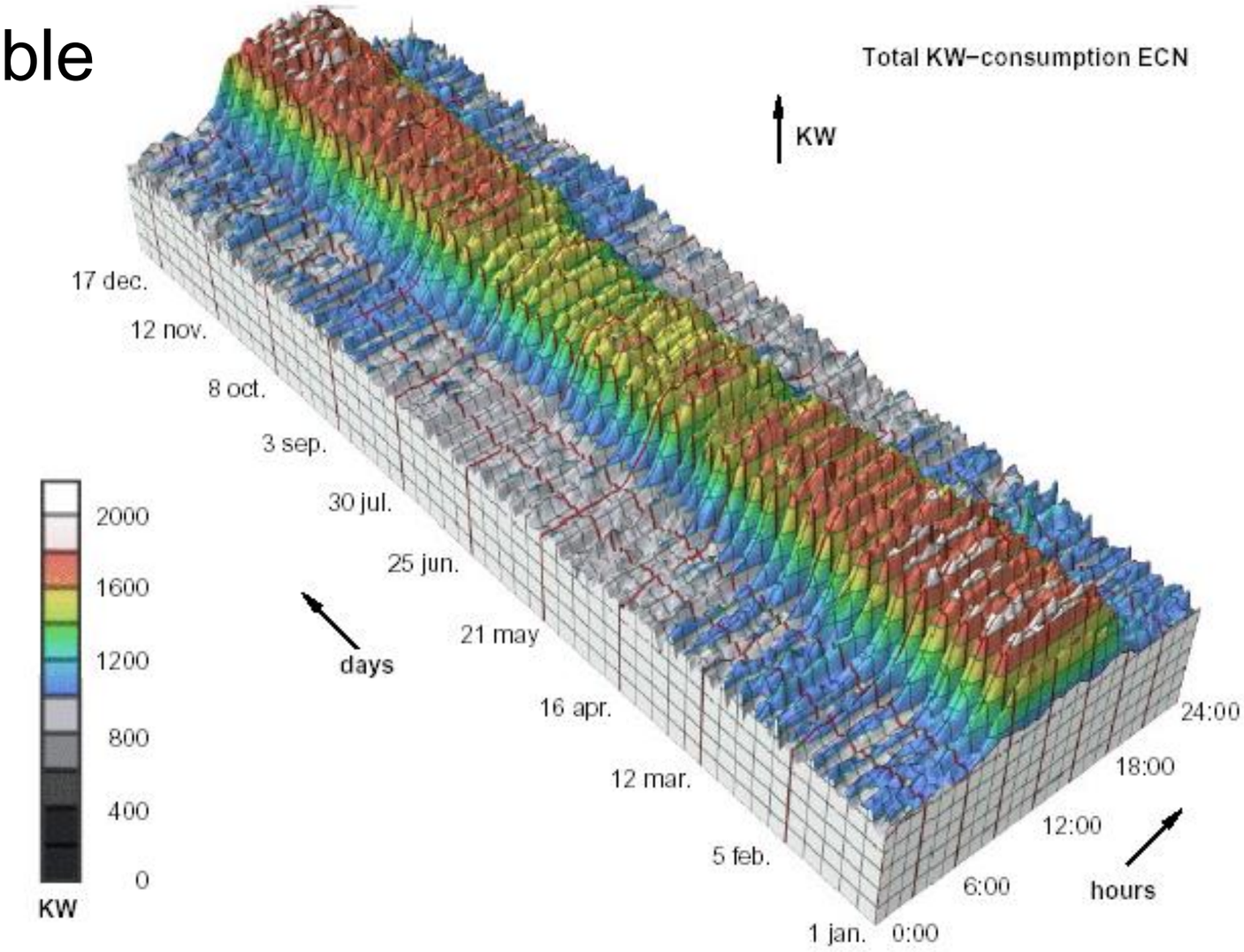
[*Exploring and Reducing the Effects of Orientation on Text Readability in Volumetric Displays*.
Grossman et al. CHI 2007]



[*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

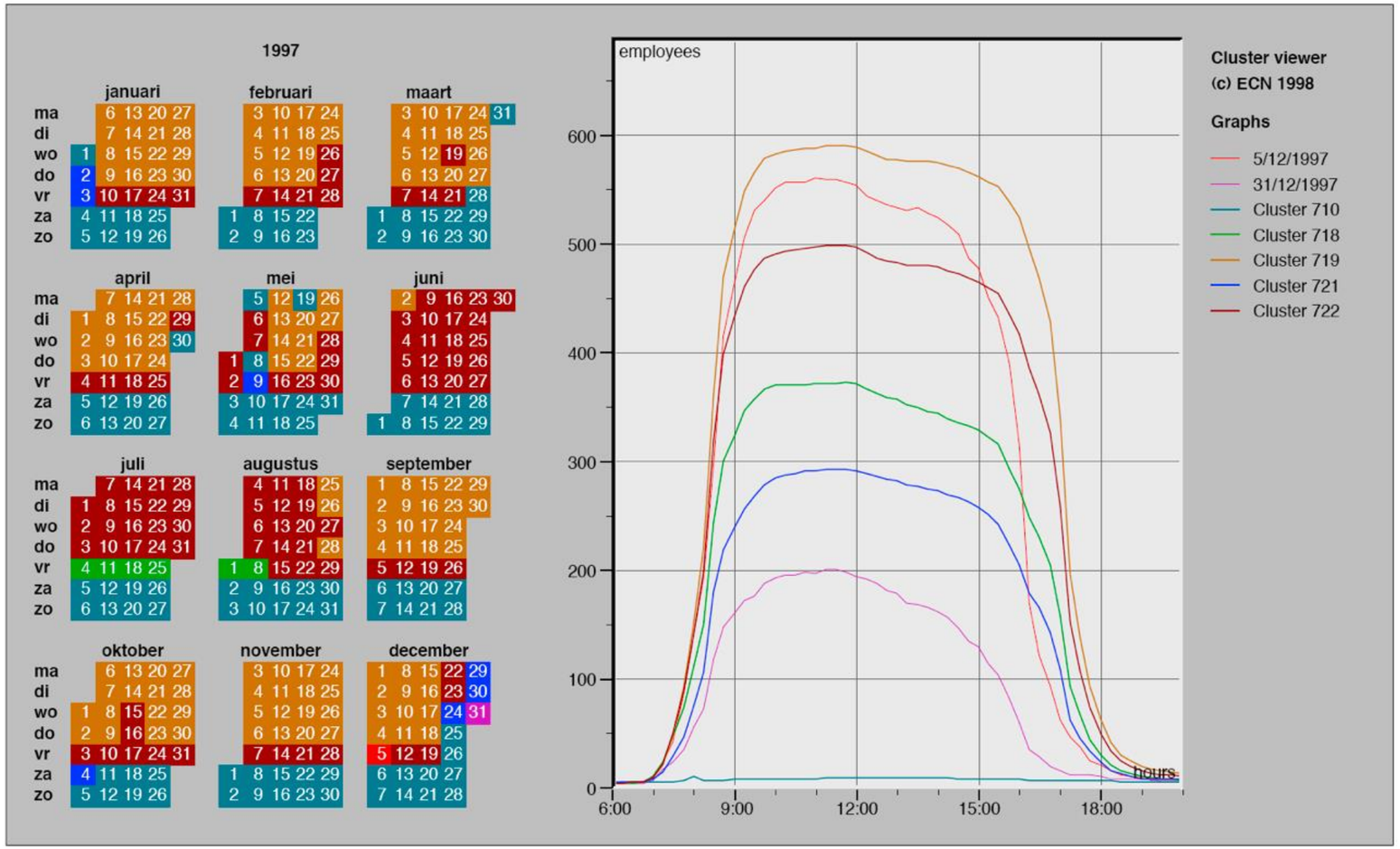
- extruded curves: detailed comparisons impossible



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

No unjustified 3D example: Transform for new data abstraction

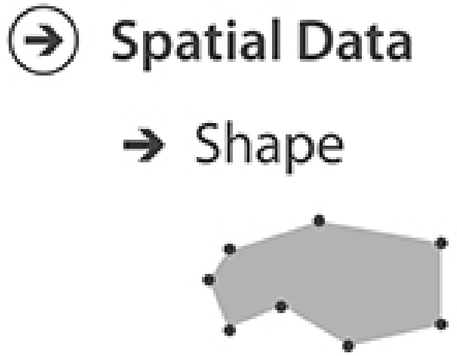
- Derived data: cluster hierarchy
- Juxtapose multiple views: calendar, superimposed 2D curves

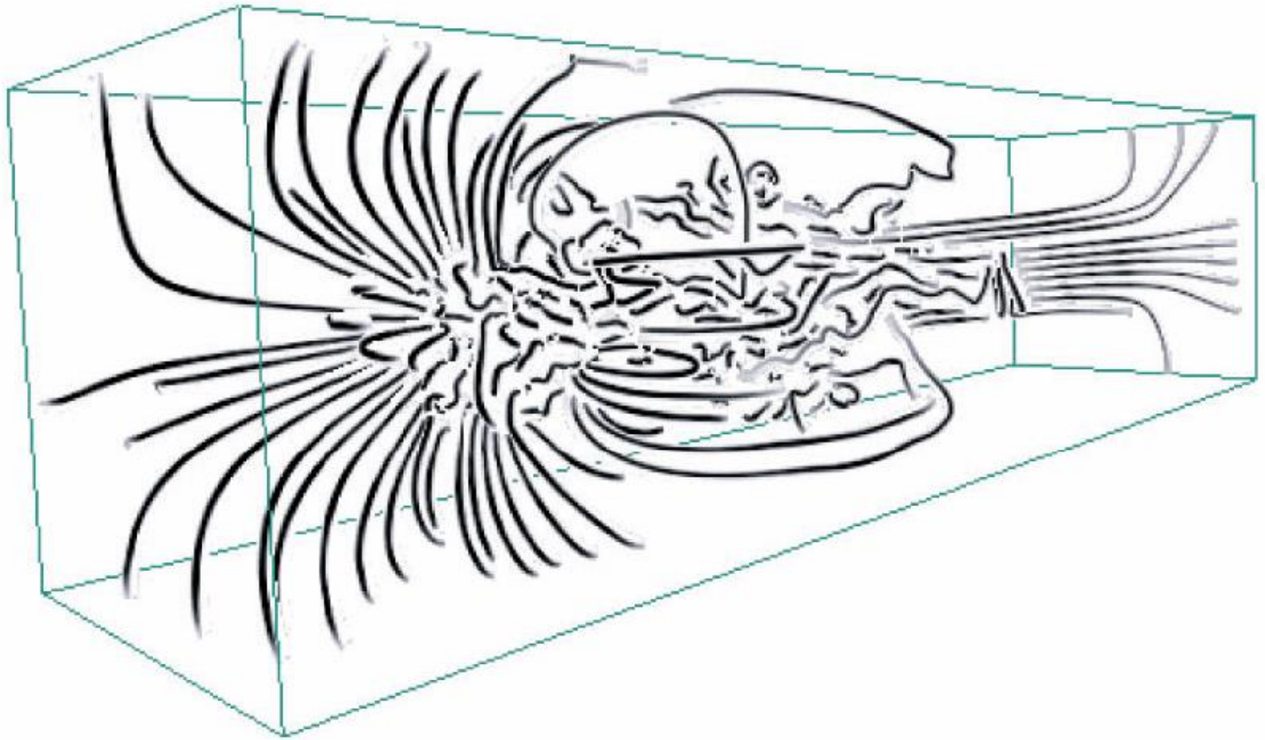


[Cluster and Calendar based Visualization of Time Series Data. van Wijk and van Selow, Proc. InfoVis 99.]

Justified 3D: shape perception

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

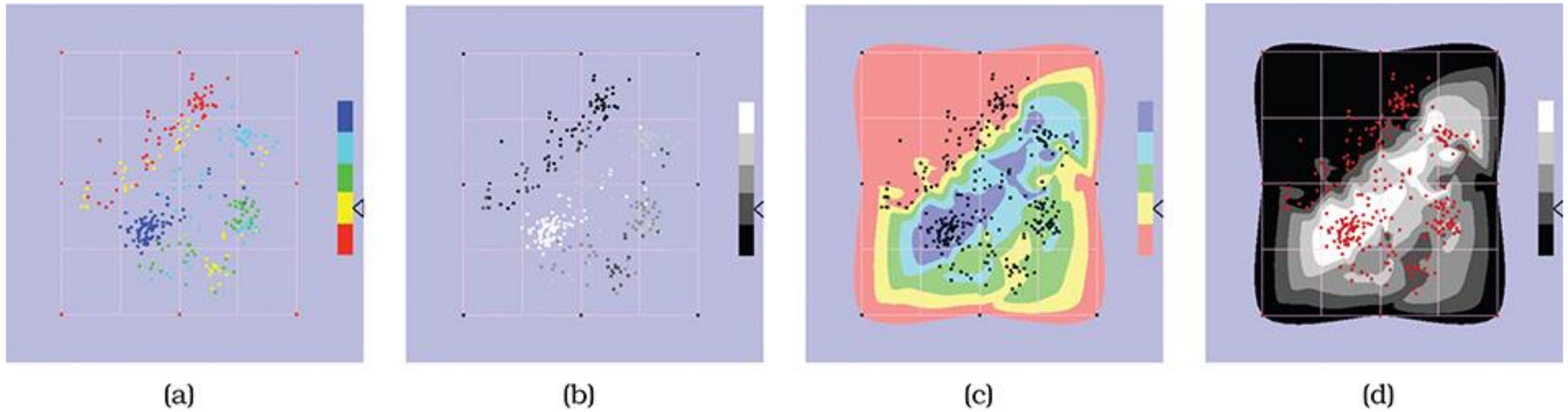


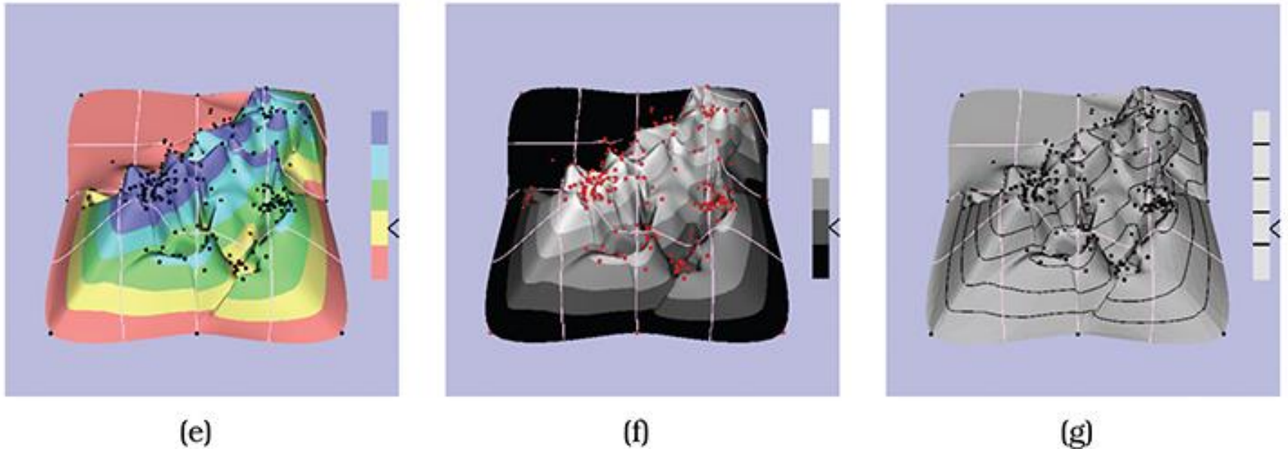


[Image-Based Streamline Generation and Rendering. Li and Shen. IEEE Trans. Visualization and Computer Graphics (TVCG) 13:3 (2007), 630–640.]

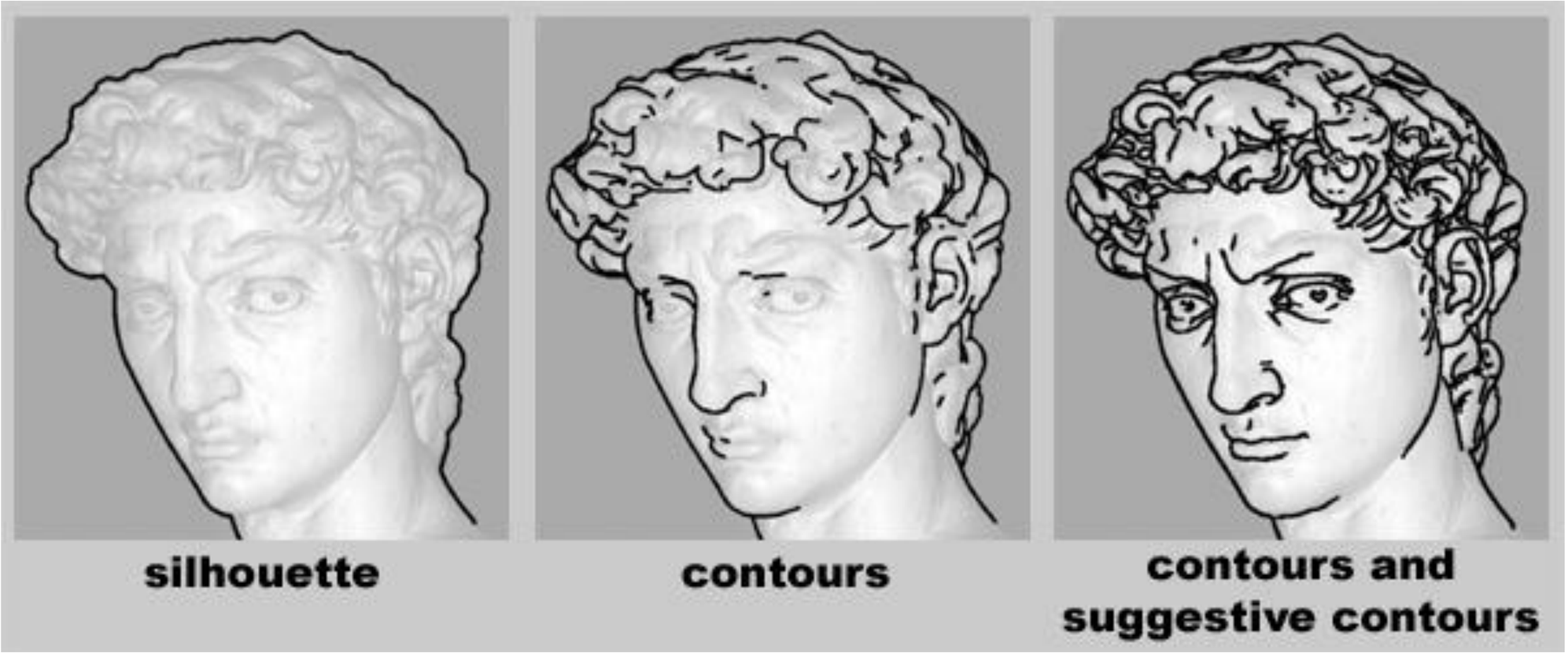
Information Landscape

- The density of the points on the plane is computed as a derived attribute and used to construct a surface whose height varies according to this attribute in order to show its value in a form similar to geographic terrain





Suggestive Contours for Conveying Shape [Doug DeCarlo et al. 2003]



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

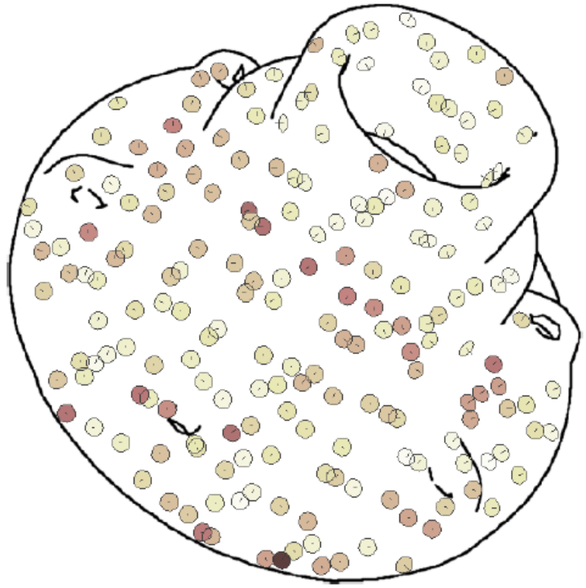
Shaded View | Contours | Suggestive Contours | Ridges & Valleys | Apparent Ridges

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

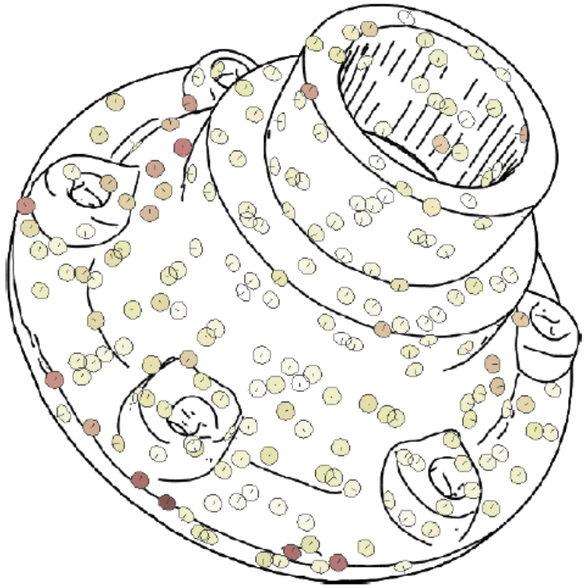
How Well Do Line Drawings Depict Shape? [Forrester Cole et al. 2009]

(a) shaded image

(b) human drawing

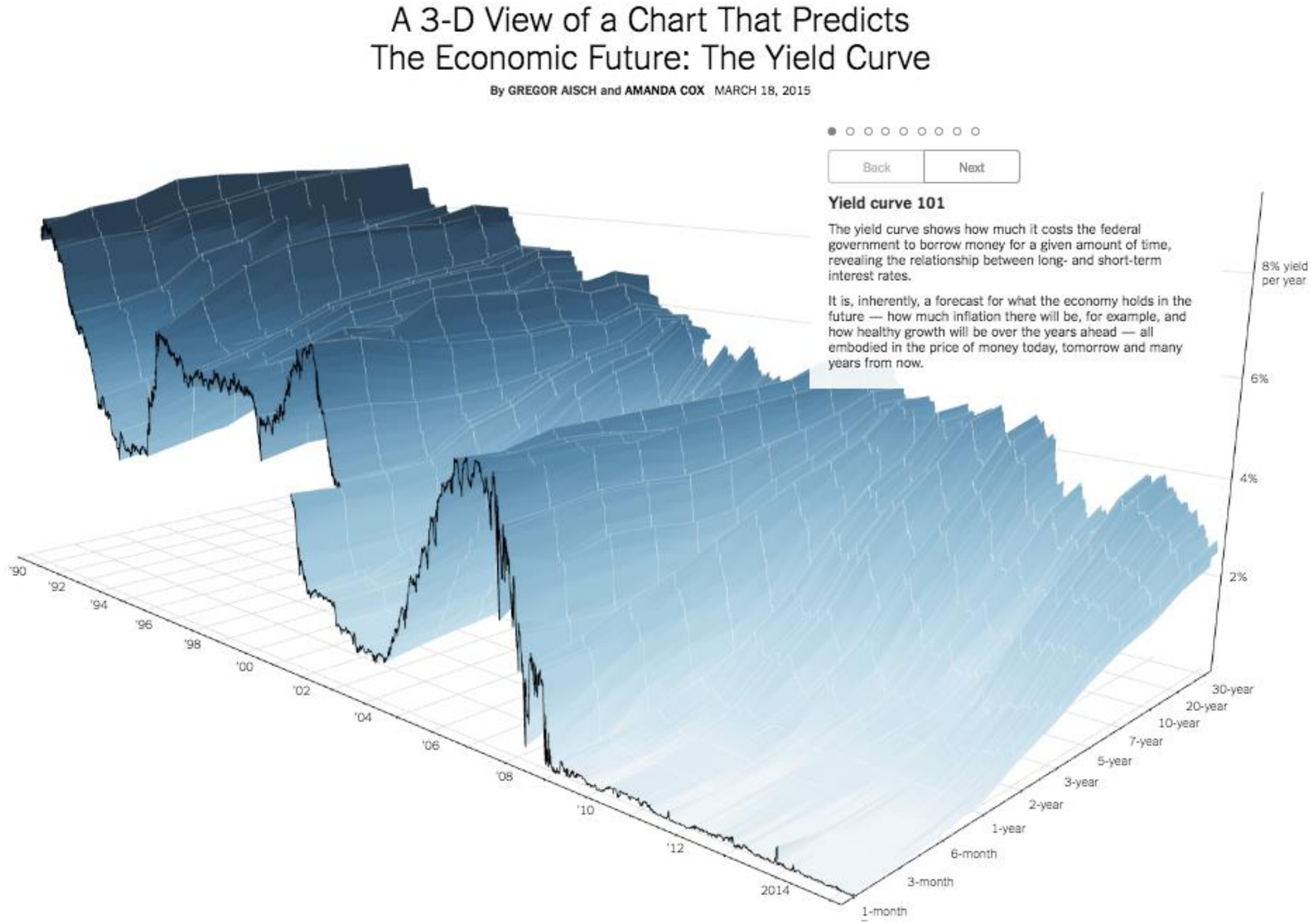


(c) contours



(d) apparent ridges

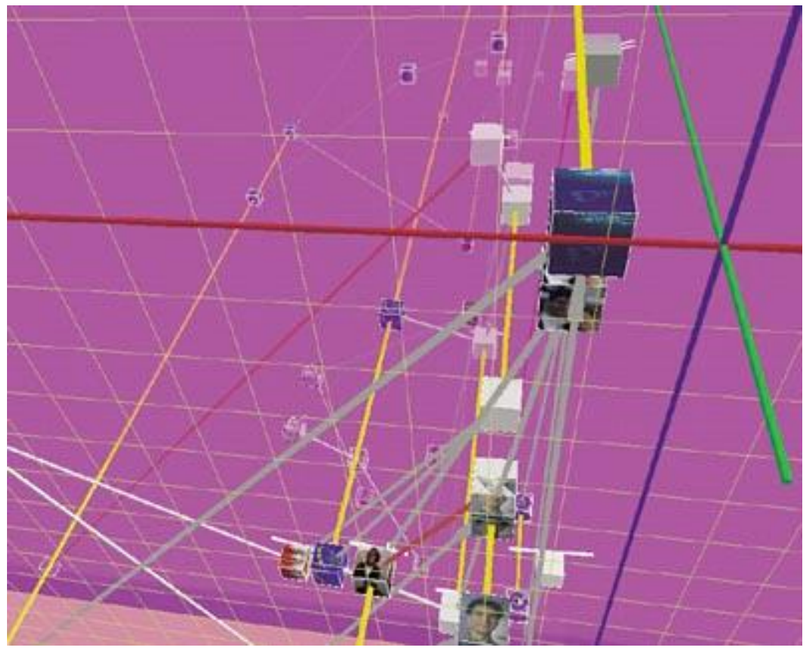
Justified 3D: Economic growth curve



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

No unjustified 3D

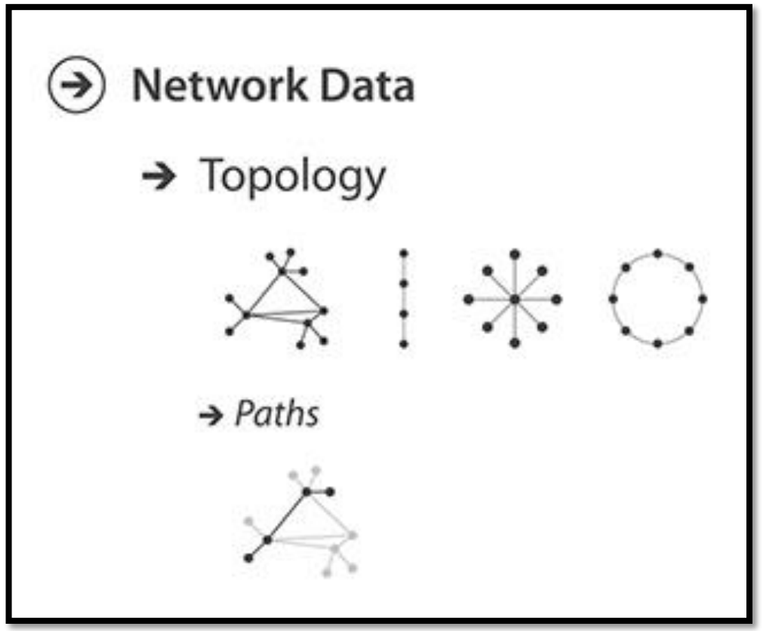
- 3D legitimate for true 3D spatial data
- 3D needs very careful justification for abstract data
  - enthusiasm in 1990s, but now skepticism
  - be especially careful with 3D for point clouds or networks

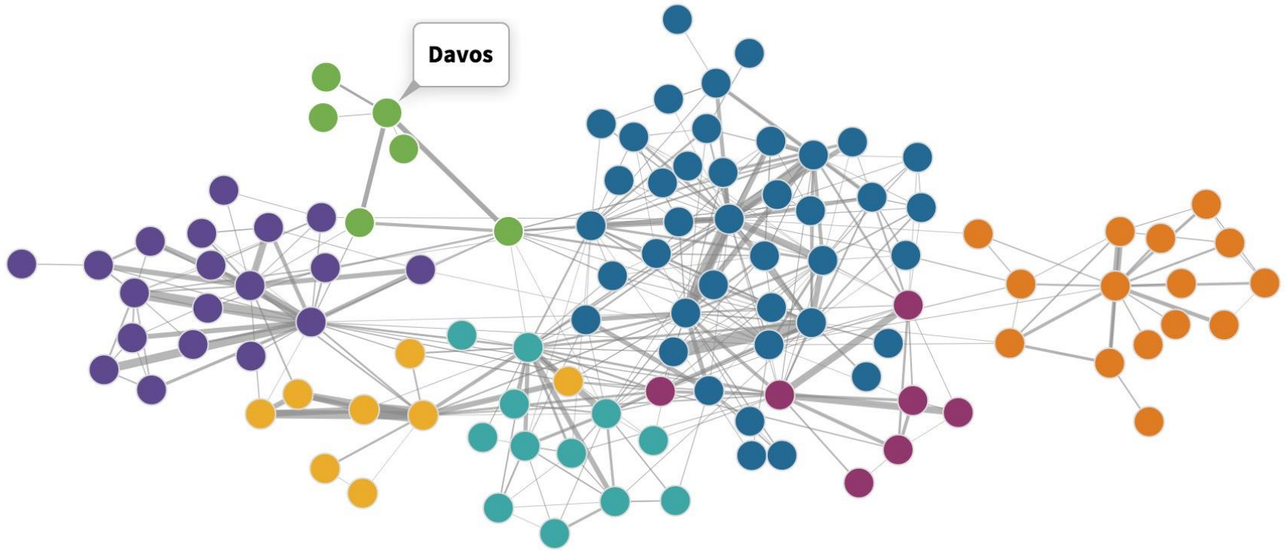


[WEBPATH-a three dimensional Web history. Frecon and Smith. Proc. InfoVis 1999]

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

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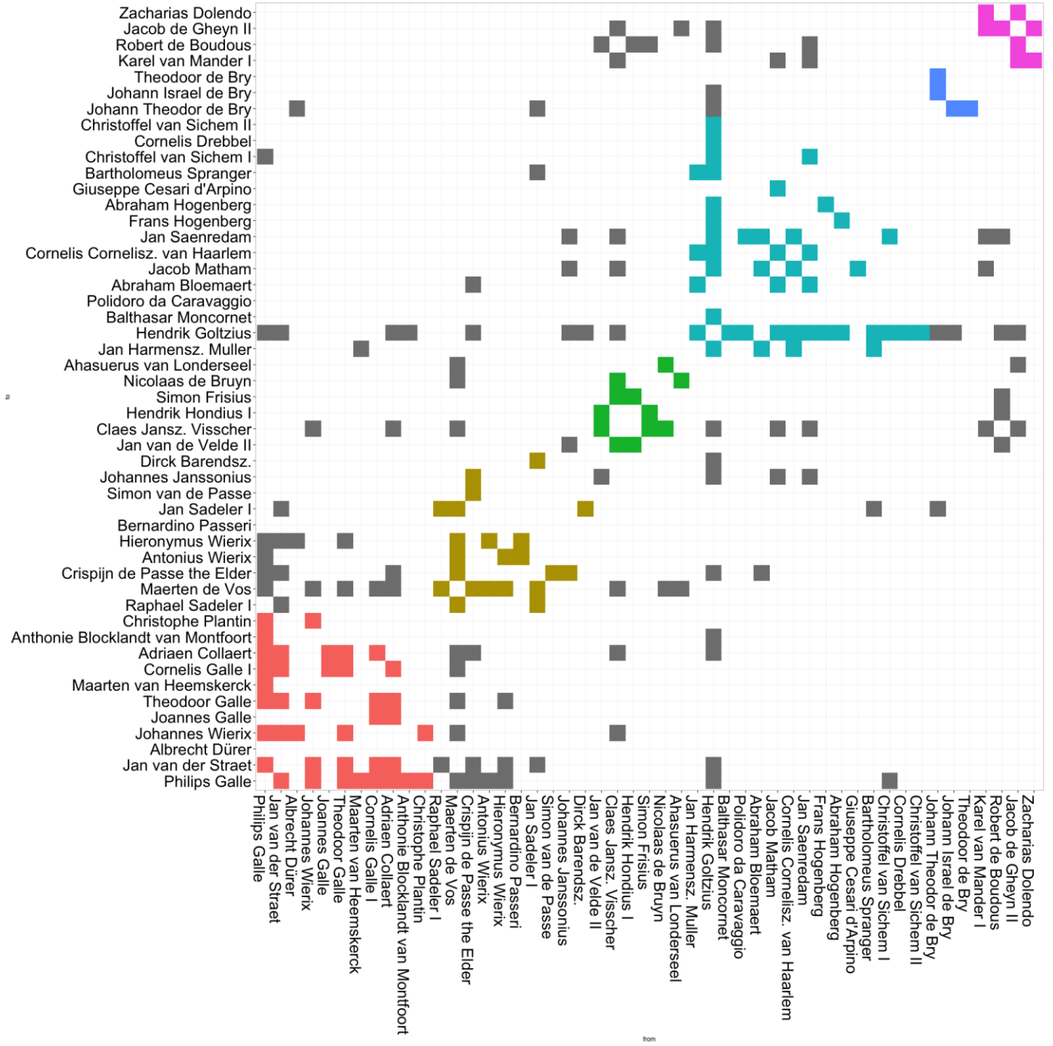
Zacharias Dolendo
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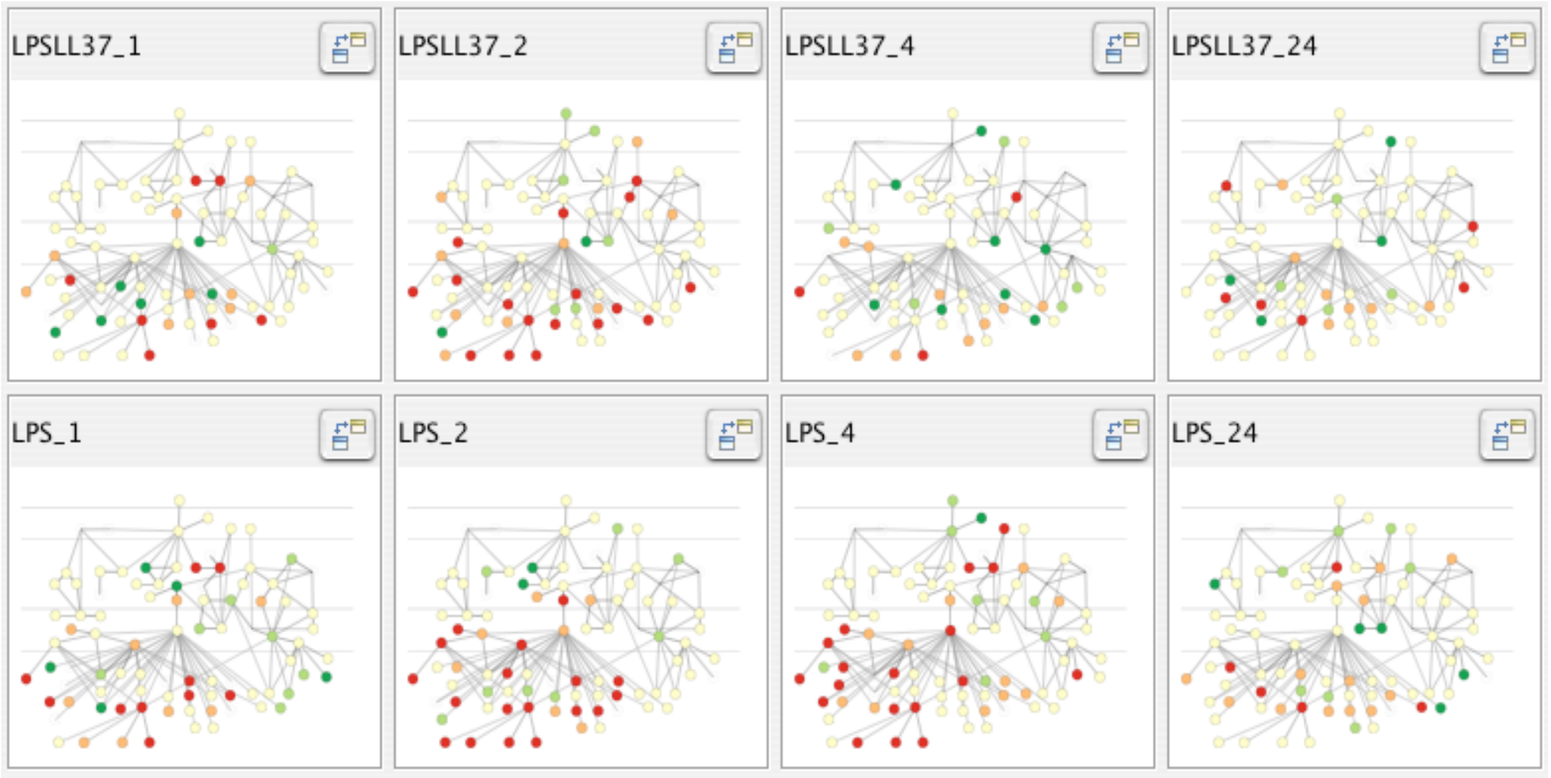
Robert de Boudous
Karel van Mander I
Theodoor de Bry
Johann Israel de Bry
Johann Theodor de Bry
Christoffel van Sichem II
Cornelis Drebbel
Christoffel van Sichem I
Bartholomeus Spranger
Giuseppe Cesari d'Arpino
Abraham Hogenberg
Frans Hogenberg
Jan Saenredam
Cornelis Cornelisz. van Haarlem
Jacob Matham
Abraham Bloemaert
Polidoro da Caravaggio
Balthasar Moncornet
Hendrik Goltzius
Jan Harmensz. Muller
Ahasuerus van Londerseel
Nicolaas de Bruyn
Simon Frisius
Hendrik Hondius I
Claes Jansz. Visscher
Jan van de Velde II
Dirck Barendsz.
Johannes Janssonius
Simon van de Passe
Jan Sadeler I
Bernardino Passeri
Hieronymus Wierix
Antonius Wierix
Crispijn de Passe the Elder
Maerten de Vos
Raphael Sadeler I
Christophe Plantin
Anthonie Blocklandt van Montfoort
Adriaen Collaert
Cornelis Galle I
Maarten van Heemskerck
Theodoor Galle
Joannes Galle
Johannes Wierix
Albrecht Dürer
Jan van der Straet
Philips Galle
from

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

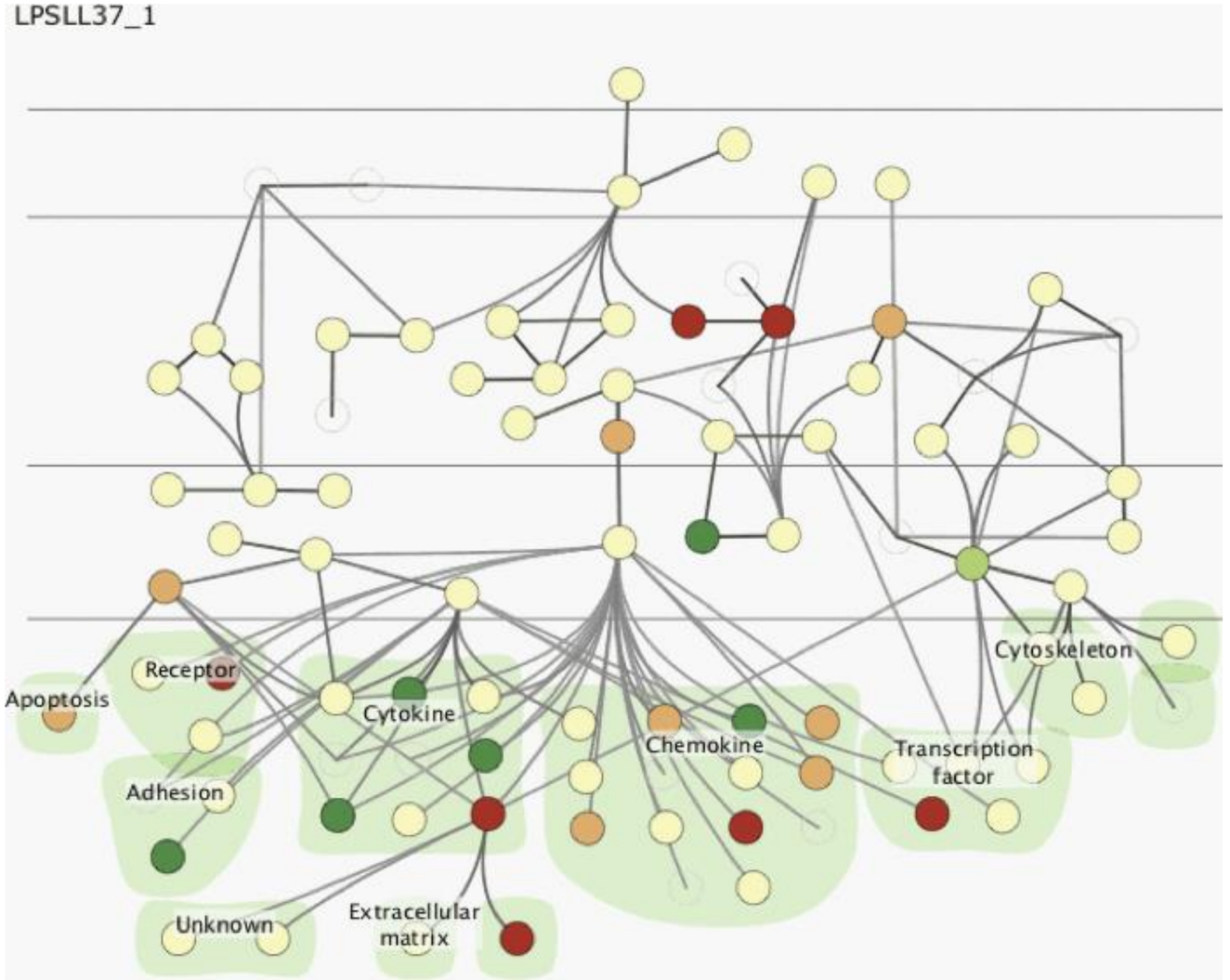


[Cerebral: Visualizing Multiple Experimental Conditions on a Graph with Biological Context. Barsky, Munzner, Gardy, and Kincaid. IEEE Trans. Visualization and Computer Graphics (Proc. InfoVis 2008) 14:6 (2008), 1253–1260.]

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

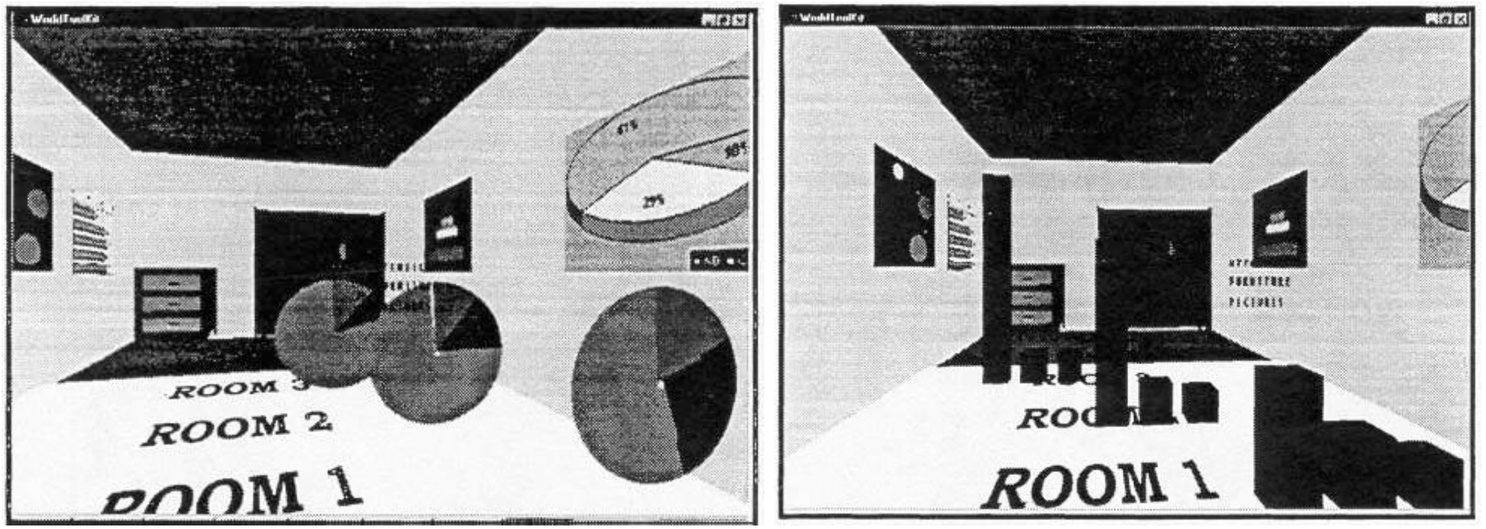


Change blindness (改變視盲)

- if attention is directed elsewhere, even drastic changes not noticeable
  - https://youtu.be/pqgwZEdoH5w

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



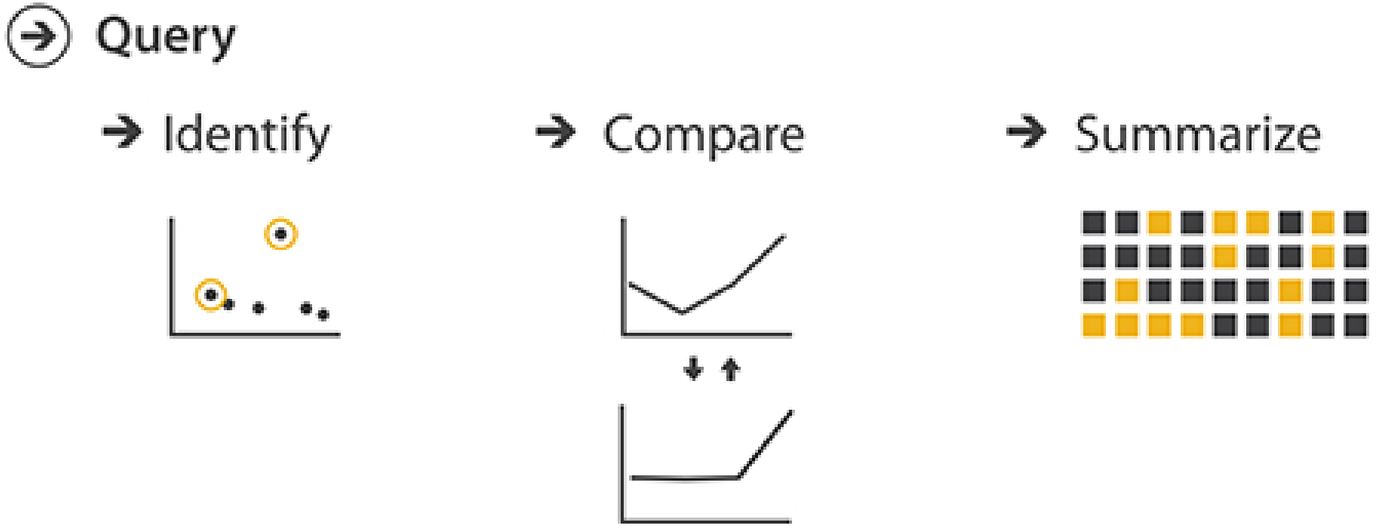
[Development of an information visualization tool using virtual reality. Kirner and Martins. Proc. Symp. Applied Computing 2000]

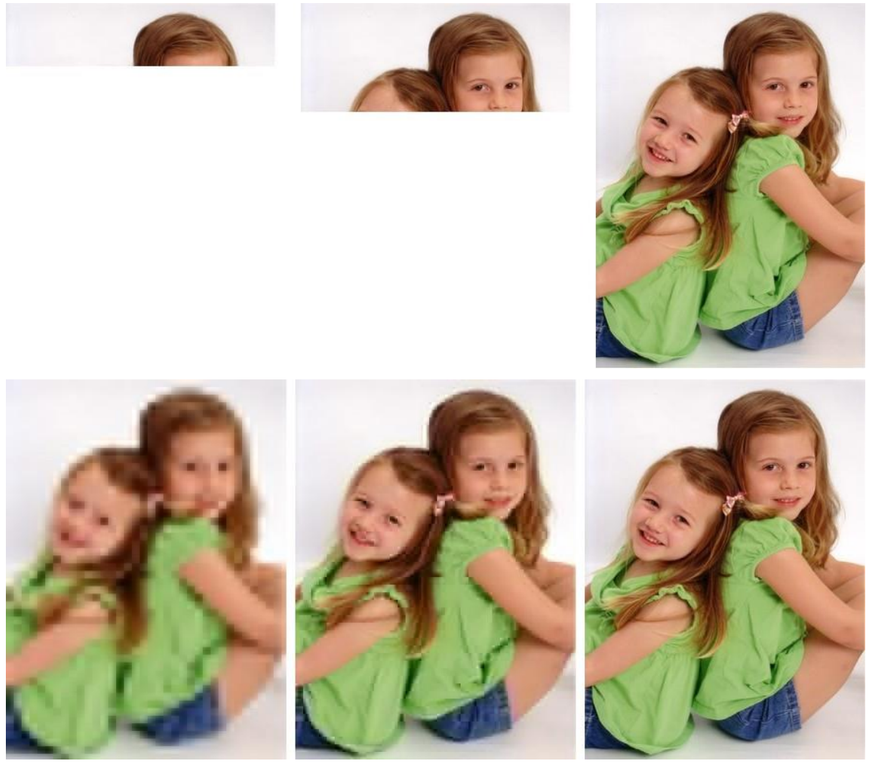
Overview first, zoom and filter, details on demand

- 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

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

Further reading

- Visualization Analysis and Design. Tamara Munzner. CRC Press, 2014.
  - *Chap 6: Rules of Thumb*