10. Presentation Approaches I
Dealing with the presentation problem

Lecture „Informationsvisualisierung"

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Concept and slides: Thorsten Büring,

3rd, revised edition

Outline

- Presentation problem
- Zoomable user interfaces (ZUIs)
  - Development history
  - Space-scale diagrams
  - 2.5D
  - Advanced ZUI designs
  - Orientation in ZUIs
- Overview+detail interfaces
  - Abstract overviews
  - Performance issues
  - View coordination
  - View Layout
  - Zoom factors

Presentation Problem

- Very often information spaces have to be displayed, which are significantly larger than the screen size
  - Too many data cases
  - Too many variables
- Potential techniques to maximize the number of information objects that can be displayed
  - Data encodings (see lectures 3 & 4)
  - Interaction and view transformations
  - Hybrid approaches

Presentation Problem

- Most common workaround: scrolling interfaces
- Advantages
  - Many users are familiar with scrollbars
  - Navigation at different speed
  - Thumbs show position and ratio of information space and view size
  - Have been found effective to move small distances
- Disadvantages
  - Only horizontal and vertical shifts
  - Scrollbars usually do not preview the content of the off-screen space
  - Take away screen space
  - Limited to linear navigation
  - Does not scale (search times and interaction sensitivity increase)

Presentation Problem

- Interaction and view transformations
  - Zoomable user interfaces
  - Overview+detail interfaces
  - Focus+context interfaces (upcoming lecture)

Zoomable User Interfaces

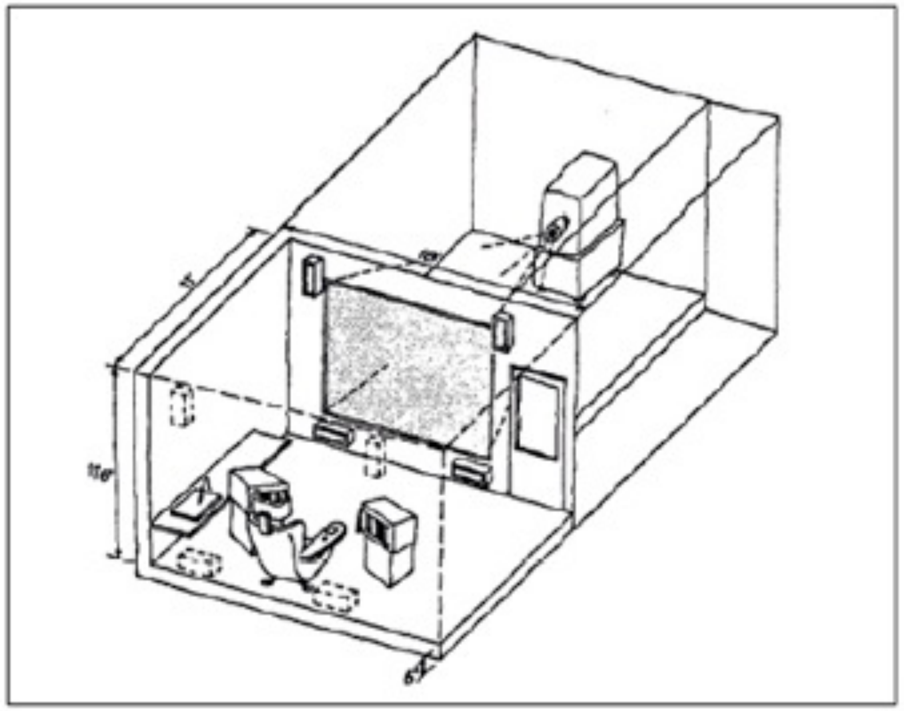
- ZUIs aka multiscale interface
- “Navigation in information spaces is best supported by tapping into our natural spatial and geographic ways of thinking” (Perlin & Fox 1993)
- “By moving through space and changing scale the users can get an integrated notion of a very large structure and its contents, and navigate through it in ways effective for their tasks” (Furnas & Bederson 1995)
- Data objects must be organized in space and scale
- Users can manipulate which part of the information space is shown, and at what scale
  - Panning: movement of the viewport over the information space at a constant scale
  - Zooming: altering the scale of the viewport such that it shows a decreasing fraction of the information space with an increasing magnification and vice versa (Spence 2007)
- Due to non-linear navigation ZUIs develop their full potential as the size of the information space grows

Zoomable presentation tool: Prezi.com

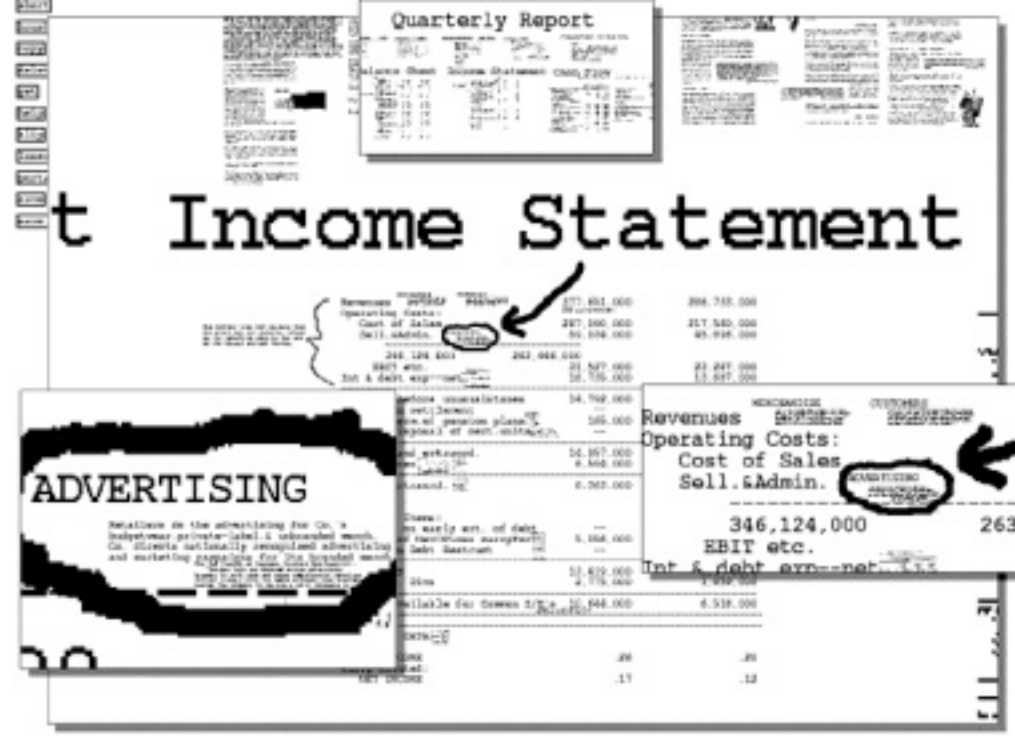
- demo: http://prezi.com/b9fk1xyfbber/

Development History

- 1978 - Spatial Data Management System (SDMS) (Donelson 1978)
- Visionary system for visualizing (and zooming) visual database representations
- Relied heavily on custom hardware
  - Rear-projected color television display
  - Octophonic sound system
  - Chair with isometric joysticks, touch-sensitive Tablets and a digital lapboard



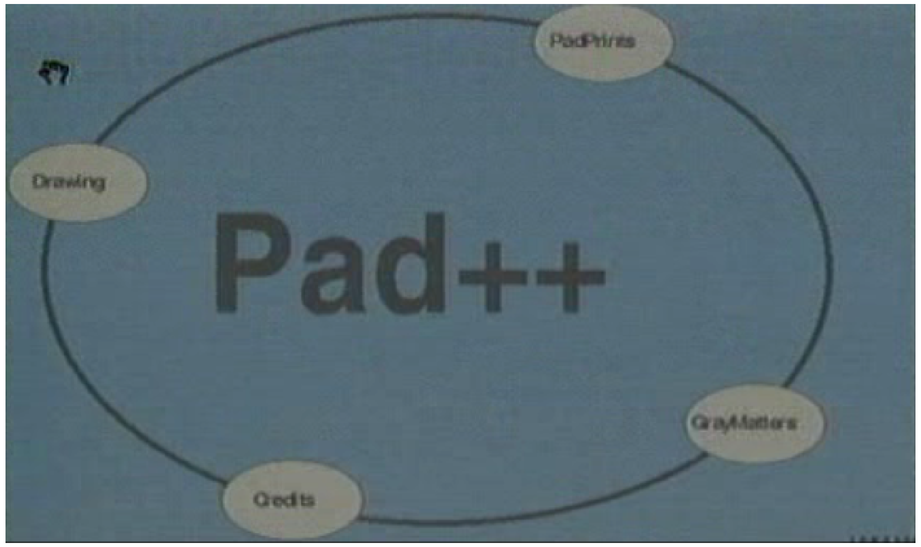
Development History

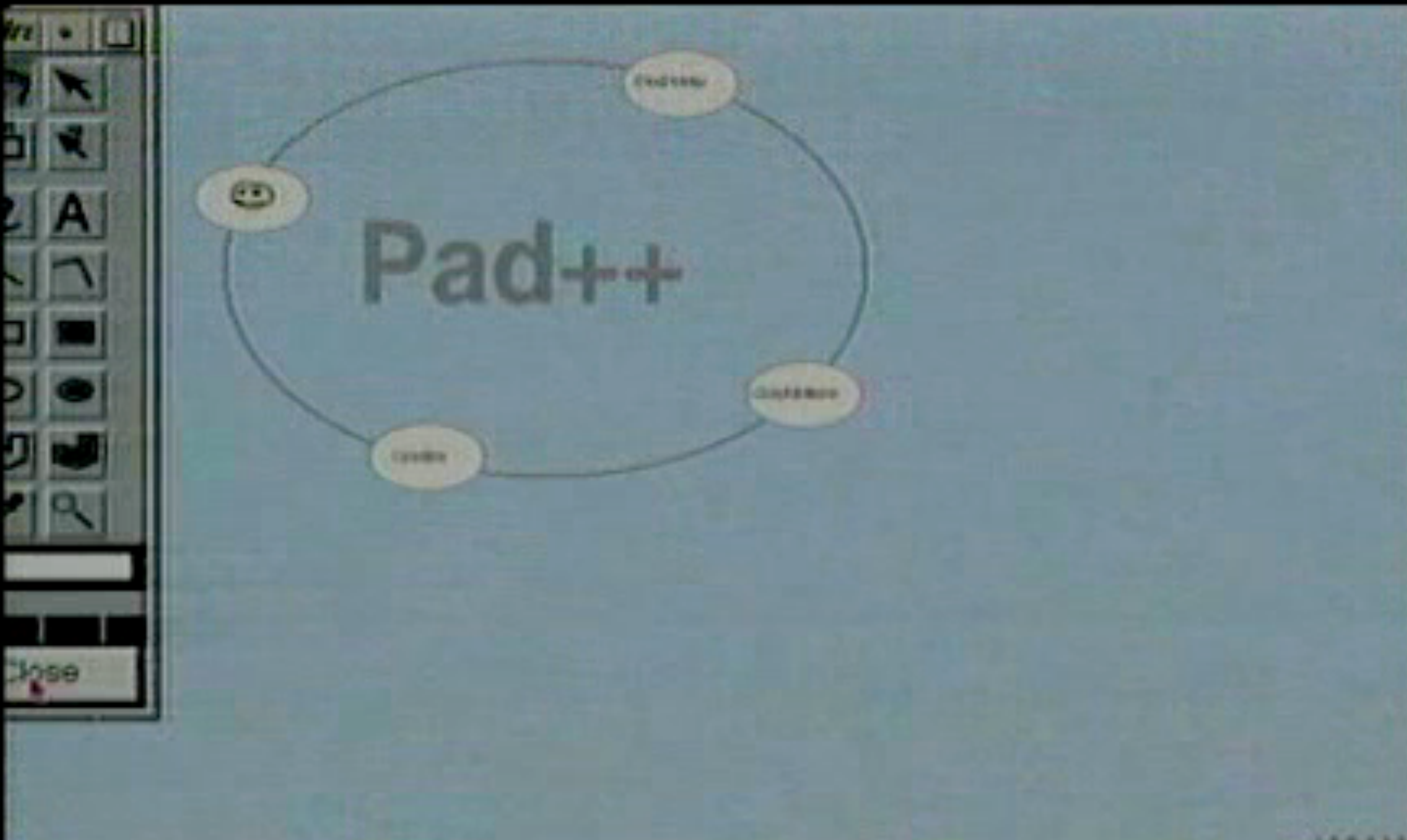


- 1993 - Pad, the first multiscale interface (Perlin & Fox 1993)
- Alternative to the Windows Paradigm
- Visualizes an infinite two dimensional information plane populated with information objects the users can interact with (e.g. text files, personal calendar...)
- Important concepts
  - Portals as customizable views to facilitate navigation
  - Semantic zooming (will be discussed later on)
  - Designed to run on standard hardware
- Screenshot shows quarterly report displayed using Pad along with portals to provide magnified views of details

Development History

- 1994 - Pad++ (Bederson & Hollan 1995), successor of Pad
- Mostly technical enhancements
- Smooth zooming with hundreds of thousands information objects
- Implemented in C++
- Supposed to support platforms ranging from workstations to PDAs and set-top boxes (scalability of ZUIs!)
- Improved platform independency was only achieved by later ZUI toolkits
  - Jazz (2000), Java
  - Piccolo (2004), Java, .NET C#, compact framework
- http://www.cs.umd.edu/hcil/jazz/




Pad++
Close

Space-Scale Diagrams

- Furnas & Bederson 1995
- Diagrams to understand and model multiscale interfaces
- Basic idea
  - 2D image represents information space
  - Construct diagram by creating copies of the 2D image at each possible scale and stacking them up to form an inverted pyramid
- Two axes u1 and u2 represent spatial dimensions of the image
- Vertical v axis represents scale (magnification from 0 to infinity)

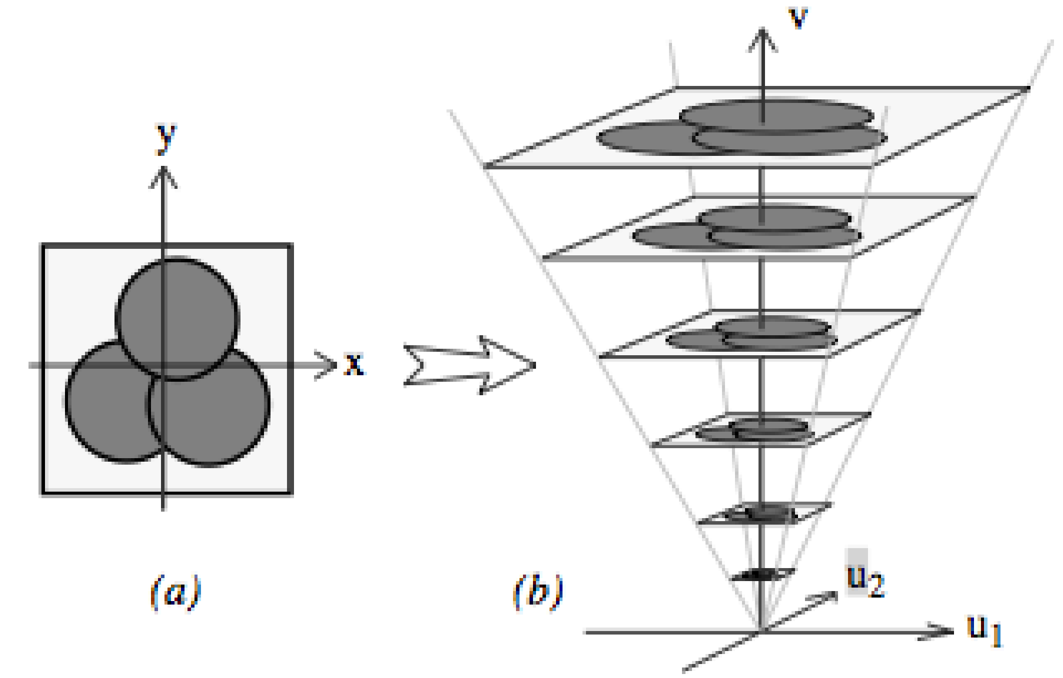


Figure 1. *The basic construction of a Space-Scale diagram from a 2D picture.*

Space-Scale Diagrams

- Property I: viewing window
  - Fixed size window which is moved through the 3D space of the diagram
  - Models all possible views, which can be achieved by zoom and pan

- Note: alternative ZUI model could represent space as a fixed 2D plane on which the size of the view window is manipulated

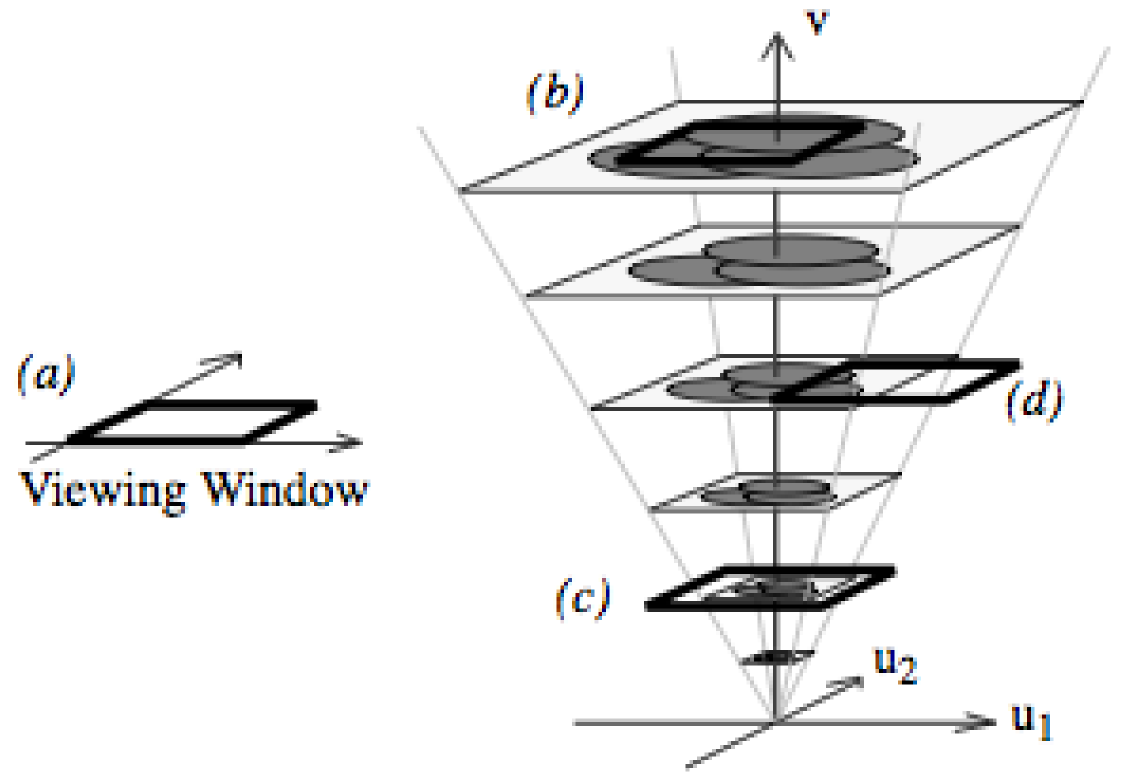


Figure 2. *The viewing window (a) is shifted rigidly around the 3D diagram to obtain all possible pan/ zoom views of the original 2D surface, e.g., (b) a zoomed in view of the circle overlap, (c) a zoomed out view including the entire original picture, and (d) a shifted view of a part of the picture.*

Furnas & Bederson 1995

Space-Scale Diagrams

- Property II
  - A point in the original 2D picture becomes a ray in this space-scale diagram
  - Hence regions of the 2D picture become generalized cones in the diagram
- Property III
  - The only meaningful contents of the space-scale diagram are properties invariant under a shear
  - Do not try to read too much out of the diagram!

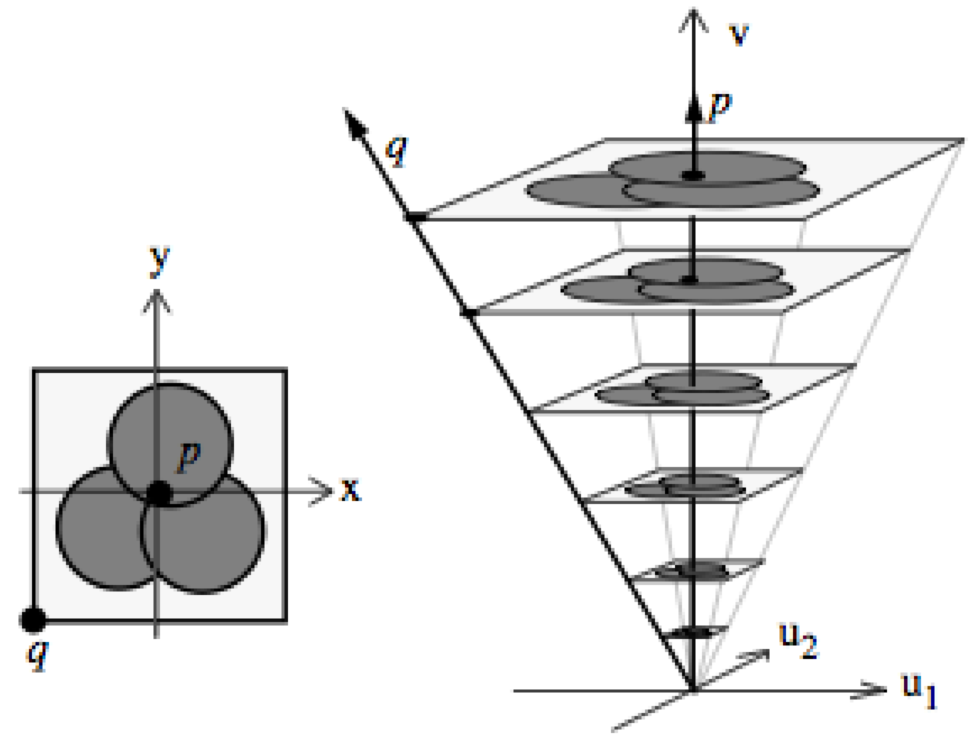
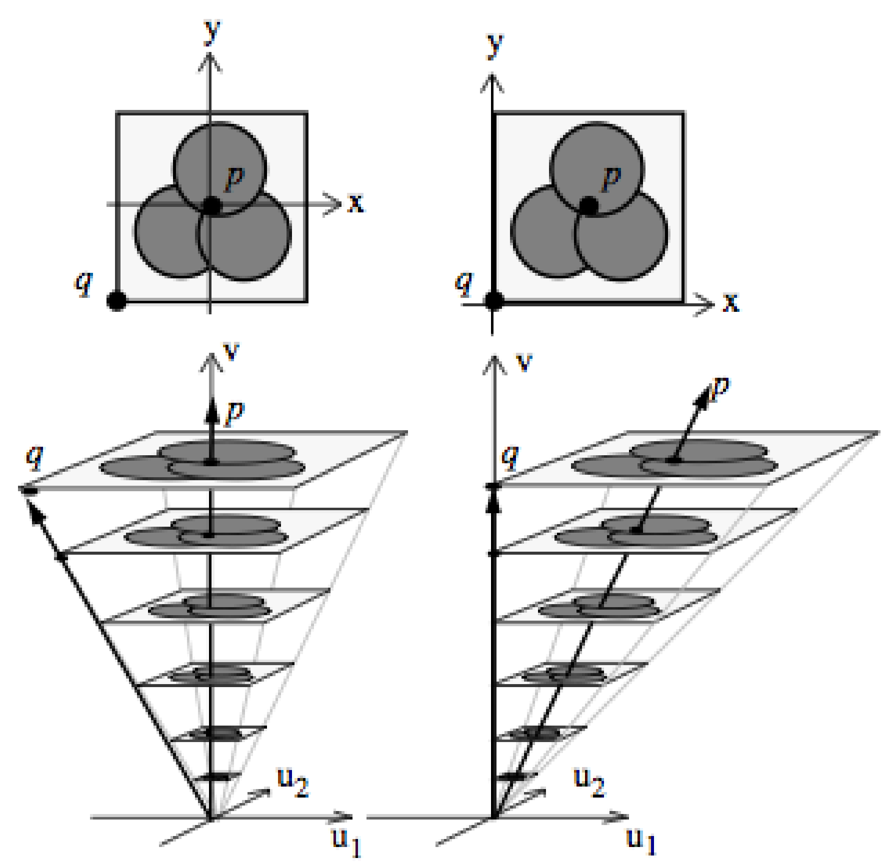
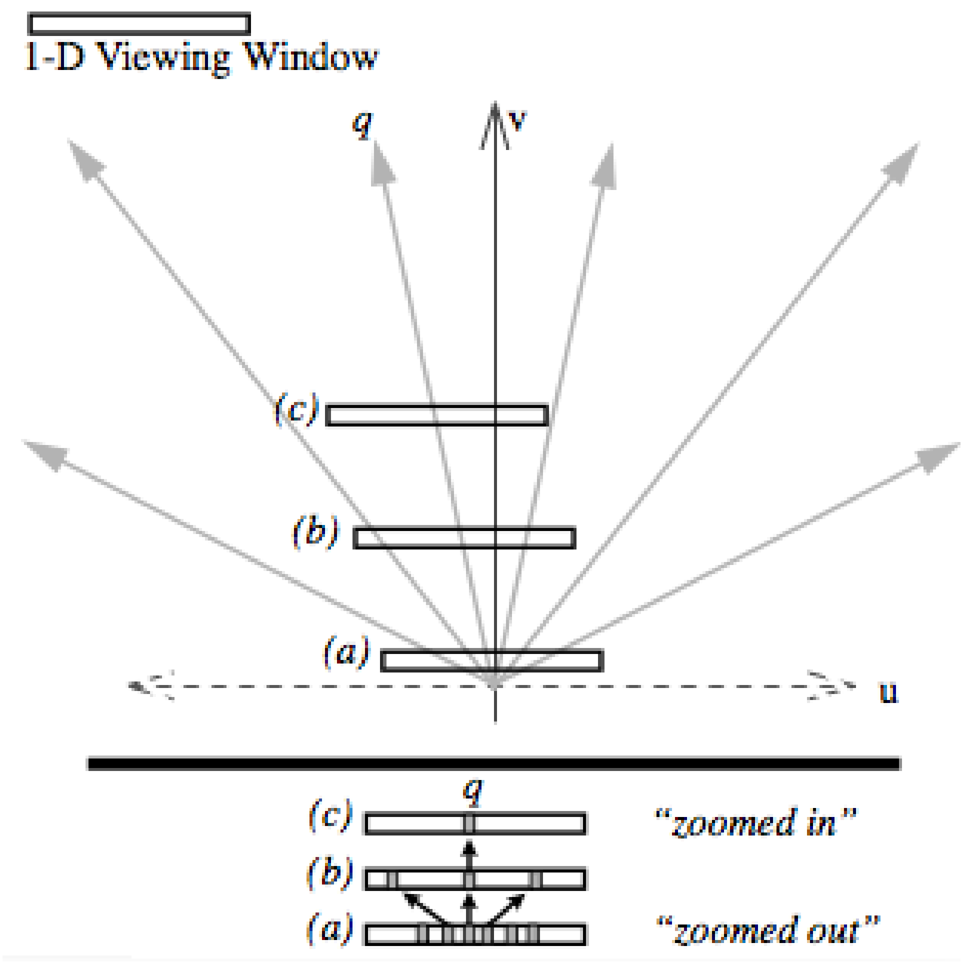


Figure 3. *Points like p and q in the original 2D surface become corresponding "great rays" p and q in the space-scale diagram. (The circles in the picture therefore become cones in the diagram, etc.)*



Space-Scale Diagrams

- Simplification of the diagram
  - Compress the two spatial dimensions to 1D
  - 3D to 2D diagram
  - Viewing window becomes a 1D slit
  - 6 rays represent six points in the 1D space
  - Example starts with a view of all 6 points and then zooms in on point q



Space-Scale Diagrams

- Study basic pan-zoom trajectories
- (a) panning: position changes, scale remains constant
- (b) pure zoom: central position remains constant, scale changes
- (c) zoom-around: zoom is centered around some fixed point other than the center of the window (in the example point q)

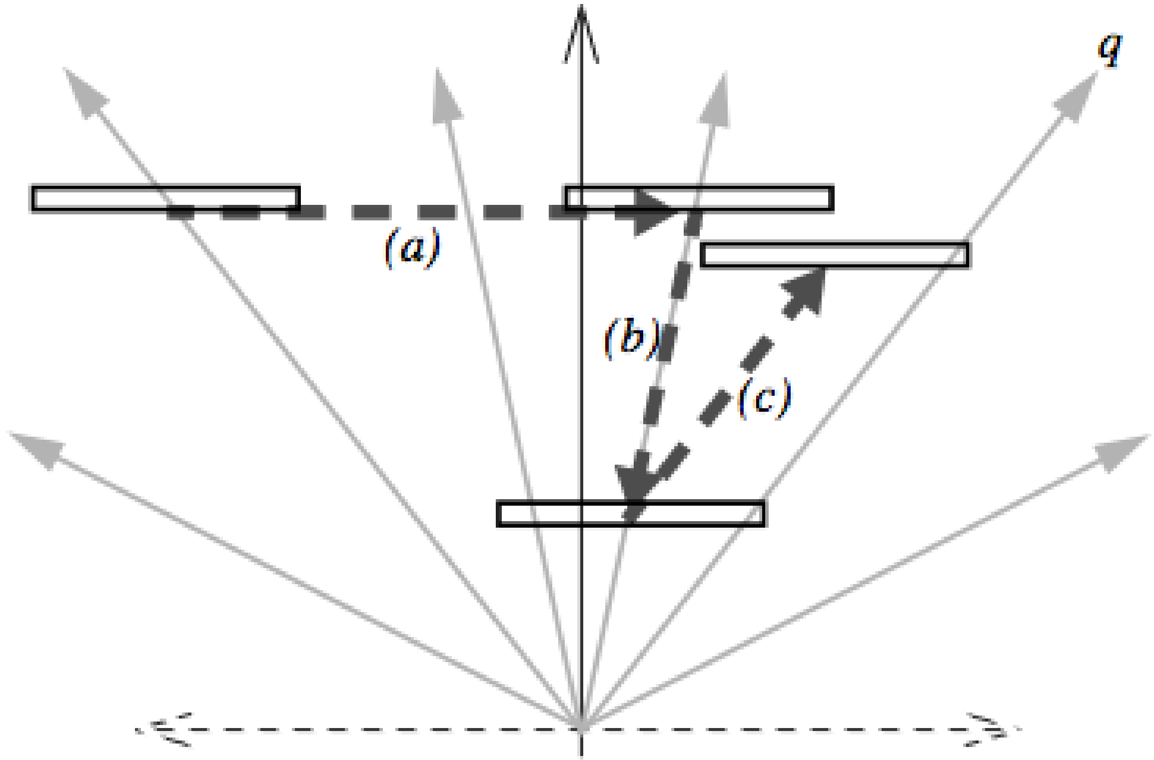


Figure 6. *Basic Pan-Zoom trajectories are shown in the heavy dashed lines:. (a) Is a pure Pan,. (b) is a pure Zoom (out), (c) is a "Zoom-around" the point q.*

Space-Scale Diagrams

- Joint pan-zoom trajectory
- Use case: automatic navigation to a pre-defined point
- Naive approach: calculate pan and scale distance separately and execute them in parallel - does not work!
- Reason
  - Pan is linear
  - Zoom is logarithmic
- Space-scale diagram shows how the trajectory s needs to be modeled
- View monotonically approaches a point in both pan and zoom
- Scale factor z must change hyperbolically with the panning of x

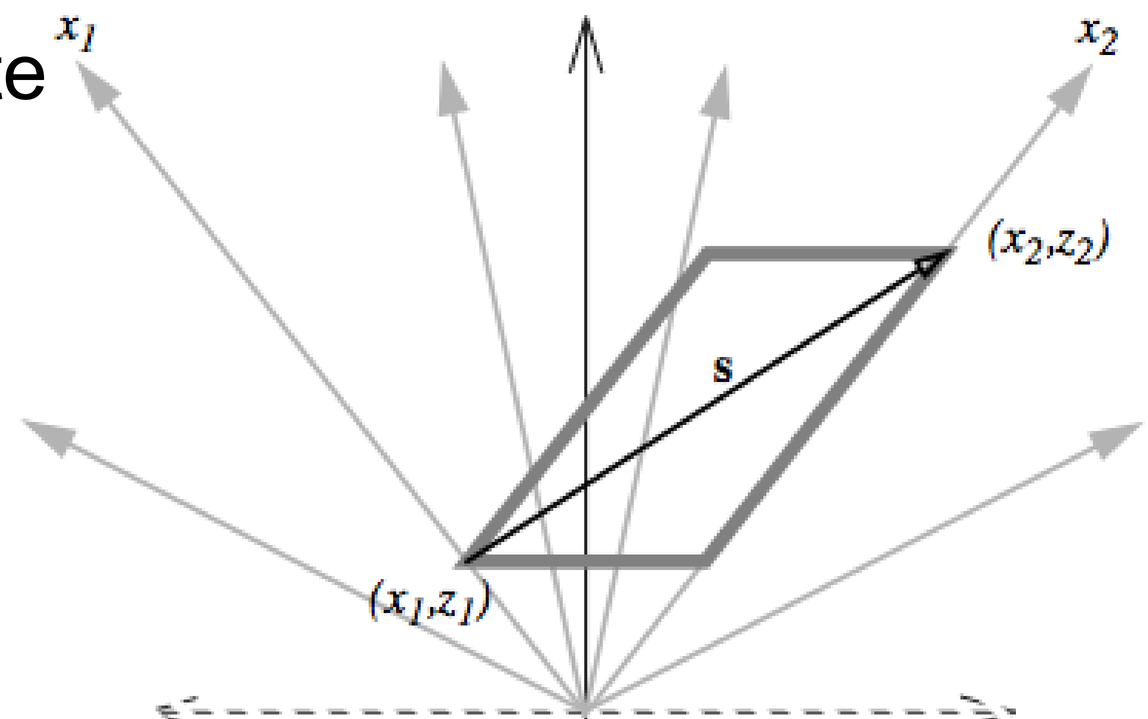


Figure 7. *Solution to the simple joint pan-zoom problem. The trajectory* **s** *monotonically approaches point 2 in both pan and zoom.*

Space-Scale Diagrams

- Shortest path between two points
- Not a straight line, i.e. no pure panning!
- Remember: zoom is logarithmic, i.e. provides exponential accelerator for navigating very large spaces
- Arrows of the trajectories represent units of cost
- Diagram shows: to travel a vast distance the following strategy is fastest
  - Zoom out to a scale at which the old and the target position are close together
  - Short pan
  - Zoom back in

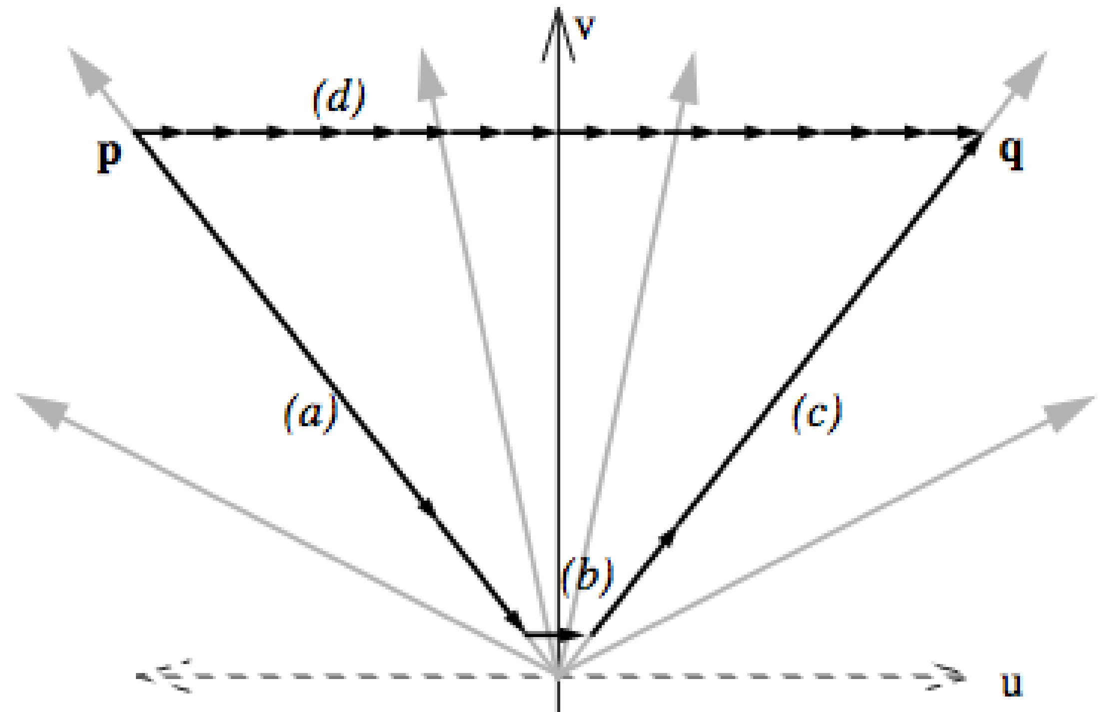
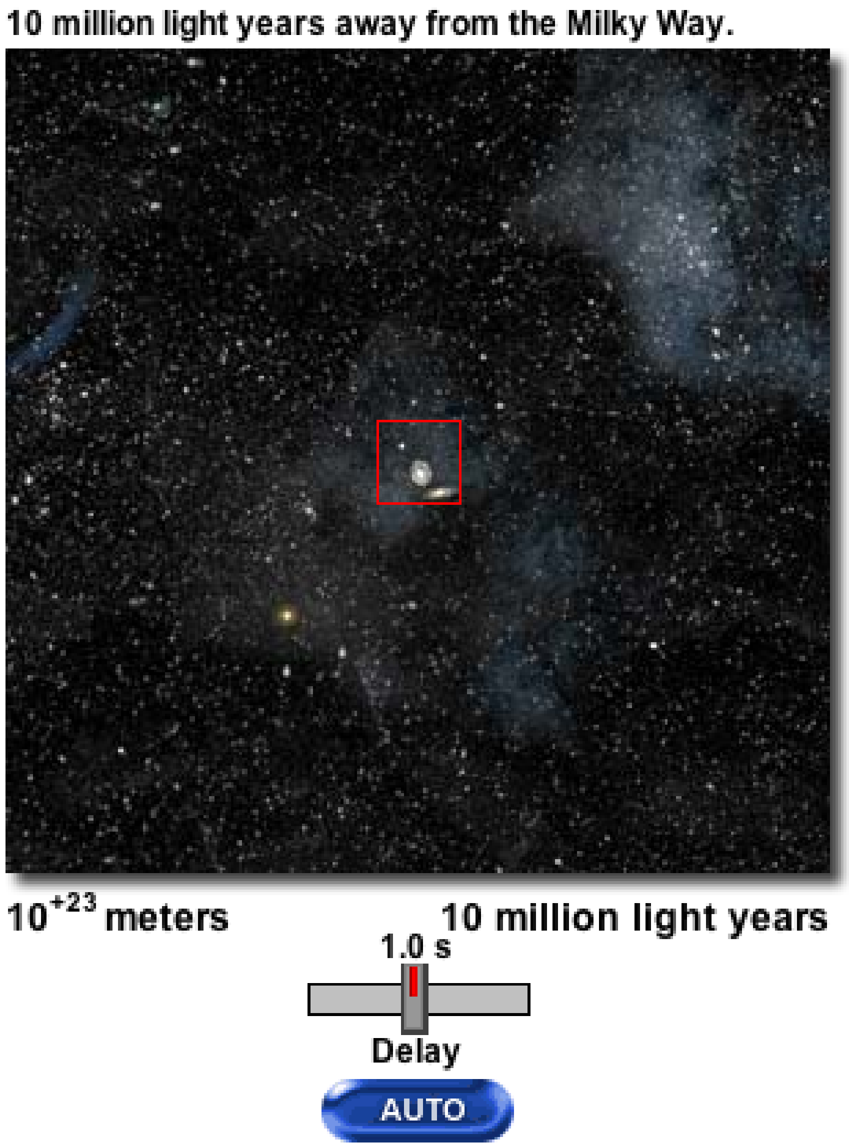


Figure 8. *The shortest path between two points is often not a straight line. Here each arrow represents one unit of cost. Because zoom is logarithmic, it is often "shorter" to zoom out (a), make a small pan (b), and zoom back in (c), than to make a large pan directly (d).*

Zoom Accelerator

- Power of ten
- 10 million light years from the Earth travel in 40 zoom steps to the protons of an oak leaf in in Tallahassee, Florida
- http://micro.magnet.fsu.edu/primer/java/scienceopticsu/powersof10/index.html



More Recent Example: Photosynth

- http://photosynth.net

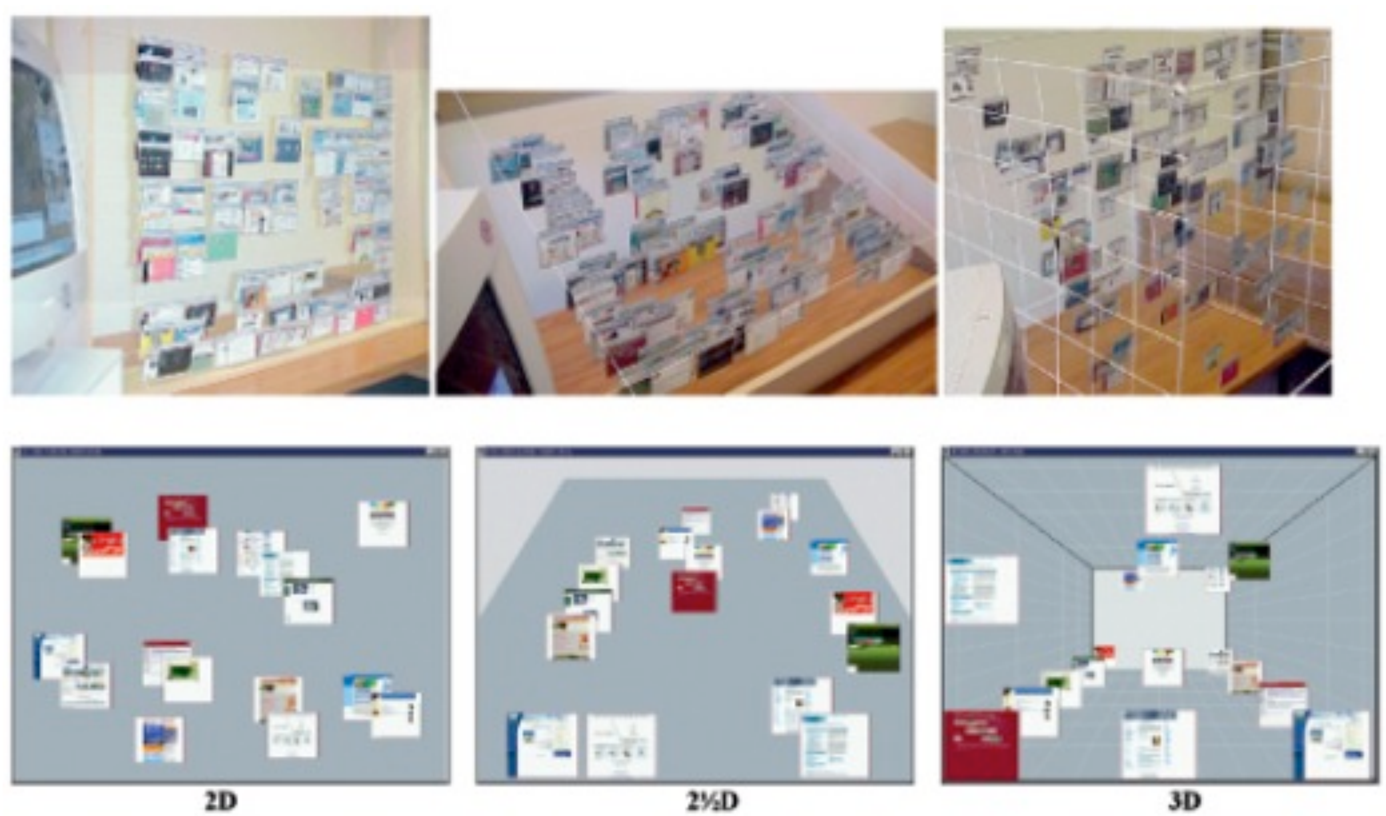
More Recent Example: Photosynth

2D, 2.5D and 3D

- ZUIs are NOT 3D but 2.5D applications
- Why not make them 3D?
  - Historical reason: developers of seminal ZUIs wanted to avoid special hardware requirements (by now 3D chips are standard)
  - Simplicity - 3D systems are usually hard to navigate using current 2D display and input device technology
- Still, it is hypothesized that high-quality 3D interfaces may better exploit the human capabilities of spatial cognition and thus can improve user performance
- Mixed empirical results in previous research

2D, 2.5D and 3D

- Example evaluation: physical and virtual systems to retrieve documents in a 2D, a 2.5D, and a 3D setting (Cockburn & McKenzie 2002)
- Results indicate performance advantage for 2D layout to locate images of web pages
- Participants also found the higher dimensional interfaces more cluttered and less efficient

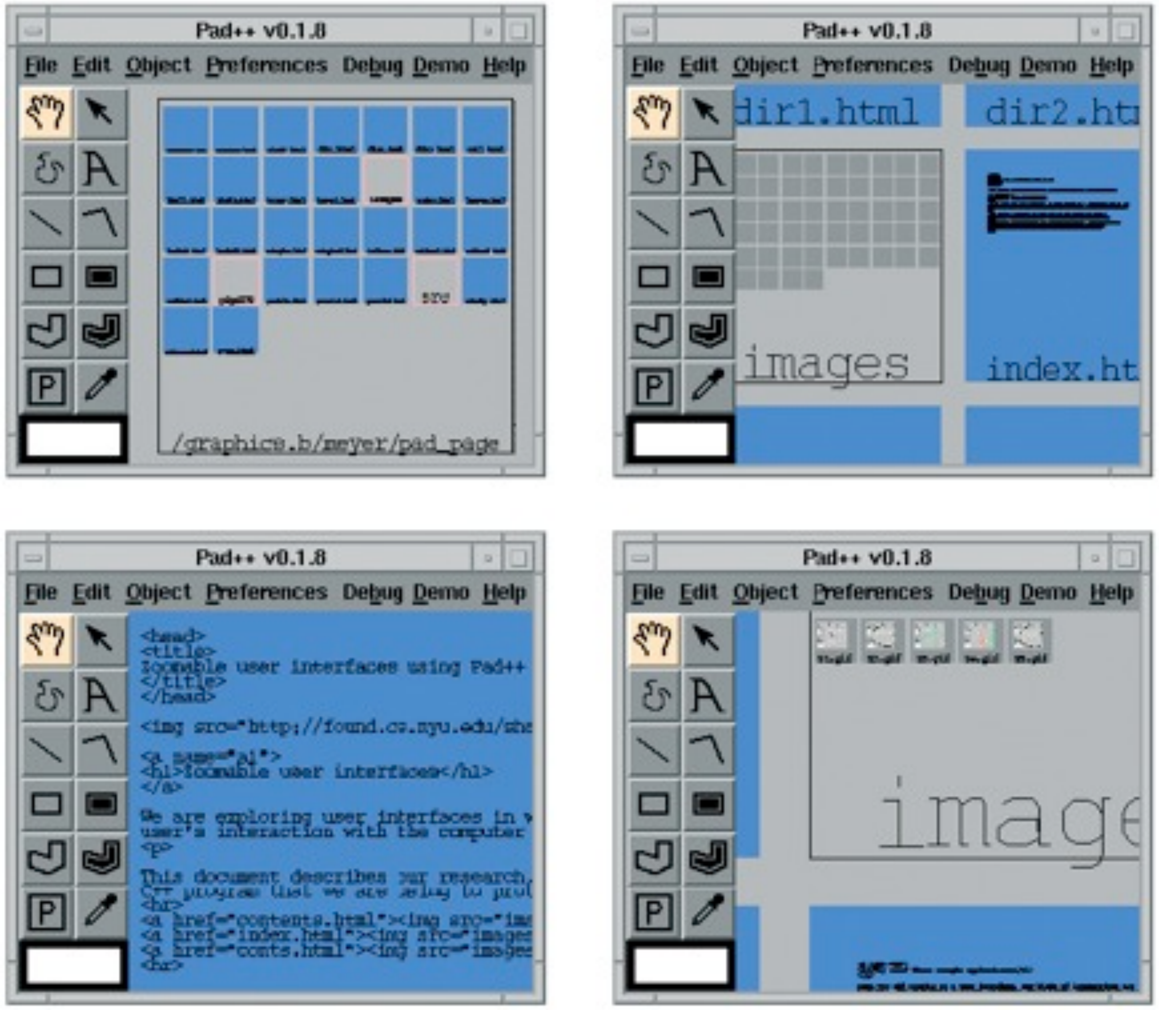


Smooth Zooming

- Older systems only provide a two-level zoom or navigation via coarse jumps
- Smooth continuous zooming
  - More demanding to implement
  - Helps the users to preserve their orientation during navigation
  - Users build a mental map of the information space
  - May improve user satisfaction via hedonic qualities - flying through space metaphor

Semantic Zoom

- Most common is geometric zoom: simply magnifies objects
- Semantic zoom: objects change their appearance as the amount of screen real estate available to them changes
- Semantic zoom provided by a directory browser implemented with Pad++ (www.cs.umd.edu/hcil/pad++)



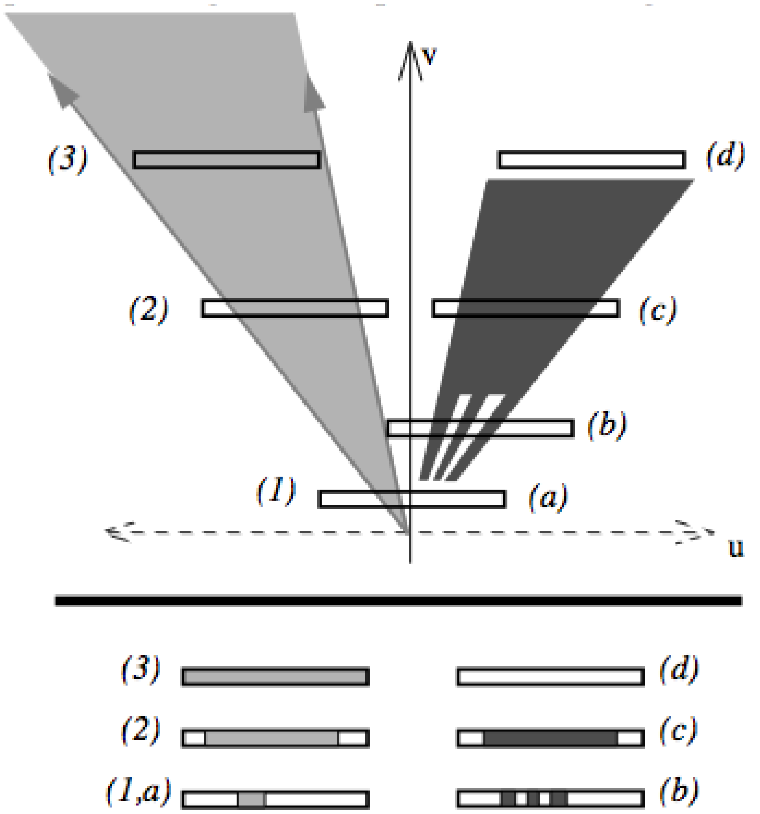
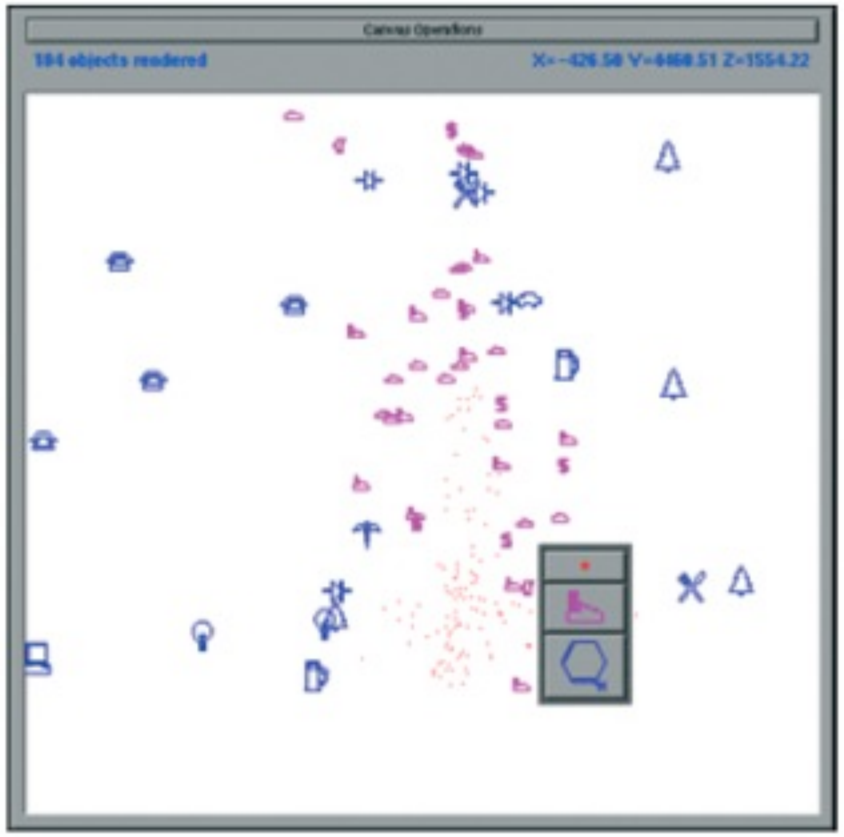


Figure 11. *Semantic Zooming. Bottom slices show views at different points.*

Goal-Directed Zoom (GDZ)

- Semantic zooming: users zoom in until the target objects shows the desired representation
- Goal-directed zoom: users choose a representation of an object and the change in scale and translation is automatically performed by the system (Woodruff et al. 1998b)

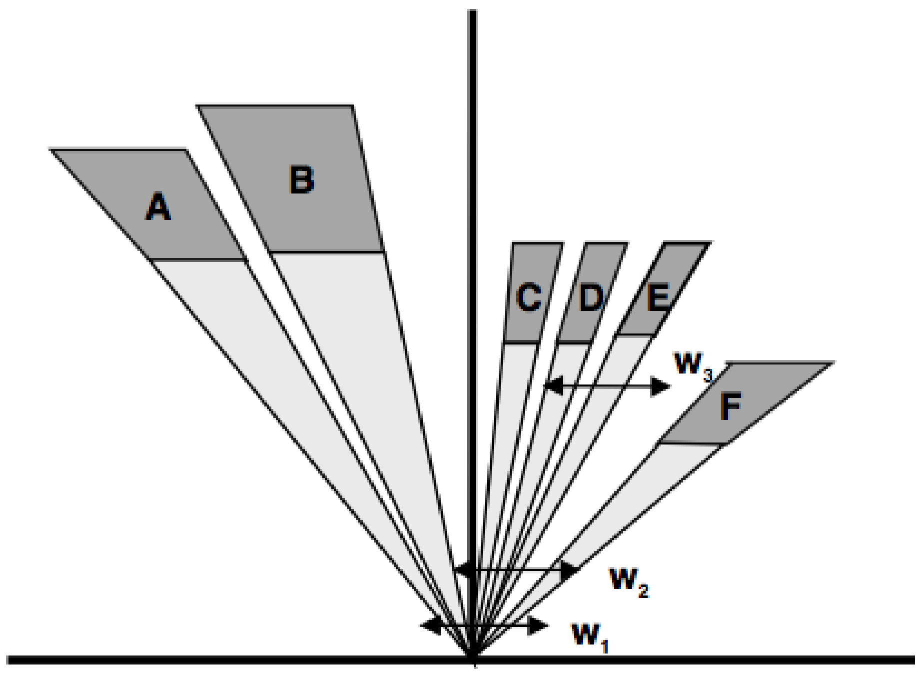


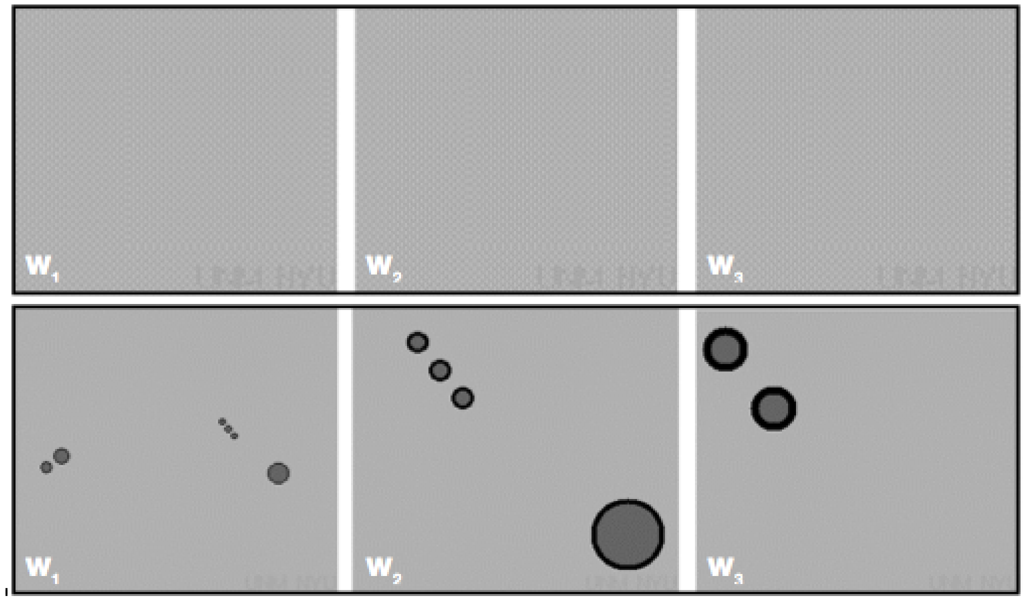
Orientation in ZUIs

- A common problem of ZUIs: the lack of context
- Continuous clipping of orientation cues during zooming
- Amount of context needed is hard to predict
- Depends on variables such as
  – Type and ordering of the information space
  – The users' familiarity with the information space
  – The task the users want to accomplish
- Example city map navigation: context needed by local citizen versus a first-time visitor
- Most straightforward way to rediscover context in ZUIs: zooming out
  – May also refresh the users' mental model of the information space
  – But: frequent zoom-outs can be tedious
  – Provide fast and precise interaction design to minimize the required effort

Desert Fog

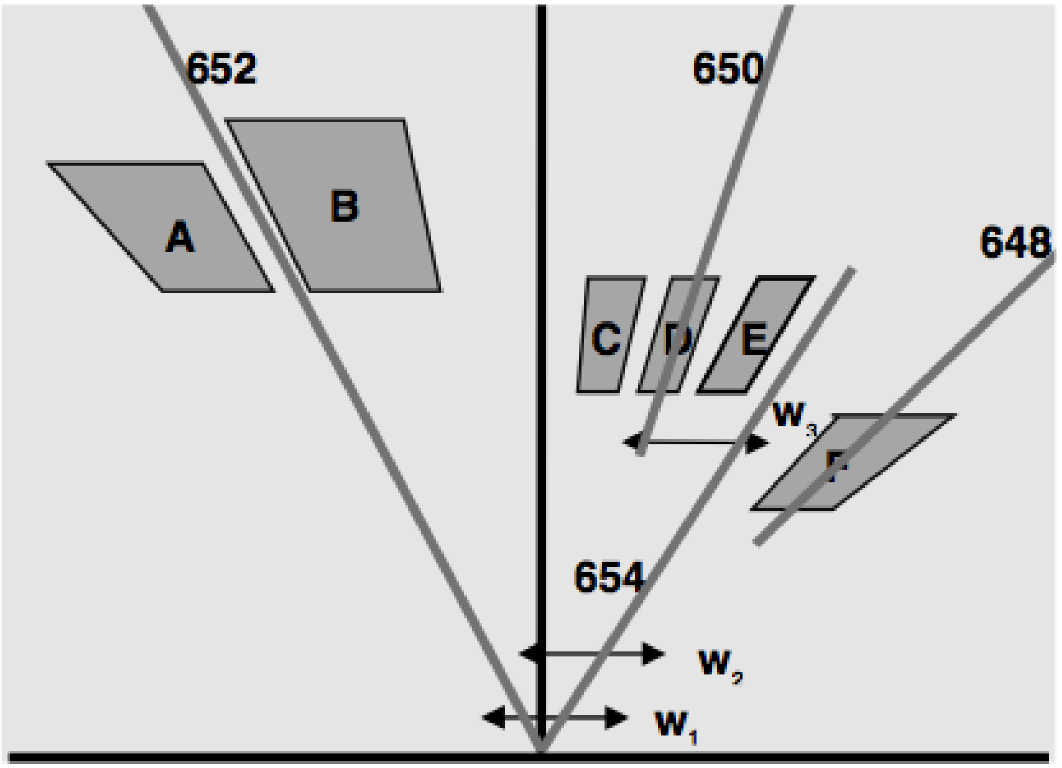
- Jul & Furnas 1998
- More severe orientation problem for large or infinite multiscale spaces
  - Users zoom into white space between information objects until the viewport goes completely blank
  - Blank screen could mean:
    - There are no more object to be found in that direction -> zoom out
    - There are objects to come, but they are too far away to be seen -> zoom in
  - What to do?

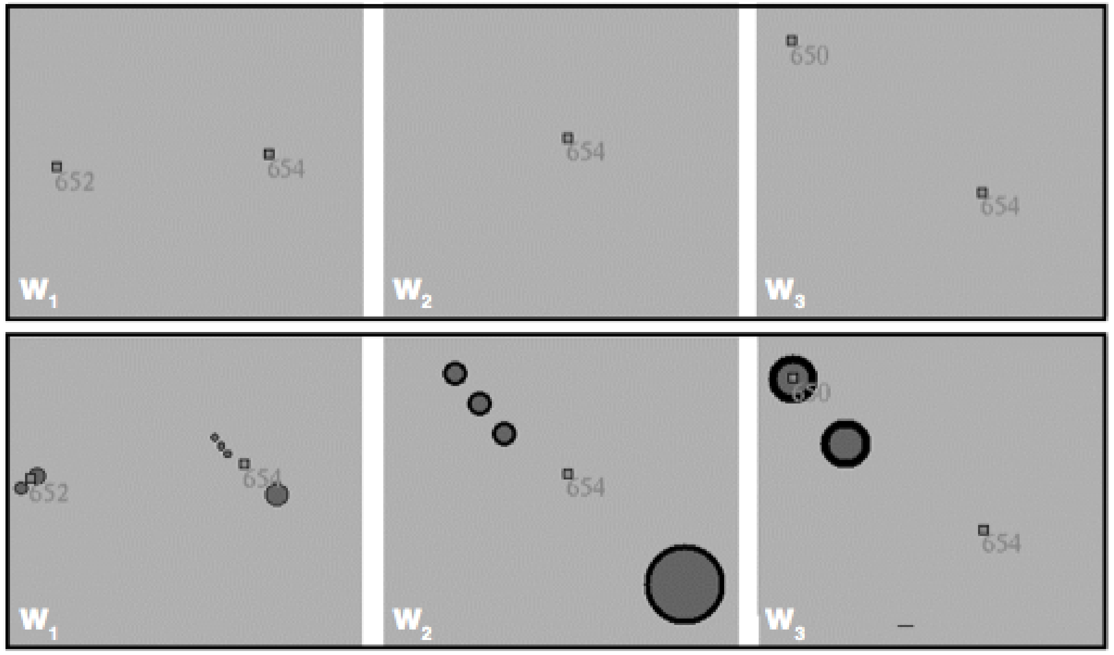




Desert Fog

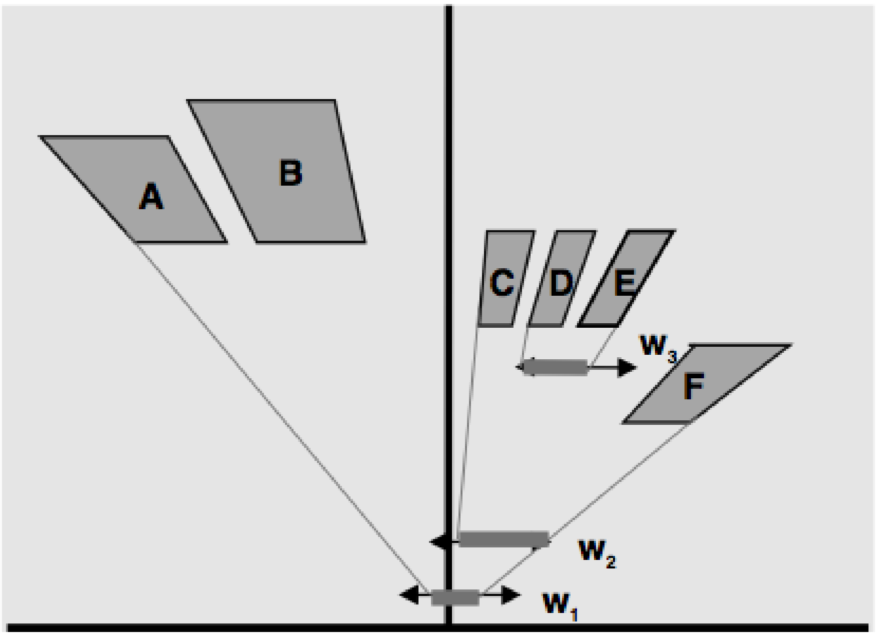
- Add multiscale residues
  - Landmarks for each information object are drawn across scale (think of it as a beacon)
  - Blank screen always means that there are no more objects in that direction
  - Problem: clutter of multiscale residues
- Apply hierarchical clustering to reduce clutter
- Based on spatial proximity
- Problems
  - Where should a landmark be located?
  - Geometric center of a cluster? Meaningful?
  - Most representative object? How to identify?
  - How many levels of the hierarchy should be displayed when? Again, can cause clutter...

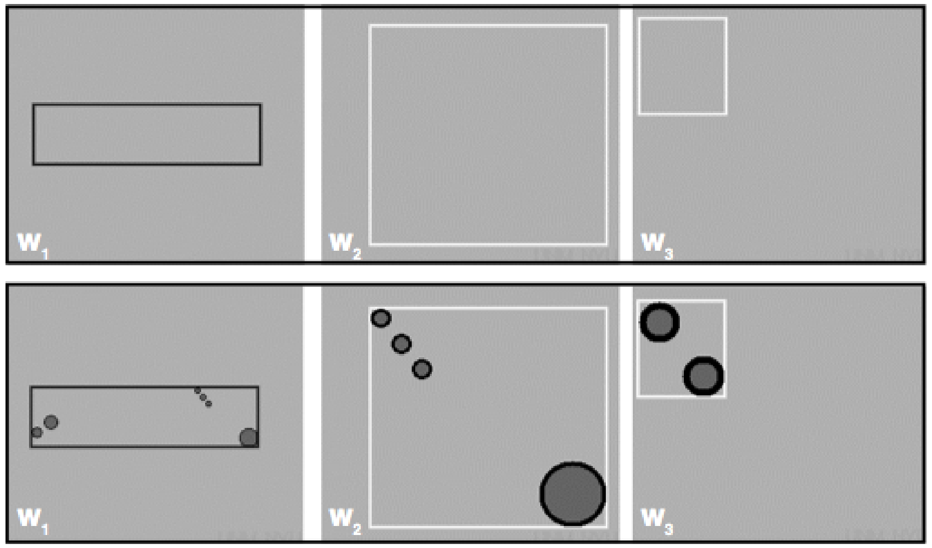




Desert Fog

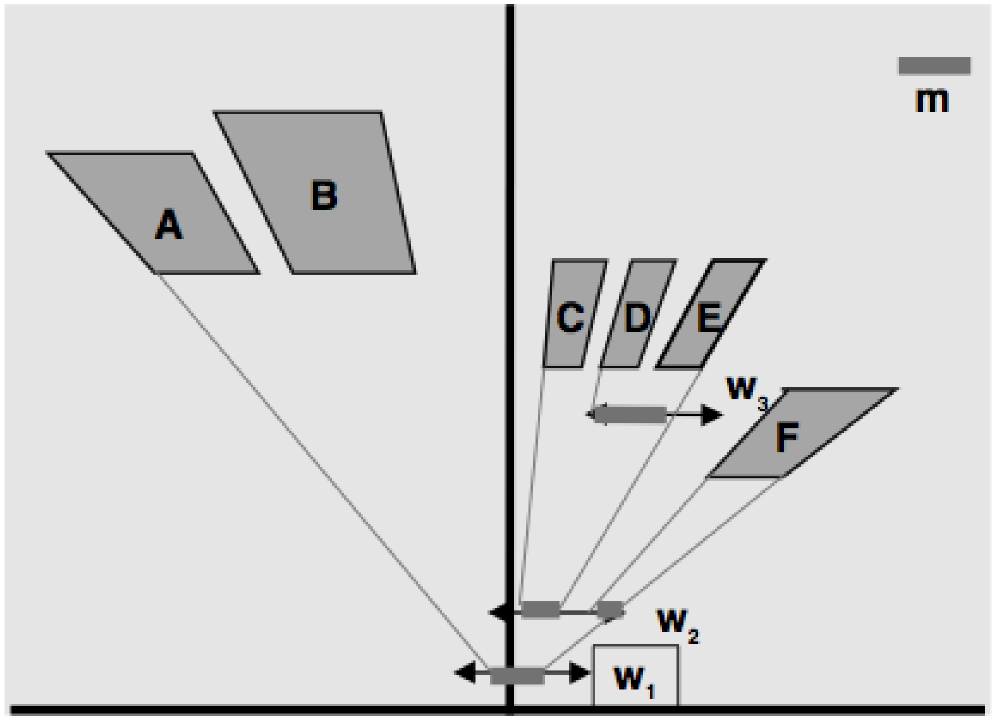
- Concept of critical zones: provide residues of views not objects
- Single critical zone
  - Only views are highlighted, which contain objects
  - Bounding rectangle encloses all contained views
  - Dark rectangle means that the critical zone contains all objects in the world - no sense to zoom out further
- Problem: where to zoom in on inside a critical zone?
- Trial and error strategy

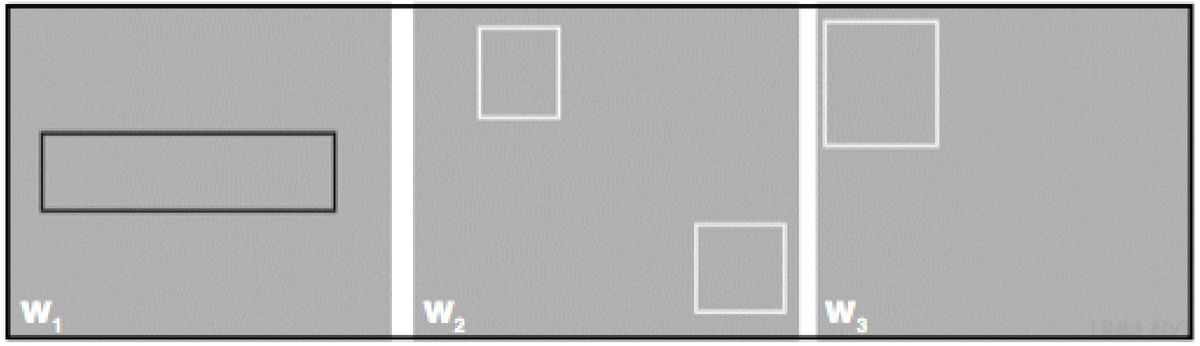


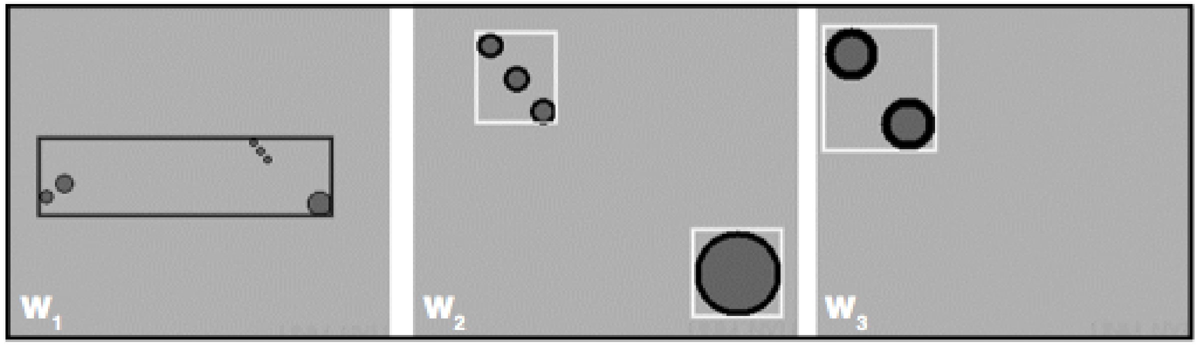


Desert Fog

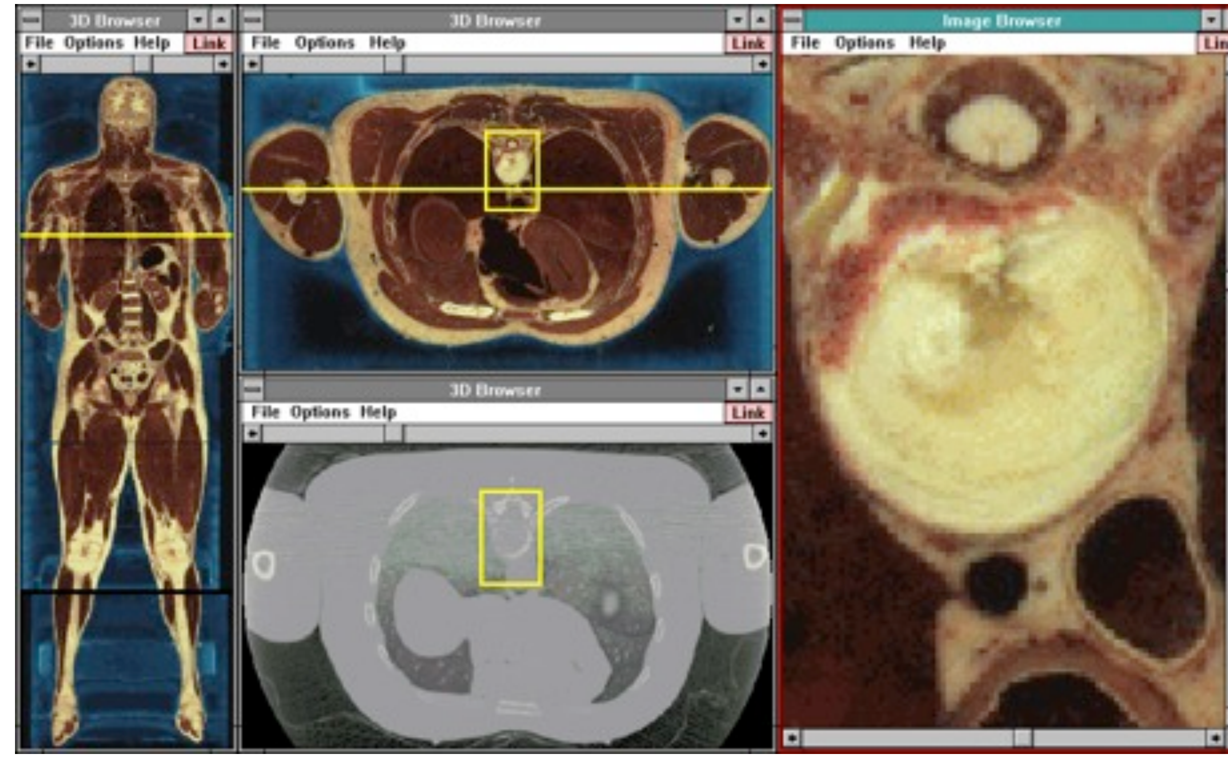
- Improve navigation aid by showing multiple smaller critical zones
- At the same time limit the number of zones to not cause clutter
- M defines a size, above which a zone is split into smaller zones





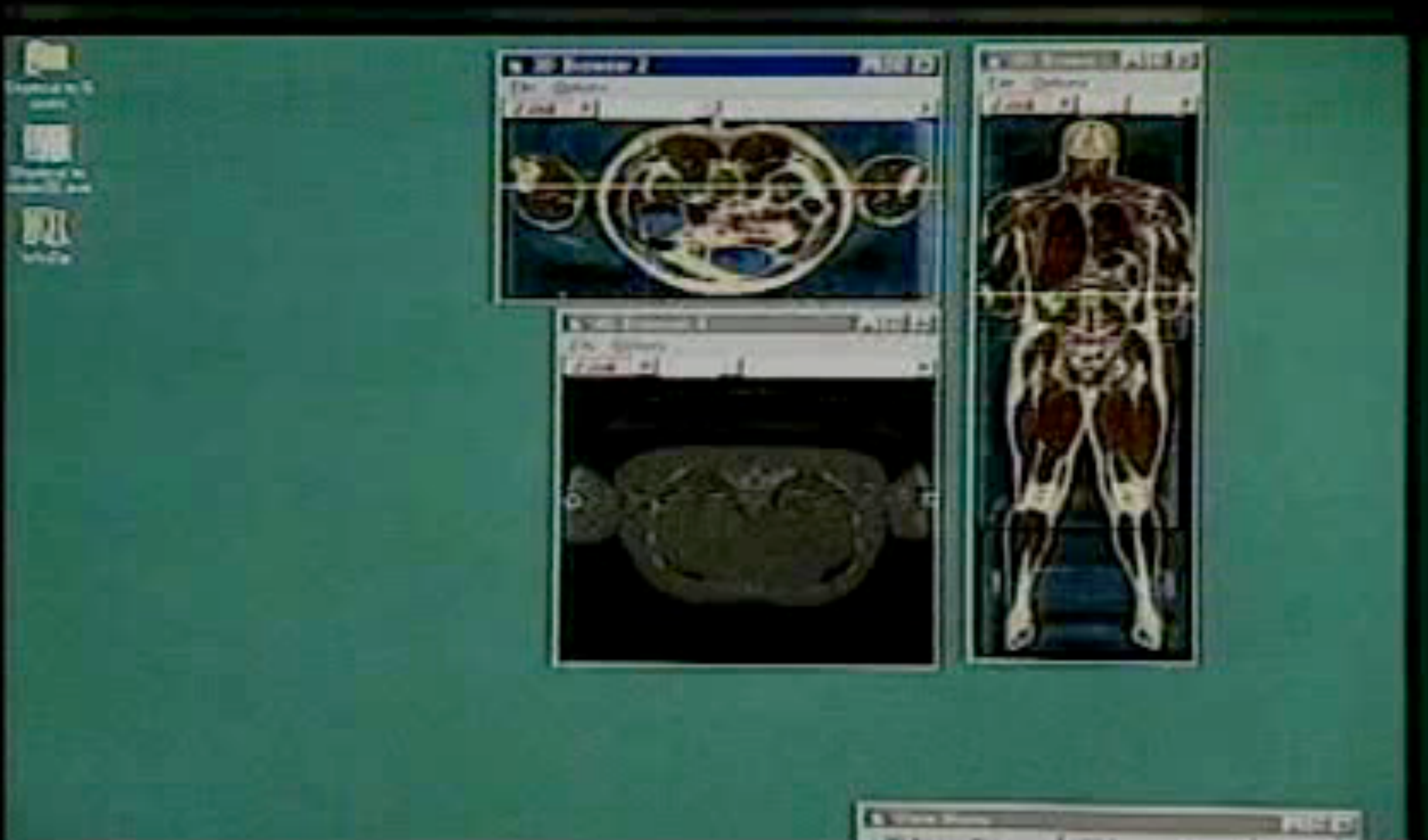


Overview+Detail

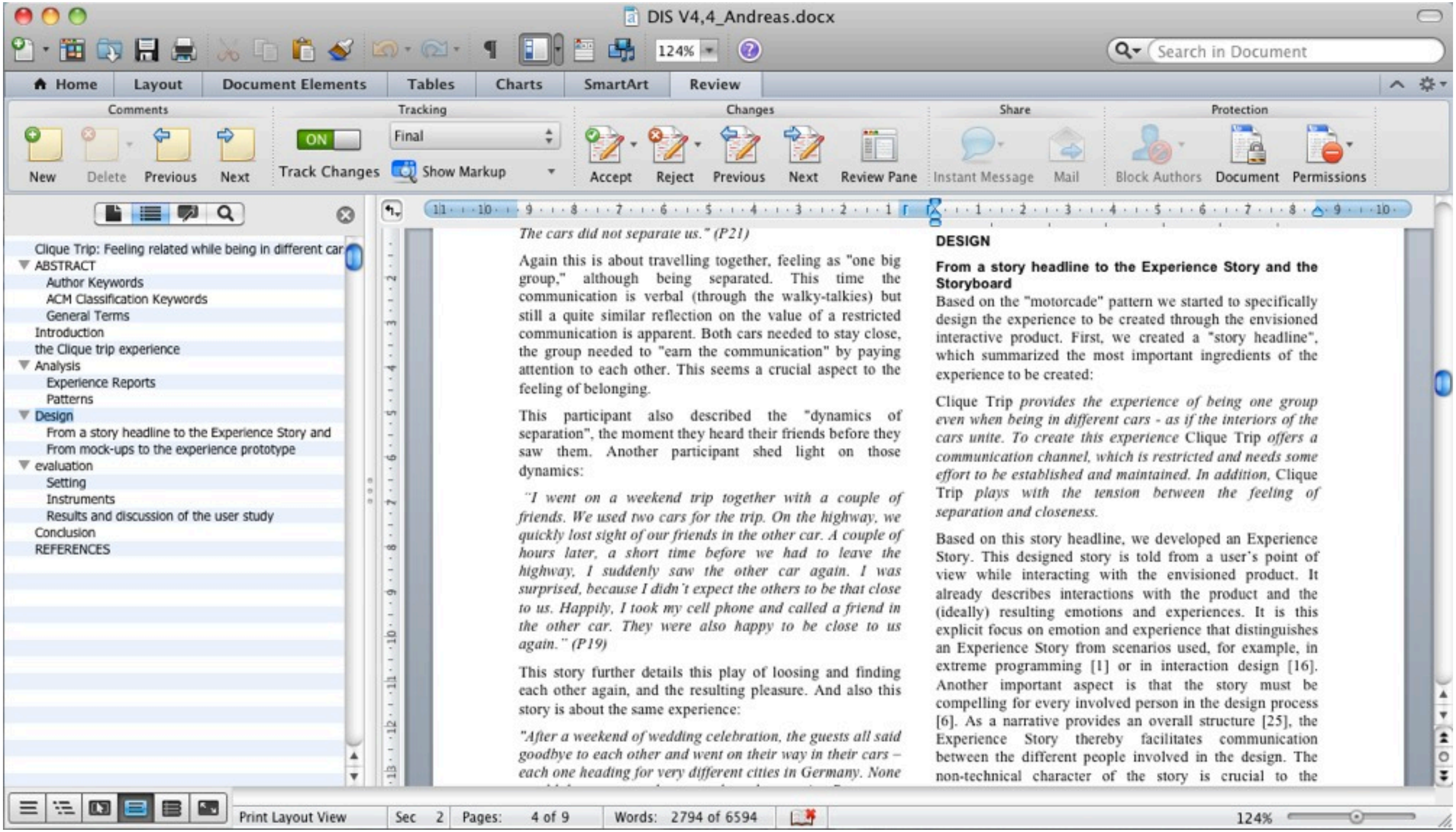


North & Shneiderman1997

- Overview+detail (O+d) interfaces are characterized by multi-window layout
  - Detail view presents details
  - Overview window provides overview information of the information space
  - Overview windows are usually also enhanced with visual cues
- O+d interface with field-of-view box give users direct and constant feedback on their position in the information space
- Thus context information is preserved



O+D in MS Word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Instant Message
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Document
Permissions
Clique Trip: Feeling related while being in different car
ABSTRACT
Author Keywords
ACM Classification Keywords
General Terms
Introduction
the Clique trip experience
Analysis
Experience Reports
Patterns
Design
From a story headline to the Experience Story and
From mock-ups to the experience prototype
evaluation
Setting
Instruments
Results and discussion of the user study
Conclusion
REFERENCES
DESIGN
From a story headline to the Experience Story and the Storyboard
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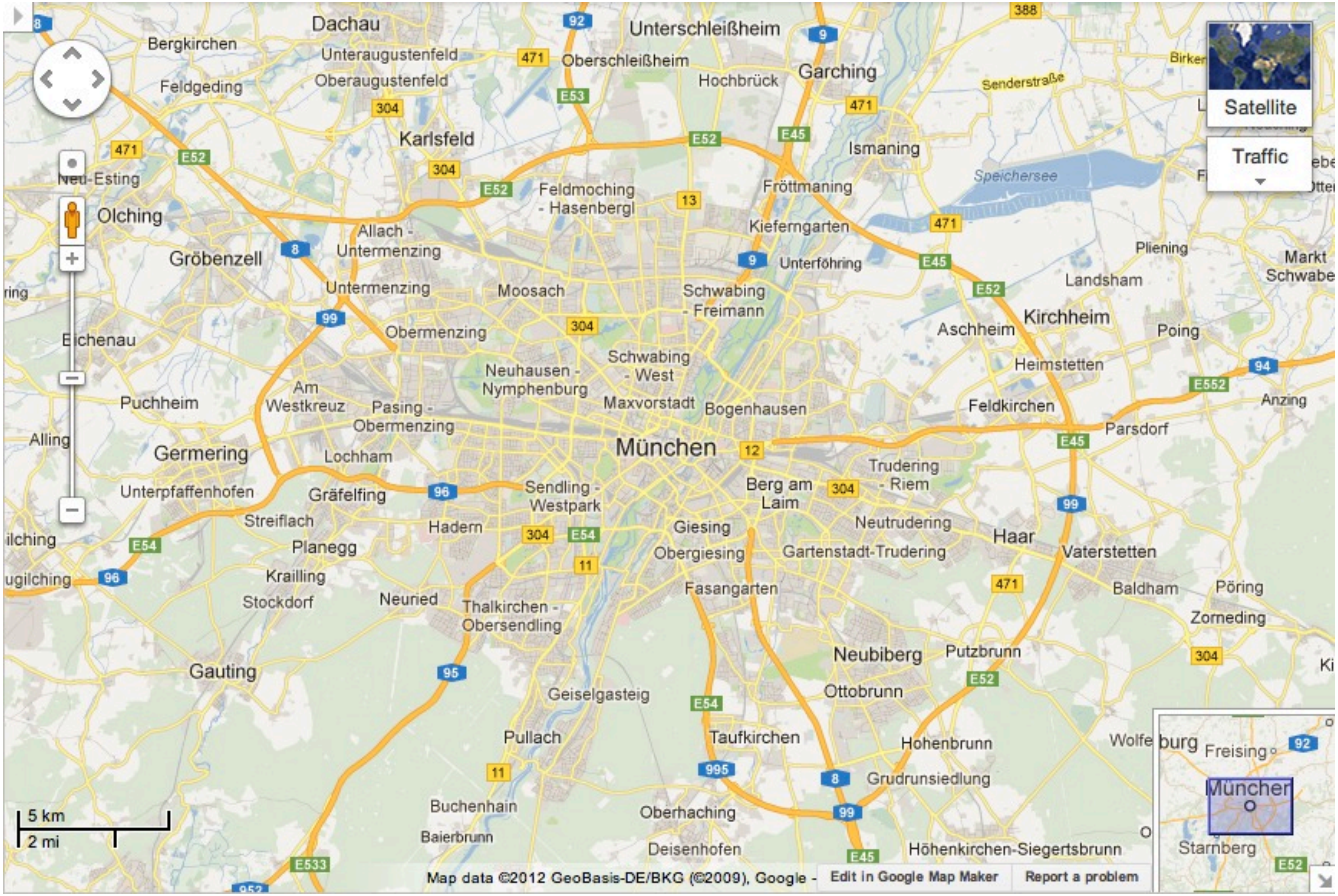
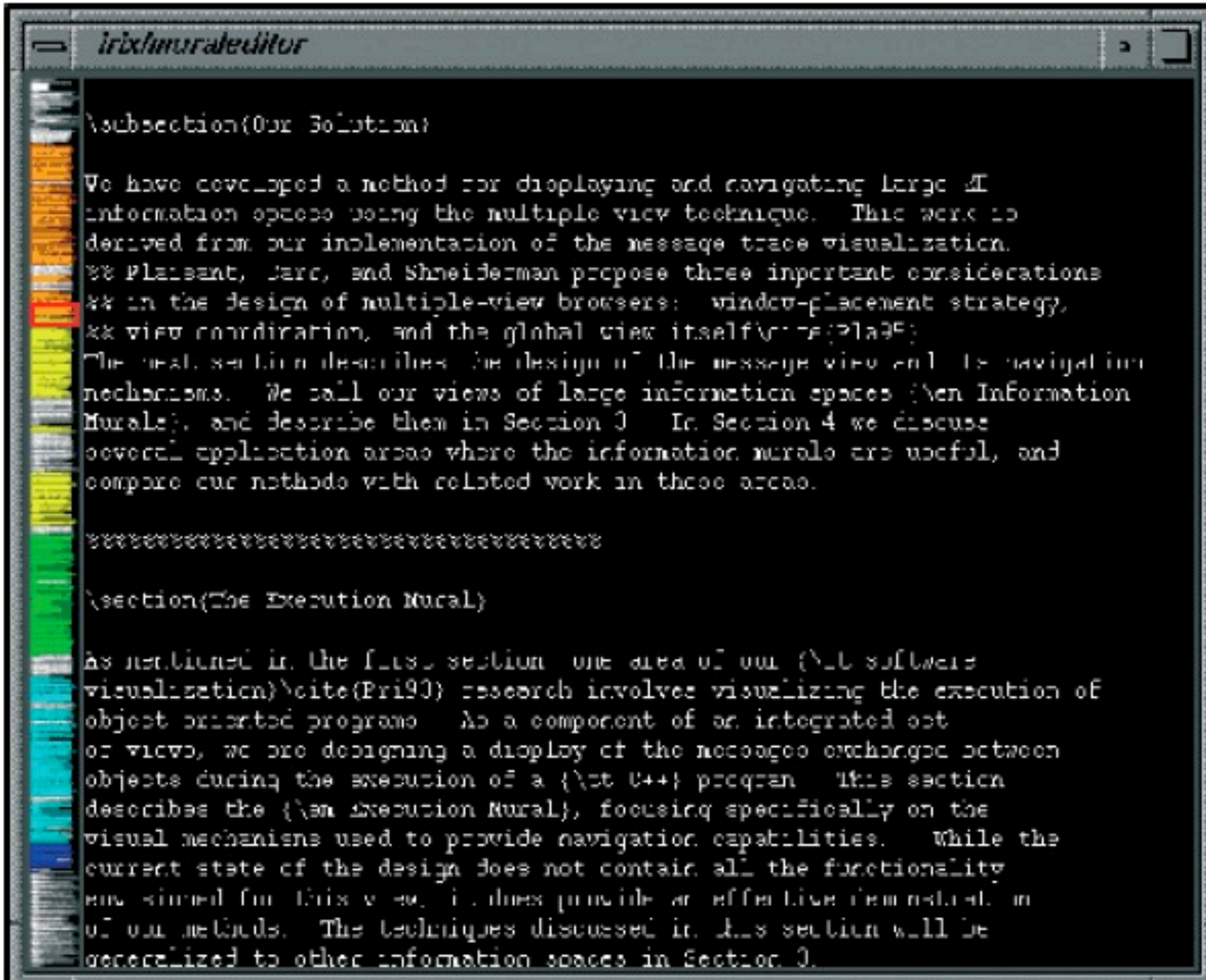
O + D in Google Maps



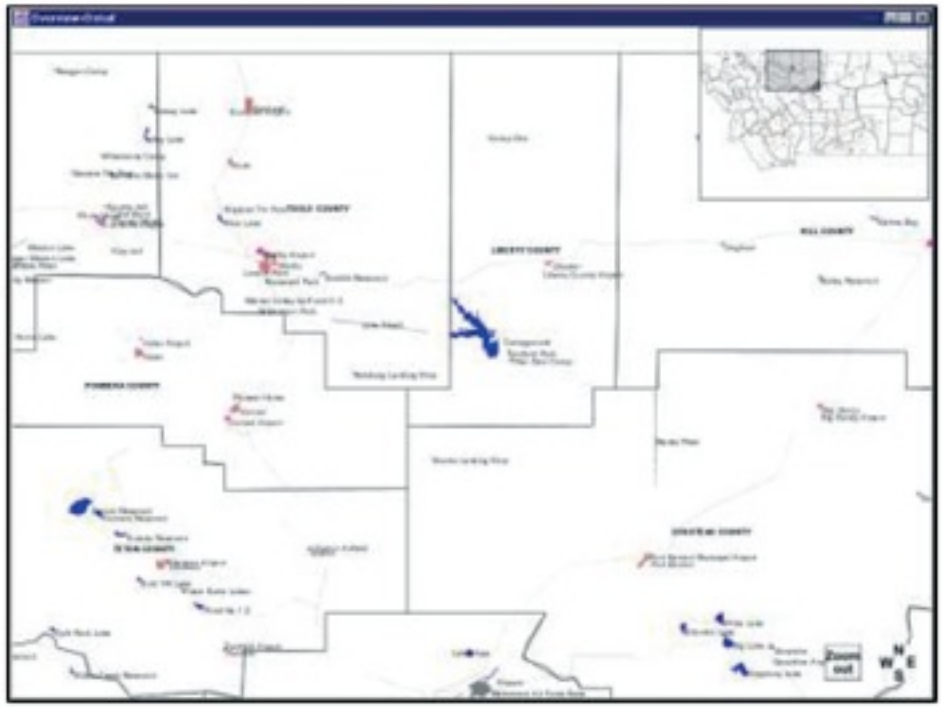
Abstract Overviews

- When showing a miniature of a reasonably large information space much detail information may be lost
- Could in some cases be solved by presenting intermediate views, but: display space limitations
- Abstract overviews use encodings to use limited screen space more effectively
- May also contain extra information not present in the detail view
- Example: document overview (Jerding & Stasko 1995)
  - Overview always shows the entire document
  - Intensity scale indicates text density
  - Color denotes sections

Abstract Overviews



Interface Performance



Hornbaek et al. 2002

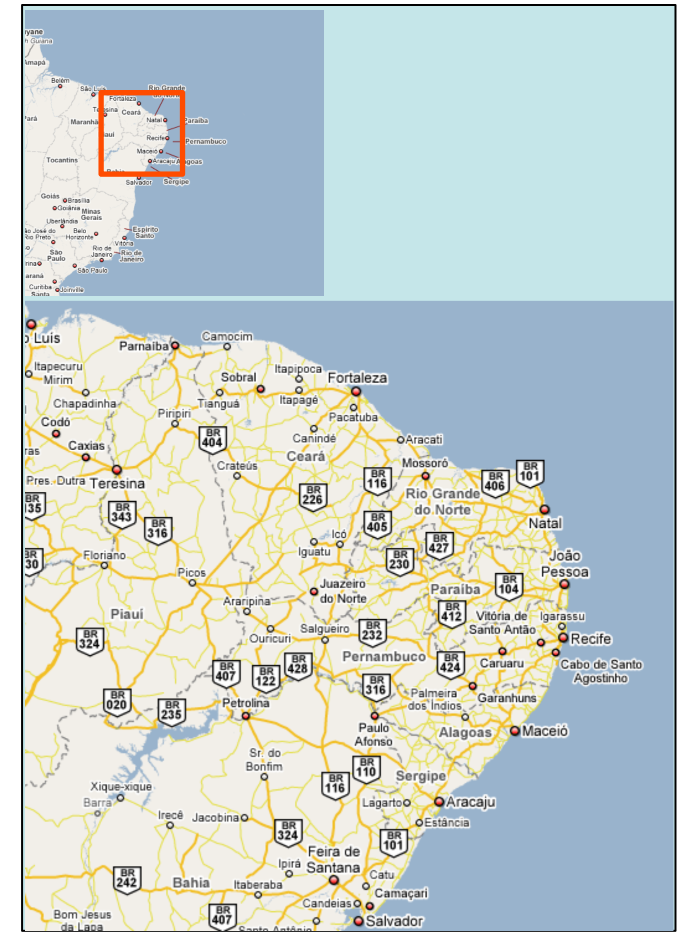
- Task-completion time
  - Navigation on the overview may significantly improve the interface performance
  - E.g. users can directly navigate to locations that are currently not visible on the detail view
  - Drawback: multiple views require time-consuming visual switching between views
- User study by Hornbaek et al. 2002
- 32 participants, counterbalanced within-subjects design
- Browsing and navigation tasks on two maps
- Two semantic ZUIs, one with and one without overview
- Participants were faster with the detail-only interface
- 80% preferred the overview-enhanced interface

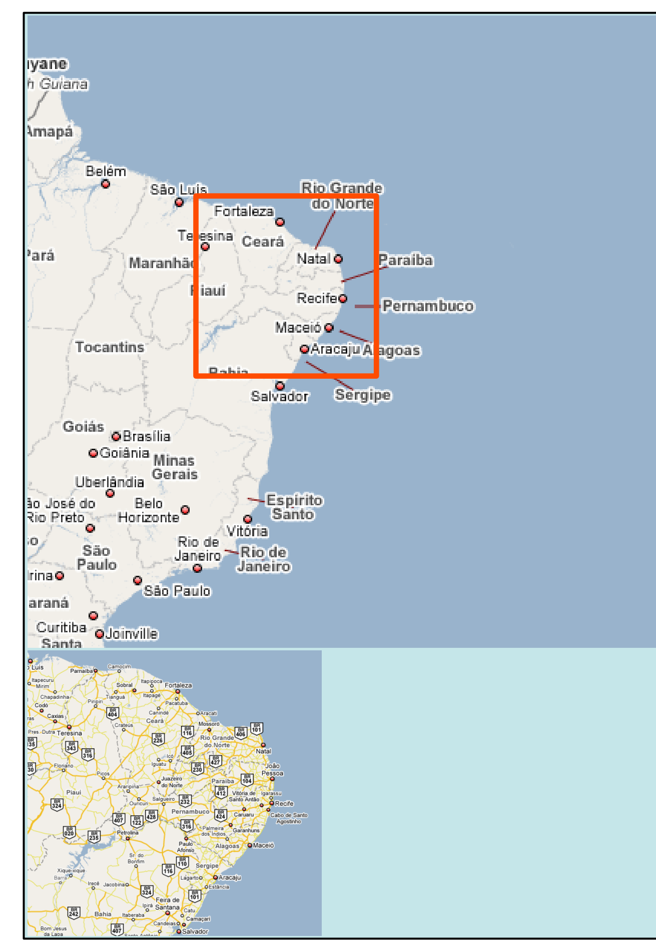
View Coordination

- Most simple o+d: overview shows a static image of the information space
  - Users are forced to compare the visual cues in the detail view with the cues in the overview
  - For reasonably large and complex information spaces, this approach is hardly usable
- Dynamic overviews
  - Visual cues such as a field-of-view box aid orientation
  - Implies coordination of views
- Coordination (also termed tight coupling)
  - Unidirectional: only one view is interactive
  - Bidirectional: supports user input in both views
- Study by North&Shneiderman2000: coordinated views were found to be 30% to 50% faster than a detail-only interface and a o+d interface with two independent views

View Layout

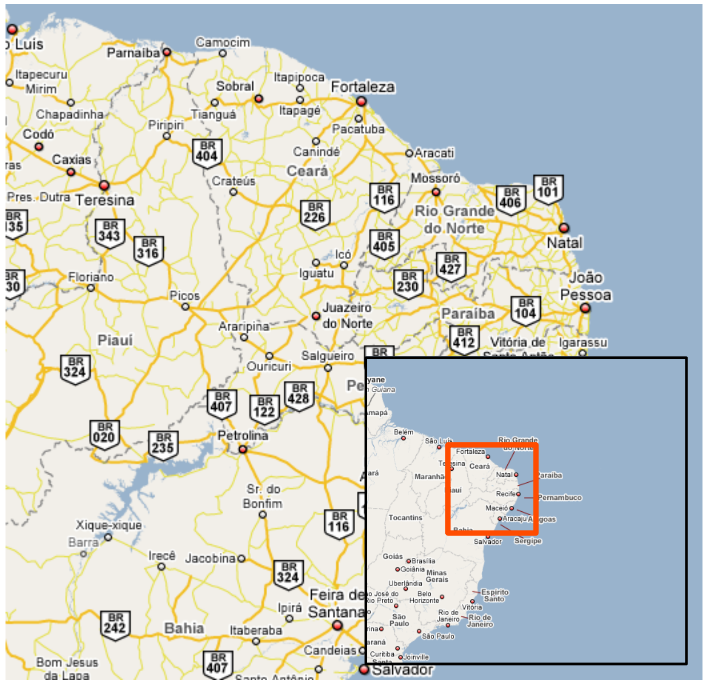
- Basic side-by-side layout of views require that the available display space is partitioned between the views
- Problem: for both views the usability increases with a growing size
- No general solution for the space tradeoff
- Layout of the views is task-dependent (Plaisant 1995)
  - Open-ended exploration or drawing tasks require a larger detail view
  - Monitoring tasks require a larger overview

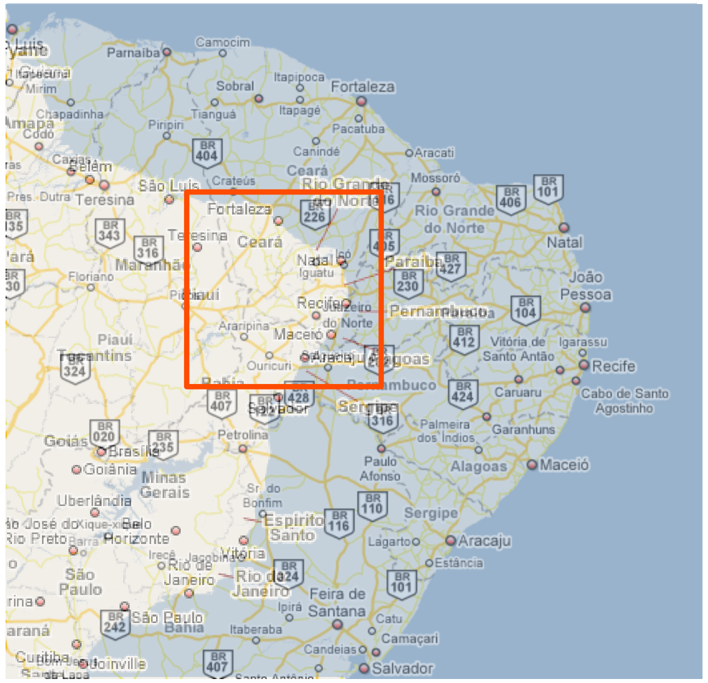




Alternative View Layouts

- Overlapping views
  - Overview overlaps with the detail view (e.g. Acrobat overview)
  - Users can drag and scale the overview view as desired
  - Problem: managing windows is time-consuming and adds extra complexity to the interface
- Automatic overviews
  - System decides when to (temporarily) display an overview
  - How to predict the need for an overview?
  - E.g. extensive zooming and panning on the detail view
  - Malfunction can be highly annoying
- Transparent overviews
  - Can be applied to both overlapping and automatic overviews
  - Problems: increased visual clutter and deteriorated readability of both detail view and overview





Zoom Factors

- Zoom factor: level of magnification between detail view and overview
- Should be
  - Less than 20 (Plaisant 1995)
  - Between 3 and 30 (Shneiderman & Plaisant 2005)
- Larger zoom factors may require intermediate views