Distortion Techniques

Cecilia R. Aragon

I247

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Acknowledgments

- Thanks to Marti Hearst for the slides

Today

- Overview + Detail Evaluation
- Distortion-based Views
  - Fisheye Menus
- Focus + Context
  - PhotoMesa
  - DateLens
  - F+C Screens

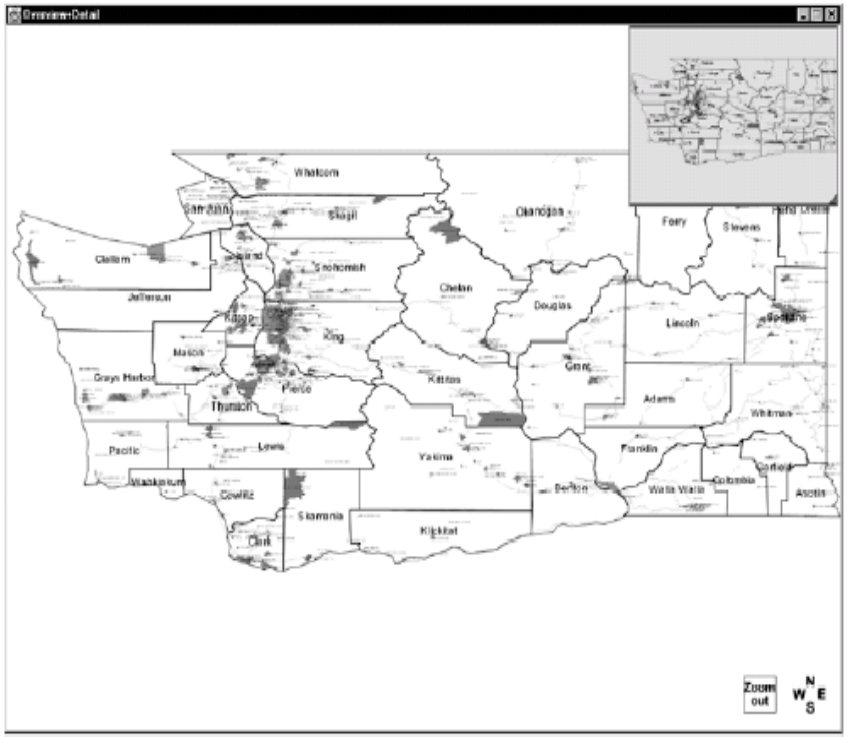
Study of Overview + Detail

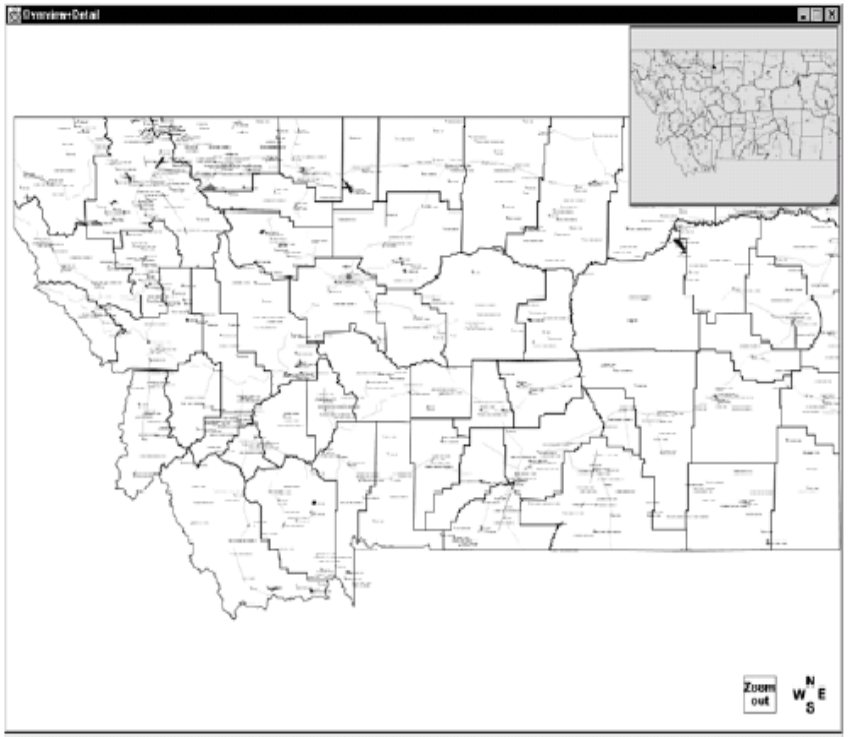
- K. Hornbaek et al., Navigation Patterns and Usability of Zoomable User Interfaces with and without an Overview, ACM TOCHI, 9(4), December 2002.

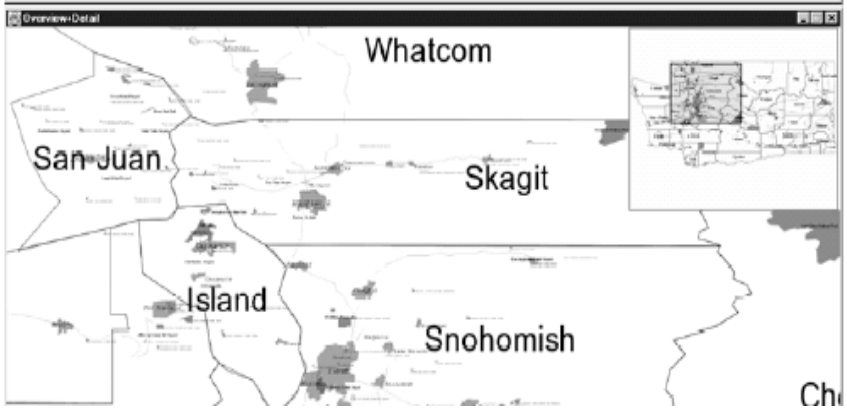
- A study on integrating Overview + Detail on a Map search task
  - Incorporating panning & zooming as well.
  - They note that panning & zooming does not do well in most studies.

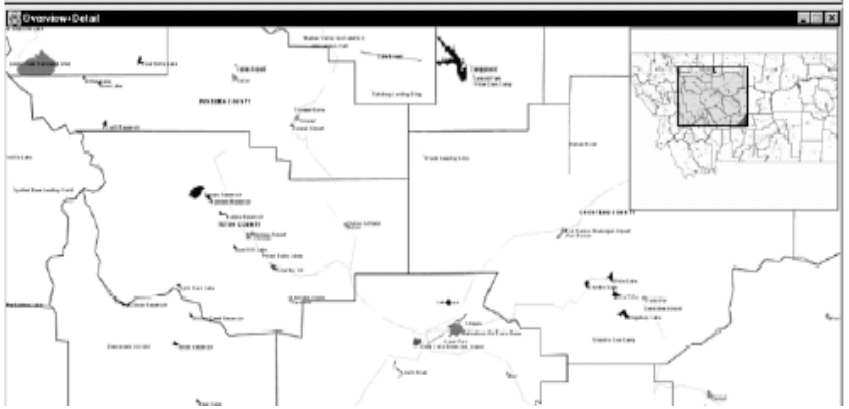
Overview + Detail

K. Hornbaek et al., Navigation patterns and Usability of Zoomable User Interfaces with and without an Overview, ACM TOCHI, 9(4), December 2002.









Overview + Detail

- K. Hornbaek et al. 2002.

- Results seem to be
  - Subjectively, users prefer to have a linked overview
  - But they aren't necessarily faster or more effective using it
  - Well-constructed representation of the underlying data may be more important.

- More research needed as each study seems to turn up different results, sensitive to underlying test set.

Showing Large Data Sets

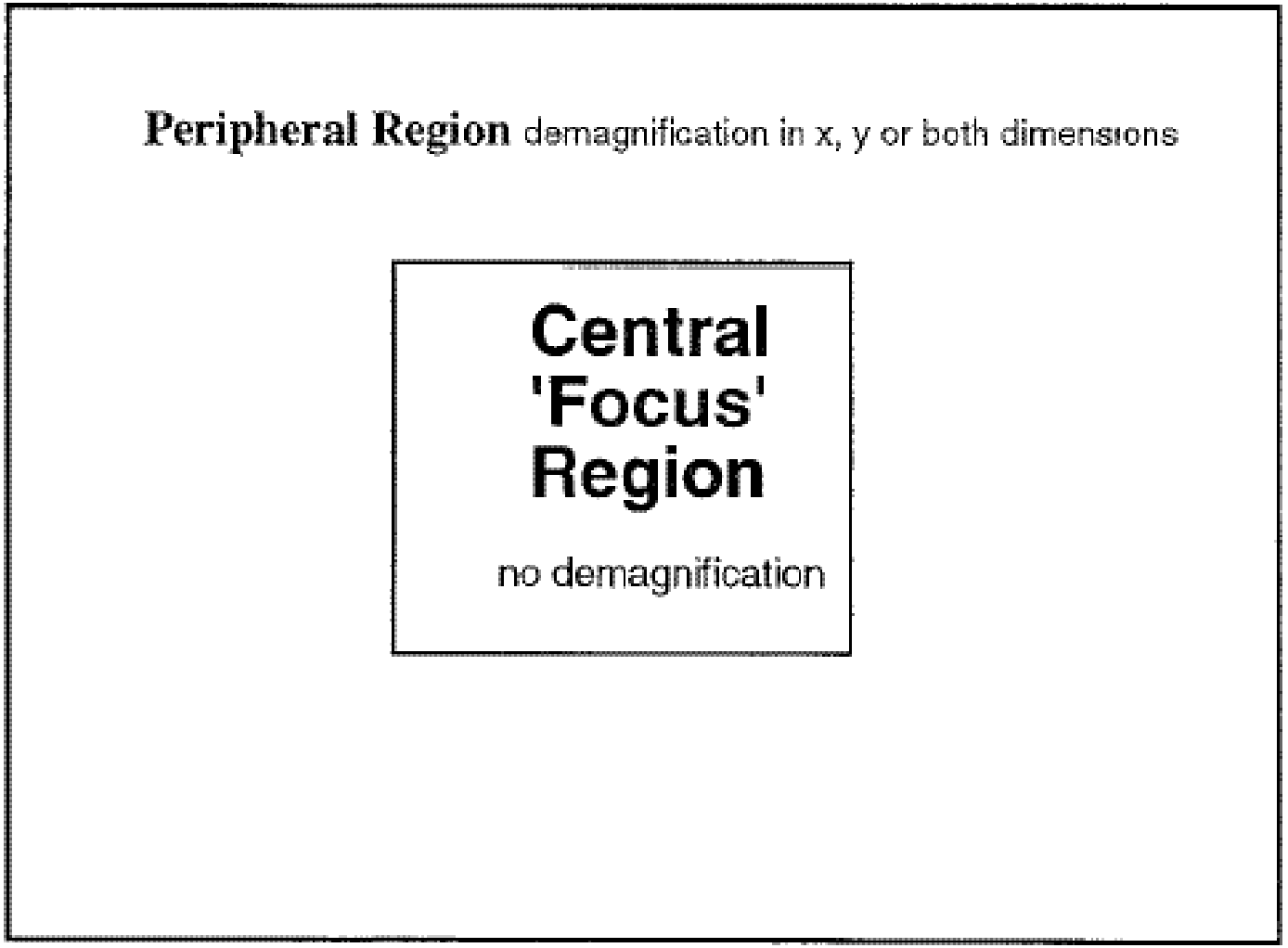
- (The following slides are based on the classic paper by Leung & Apperly ’94.)
- How to show large amounts of information in a static space?
- Non-distortion-oriented approaches:
  - Displaying a portion of the information at a time;
  - Scrolling or paging access
  - Providing hierarchical access
  - Structure-specific presentation

Slide adapted from Fengdong Du

Distortion-based Views

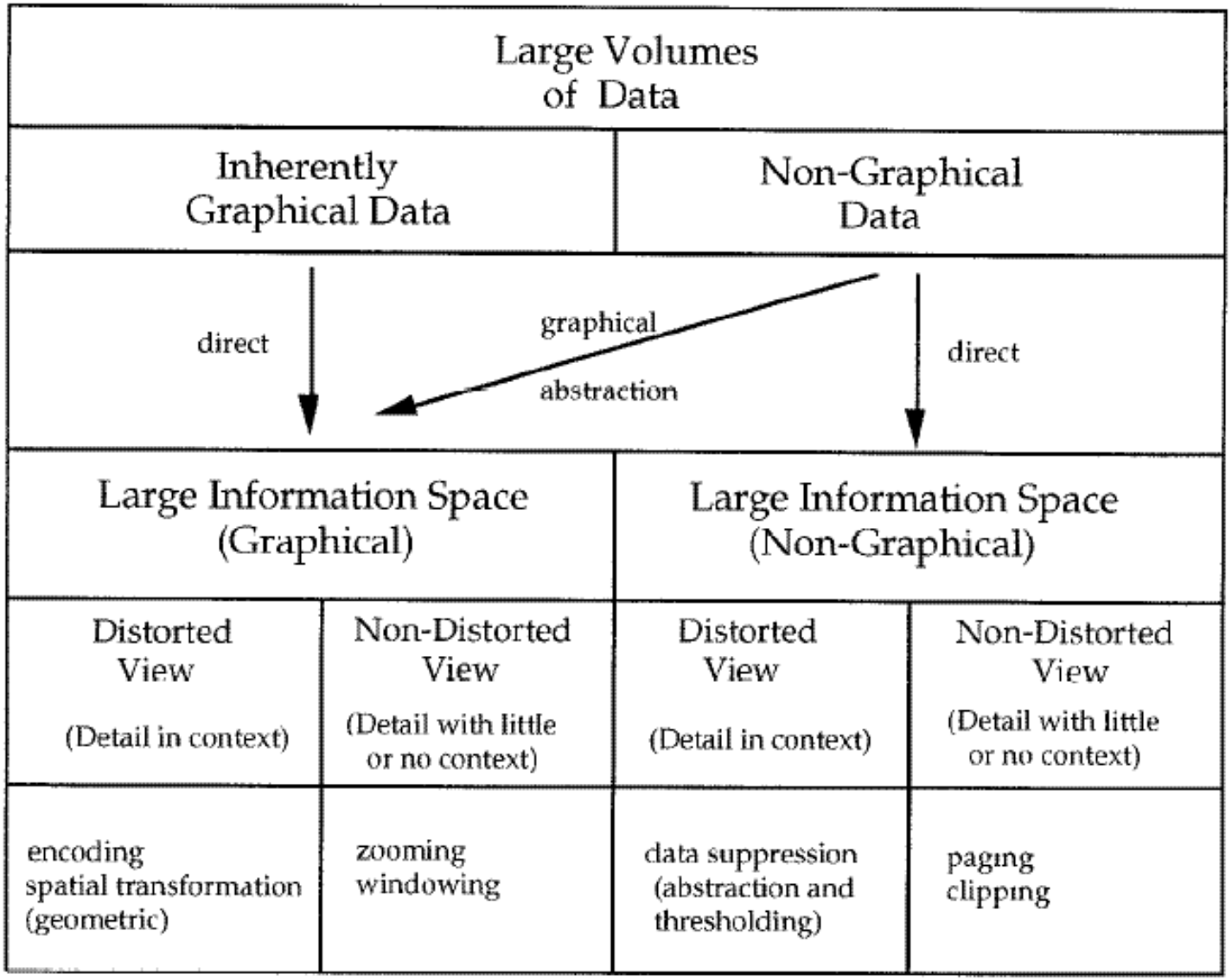
- Distortion-oriented Approaches:
  - Distort an image of a large amount of information so that it can fit in screen.
  - Allow the user to examine a local area in detail;
  - At the same time, present a global view of the information space;
  - Provide navigation mechanism.
- Co-existence of local details with global context at reduced magnification.
- A focus region to display detailed information.
- De-magnified view of the peripheral areas is presented around the focus area.

Slide adapted from Fengdong Du



Slide adapted from Fengdong Du

Image from Leung & Apperly '94



Slide adapted from Fengdong Du

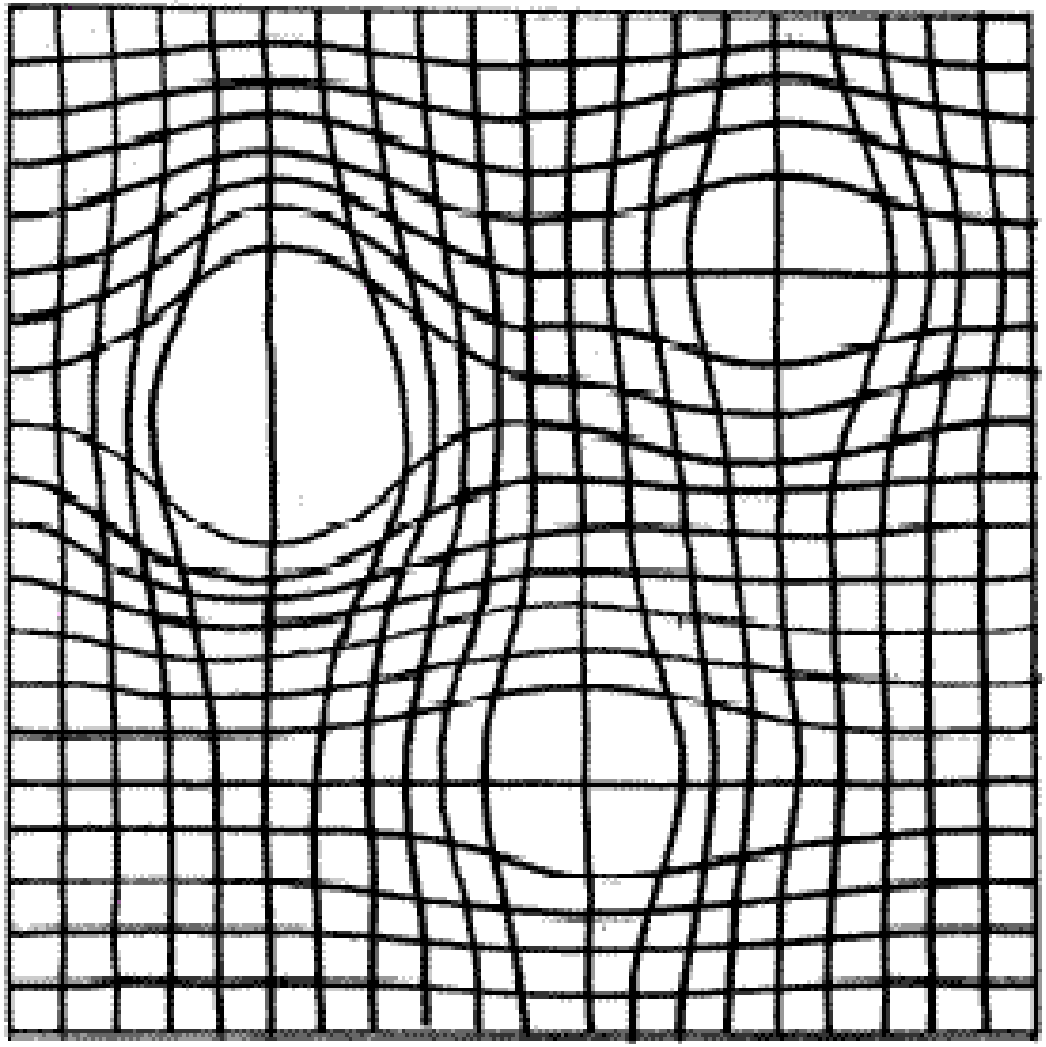
Image from Leung & Apperly '94

A Metaphor

- Treat the displayed information as it was printed on a stretchable rubber sheet with rigid frame.
- Any stretching in one part of the sheet results in an equivalent amount of shrinkage in other areas.
- The consequence of the stretching and the shrinking of the sheet is an overall distorted view.

Slide adapted from Fengdong Du

Stretchable Rubber Sheet



Slide adapted from
Fengdong Du

Image from Leung & Apperly ’94

Distortion-based Techniques

- Polyfocal Display – Kadmon & Shlomi 78
- Bifocal Display – Spence & Apperley 82
- Perspective Wall – Mackinlay et al 91
- Fisheye View – Furnas 86
- Graphical Fisheye View – Sarkar & Brown 92

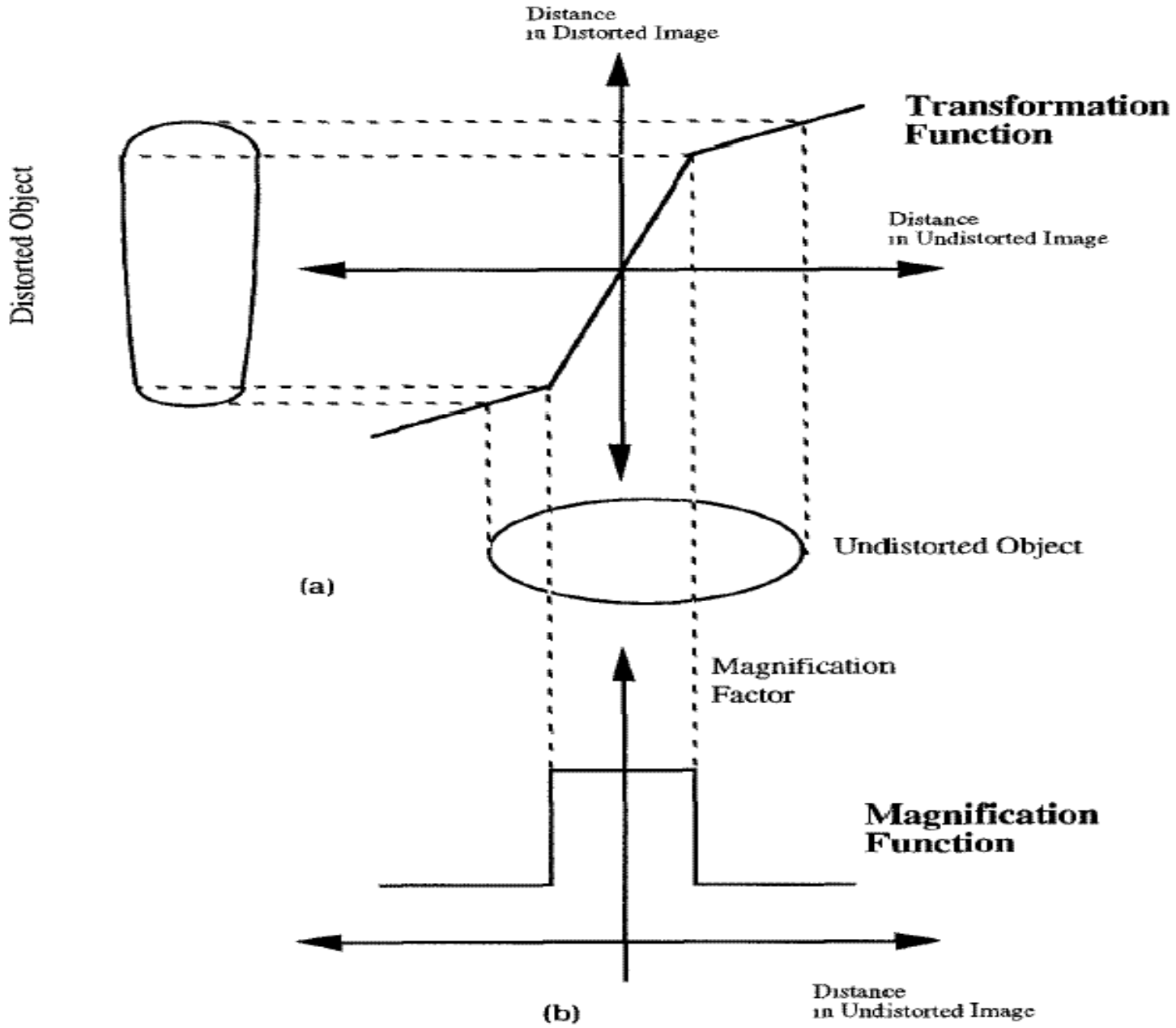
Slide adapted from Fengdong Du

Polyfocal Display

Kadmon & Shlomi 78

- A distorted view is created by applying a transformation function to an undistorted image.
- A magnification function provides a profile of the magnification factors for the entire area of image.

Slide adapted from Fengdong Du



Slide adapted from
Fengdong Du

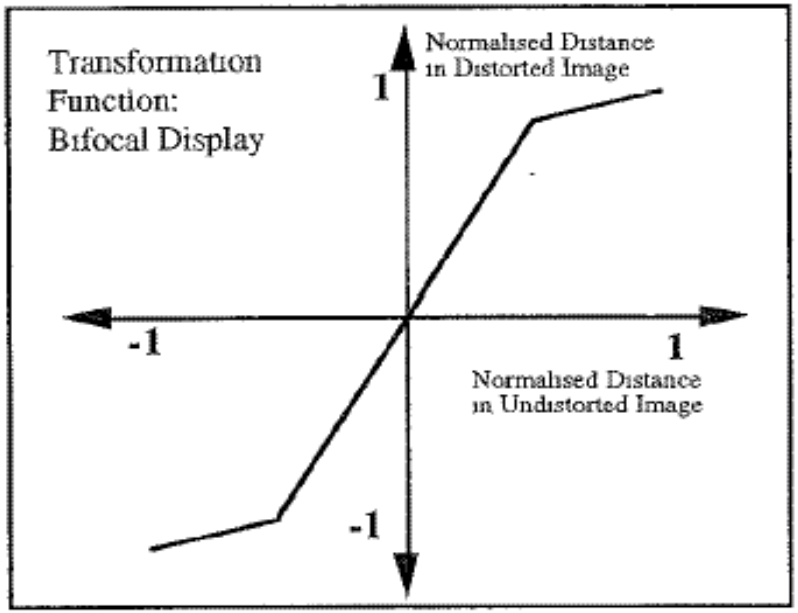
Image from Leung & Apperly '94

Bifocal Display

Spence & Apperley 82

- Distort one or two dimensions with linear transformation function.
- Combination of detailed view and two distorted side views.

Slide adapted from
Fengdong Du



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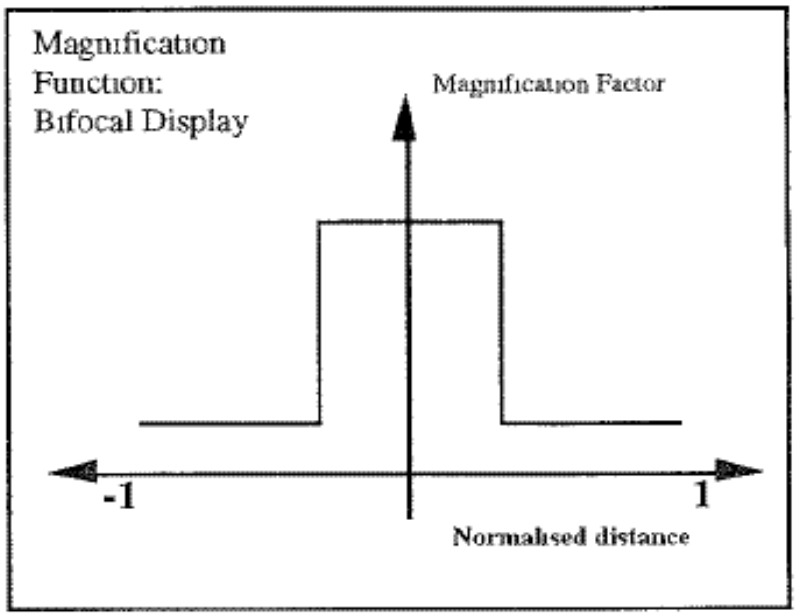

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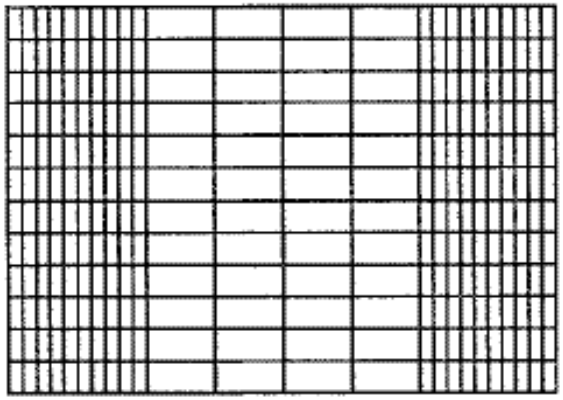

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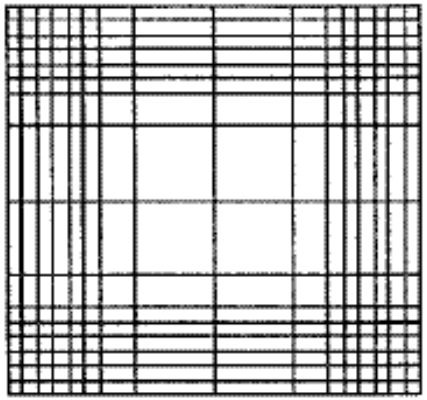

(d)

Slide adapted from
Fengdong Du

Image from Leung & Apperly '94

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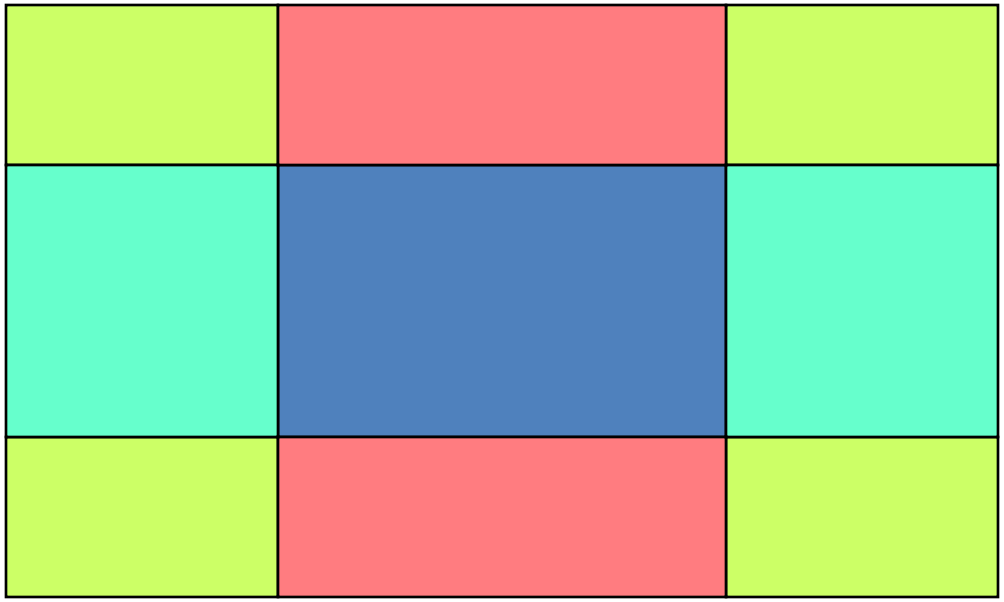


	Demagnified in X and Y, but no distortion
	Demagnified and distorted in X
	No demagnification or distortion
	Demagnified and distorted in Y

Slide adapted from
Fengdong Du

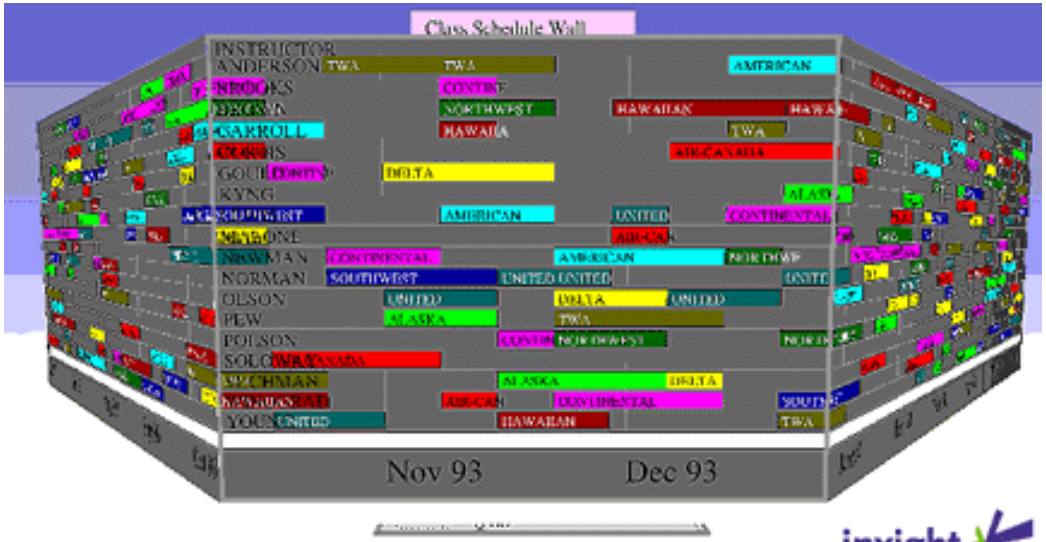
Perspective Wall

- Mackinlay, Card, Robertson ‘91
- A conceptual descendent of the Bifocal display.
- Smoothly integrated detailed and contextual views.
- Side panels are demagnified directly proportional to their distance from the viewer.

Slide adapted from Fengdong Du

Perspective Wall

- Similar to Bifocal, except demagnifies at increasing rate, while Bifocal is constant
- Visualizes linear information such as timeline
- Adds 3D but uses excess real estate on screen



Slide adapted from Hornung & Zagreus

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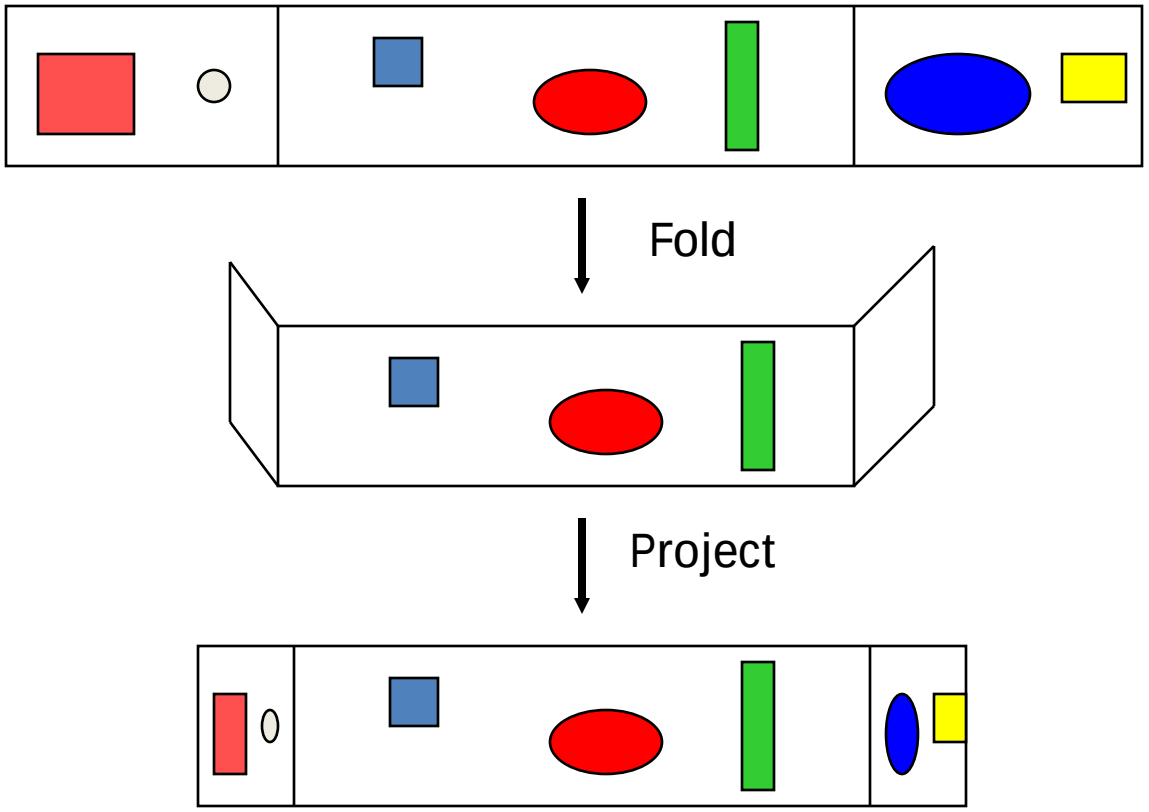

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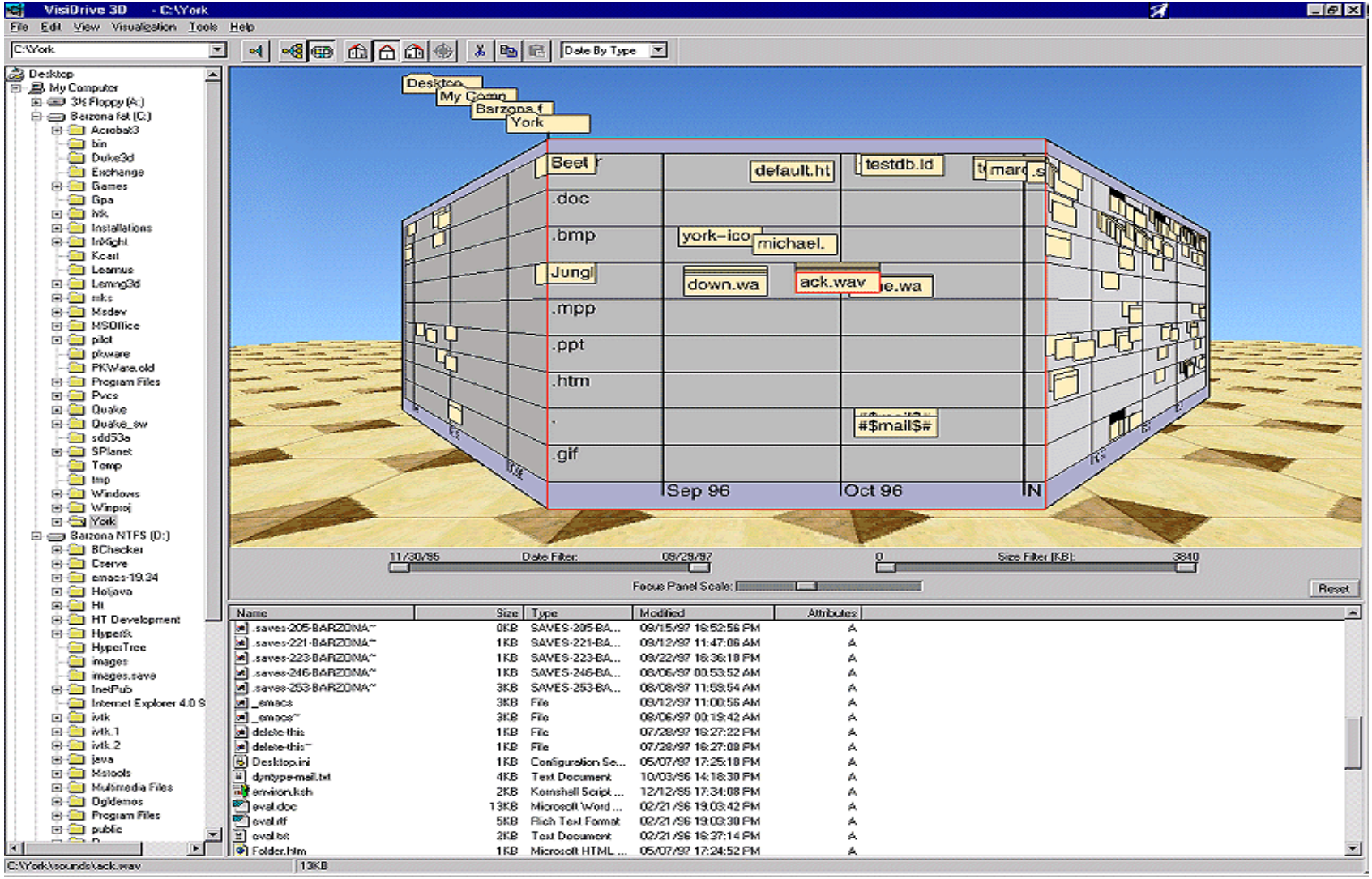
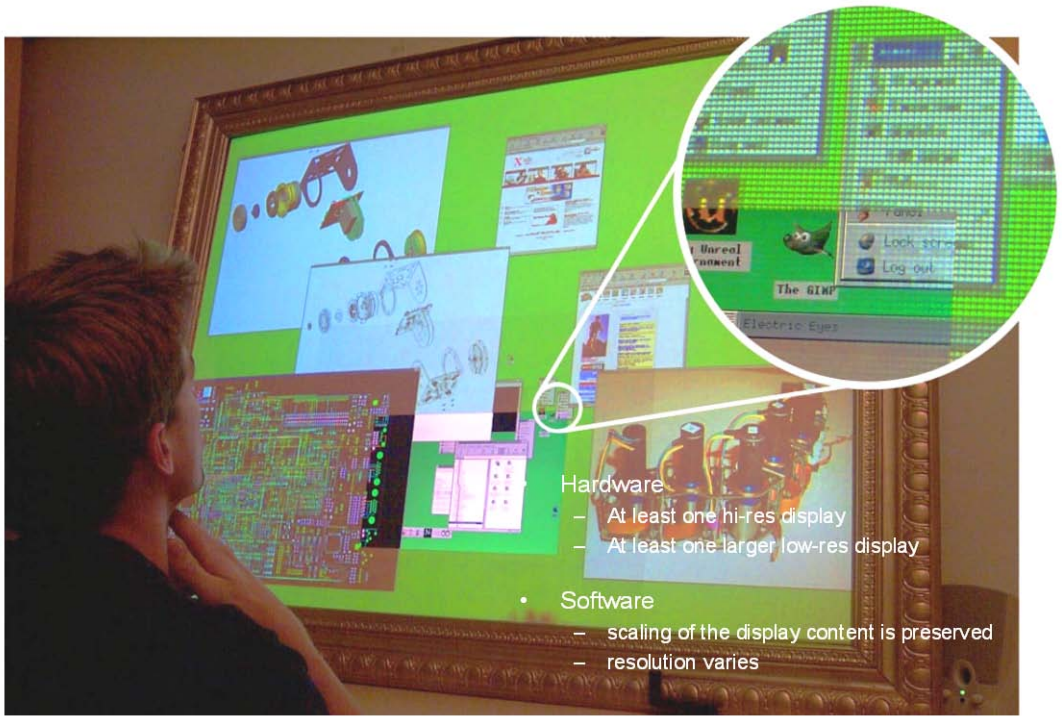
Fengdong Du



Slide adapted from
Fengdong Du

Focus+Context Applied Physically

- Baudisch, Good ’02



http://www.patrickbaudisch.com/publications/2002-Baudisch-CHI02-FocusPlusContextScreens.wmv

Fisheye View

- Originally proposed by Furnas (1986), but many variations of applications.
- Basic idea: more relevant information presented in great detail; the less relevant information presented as an abstraction.
- Relevance is computed on basis of the importance of information elements and their distance to the focus.

Slide adapted from Fengdong Du

Graphical Fisheye View

- An extension of the fisheye view concept.
- Could be also considered as a special case of polyfocal display.
- Topological network, multi-layer data and hierarchical structures
- Topology-preserving maps

Slide adapted from Fengdong Du

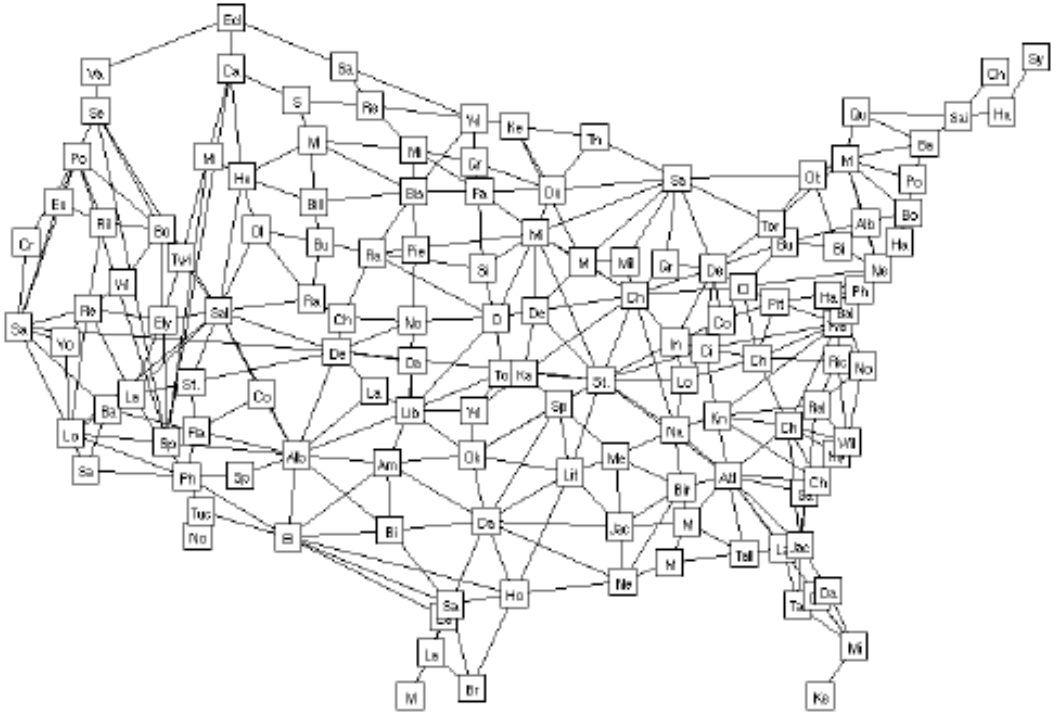


Figure 1: A graph with 134 vertices and 338 edges. The vertices represent major cities in the United States, and the edges represent paths between neighboring cities. (Typically, the edges would be annotated with the distance and driving time between the cities.) The *a priori importance* value assigned to each vertex is proportional to the population of the corresponding city. Fisheye views of this graph appear in Figures 2–6

Slide adapted from
Fengdong Du

Image from Sarkar & Brown '92

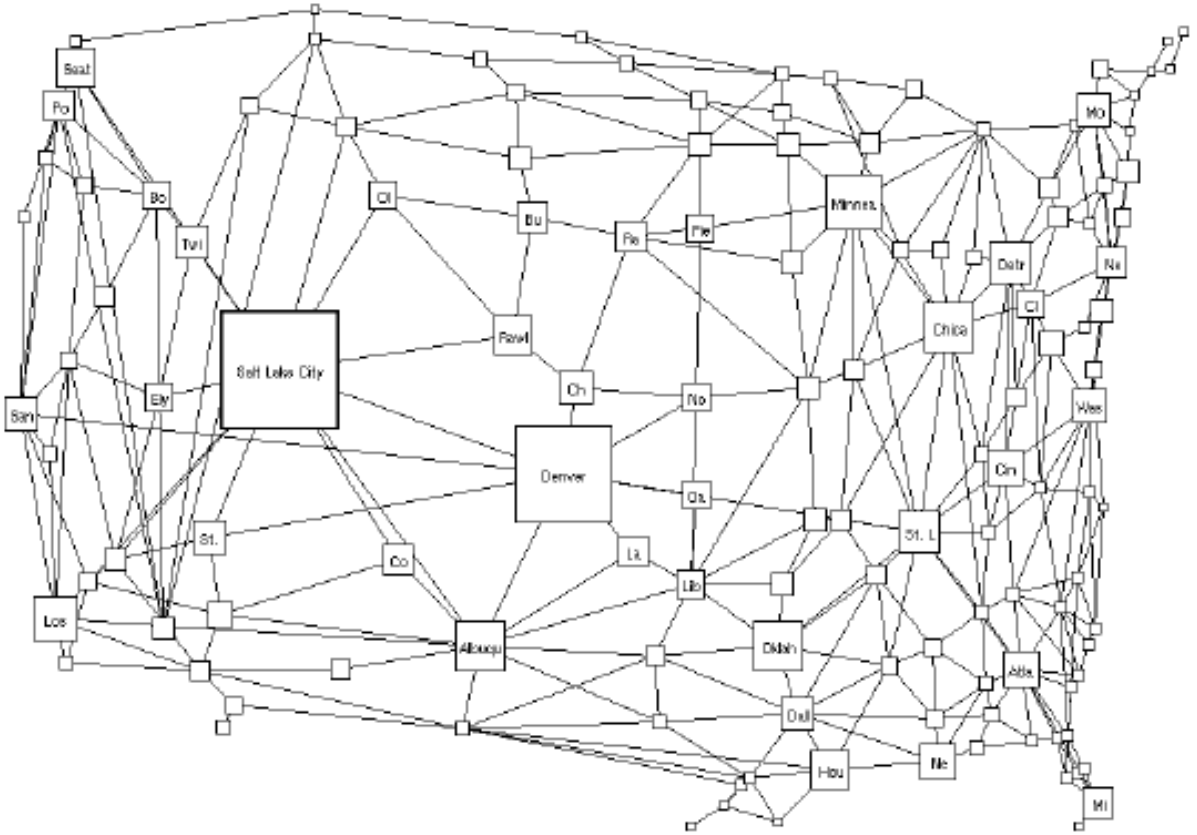


Figure 4: A fisheye view of the graph in Figure 1, with the focus on Salt Lake City. The level of distortion is the same as in Figure 3; only the location of the focus has changed. The values of the fisheye parameters are $d = 2, c = 0.5, e = 0.5, VWcutoff = 0$.

Slide adapted from
Fengdong Du

Image from Sarkar & Brown '92

Fisheye Menu

Fisheye Menus, B. Bederson, in the Proceedings of ACM UIST 2000, pp. 217-226.

- Dynamically change the size of a menu item to provide a focus area around the mouse pointer, while allowing all menu items to remain on screen
- All elements are visible but items near cursor are full-size, further away are smaller
- “Bubble” of readable items move with cursor

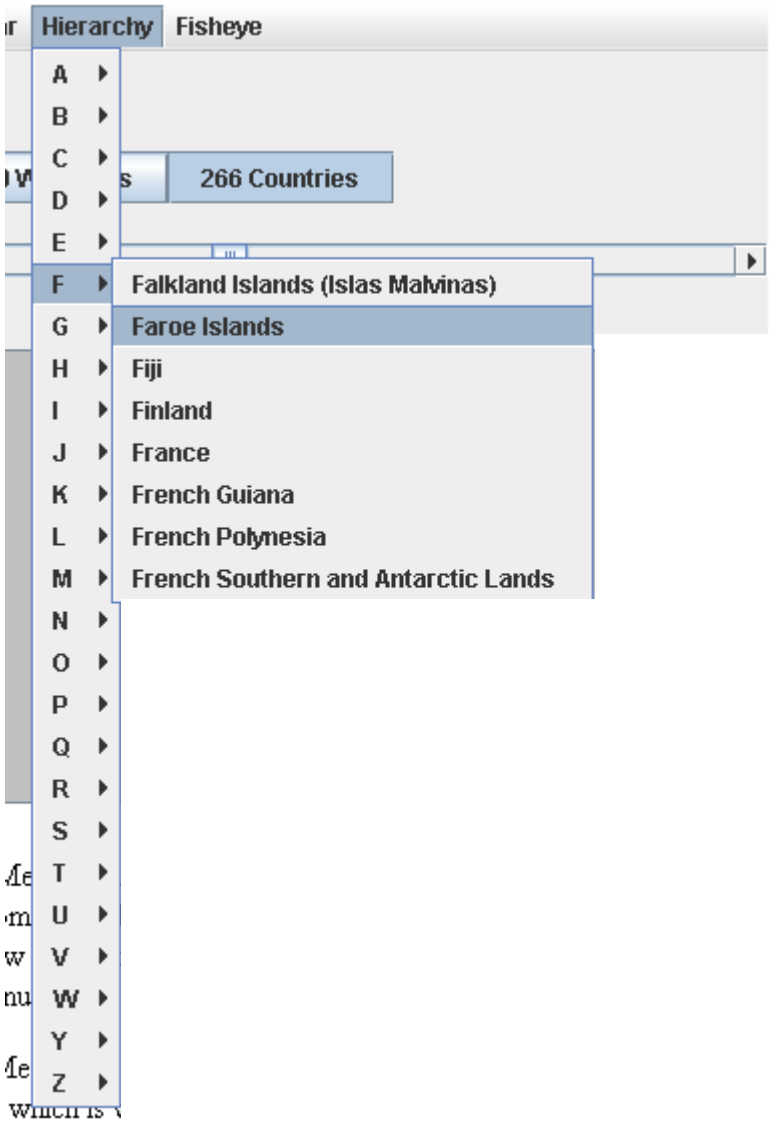
Slide adapted from Hornung & Zagreus

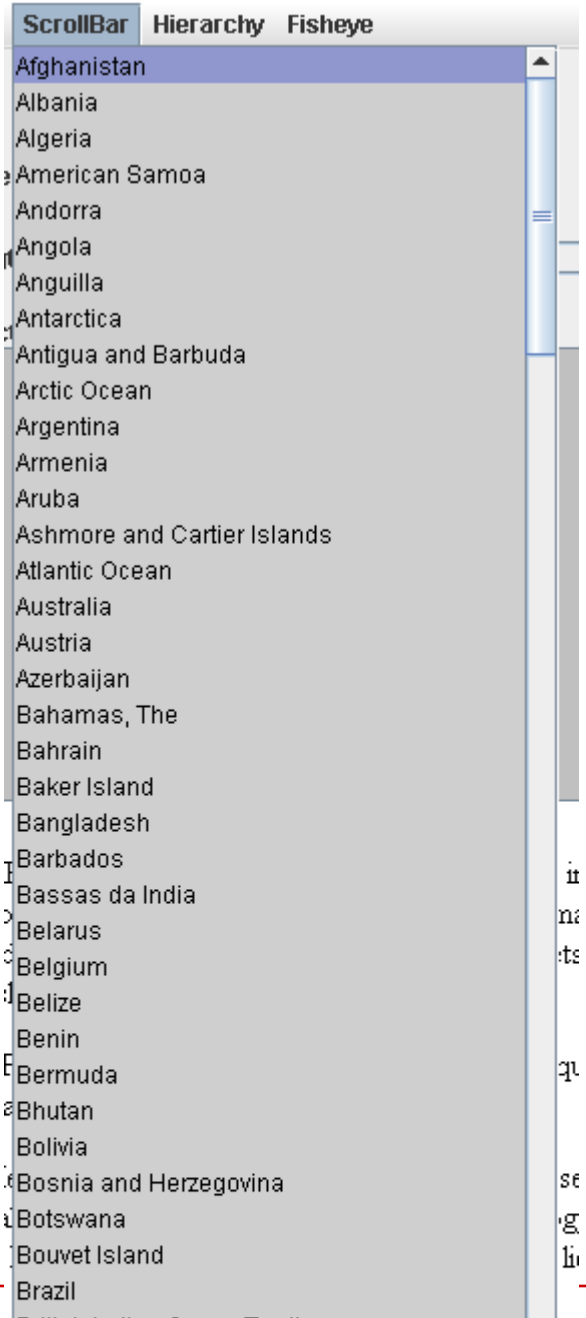
Fisheye Menu

- Distortion Function
  - Maximum font size
  - Focus length (number of items at full size)
    - Together these control the trade-off between the number of items at full size and the size of the smallest item
      - Focus length ↑ small items ↓ distortion ↑
- Alphabetic Index
  - Indexes can decrease search time
  - Index is positioned so that if cursor is aligned with it, the item will be the first one for that letter
    - Initial design had current position, but this was confusing because it moved

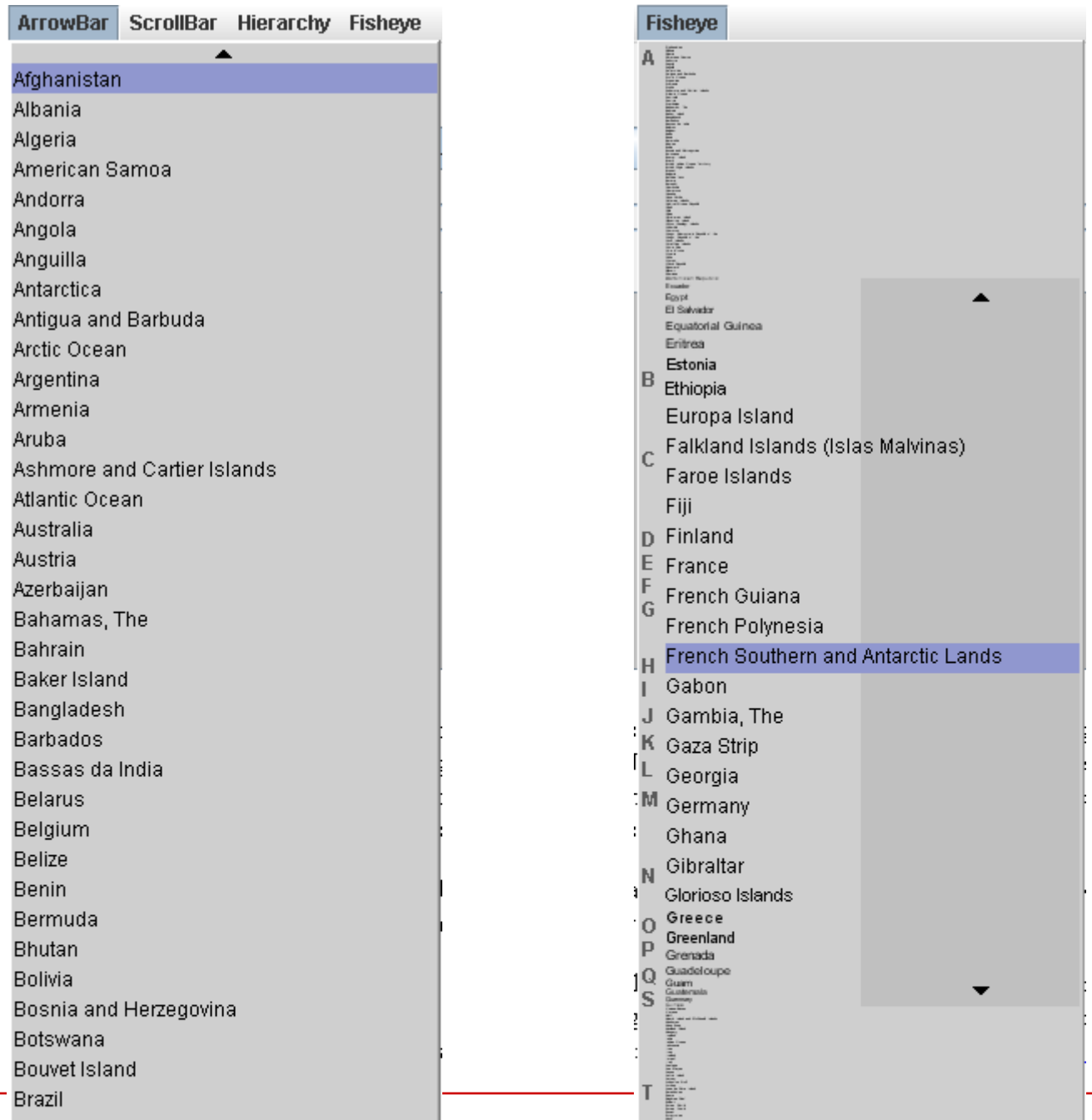
Slide adapted from Hornung & Zagreus

http://www.cs.umd.edu/hcil/fisheyemenu/fisheyemenu-demo.shtml





http://www.cs.umd.edu/hcil/fisheyemenu/fisheyemenu-demo.shtml



Focus Lock

- Item are difficult to select because small mouse movements result in change of focus
- “Focus Lock” allows user to freeze focused area and move mouse freely
  - If cursor moves outside focus area, the area will expand, and perhaps push ends off the screen

Slide adapted from Hornung & Zagreus

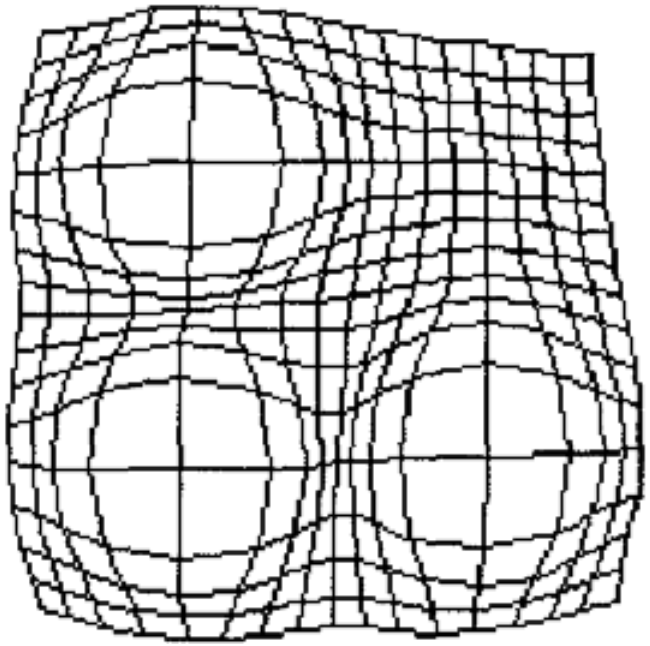
Evaluation

- Small 10 person test, ½ programmers
  - Compared hierarchy, fisheye, scrollbar, and arrow bar (scrolling arrows)
  - Looking for trends
- Results
  - Hierarchy was best for goal-directed task
  - Fisheye preferred for browsing
    - Not significantly though
    - Non-programmers rated it much lower than programmers
  - Only one person discovered Focus Lock
  - Index was thought to be interactive

Slide adapted from Hornung & Zagreus

Polyfocal Display

- Highest peak is focus of display
- Distorts shape of boundaries
- Troughs surrounding peaks are highly distorted and can effectively be shrunk to nothing



Slide adapted from Hornung & Zagreus

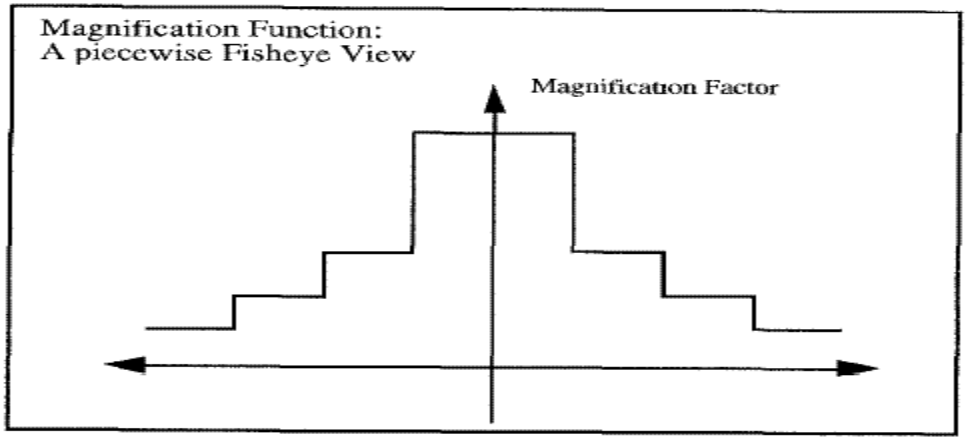
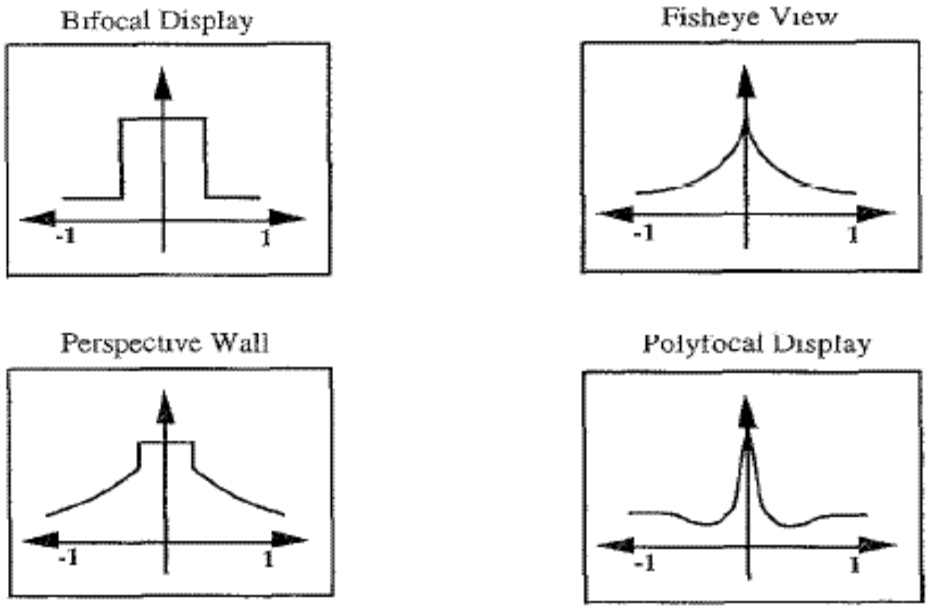


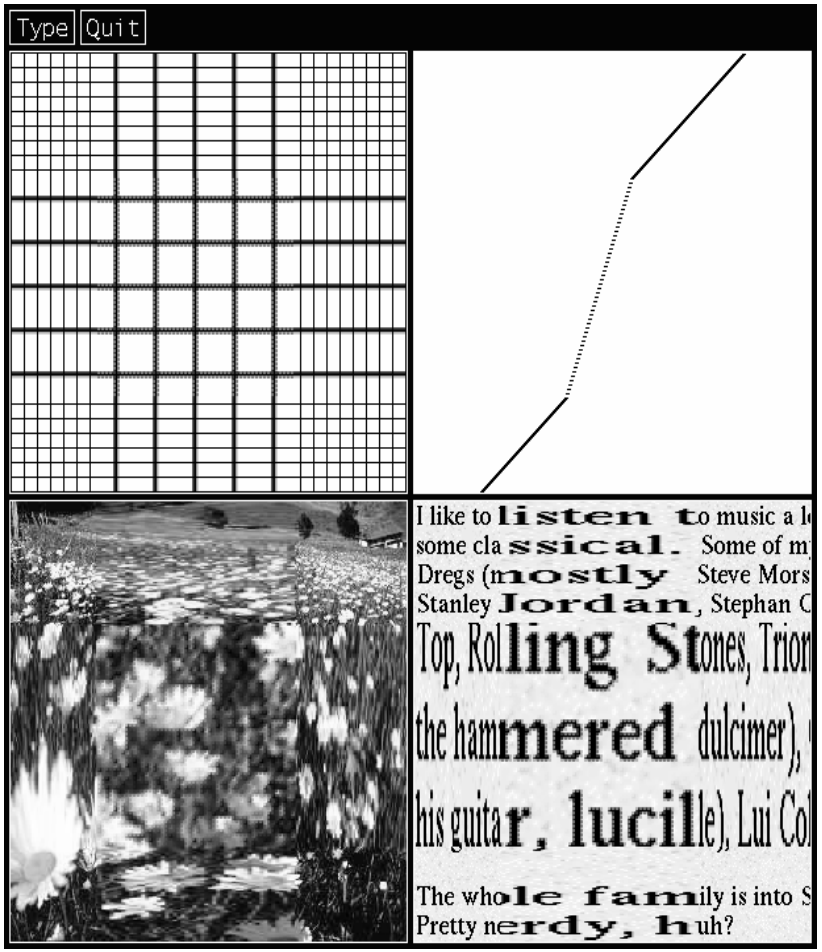
Fig. 14. The magnification function of a piecewise Fisheye View.



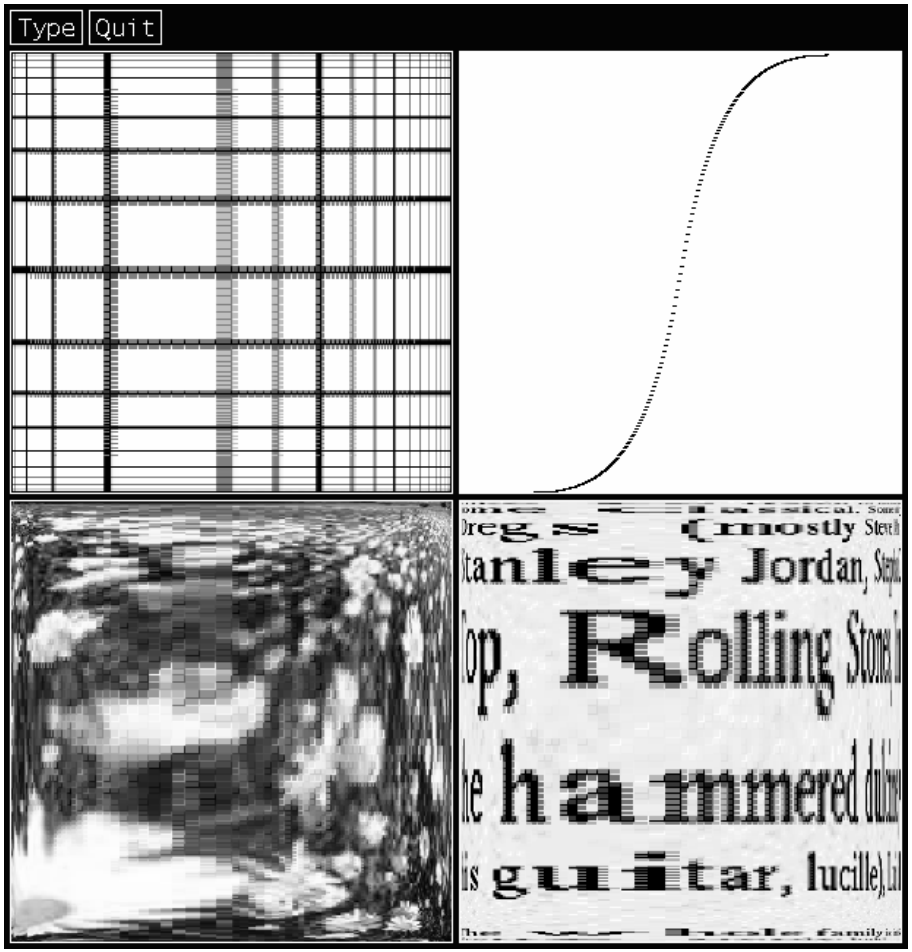
Slide adapted from
Fengdong Du

Image from Leung & Apperly '94

Comparisons



Bifocal View



Polyfocal View

Taxonomy of Distortion-based Techniques

- Magnification
  - Piecewise continuous magnification function
    - Bifocal display: constant magnifications
    - Perspective wall: varying magnifications
  - Continuous magnification function
    - Polyfocal display
    - Fisheye view
  - Continuous magnification function can be simulated by piecewise functions.

Slide adapted from Fengdong Du

Implementation Issues

- Distortion-based techniques have widely different complexities, depending on the transformation function.
- Tradeoff needs to be made to choose computational power and the system memory.
- Distortion with continuous magnification functions are hard to apply the cutting and pasting technique.

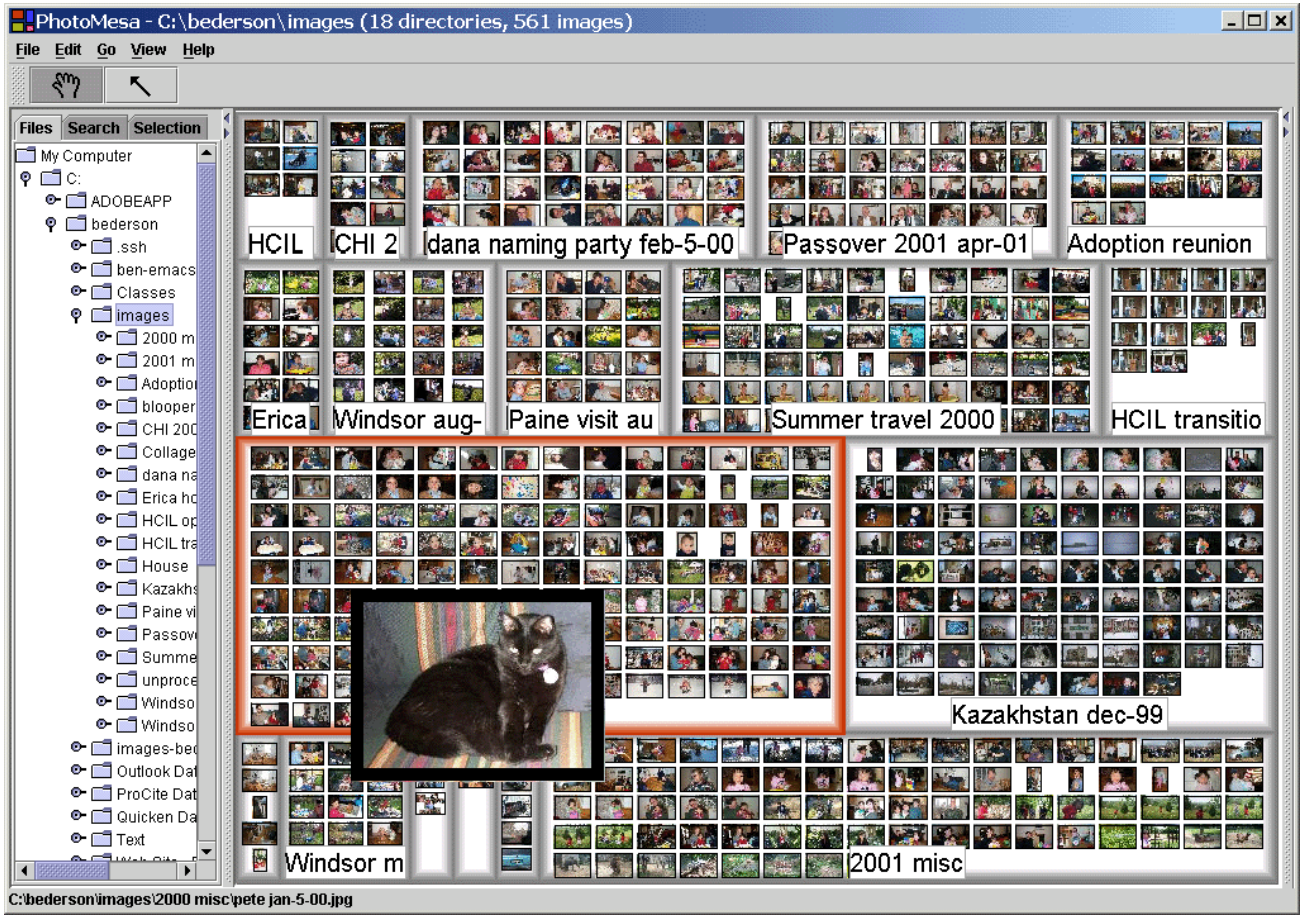
Slide adapted from Fengdong Du

Focus + Context

- Can go hand-in-hand with distortion – like fisheye
- Works with zooming if animated – Photomesa
- "Allows dynamic interactive positioning of the local detail without severely compromising spatial relationships."
  - *Leung & Apperley*
- "One challenge in navigating through any large dataspace is maintaining a sense of relationship between what you are looking at and where it is with respect to the rest of the data."
  - *Bederson & Hollan*

Slide adapted from Hornung & Zagreus

PhotoMesa:
Zooming and Focus+Context



http://www.cs.umd.edu/hcil/photomesa
http://www.ibiblio.org/openvideo/video/hcil/hcil2001_03.mpg

Slide adapted from Hon, Ng & Zagreus

PhotoMesa Interface

PhotoMesa: A Zoomable Image Browser Using Quantum Treemaps and Bubblemaps, B. Bederson, UCM UIST 2001

- Zooming is primary presentation mechanism
- Zoom in, zoom out on levels of thumbnails
- Quickly drill down to individual picture (at full resolution)
- Outline shows area of next zoom level
- History of views
- Thumbnail zooms up when hover w/cursor
- Export images
- Cluster by filename

Slide adapted from Hornung & Zagreus

PhotoMesa Goals

- Automatically lay out images
- Use immediately – little setup time
- Large set of images in context
- Default groupings are by directory, time, or filename
  - No hierarchy
    - Makes managing photos difficult: can delete, but reorganization a problem
- Can add metadata

Slide adapted from Hornung & Zagreus

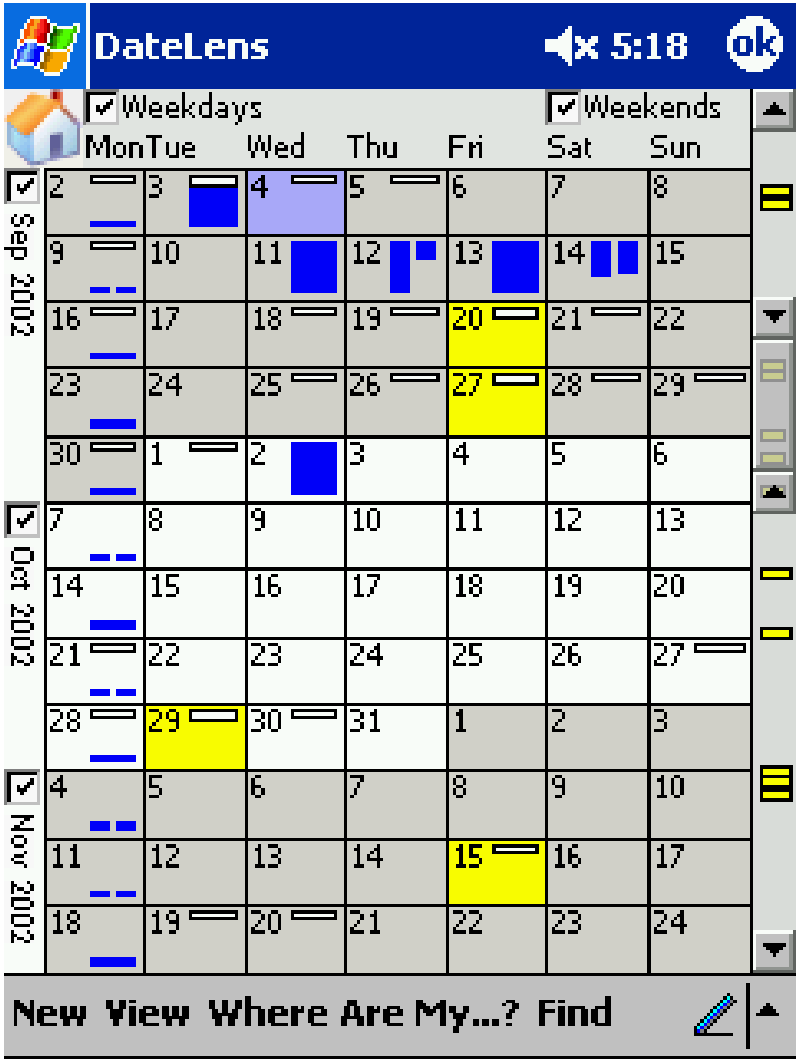
Bubblemaps

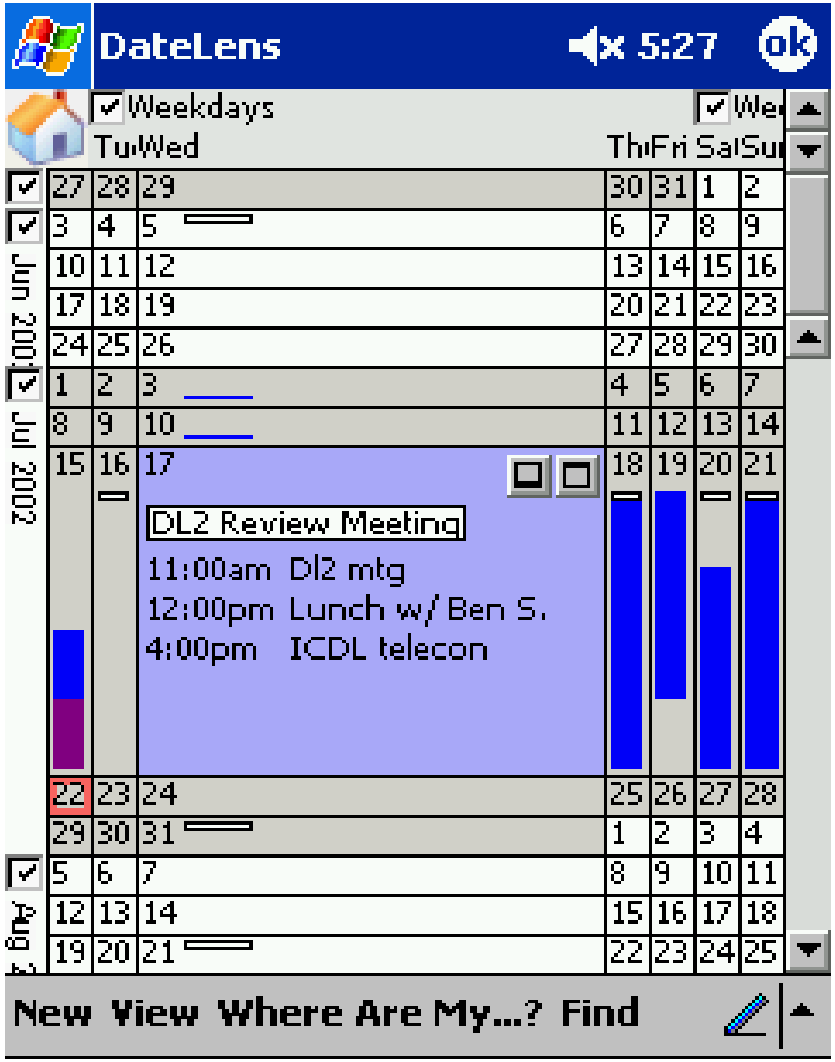
- Like Quantum Treemaps, elements guaranteed to be same size
- Arbitrary shapes
- No wasted space
- May be harder to visually parse than QT

Slide adapted from Hornung & Zagreus

Zooming User Interfaces: DateLens

(Bederson et al. ’03)





http://www.cs.umd.edu/hcil/datelens