

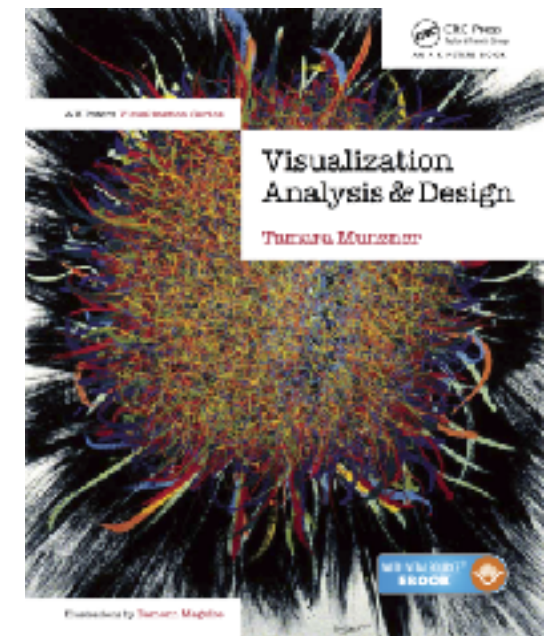
Visualization Analysis & Design

Rules of Thumb (Ch 6)

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University of British Columbia

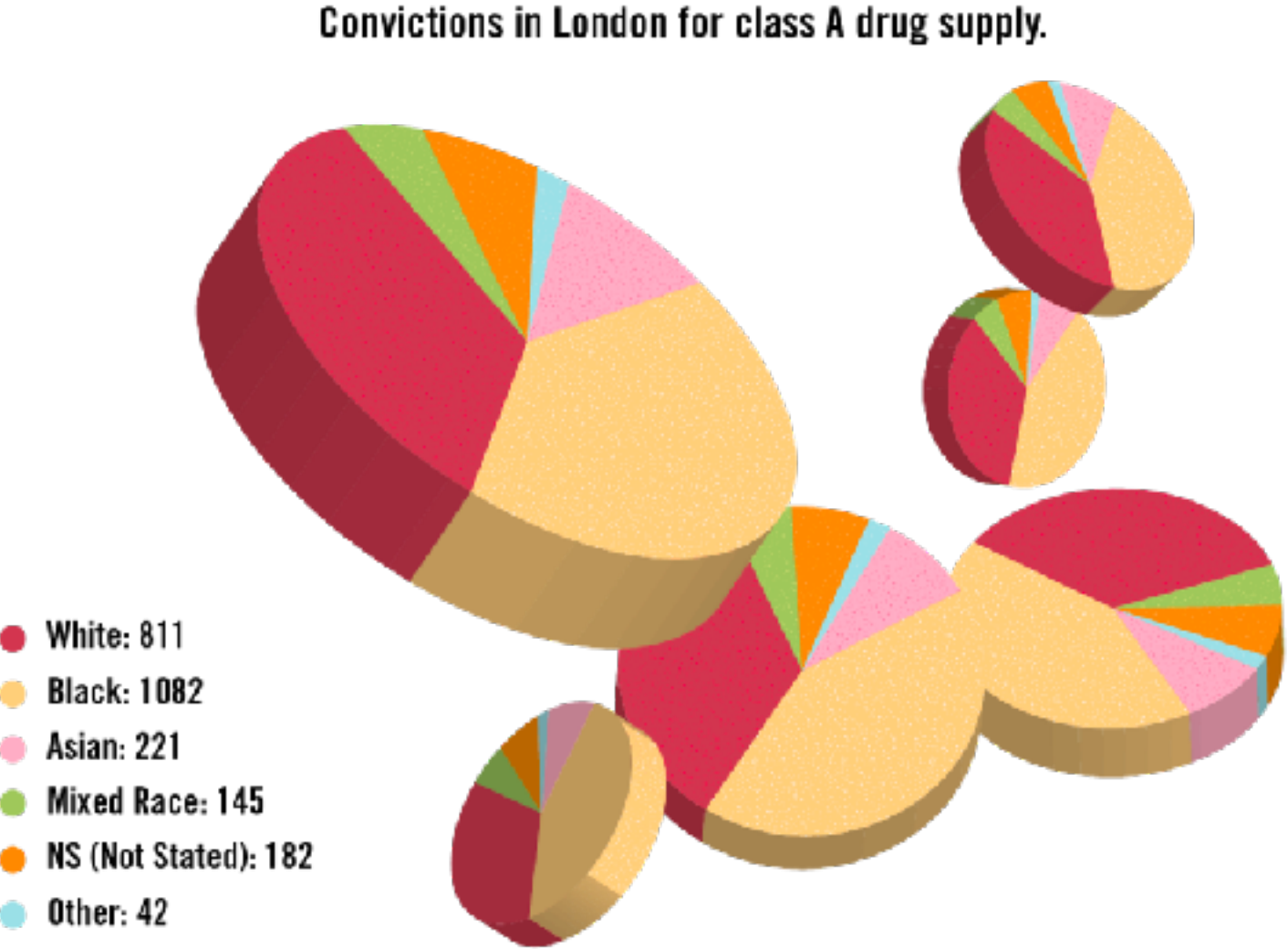
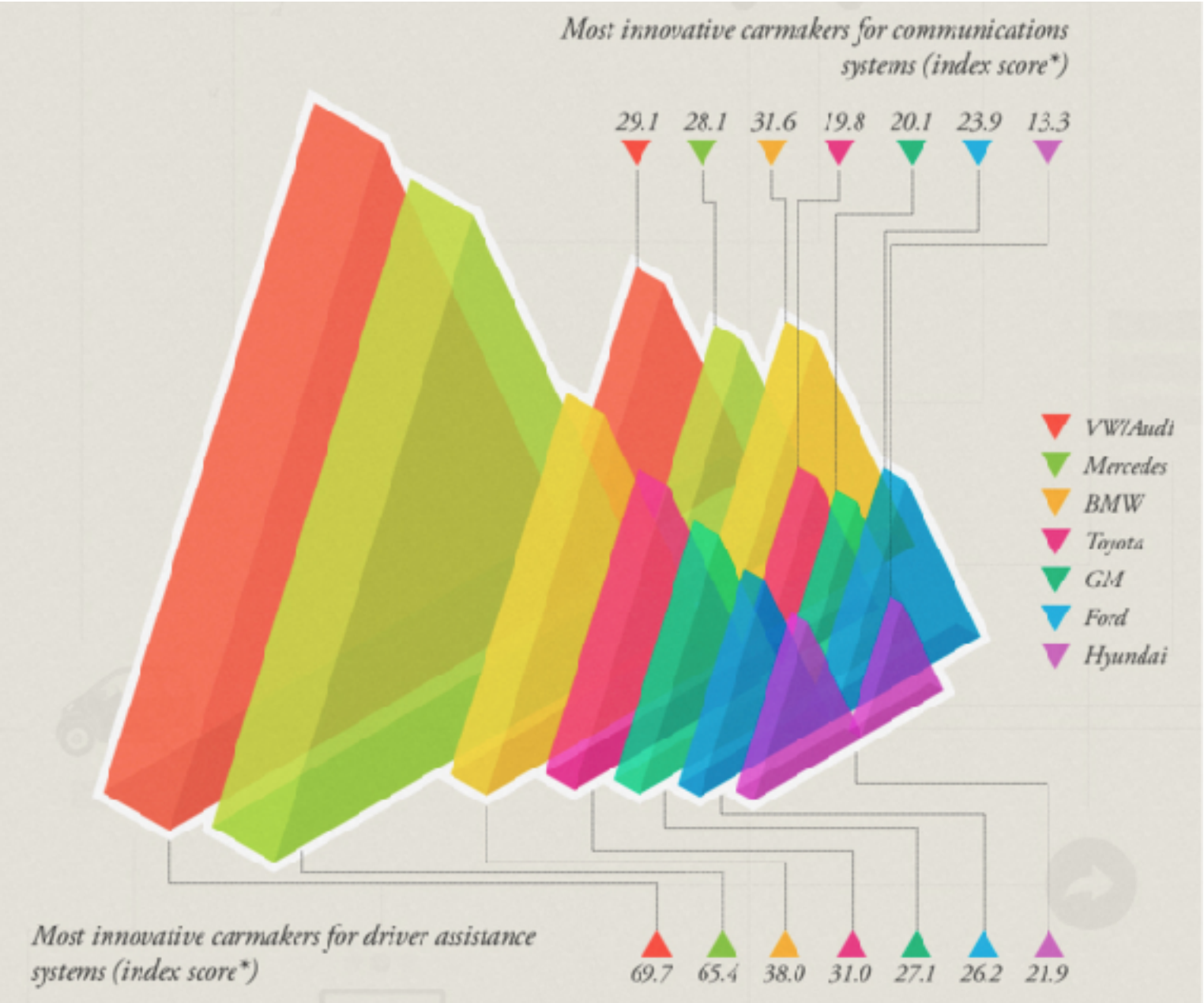
[@tamaramunzner](#)



Rules of Thumb

- Guidelines and considerations, not absolute rules
 - when to use 3D? when to use 2D?
 - when to use eyes instead of memory?
 - when does immersion help?
 - when to use overviews?
 - how long is too long?
 - which comes first, form or function?

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>

Depth vs power of the plane

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

➔ Magnitude Channels: Ordered Attributes

Position on common scale



Position on unaligned scale



Length (1D size)



Tilt/angle



Area (2D size)



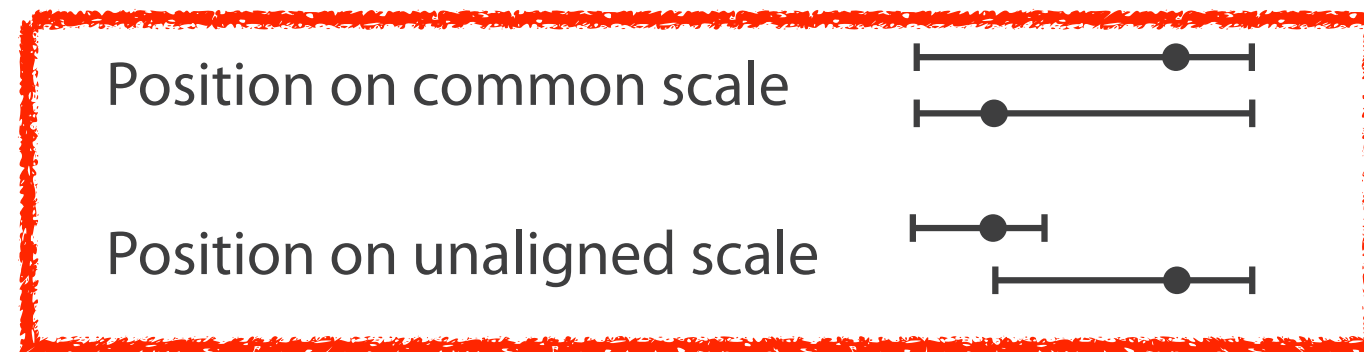
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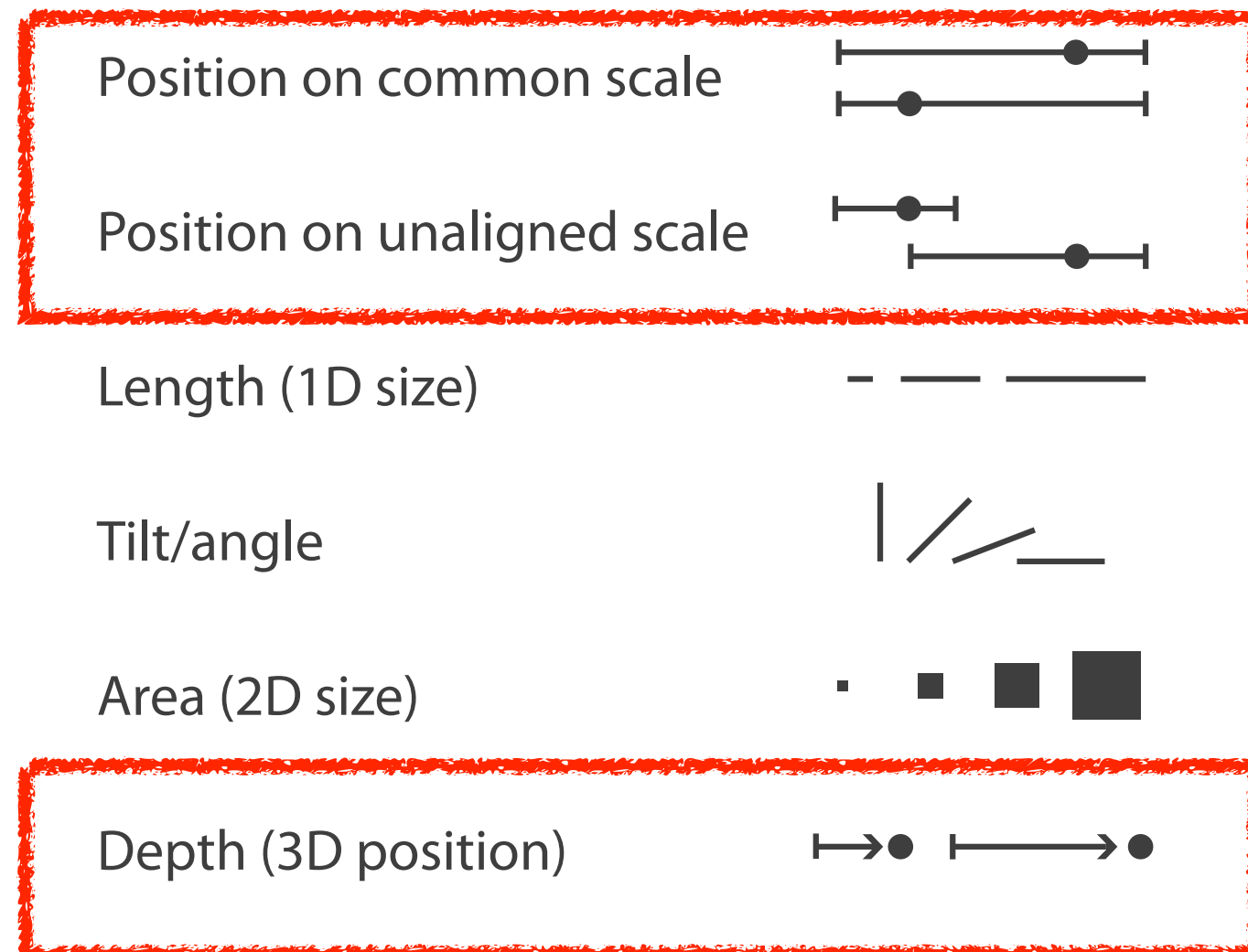
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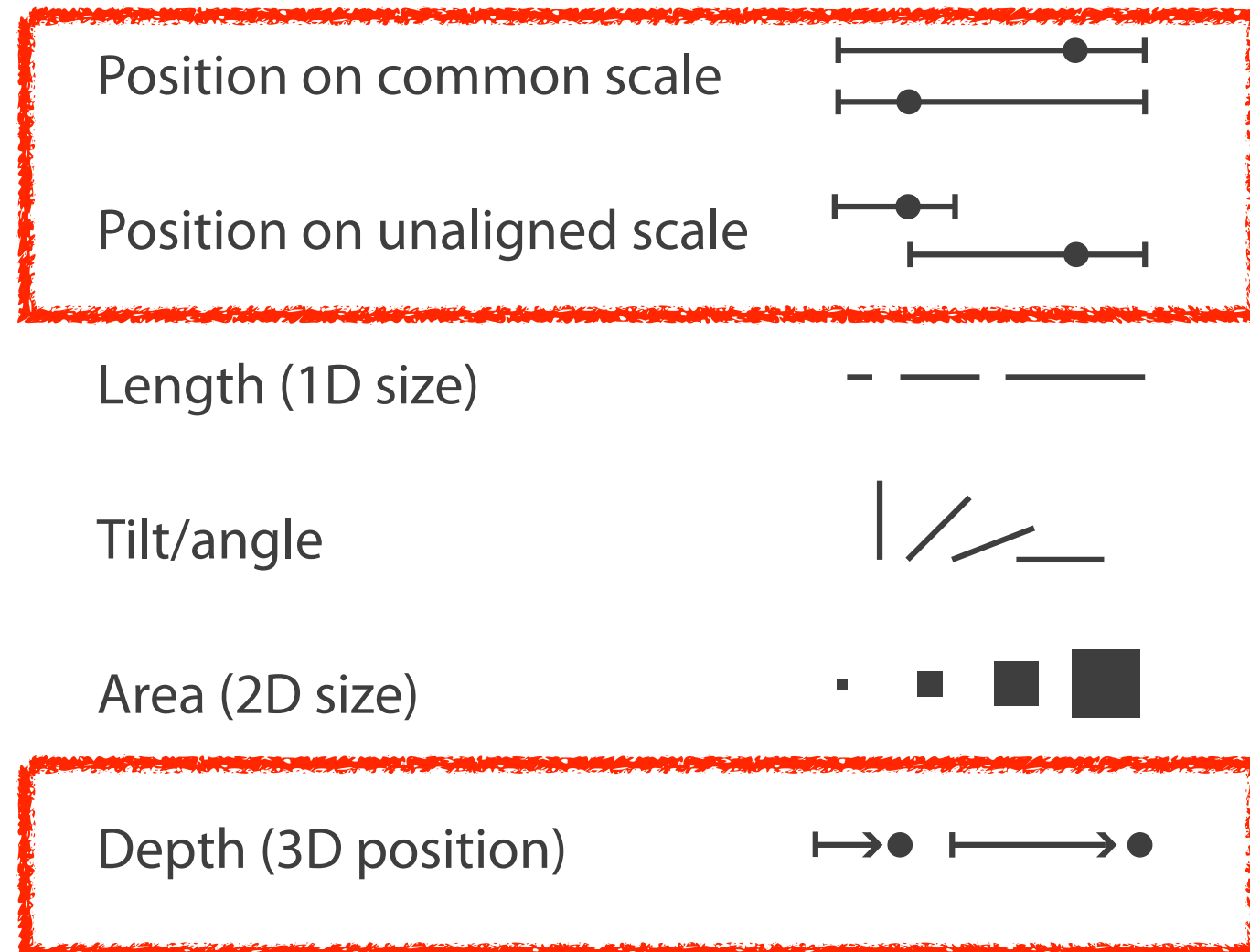
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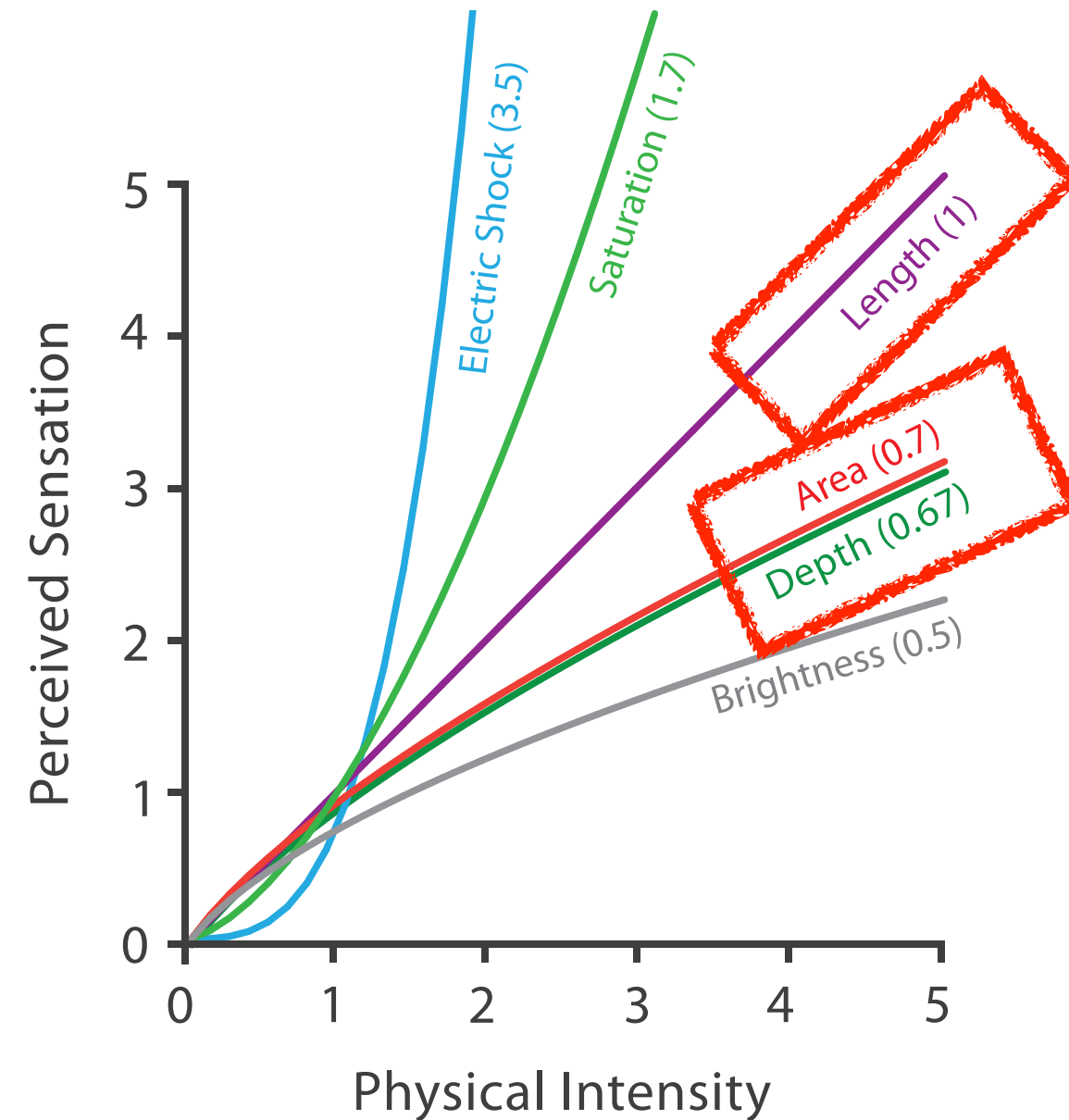
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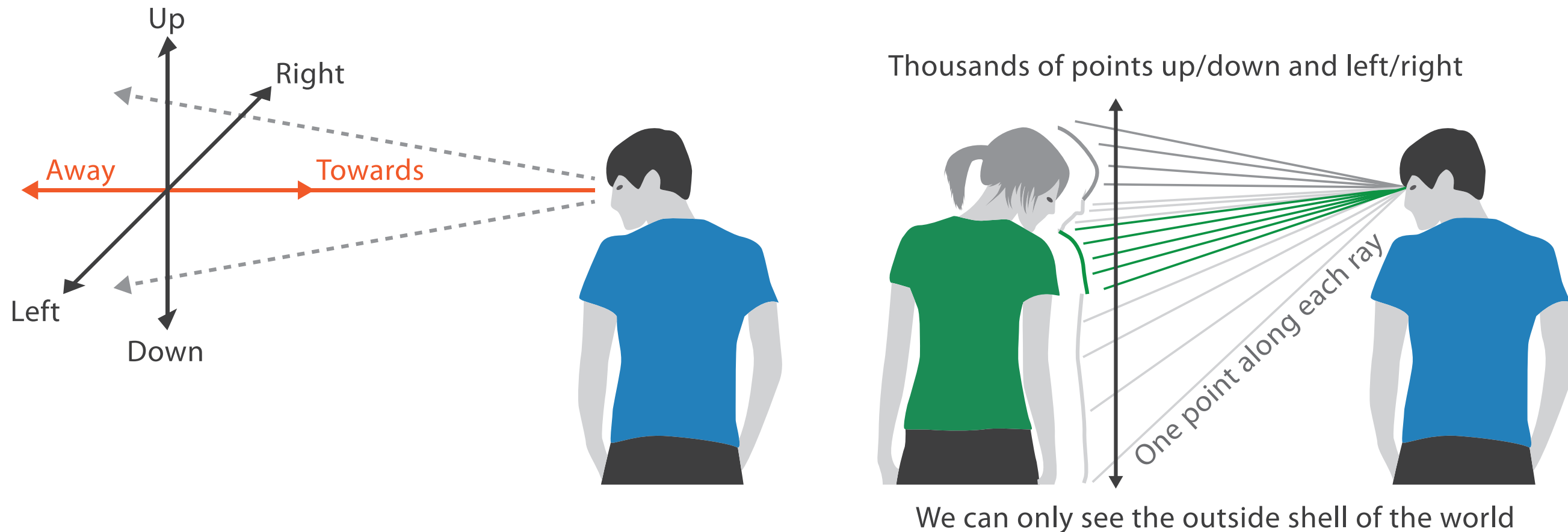


Steven's Psychophysical Power Law: $S = I^N$



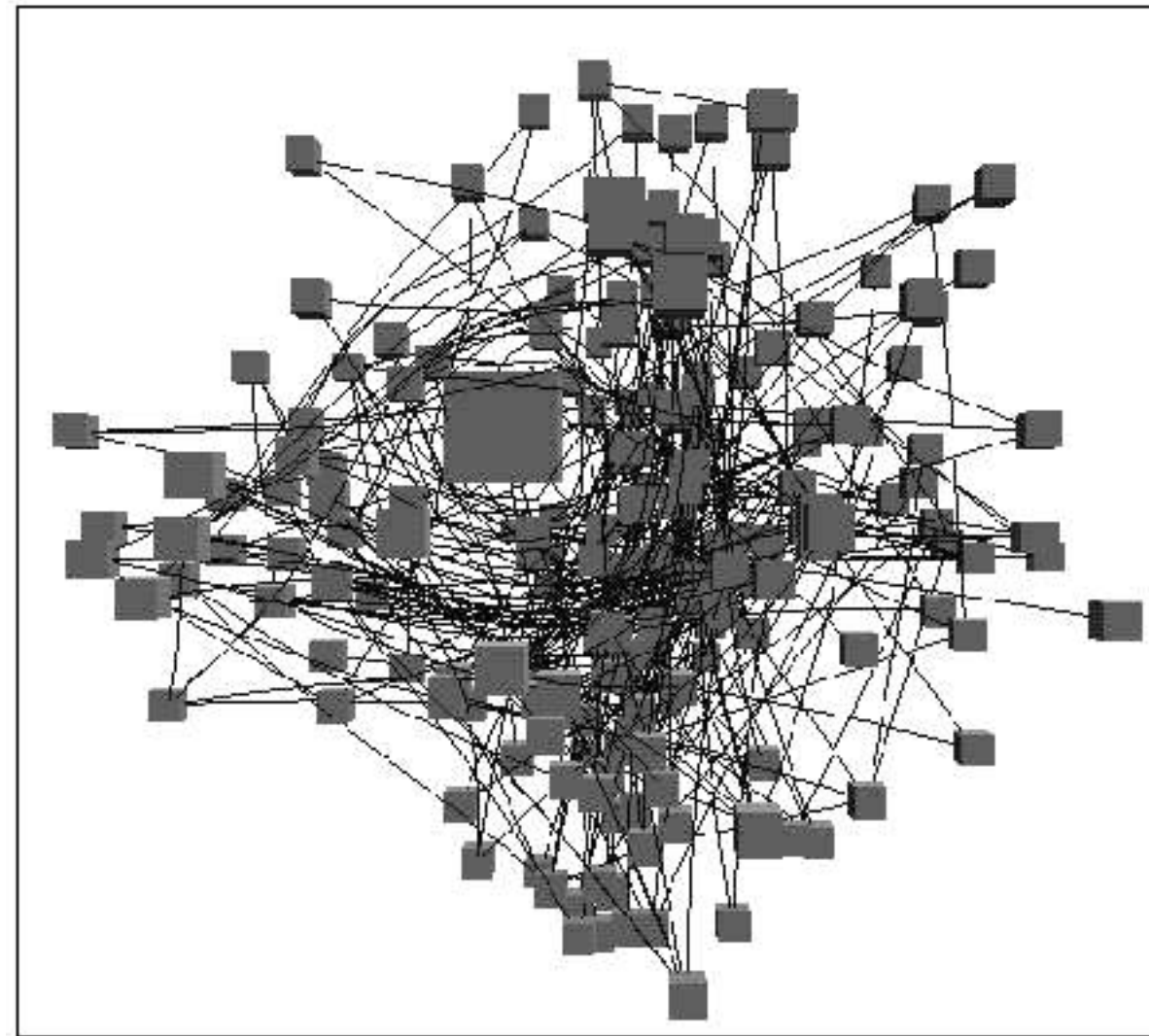
No unjustified 3D: Danger of depth

- 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.]

Perspective distortion loses information

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



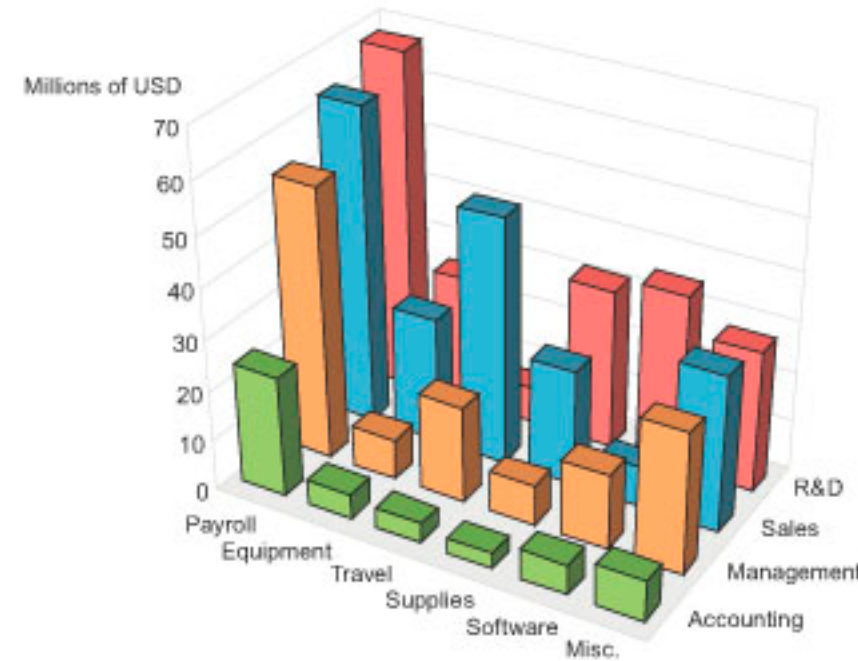
[Visualizing the Results of Multimedia Web Search Engines. Mukherjea, Hirata, and Hara. InfoVis 96]

3D vs 2D bar charts

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

Question 7: Which graph makes it easier to determine R&D's travel expense?

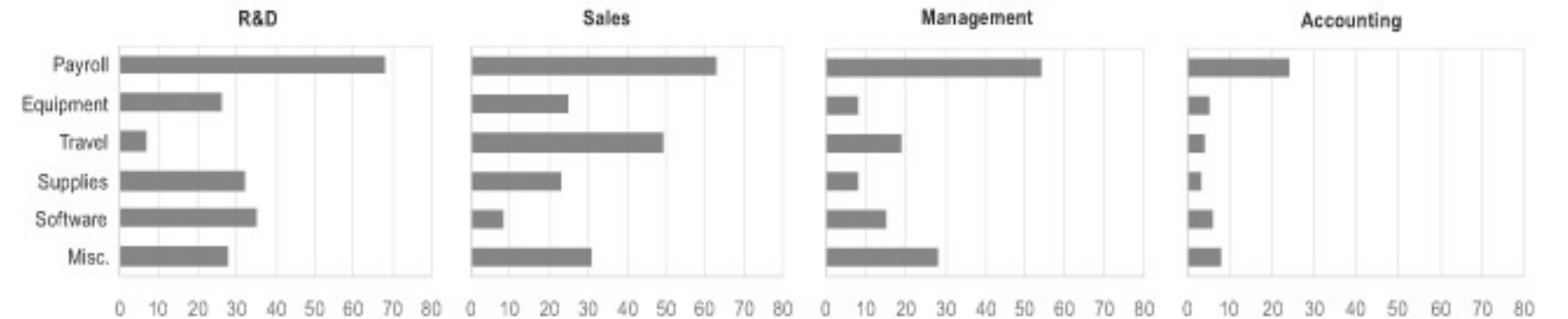
2006 Expenses by Department



3-D Bar Graph (left)

2-D Bar Graphs (below)

2006 Expenses by Department in Millions of USD

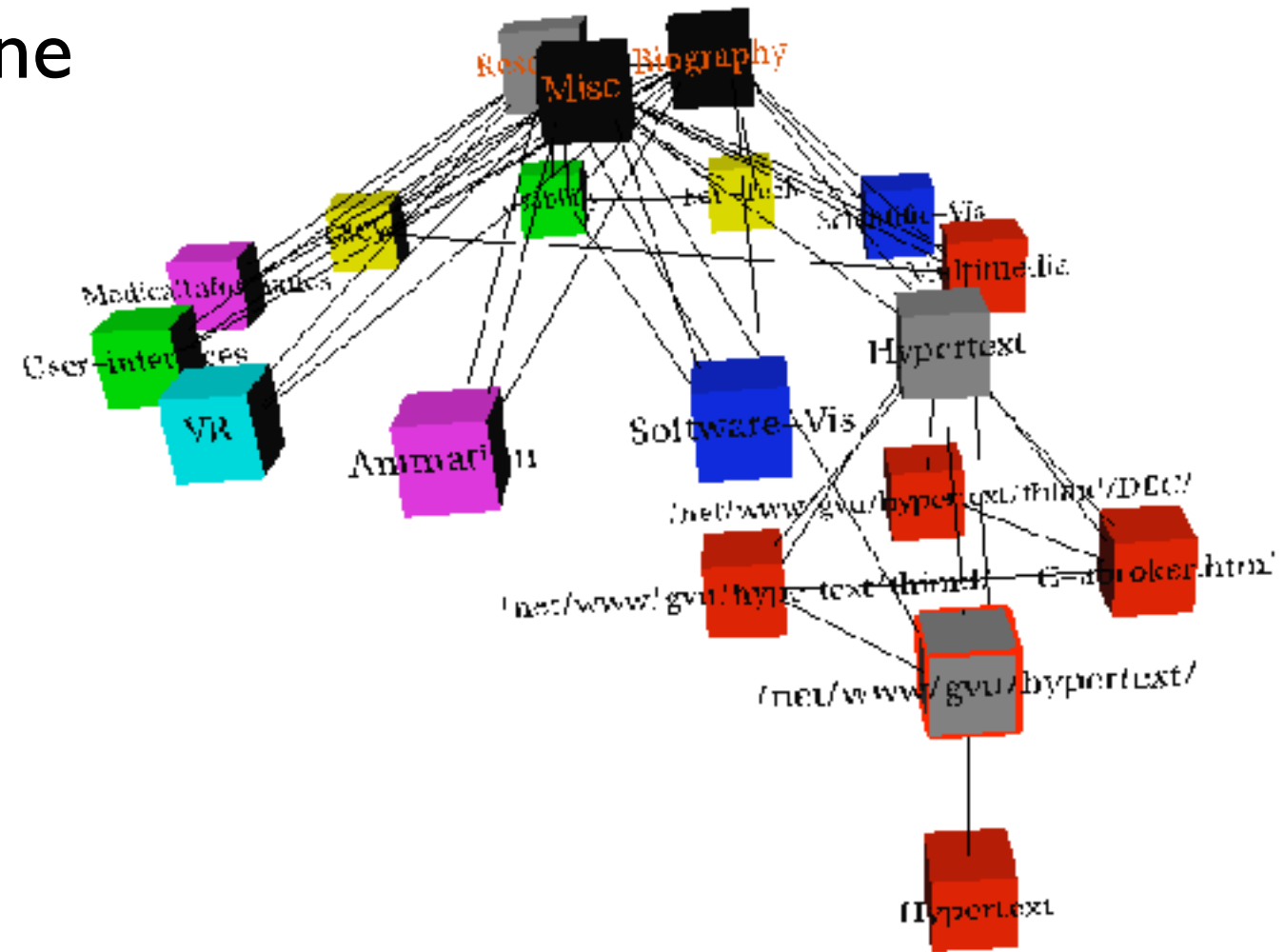


Tilted text isn't legible

- text legibility
 - far worse when tilted from image plane

- further reading

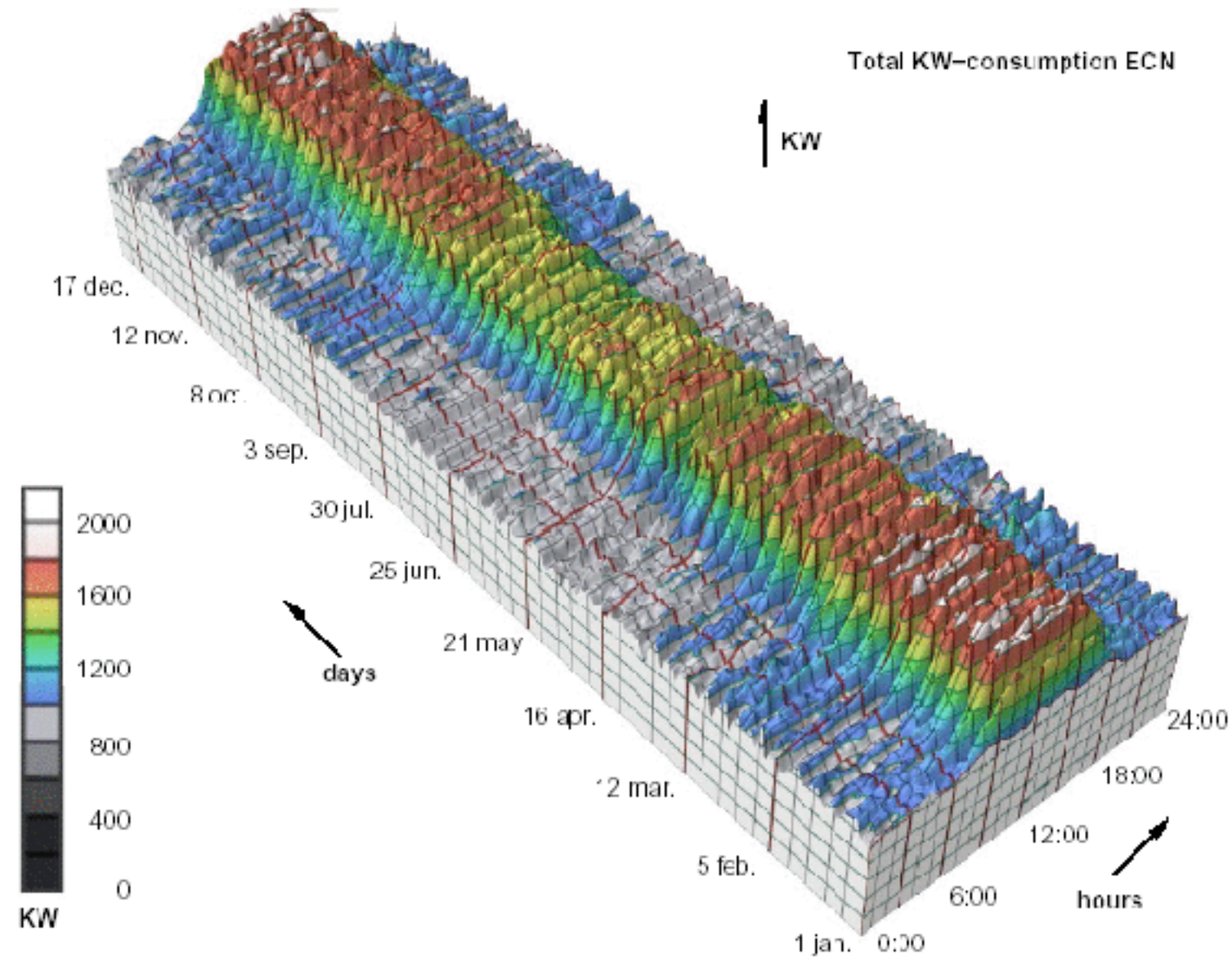
Exploring and Reducing the Effects of Orientation on Text Readability in Volumetric Displays.
Grossman et al. CHI 2007



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

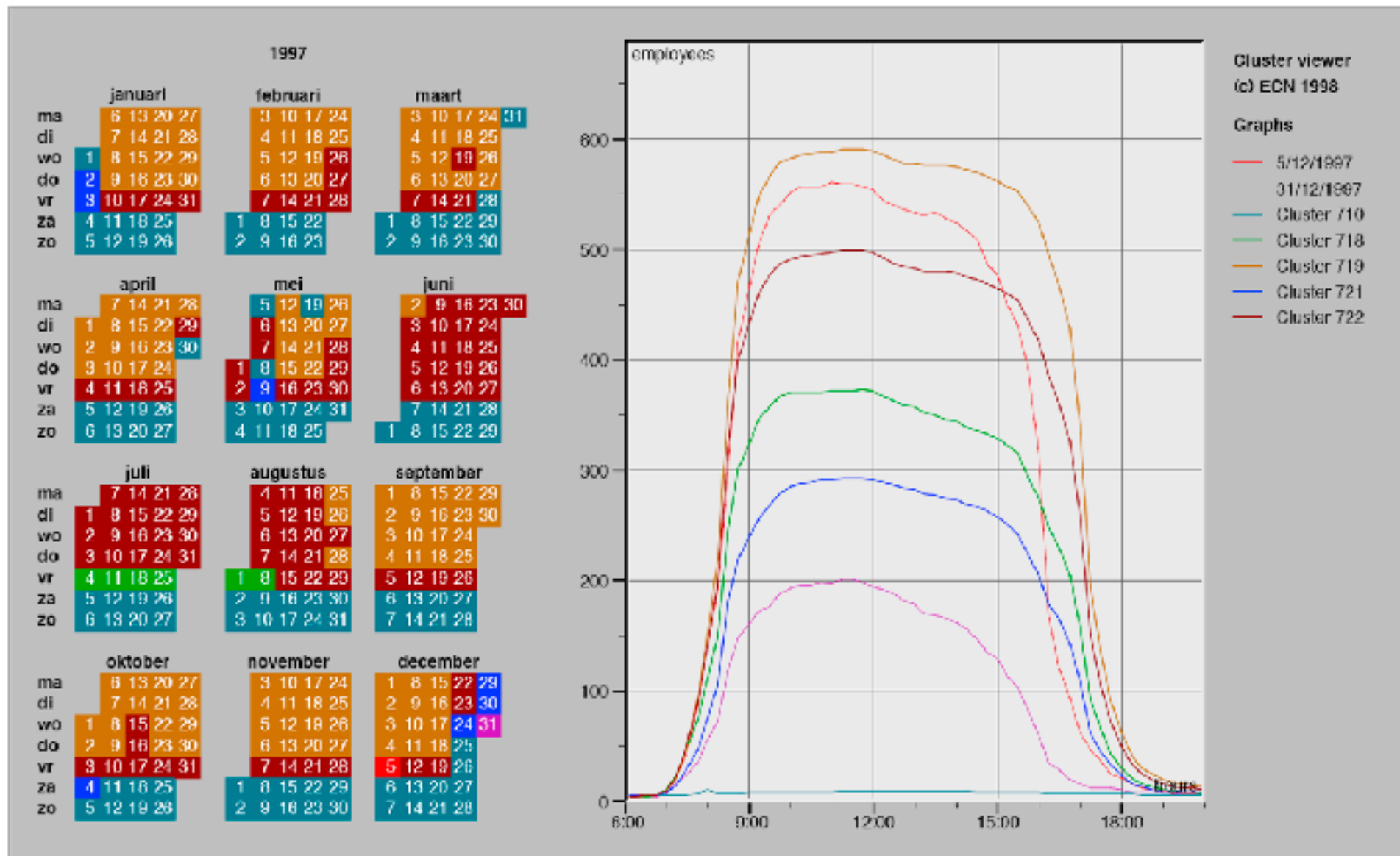
No unjustified 3D example: Time-series data

- extruded curves: detailed comparisons impossible



No unjustified 3D example: Transform for new data abstraction

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



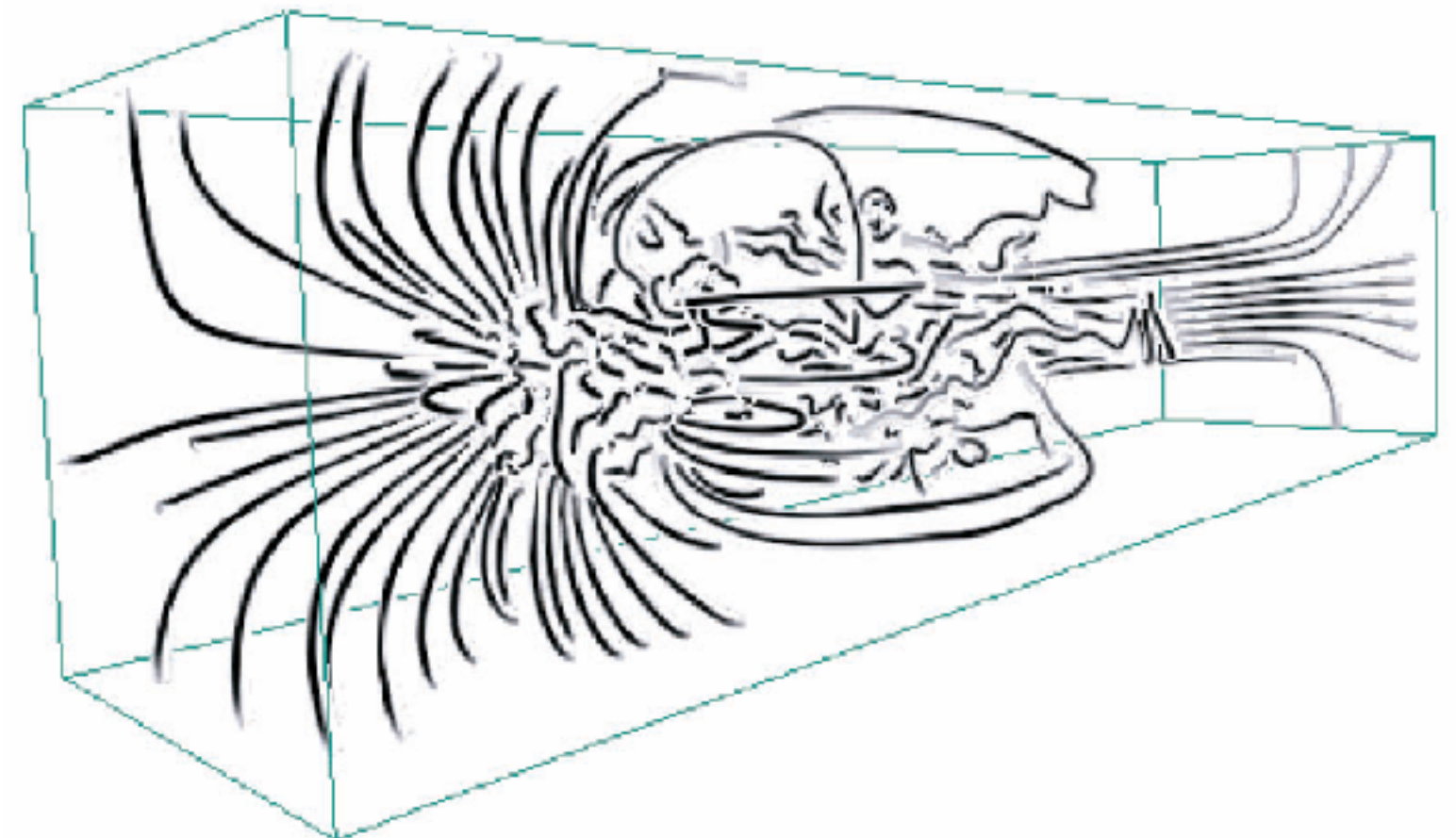
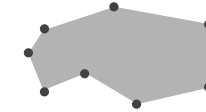
Justified 3D: shape perception

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

 Targets

 Spatial Data

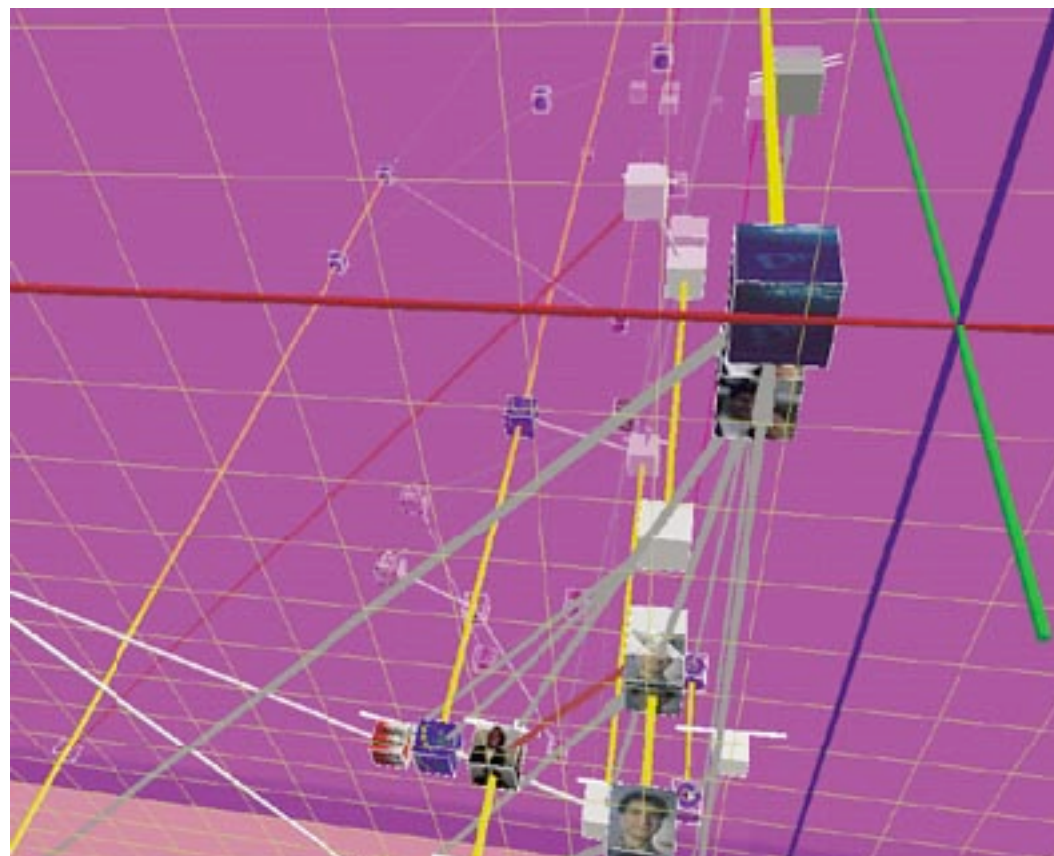
→ Shape



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

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]

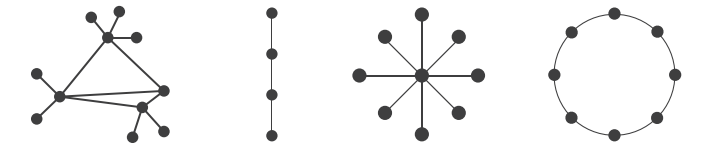
No unjustified 2D

- 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



→ Network Data

→ Topology



→ Paths



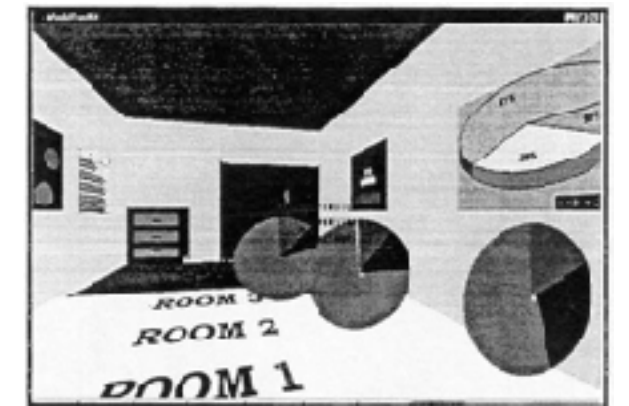
Eyes beat memory

- 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

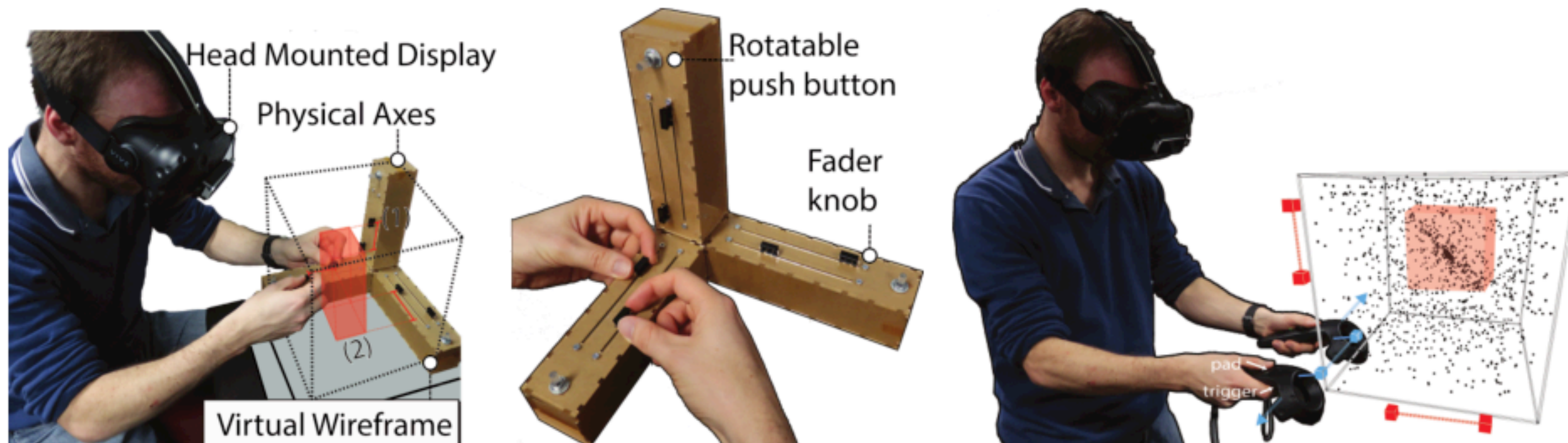


Resolution beats immersion

- 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
- first wave: virtual reality for abstract data difficult to justify
- second wave: AR/MR (augmented/mixed reality) has more promise



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



[A Design Space for Spatio-Data Coordination: Tangible Interaction Devices for Immersive Information Visualisation. Cordeil, Bach, Li, Elliott, and Dwyer. Proc. PacificVis 2017 Notes.]

Overview first, zoom and filter, details on demand

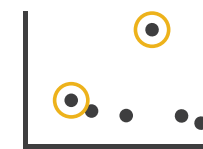
- influential mantra from Shneiderman

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

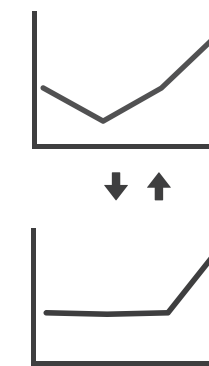
- **overview = summary**
 - microcosm of full vis design problem

→ Query

→ Identify



→ Compare



→ Summarise



Rule of thumb: **Responsiveness is required**

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 - rendering speed when item count is large (guaranteed frame rate)

Function first, form next

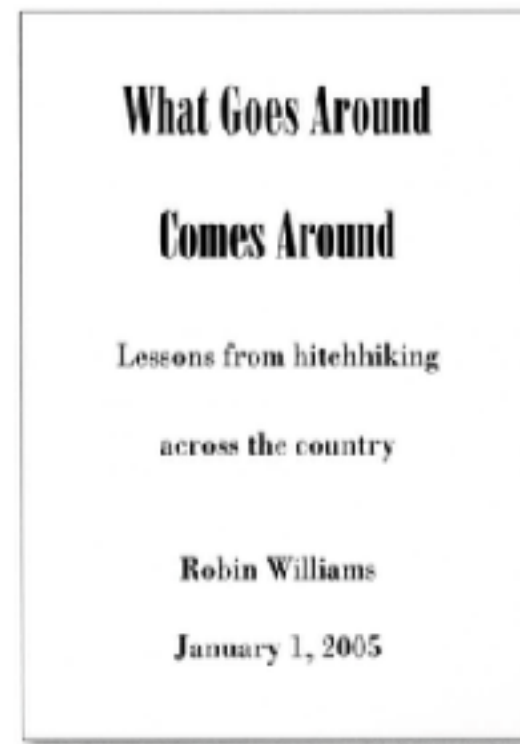
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 - usually impossible to add function retroactively

Function first, form next

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

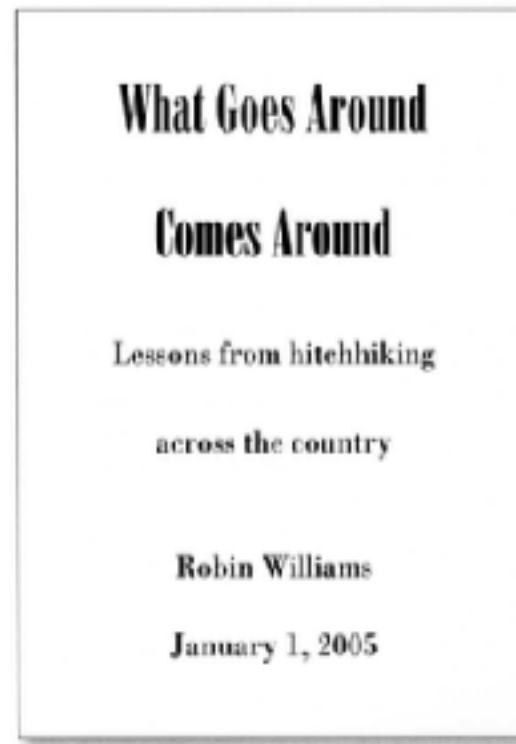
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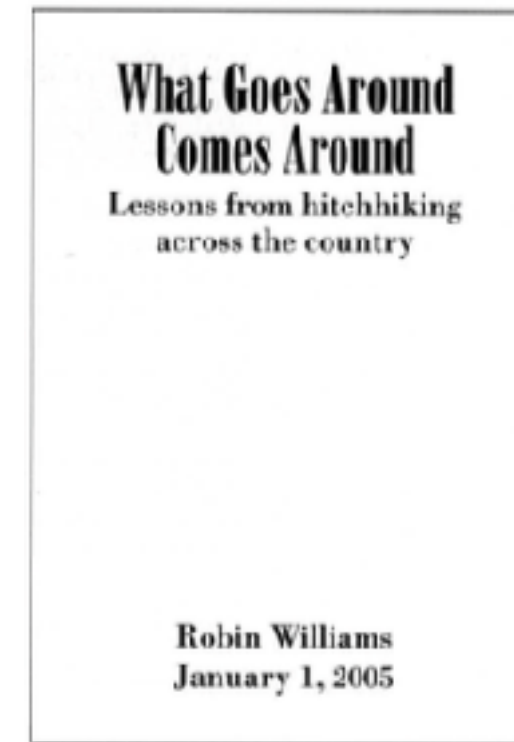
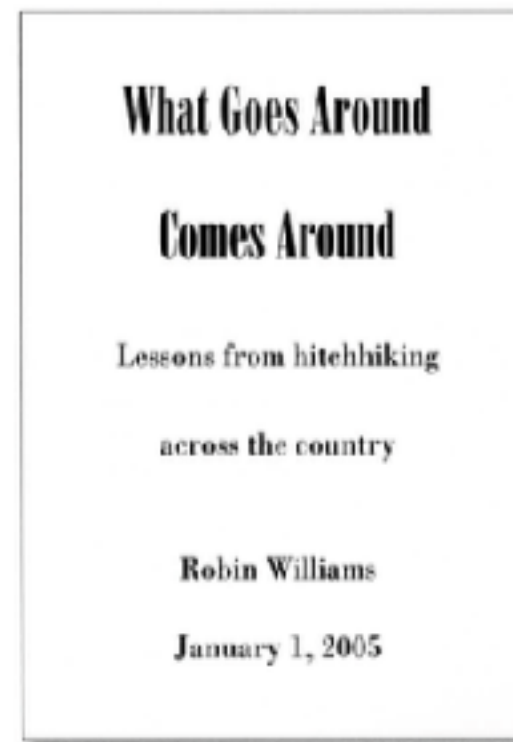
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- proximity
 - do group related items together
 - avoid equal whitespace between unrelated



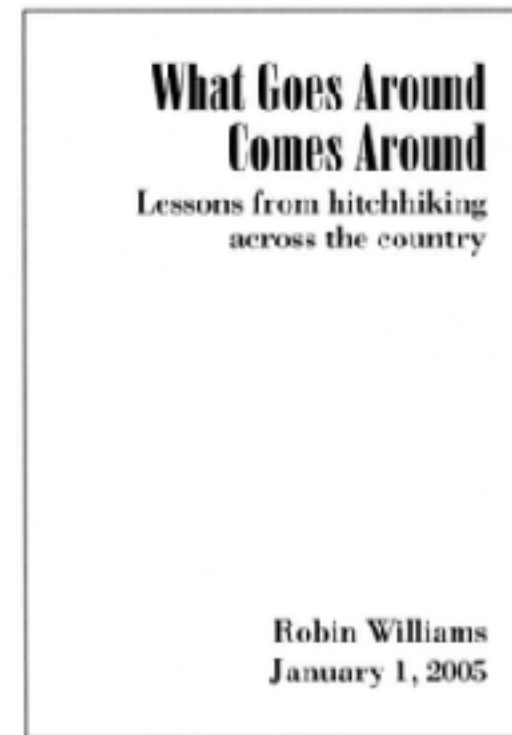
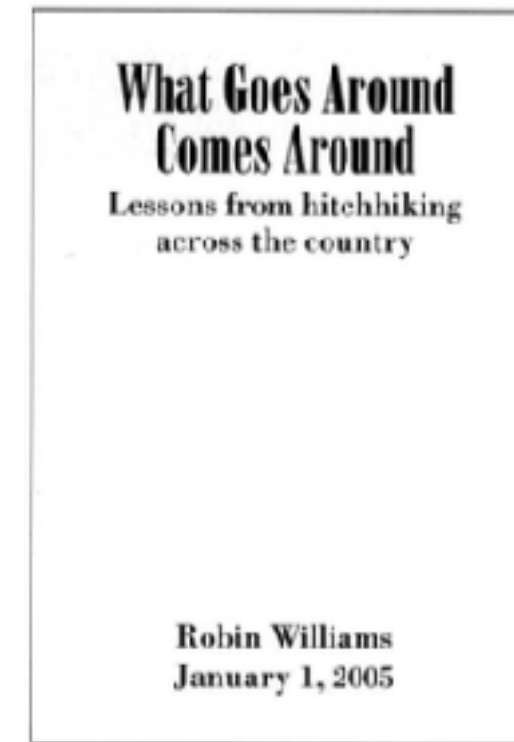
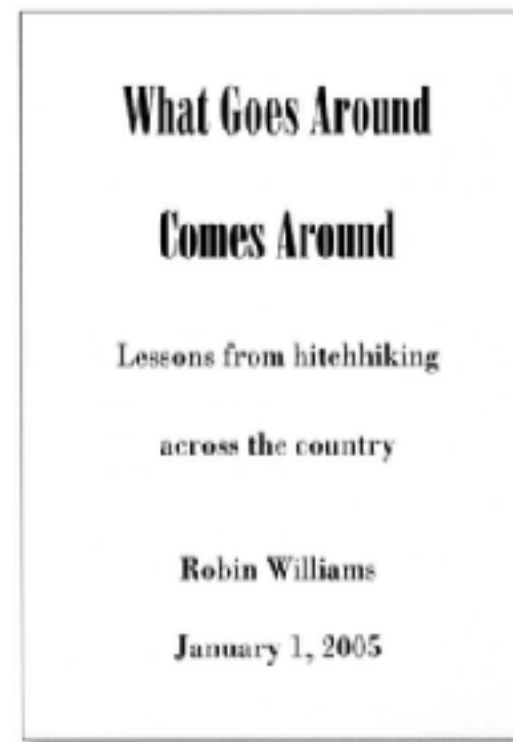
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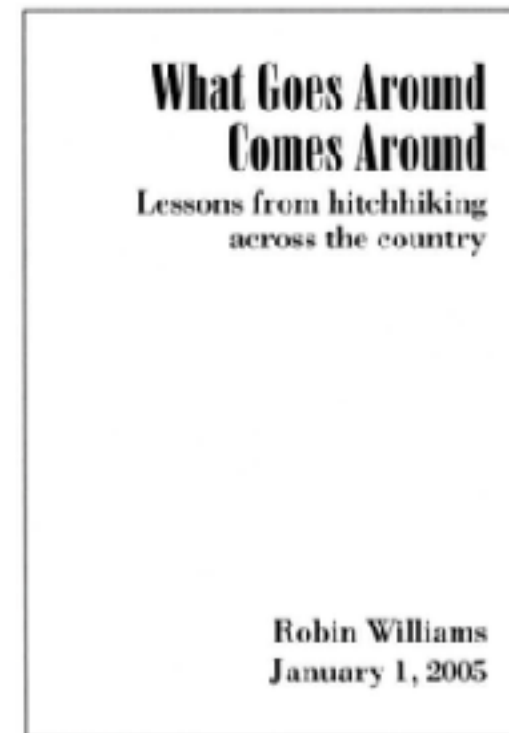
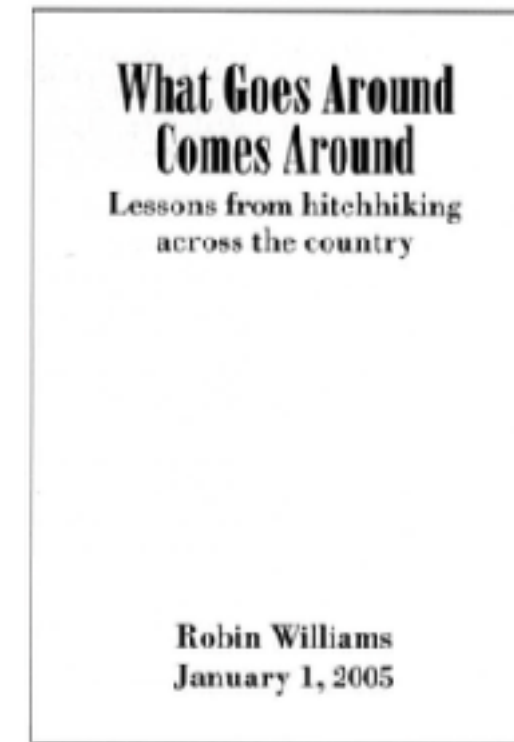
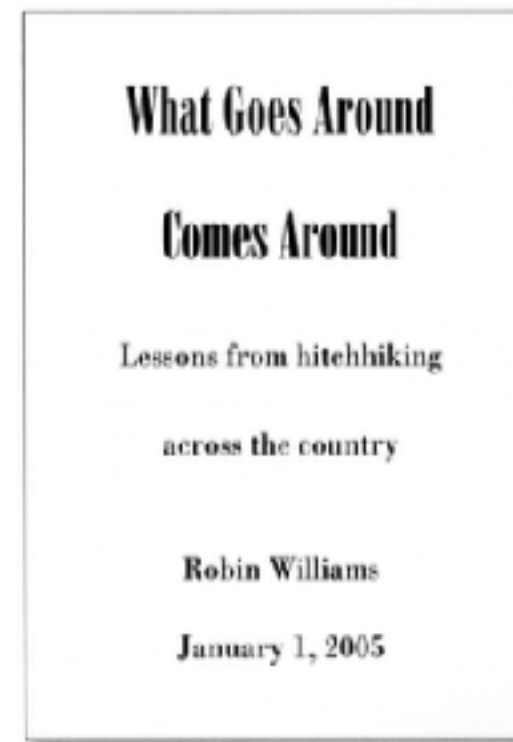
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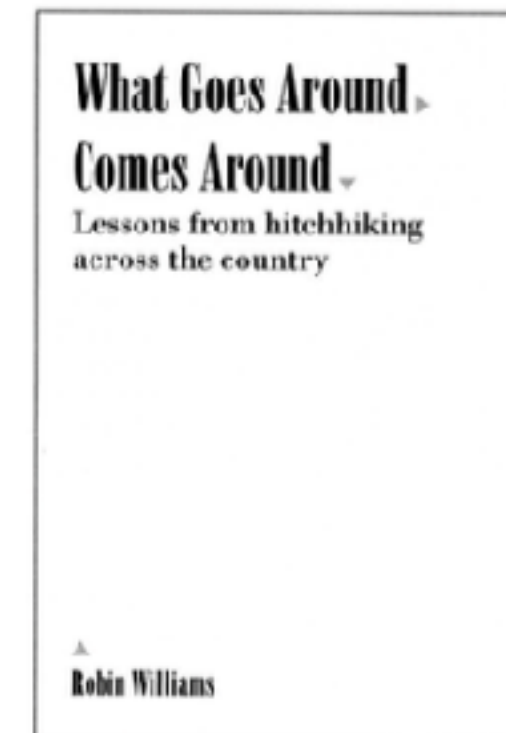
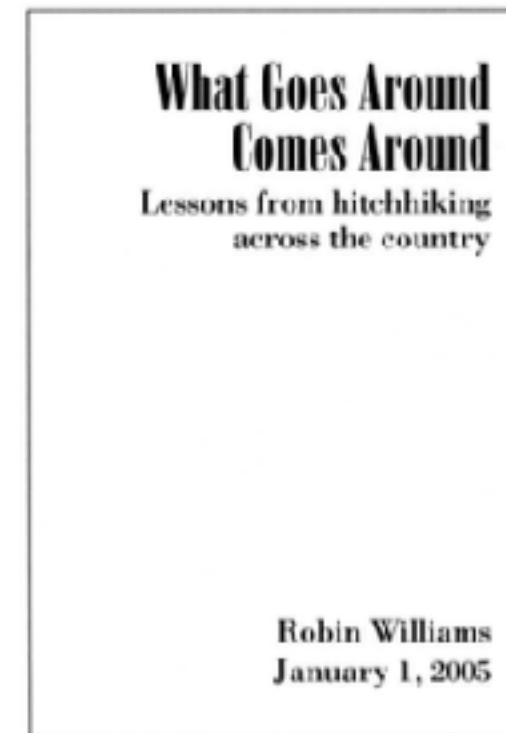
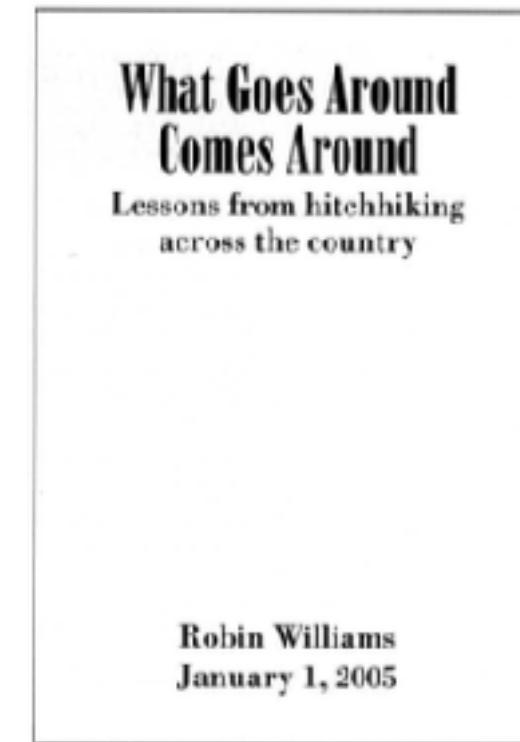
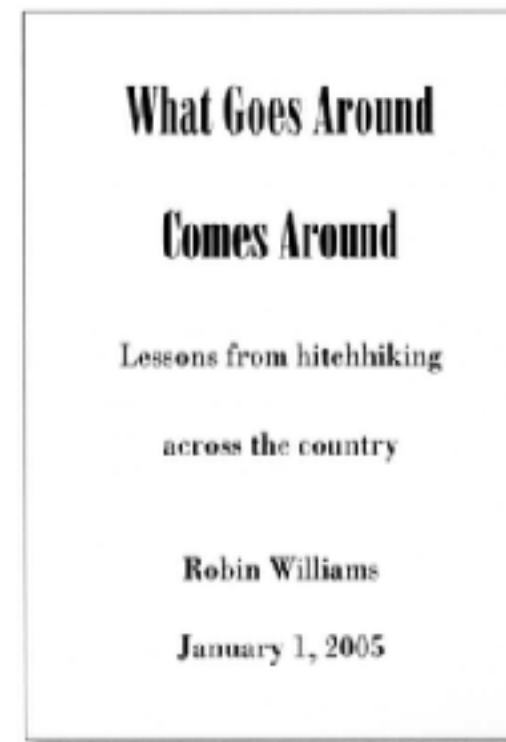
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- repetition
 - do unify by pushing existing consistencies



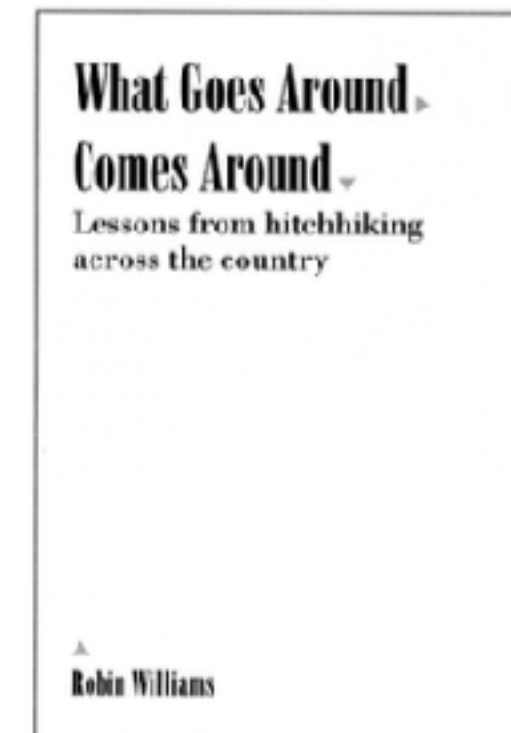
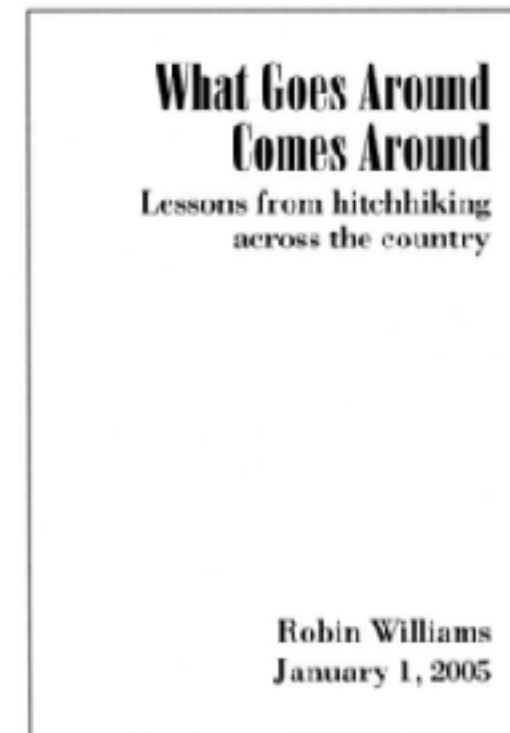
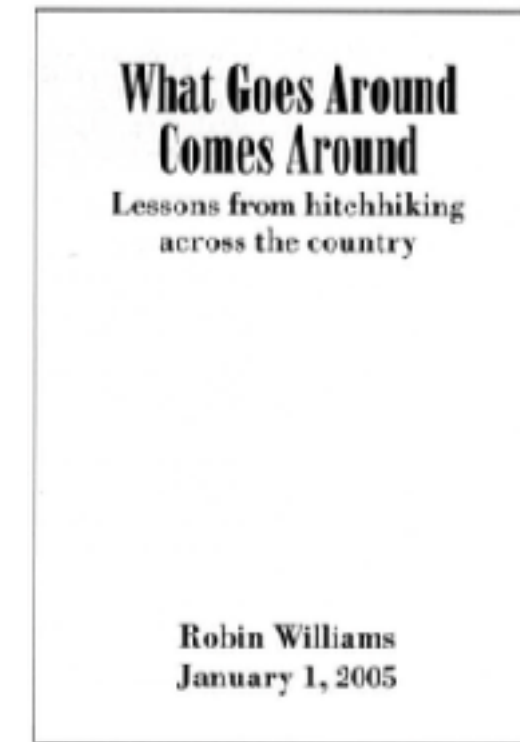
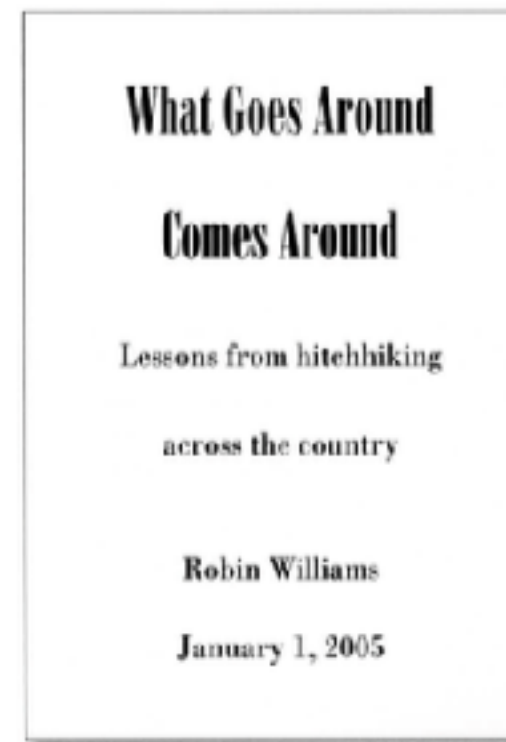
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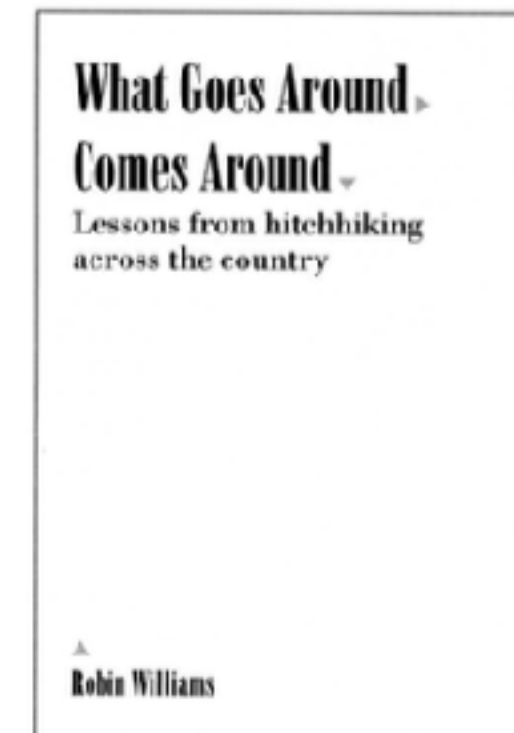
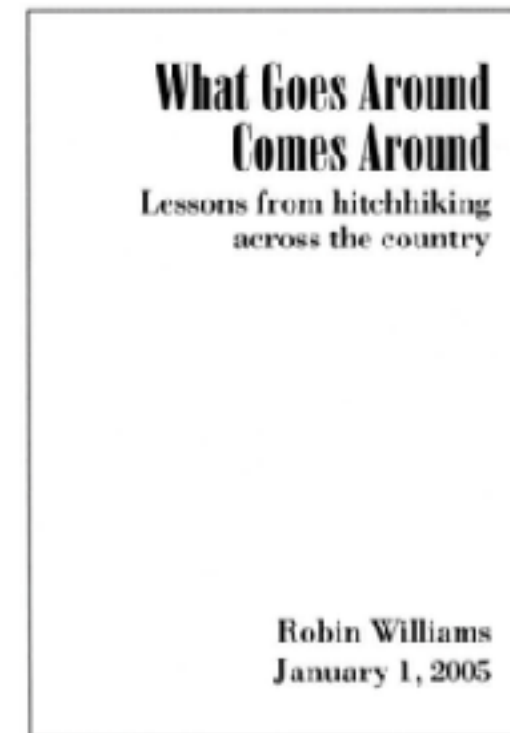
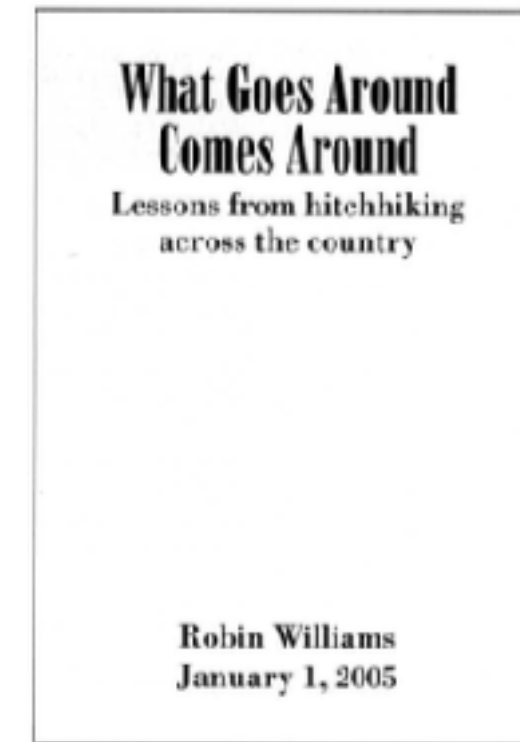
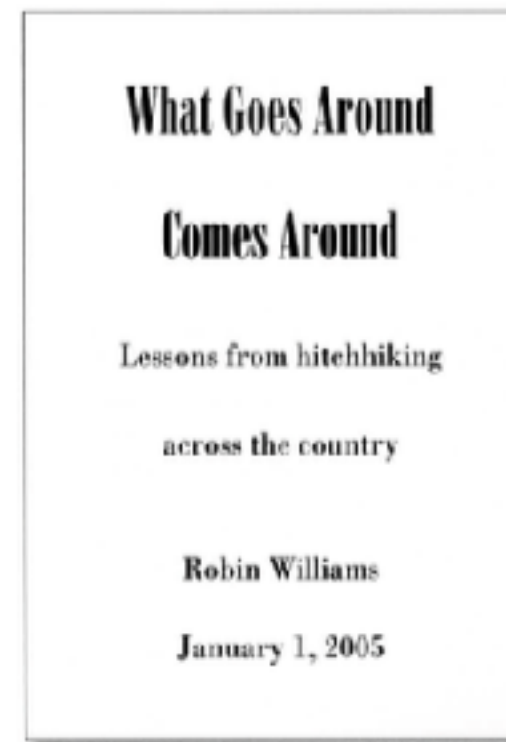
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- contrast
 - if not identical, then very different
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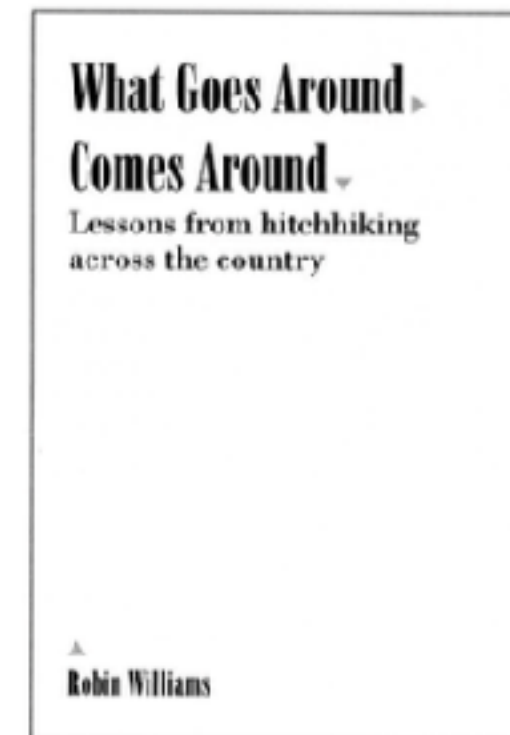
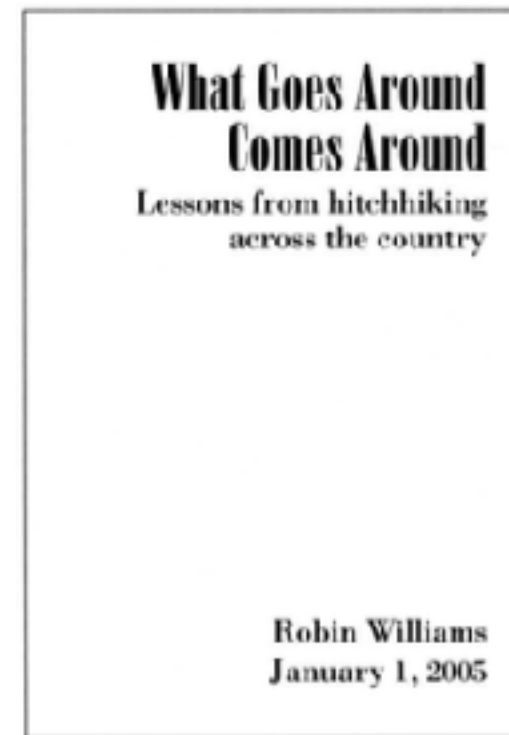
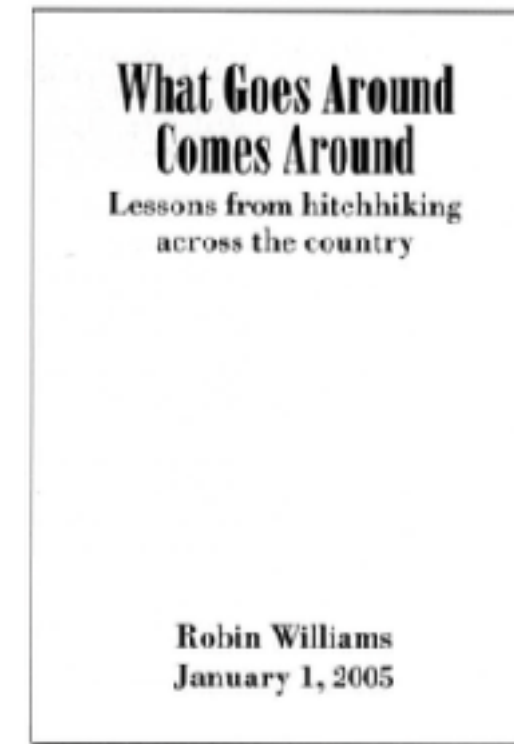
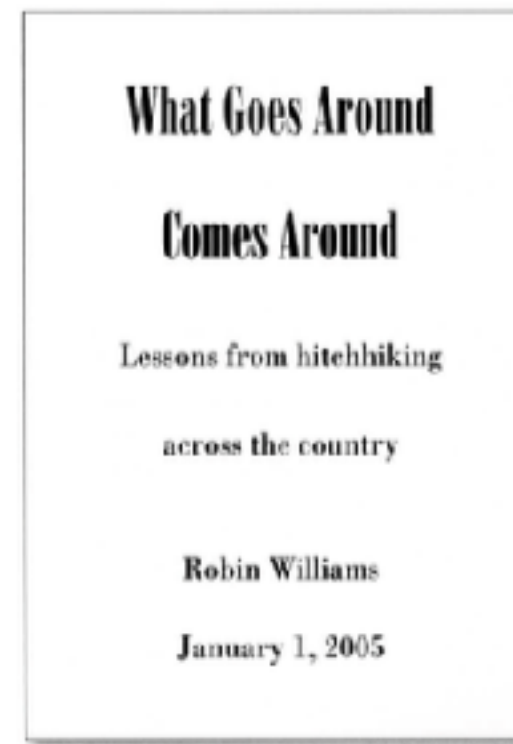
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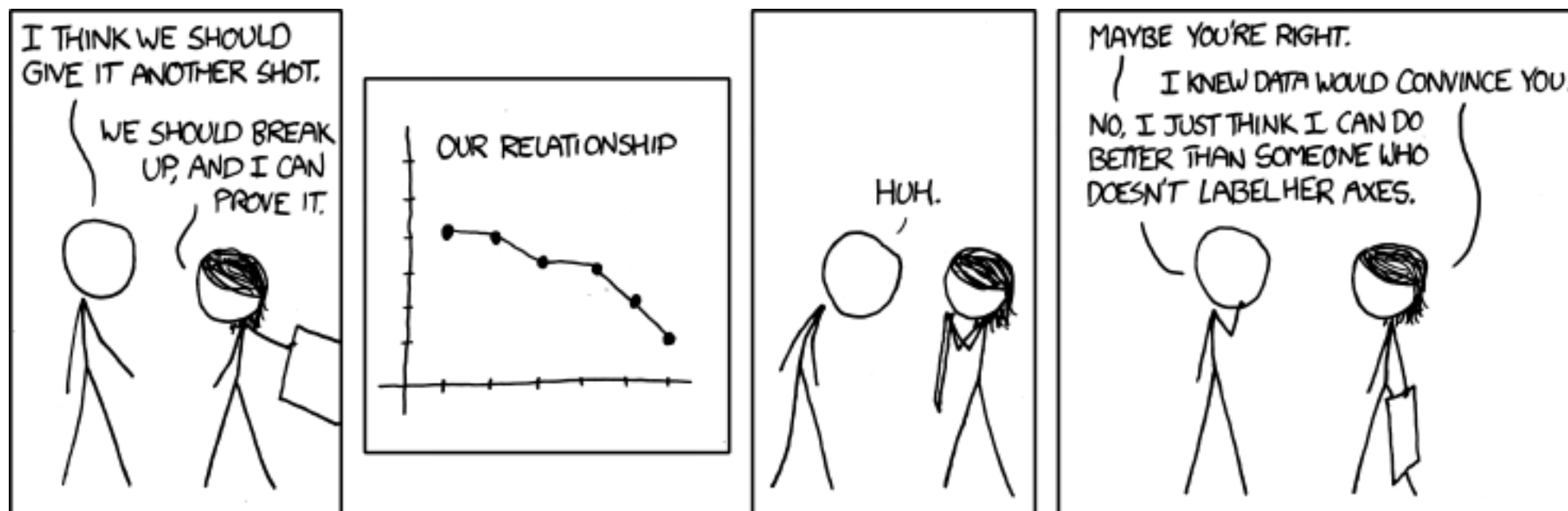
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- *The Non-Designer's Design Book, 4th ed. Robin Williams, Peachpit Press, 2015.*
 - fast read, very practical to work through whole thing

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 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**