Visualization (Vis)

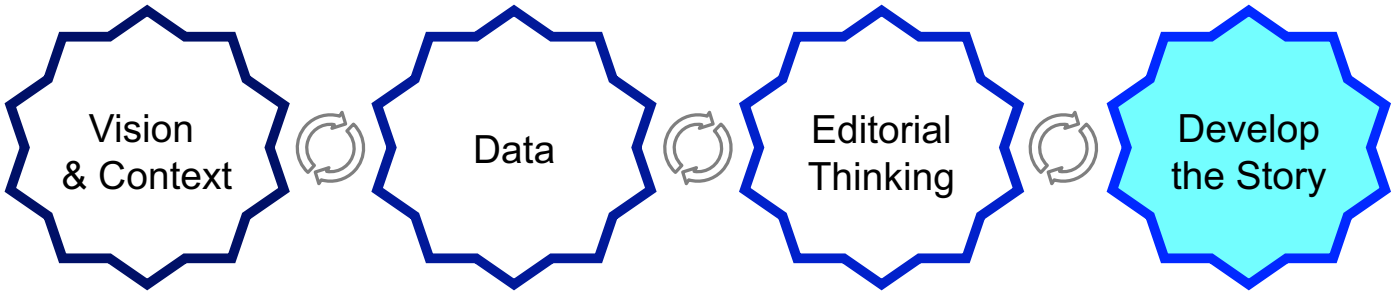
Storytelling with Interactive Data Visualizations

Lecture 6

–

Rules of Thumb

Develop the Story: Visual Encoding – Rules of Thumb



- Visual Encoding and Charts
- Rules of Thumb
- Interactivity and Storytelling
- Annotation, Colour and Composition

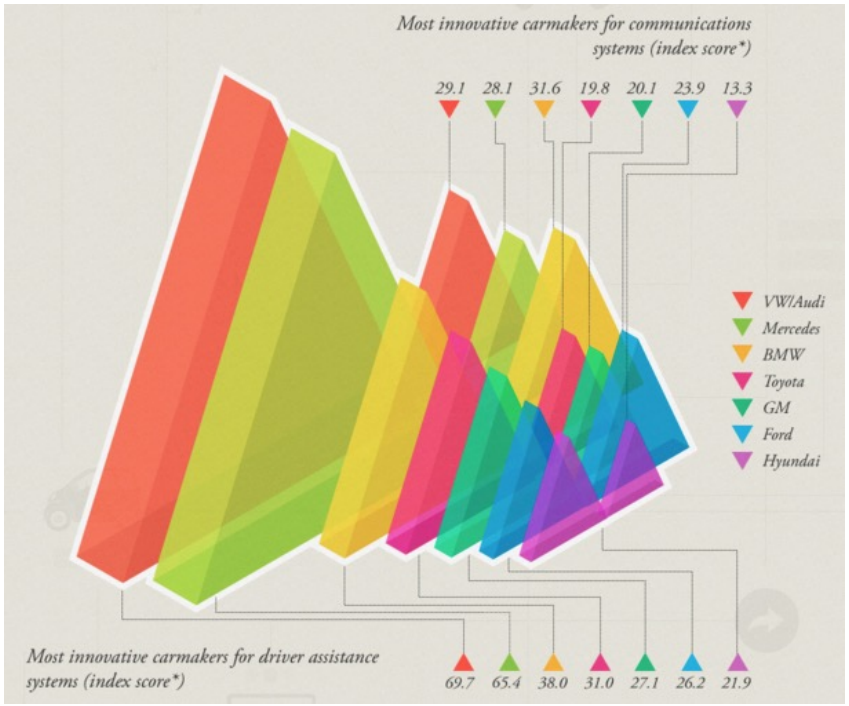
Rules of Thumb

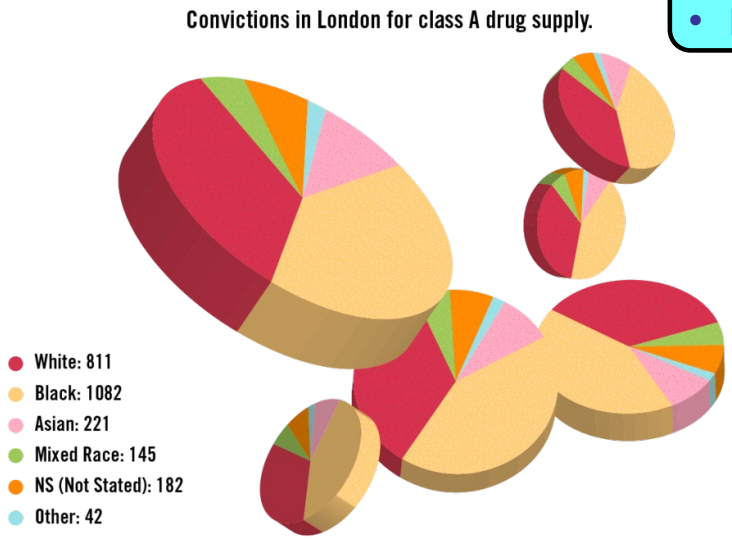
1.  The 7 Rules of Thumb

Rules of Thumb (by T. Munzner)

- 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

Unjustified 3D all too common!



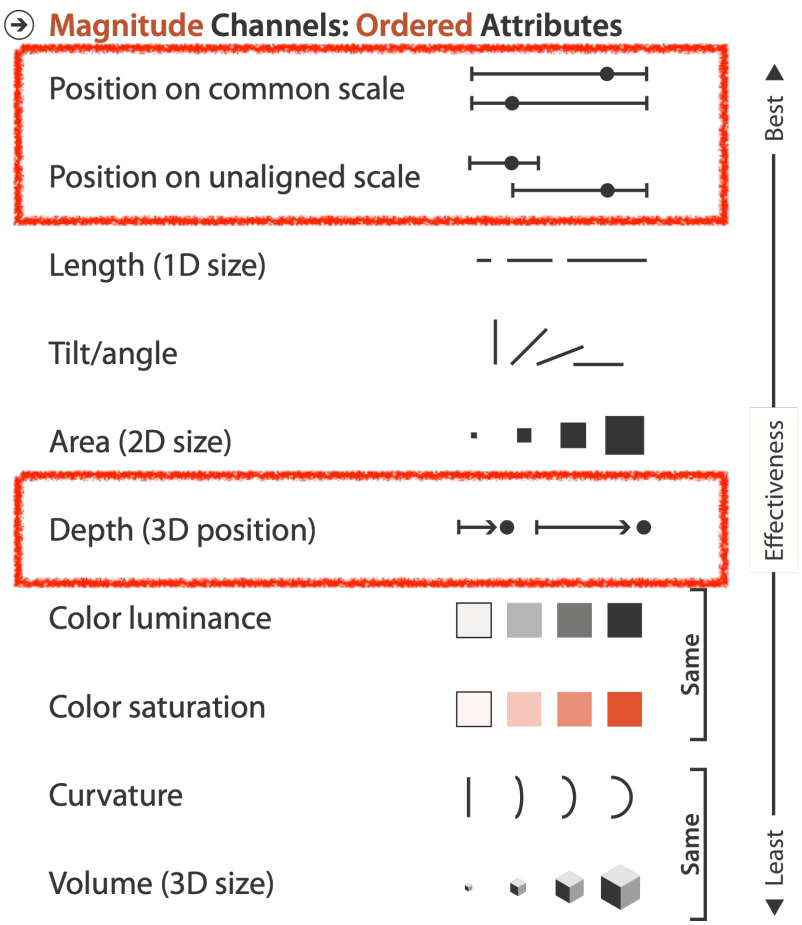


- No unjustified 3D
  - Power of the plane
  - Disparity of depth
  - Occlusion hides information
  - Perspective distortion dangers
  - Tilted text isn't legible
- No unjustified 2D
- Eyes beat memory
- Resolution over immersion
- Overview first, zoom and filter, details on demand
- Responsiveness is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

Source: http://viz.wtf/post/137826497077/eye-popping-3d-triangles and http://viz.wtf/post/139002022202/designer-drugs-ht-ducqn

Power of the Plane (vs. Depth)

- High-ranked spatial position channels:
  - **Planar** spatial position
  - Not depth!

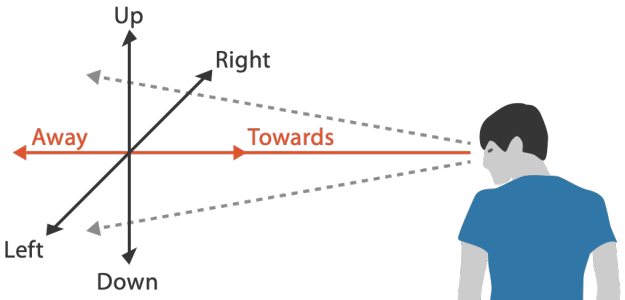


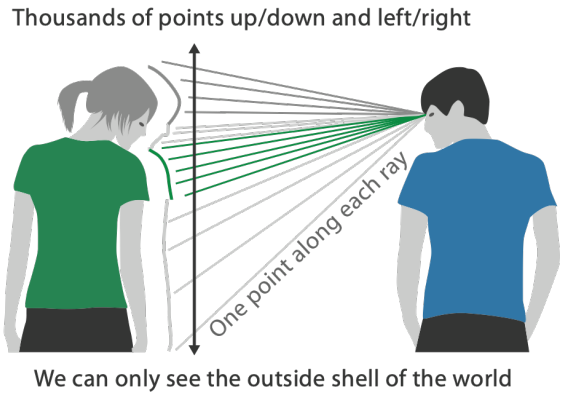
- No unjustified 3D
  - Power of the plane
  - Disparity of depth
  - Occlusion hides information
  - Perspective distortion dangers
  - Tilted text isn't legible
- No unjustified 2D
- Eyes beat memory
- Resolution over immersion
- Overview first, zoom and filter, details on demand
- Responsiveness is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

Source: T. Munzner, Visualization Analysis and Design

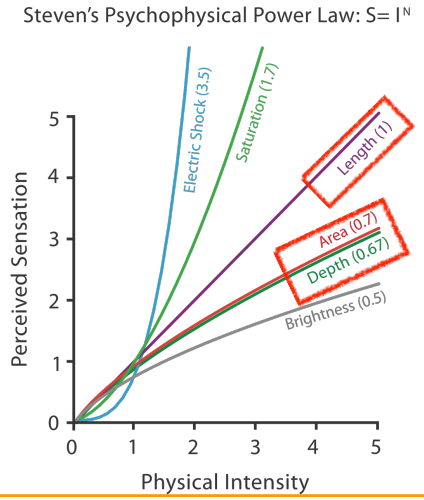
Disparity of Depth

- 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





- 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



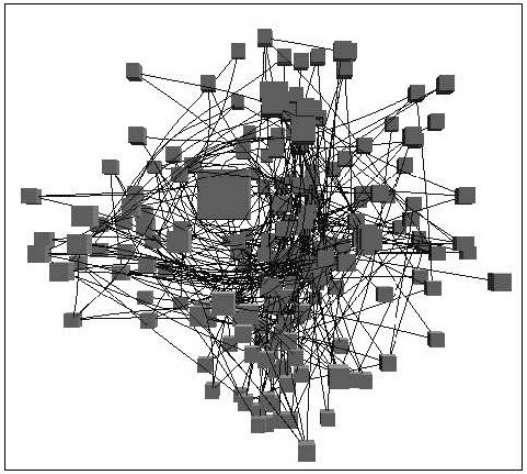
Source: T. Munzner, Visualization Analysis and Design after Colin Ware, Visual Thinking for Information Design

Occlusion Hides Information

- Occlusion: some objects are hidden behind others, indicating relative distance.
  - Motion Parallax: As we move, occlusion relationships change, helping us understand relative distances.
- Costs of Occlusion
  - Hidden Information: Important data might be hidden behind other objects
  - Time Cost: Discovering occluded details via navigation takes time
  - Using spatial position for nonspatial data can make occlusion very problematic
  - Unpredictable shapes require memory to synthesize a 3D understanding.
  - Understanding complex structures can be time-consuming and difficult.
- Design Considerations:
  - Interactive Navigation: Critical for complex scenes (increases time cost)

➔ Need to weigh Benefits of 3D vs. inherent Costs

- 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

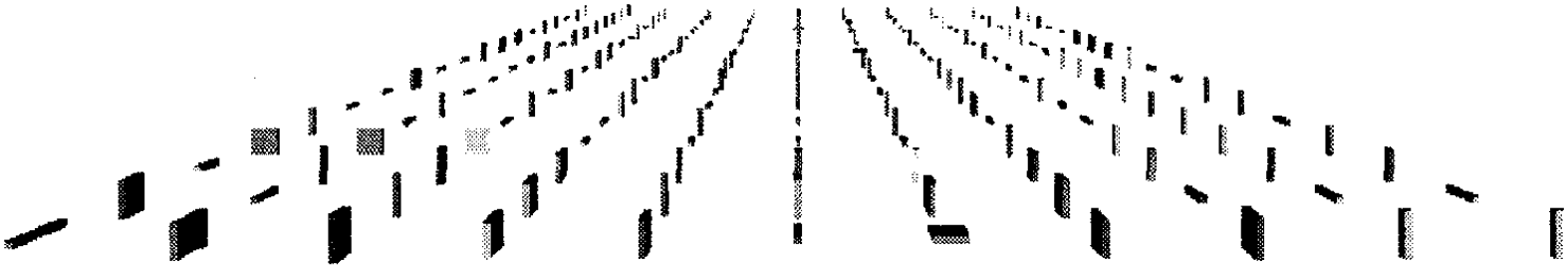


Source: T. Munzner, Visualization Analysis and Design after Distortion Viewing Techniques for 3D Data. Carpendale et al. InfoVis1996.

Perspective distortion loses information

- Perspective Distortion: Distant objects appear smaller and change their planar position on the image plane
  - Interferes with all size channel encodings
  - Power of the plane (and size channel) is lost!

- 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

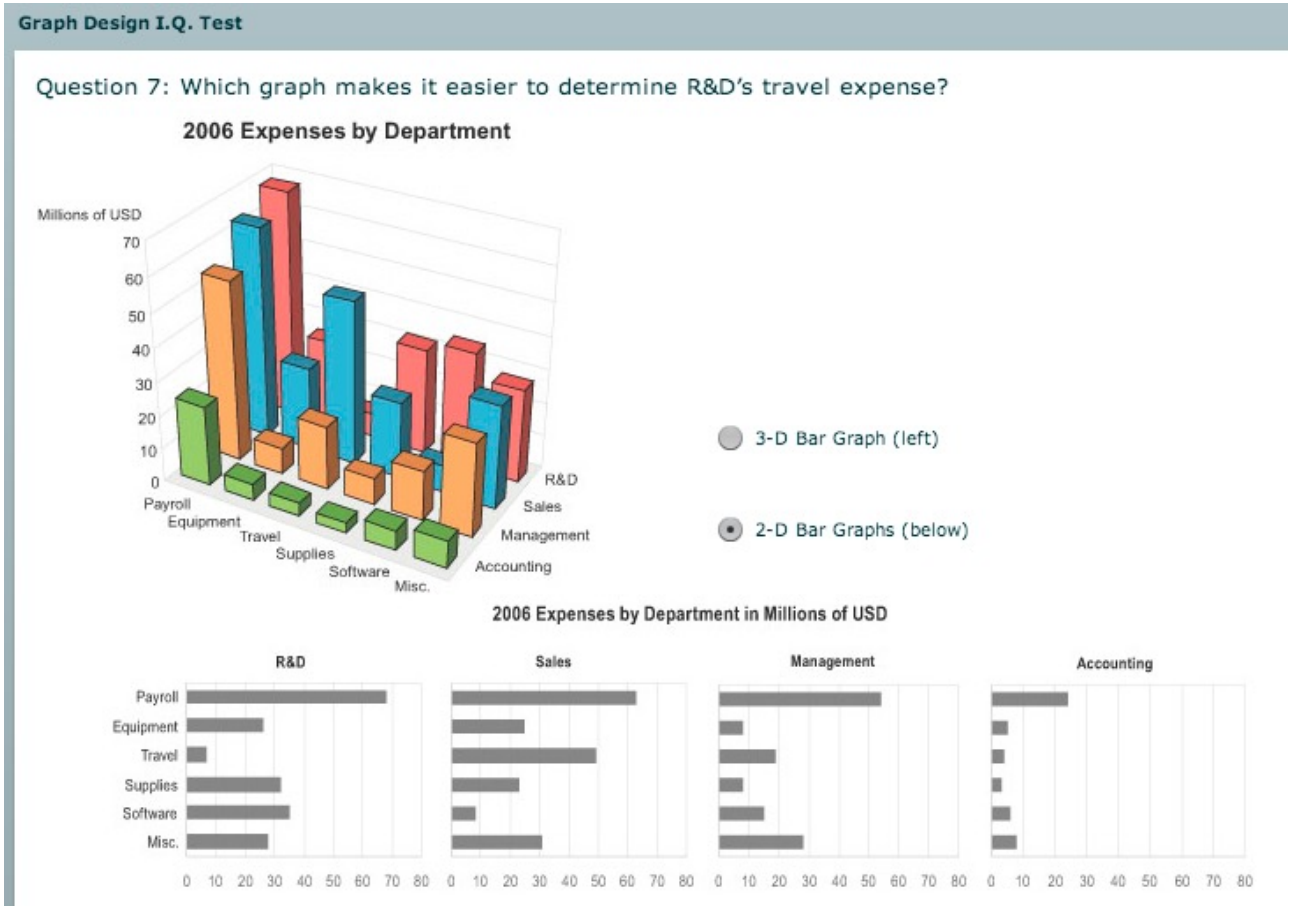


Source: T. Munzner, Visualization Analysis and Design after Visualizing the Results of Multimedia Web Search Engines. Mukherjea, Hirata, and Hara. InfoVis 96

Example: 3D bar graphs

- 3D bars: hard to justify!
  - Perspective distortion
  - Occlusion

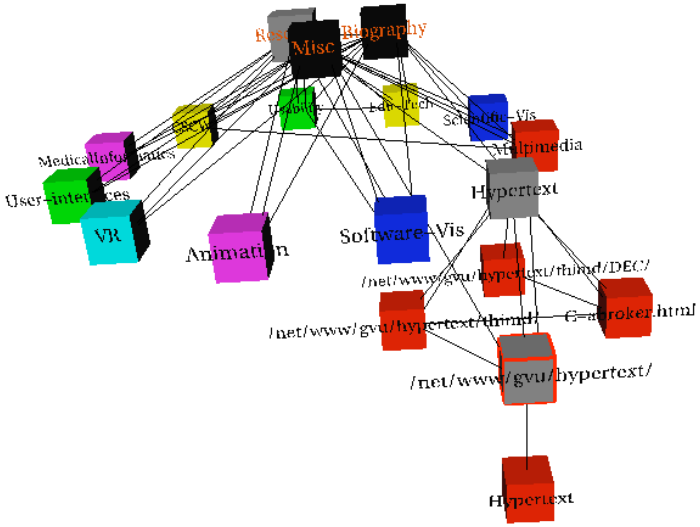
  ➔ Faceting into 2D almost always better choice



Source: T. Munzner, Visualization Analysis and Design after http://perceptualedge.com/files/GraphDesignIQ.html

Tilted text isn't legible

- Text Legibility: far worse when tilted from image plane

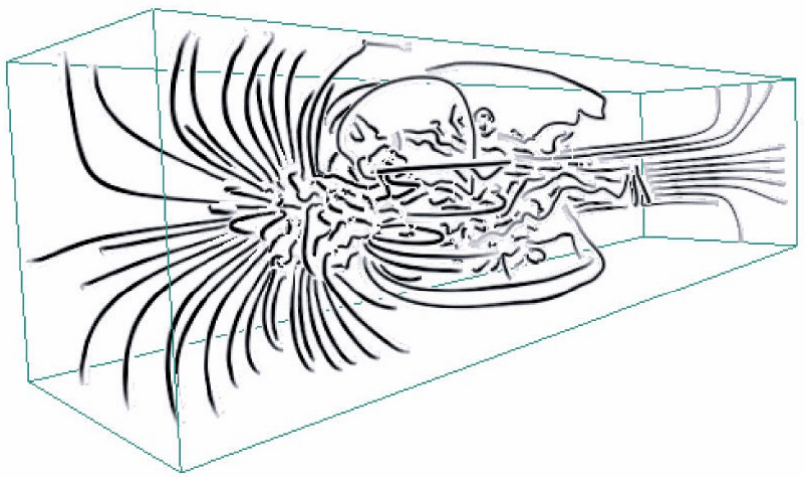


- No unjustified 3D
  - Power of the plane
  - Disparity of depth
  - Occlusion hides information
  - Perspective distortion dangers
  - Tilted text isn't legible
- No unjustified 2D
- Eyes beat memory
- Resolution over immersion
- Overview first, zoom and filter, details on demand
- Responsiveness is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

Source: T. Munzner, Visualization Analysis and Design after Visualizing the World-Wide Web with the Navigational View Builder. Mukherjea and Foley. Computer Networks and ISDN Systems, 1995

Example: Justified 3D

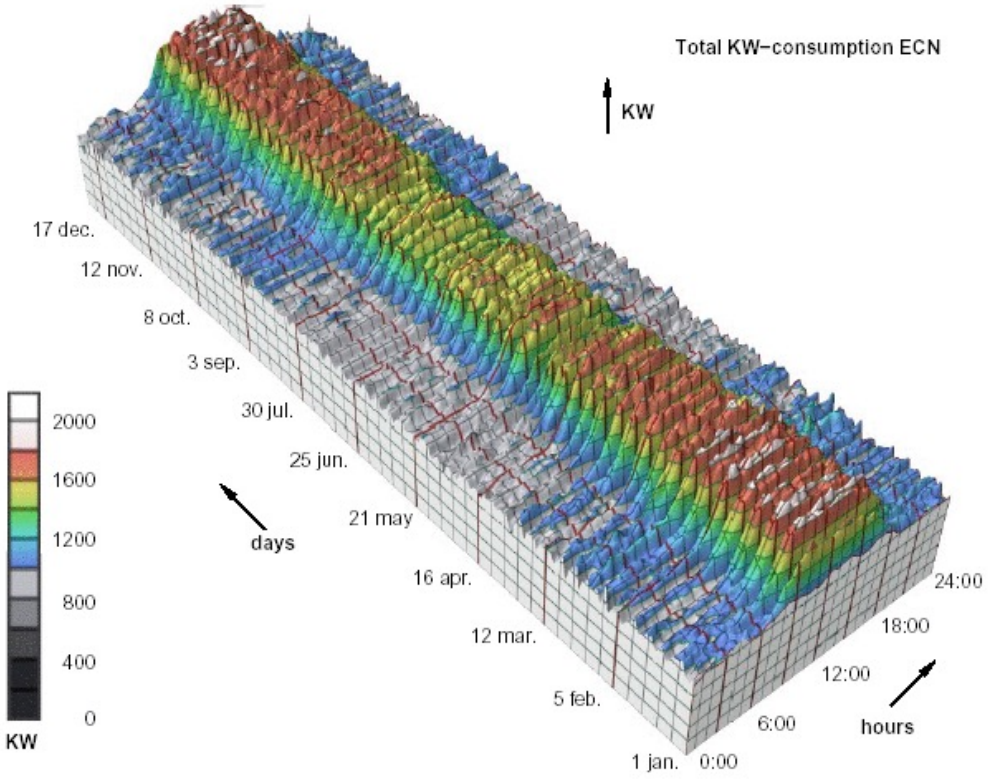
- Benefits outweigh costs when task is shape perception for 3D spatial data
  - Interactive navigation supports synthesis across many viewpoints



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

Example: Unjustified 3D – Time Series Data (1)

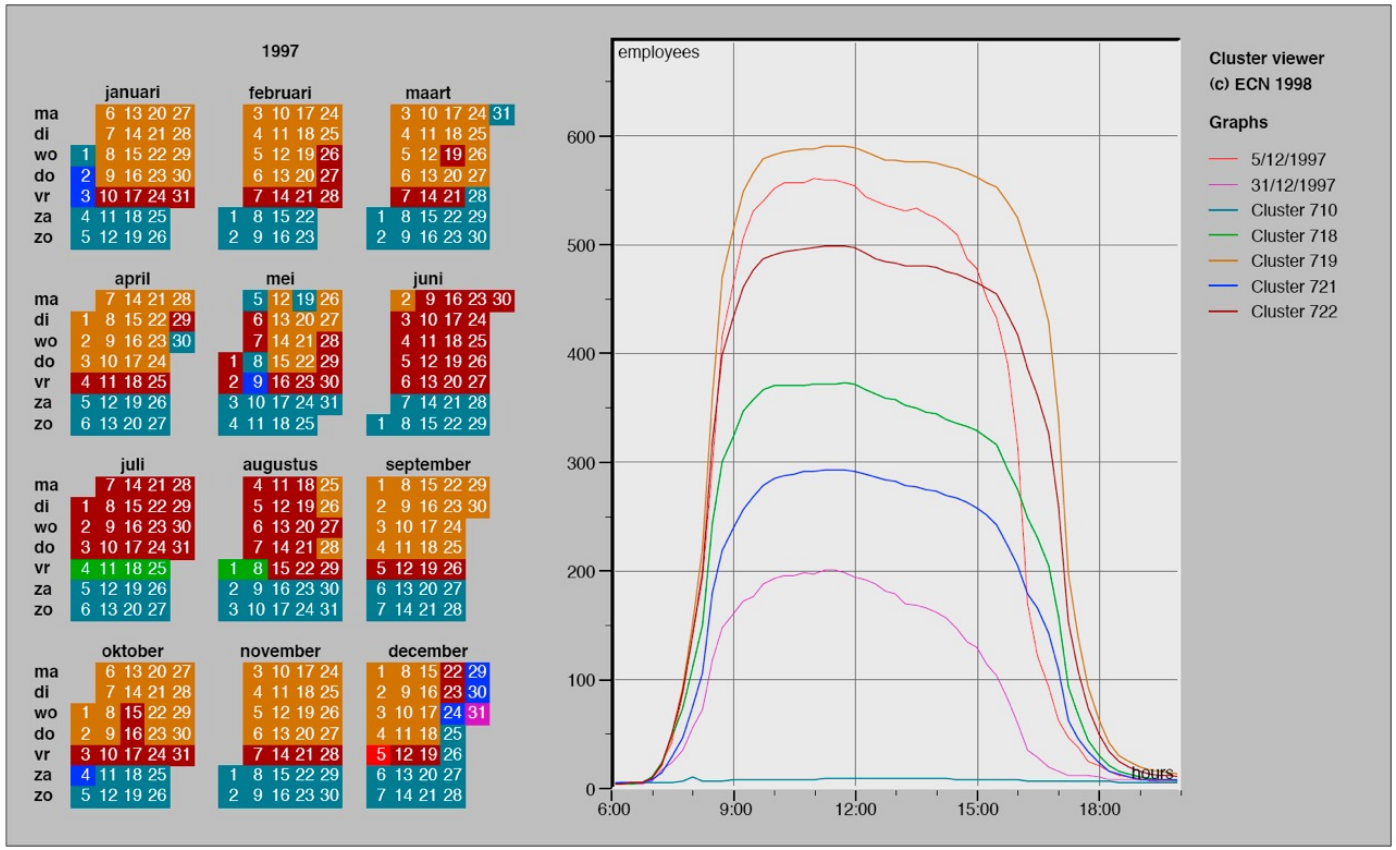
- Extruded curves: detailed comparisons impossible



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

Example: Unjustified 3D – Time Series Data (2) – Transform Data

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



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

No unjustified 3D - Summary

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

- 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 2D

- 2D Layouts vs. 1D Lists
  - 2D Layouts: Often used for representing network data
  - 1D Lists: Show data linearly, typically maximizing information density
- Strengths of 1D Lists
  - 1. Maximal Information Density
    - Example: Text labels can be shown in minimal space
    - 2D layouts like node-link diagrams need more space
  - 2. Effective for Lookup Tasks
    - Example: Alphabetical lists allow quick lookup of known labels
    - Finding a label in a 2D node-link layout can be cumbersome
- Considerations for Choosing Layout
  - Lookup Tasks: Linear lists more efficient
  - Benefits outweigh costs when topological structure/context important for task

- 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

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

- 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

Source: T. Munzner, Visualization Analysis and Design

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
- When to Use Immersion
  - 3D Spatial Data: May justify immersion if the sense of presence outweighs the drawbacks
  - Nonspatial Data: Rarely necessary

- 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

Overview first, zoom and filter, details on demand

- 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

- Ben Shneiderman's Mantra
  - Overview First: Start with a broad awareness of the entire information
  - Zoom and Filter: Navigate and reduce data to focus on specific areas
  - Details on Demand: Access detailed information as needed
- Challenges with Large Datasets
  - Pixel Limitation: reducing mark size to a single pixel may not suffice
  - ➔ Reduce number of marks by aggregating data items
- Types of Overviews
  - Static Overview: A less detailed summary view
  - Dynamic Overview: Changes over time with user interaction, supporting zoom and filter actions
  - Embedded Overview and Detail: Combining both in a single view for continuous context
- Examples
  - Geometric Zooming: Zooming out to show all items smaller
  - Semantic Zooming/Dynamic Aggregation: Qualitatively different representations at different zoom levels
  - Detail Views: More detailed views popping up in response to user selection or alongside the overview

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
  - 10 seconds: brief tasks
    - bounded response after dialog
- Scalability considerations
  - Highlight selection without complete redraw of view
  - 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)

- 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

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

- 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

Your Turn !

Exercise 1

Key Insights

Scandinavian World Heritage Sites – Part 1

Your Turn !

Exercise 2

Key Insights

Scandinavian World Heritage Sites – Part 2

Key Takeaways – The 7 Rules of Thumb

- 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