Vorlesung
Advanced Topics in HCI
(Mensch-Maschine-Interaktion 2)

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WS2003/2004
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Lie factor

$$\textbf{lie factor} = \frac{\text{size of effect shown in graph}}{\text{size of effect in data}}$$

where

$$\textbf{size of effect} = \frac{|\text{second value - first value}|}{\text{first value}}$$

A lie factor that is either much higher or much lower than one is bad. A **high** lie factor **exaggerates** differences between values. A **low** lie factor **obscures** differences between values.

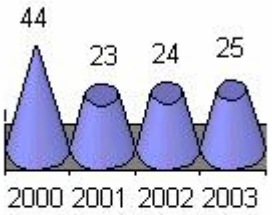
A common example of a **high** lie factor occurs when both dimensions of a two-dimensional figure are made proportional to the same data, so that the size of the figure is proportional to the square of the data; for instance,

Year	Books circulated
2001	100 
2002	141 
2003	200 

where the lie factor is about 2.4.

http://instruct.uwo.ca/fim-lis/504/504gra.htm

An example of a **low** lie factor can be seen in the "Cones" custom chart format in Microsoft Excel.



The heights of the (truncated) cones are proportional to the data, but their areas on the screen and their apparent volumes make the larger data values seem relatively small.

Charting on a **logarithmic** scale can also produce a low lie factor.

http://instruct.uwo.ca/fim-lis/504/504gra.htm

Chapter 2: Information Visualization

Table of Content

- Information & representation
- What is information visualization
- Perception basics
- Standard techniques
- Principles and Taxonomy
- Options for visualization & Examples

Techniques

- Focus & Context
- Zoom & Pan

Background

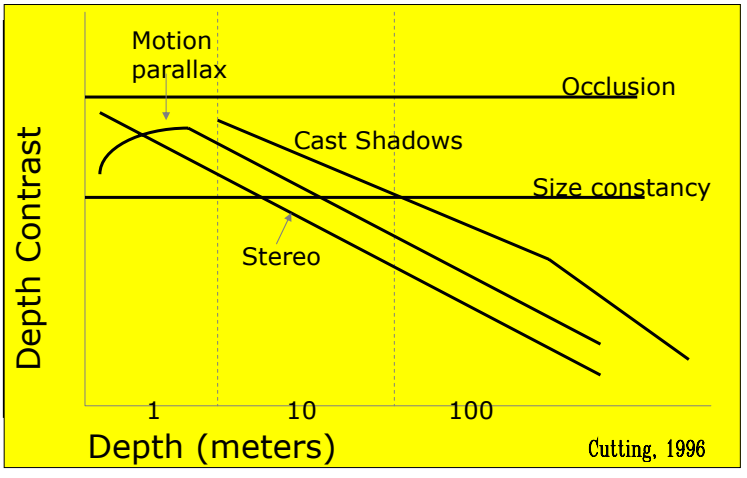
- Useful Field of View (UFOV)
  - expands searchlight metaphor
  - size of region from which we can rapidly take information
  - maintains constant number of targets
- Tunnel Vision and Stress
  - UFOV narrows as cognitive load/stress goes up
- Role of Motion in Attracting Attention
  - UFOV larger for movement detection

Depth Perception Theory

- Perceived Depth = Weighted sum of all Depth Cues
- Rank the cues in importance
  - e.g.
    - Occlusion
    - Motion Parallax
    - Stereo
    - Size constancy
    - Etc.

Depth Perception Theory

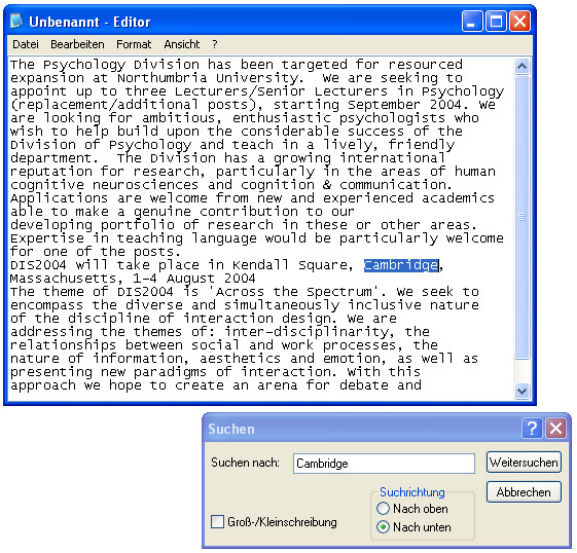
- Importance changes with distance



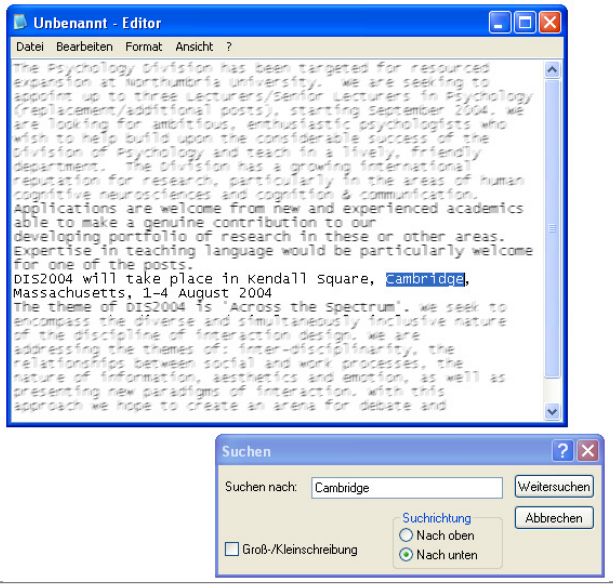
Depth of Field

- Guiding user attention by blurring less relevant parts of an image
- Keeping the context
- Semantic Depth of field = blurring objects based on their relevance

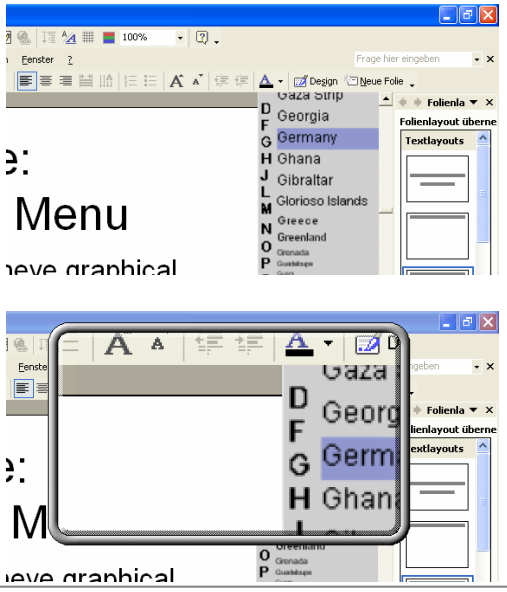
Semantic Depth of Field - Example



Semantic Depth of Field - Example



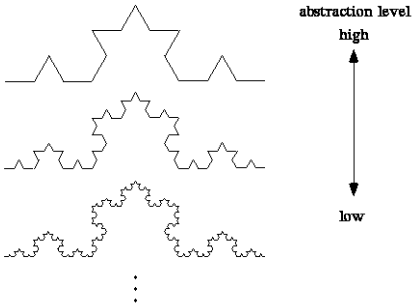
Magnifying Glass

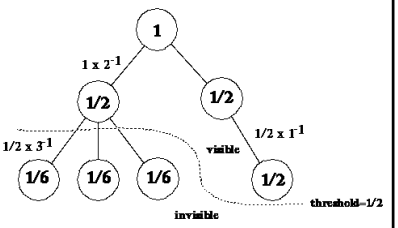


- Magnifying glass hides context!
- This is not focus+context

Fractal Views

- Information structures regarded as complex objects
- Abstraction of objects
- Controlling amount of information that is displayed





- http://www.vogue.is.uec.ac.jp/~koike/papers/tois95/tois95.html
- **Hideki Koike. Fractal Views: A Fractal-Based Method for Controlling Information Display** *ACM Transaction on Information Systems*, Vol. 13, No. 3, July, pp.305-323, ACM, 1995.

Alternate Geometry

- Euclidean geometry – we use it since primary school…
  - 3 angles of a triangle add up to?
  - Shortest distance between two points?
- Spherical geometry
  - Geographical view of the world
    - What is the shortest way from Moscow to San Francisco?
    - Sum of angles of a triangle between Paris, NY, and Cape Town?
  - http://math.rice.edu/~pcmi/sphere/
- Hyperbolic Geometry / Space
  - Theory of Relativity
  - The “fifth” dimension
  - Can be projected into 2-D as a *pseudosphere*
  - Key: As a point moves away from the center towards the boundary circle, its distance approaches *infinity*
  - http://cs.unm.edu/~joel/NonEuclid/ (Applet)

Focus + Context

- Basic Idea:
  - Show selected regions of interest in greater detail (*focus*)
  - Preserve global view at reduced detail (*context*)
  - NO occlusion - All information is visible simultaneously
- Techniques
  - Fisheye views
  - Fisheye lens
  - Continuously variable zoom
  - Nonlinear magnification
  - Hyperbolic views
  - Distortion viewing
  - Rubber sheet views

Focus + Context

- Often combined with distortion
  - E.g. fisheye
  - Data not in focus is suppressed and distorted
  - Data of interest is larger and clearer
- "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*

Distorted vs. Non-distorted

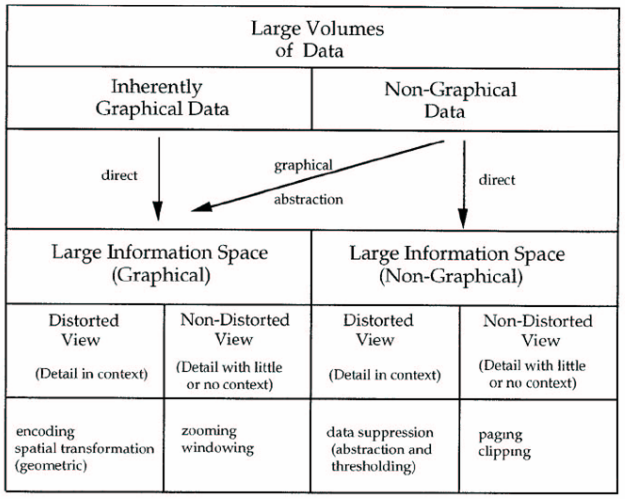
- Non-distorted
  - Display only a selection at a time
  - Scrolling
  - Paging access
  - hierarchical strcuture
  - Structure-specific presentation
- Distorted
  - See the following slides

Leung & Apperley: Distortion

Unified theory of distortion techniques

- "…stretchable rubber sheet mounted on a rigid frame"
- Stretching = Magnification
- Stretching one part must equal shrinkage in other areas

Taxonomy for presentations and distortions



Leung & Apperley

Fig. 1. A taxonomy of presentation techniques for large graphical data spaces.

Distortions

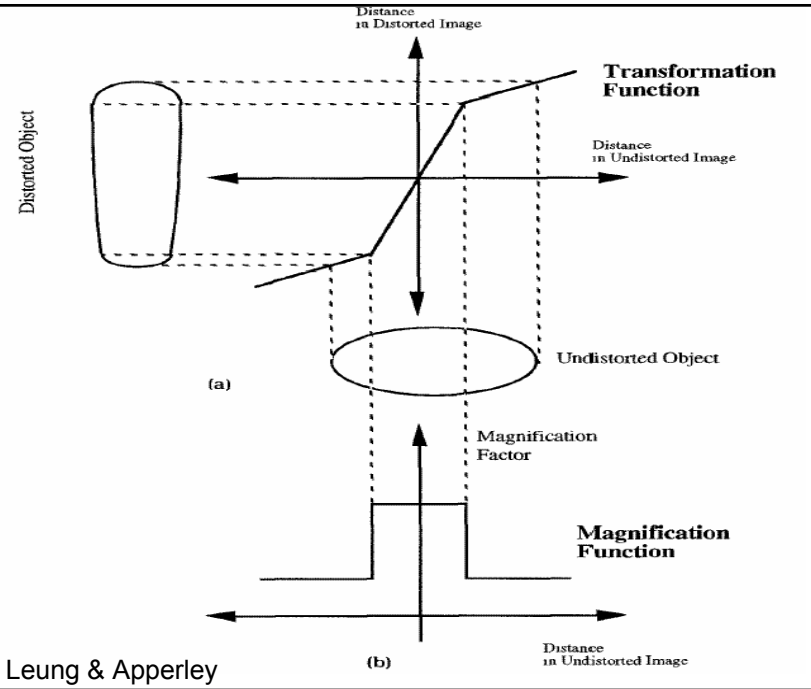
- Method
  - Post-Process: Modify results after primary graphical mapping
  - In-Process: Distortion during the primary graphical mapping
- Types
  - Focus+context – change display size relative to focus
  - Highlighting – change display type relative to focus

Distortion-based Techniques

- Bifocal Display
- Polyfocal Display
- Perspective Wall
- Fisheye View
- Graphical Fisheye View

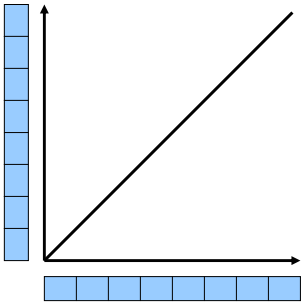
Distortion

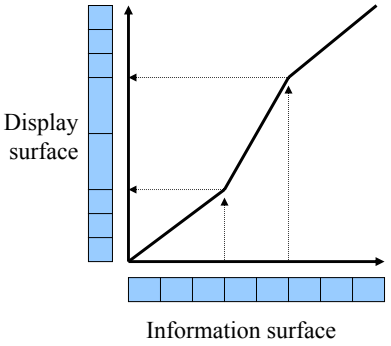
- A distorted view is created by applying a transformation function to an undistorted image.
- A magnification function, provides a profile of the magnification factors for the entire area of image.



Leung & Apperley

Visual Transfer Functions



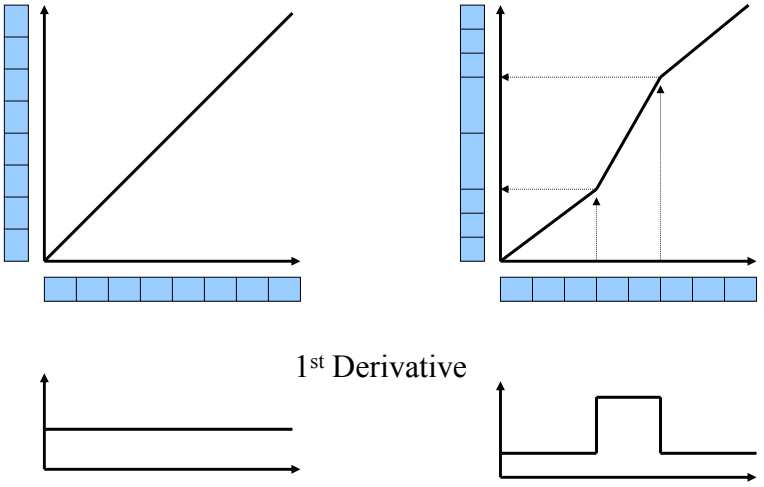


Identity function =
normal flat overview

Bifocal

From http://people.cs.vt.edu/~north/infoviz/lecture11.ppt

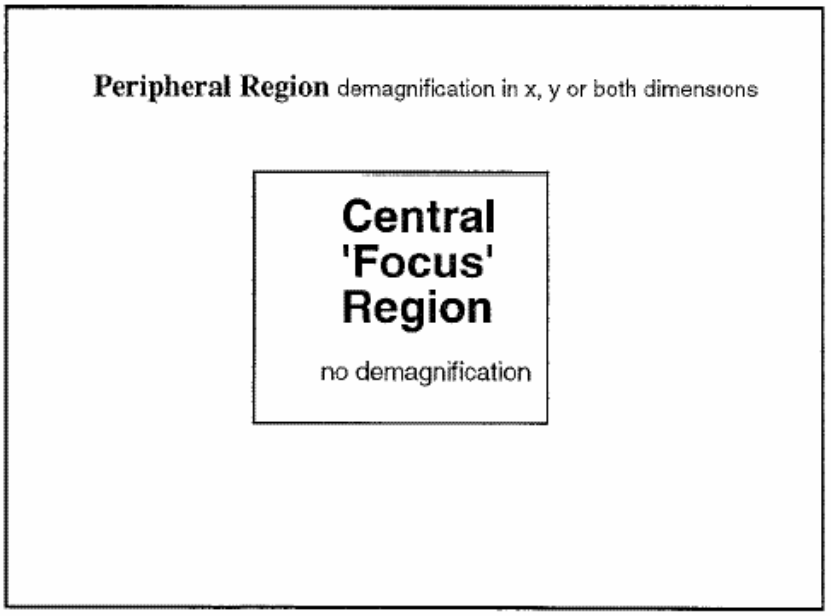
Magnification Functions



From http://people.cs.vt.edu/~north/infoviz/lecture11.ppt

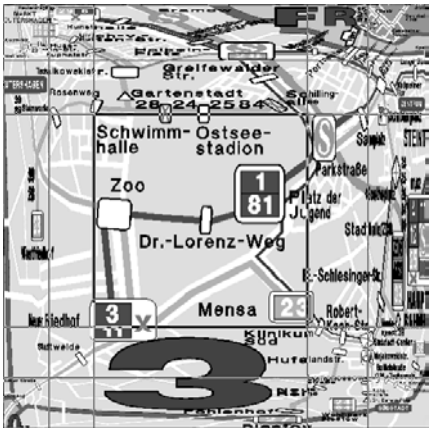
Idea of Distortion-based Techniques

- Co-existence of local details with global context at reduced magnification.
- A focus region to display detailed information.
- Demagnified view of the peripheral areas is presented around the focus area.



Leung & Apperley

Rectangular Fish Eye View



- Rauschenbach, U.: *"The Rectangular Fish Eye View as an Efficient Method for the Transmission and Display of Large Images"*, in: Proceedings of IEEE ICIP'99, Kobe, Japan, Oct. 25-28, 1999. http://wwwicg.informatik.uni-rostock.de/Projekte/MoVi/Publications/ICIP99/

Rectangular Fish Eye View Regions

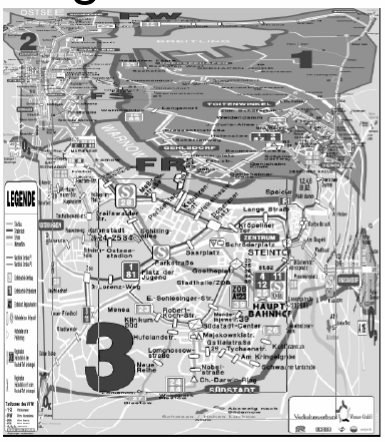


Figure 3: Rectangular fish eye view example

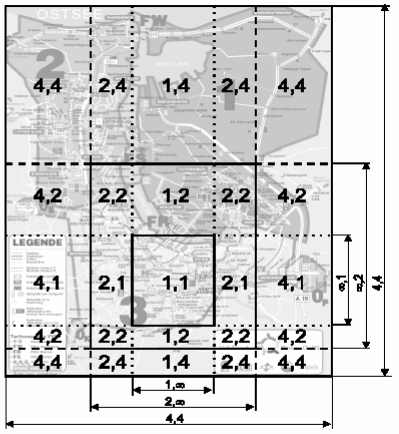
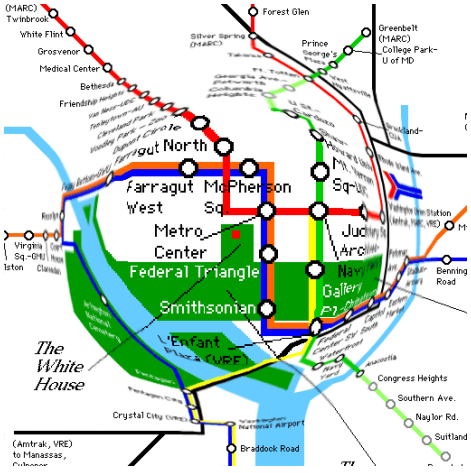


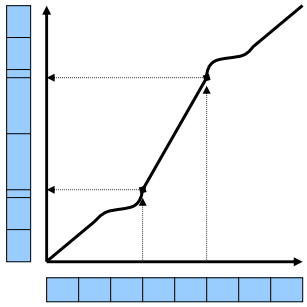
Figure 4: Generating RoI grid

- Rauschenbach, U.; and Schumann, H.: *"Flexible Embedded Image Communication using Levels of Detail and Regions of Interest", in: Proceedings of IMC '98 - Rostock, Germany - November 24-25, 1998.*

"Bubble"

Disadvantage: local context highly de-magnified

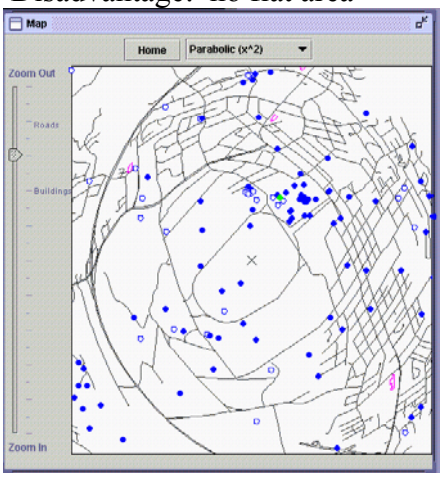


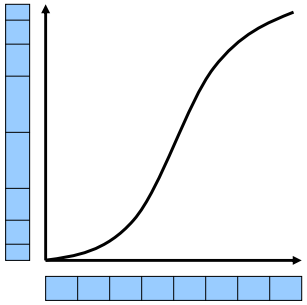


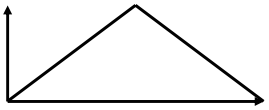
From http://people.cs.vt.edu/~north/infoviz/lecture11.ppt

“Fisheye”, “wide-angle lens”

Disadvantage: no flat area



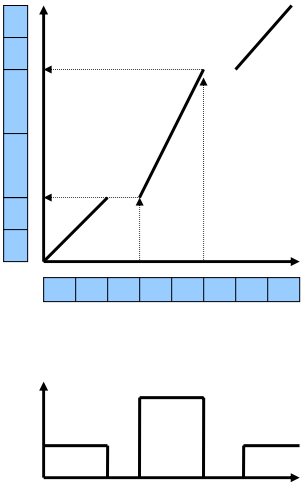




From http://people.cs.vt.edu/~north/infoviz/lecture11.ppt

Why not magnifying glass?

- Hides local context

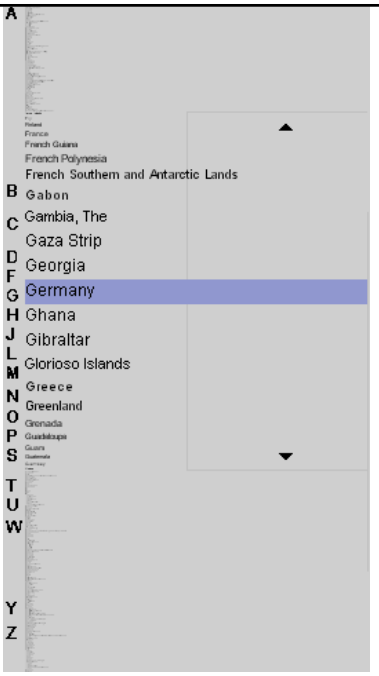


From http://people.cs.vt.edu/~north/infoviz/lecture11.ppt

Example: Fisheye Menu

- Applies fisheye graphical visualization techniques to linear menus
- For very long menus as alternative to
  - Hierarchies
  - Scrolling
  - Arrow-bars

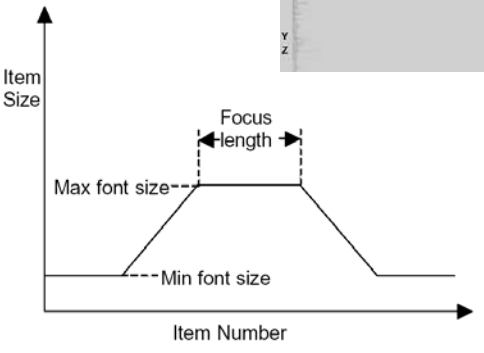
- Benjamin B. Bederson. Fisheye Menus. UIST'00
- Demo
  http://www.cs.umd.edu/hcil/fisheyemenu/fisheyemenu-demo.shtml



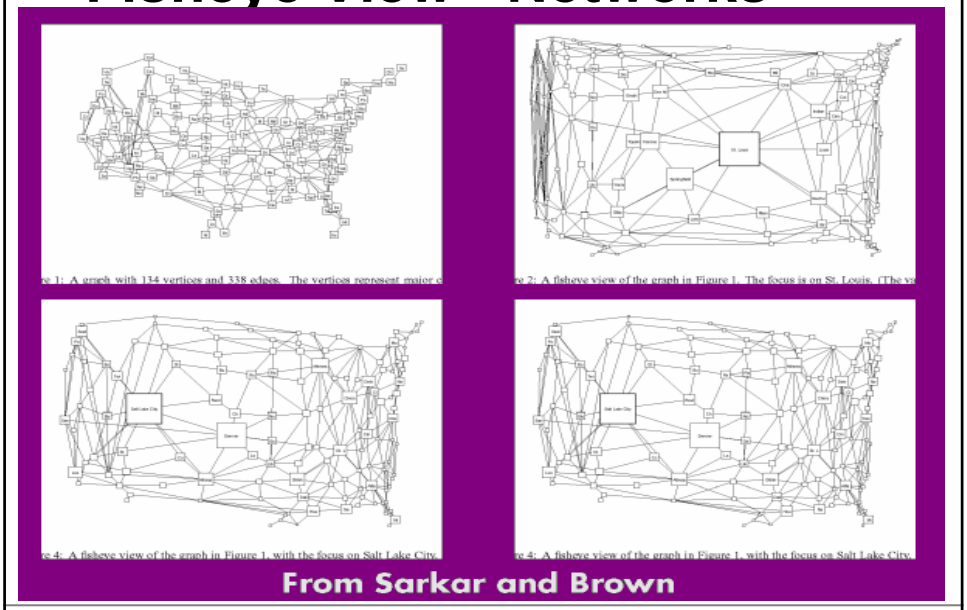
Implementation & Evaluation Fisheye Menu

- Calculating font size
- Minimal change moves the centre → hard to select
- Lock mode

- Evaluation
  - Some users like it
  - Other don't …



Fisheye View - Networks

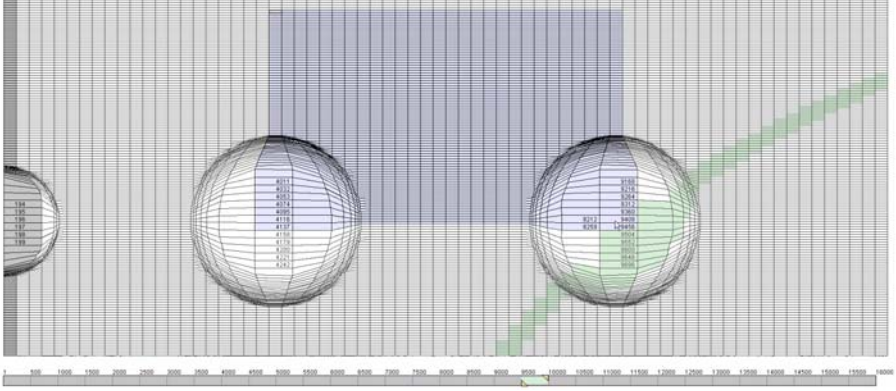


From Sarkar and Brown

FiCell Project

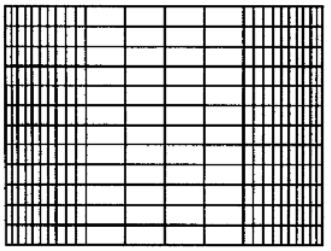
http://iihm.imag.fr/vernier/

- Two hills on the first and last column of the selected area to compare data

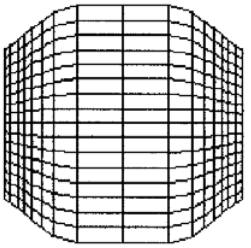


Piecewise Non-Continuous Magnification Functions

- Bifocal Display, Perspective Wall



Bifocal Display

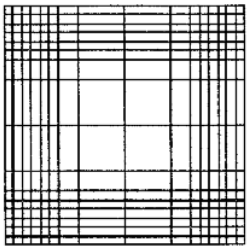


Perspective Wall

From http://www.sims.berkeley.edu/courses/is247/s02/lectures/ZoomingFocusContextDistortion.ppt

Bifocal Display

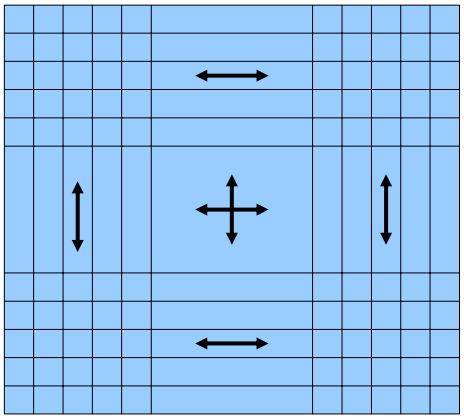
- Combination of detail view and two distorted side views
- Can be applied in 2D
  - Since the corners are distorted by the same amount in x and y, it's just scaled, not distorted

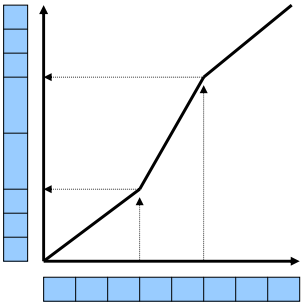


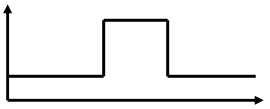
From http://www.sims.berkeley.edu/courses/is247/s02/lectures/ZoomingFocusContextDistortion.ppt

Bifocal Display

Disadvantage: 1 dimensional stretching on the 4 sides

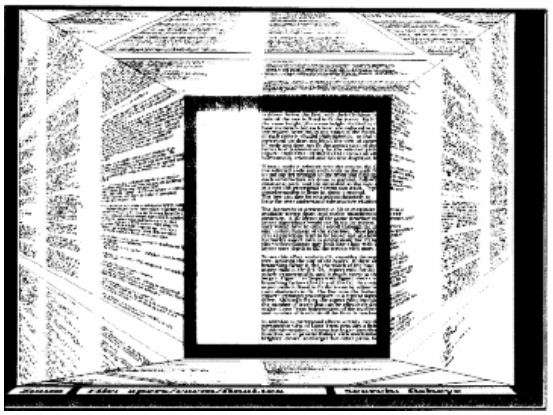


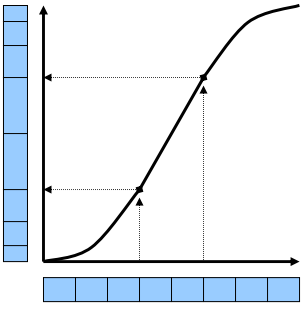


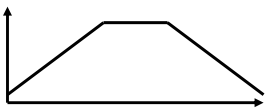


From http://people.cs.vt.edu/~north/infoviz/lecture11.ppt

Document Lens

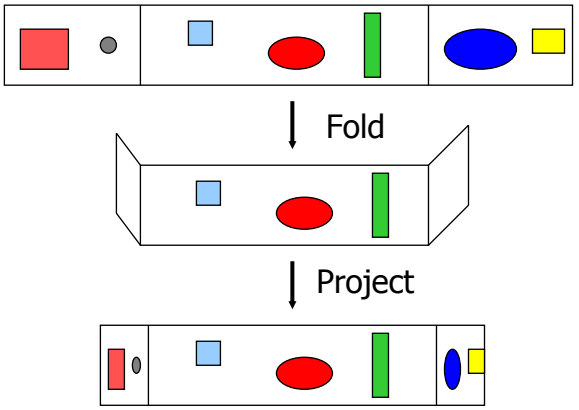






From http://people.cs.vt.edu/~north/infoviz/lecture11.ppt

Basic idea – Perspective Wall



From http://www.cs.ubc.ca/~tmm/courses/cpsc533c-03-spr/0324.fengdongdu.ppt

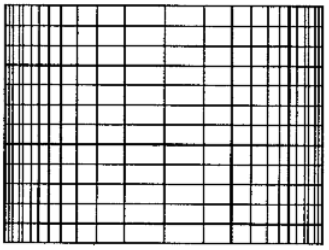
Perspective Wall

- Similar to Bifocal, except demagnifies at increasing rate, while Bifocal is constant
- Visualizes linear information such as timeline
- Adds 3D but wastes real estate on screen (which is contrary to prime objectives of distortion techniques)

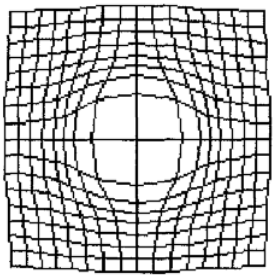
From http://www.sims.berkeley.edu/courses/is247/s02/lectures/ZoomingFocusContextDistortion.ppt

Continuous Magnification Functions

- Fisheye View, Polyfocal Display
  - Can distort boundaries because applied radially rather than x y



1D Fisheye

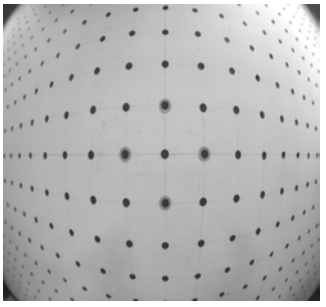


2D Polyfocal

From http://www.sims.berkeley.edu/courses/is247/s02/lectures/ZoomingFocusContextDistortion.ppt

Fisheye View

- Thresholding
  - Information elements have numbers based on relevance and distance from point of focus
  - Value then determines what information is to presented or suppressed

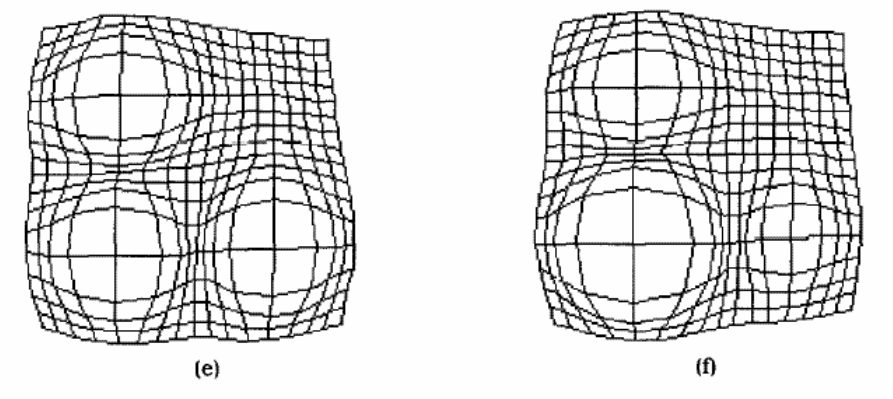


Polar Fisheye View
Image from Shishir Shaw
University of Texas, Austin
www.adires.com/~castleman/proj_02.html

From http://www.sims.berkeley.edu/courses/is247/s02/lectures/ZoomingFocusContextDistortion.ppt

Multifocal Polyfocal Projection

Focal points where there is interest in the visualization, e.g. maps

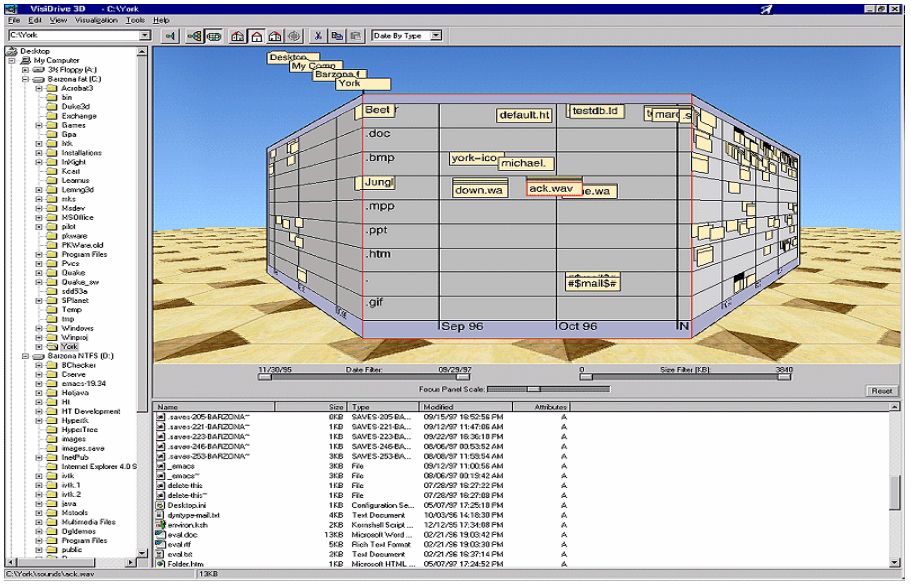


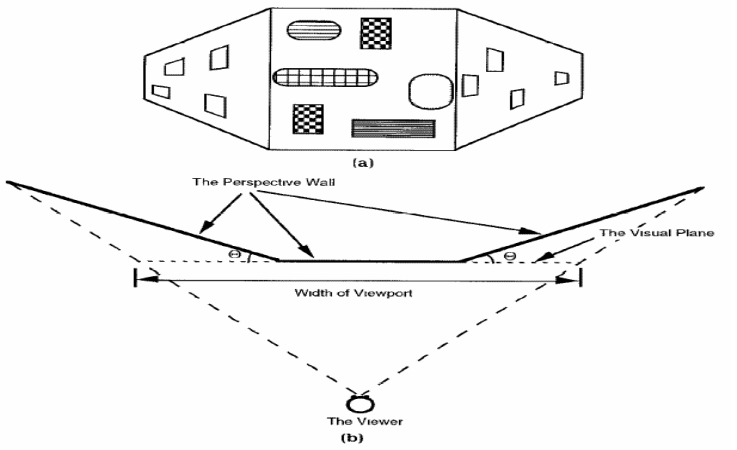
From http://www.sims.berkeley.edu/courses/is247/s02/lectures/ZoomingFocusContextDistortion.ppt

Multifocal Polyfocal Projection

- Multiple peaks in the display
- No restriction on the numbers of peaks in the magnification function.
- Need to consider the computation time and the comprehensibility of the distorted image.

From http://www.sims.berkeley.edu/courses/is247/s02/lectures/ZoomingFocusContextDistortion.ppt





The view is dependent on the length of the wall, the width of the view port, the angle Θ, the size of the central region.

From http://www.cs.ubc.ca/~tmm/courses/cpsc533c-03-spr/0324.fengdongdu.ppt

Fisheye View

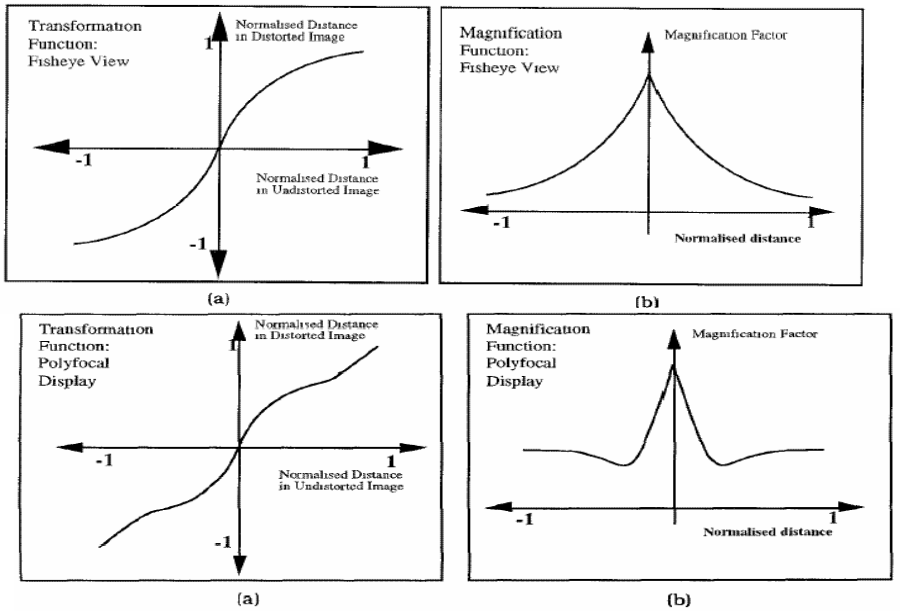
- Originally proposed by Furnas (1986), but many variations of applications.
- Basic idea: more relevant information presented in great detail; the less relevant information presented as an abstraction.
- Relevance is computed on basis of the importance of information elements and their distance to the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

From http://www.cs.ubc.ca/~tmm/courses/cpsc533c-03-spr/0324.fengdongdu.ppt

(Continued)

- Degree of interest (DOI) function:
  - DOI(a|.=b) = API(a) – D(A,b)
    - DOI(a|.=b): DOI of a, given the current focus is b.
    - API(a): static global apriori importance measure.
    - D(a,b): distance between a and b.

From http://www.cs.ubc.ca/~tmm/courses/cpsc533c-03-spr/0324.fengdongdu.ppt



From http://www.cs.ubc.ca/~tmm/courses/cpsc533c-03-spr/0324.fengdongdu.ppt

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.

From http://www.cs.ubc.ca/~tmm/courses/cpsc533c-03-spr/0324.fengdongdu.ppt

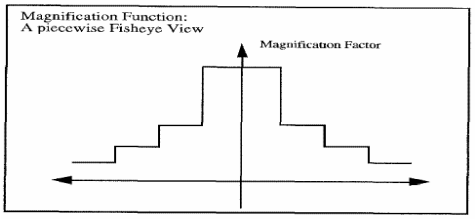
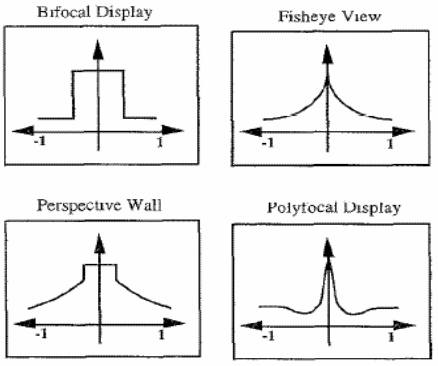


Fig. 14. The magnification function of a piecewise Fisheye View.



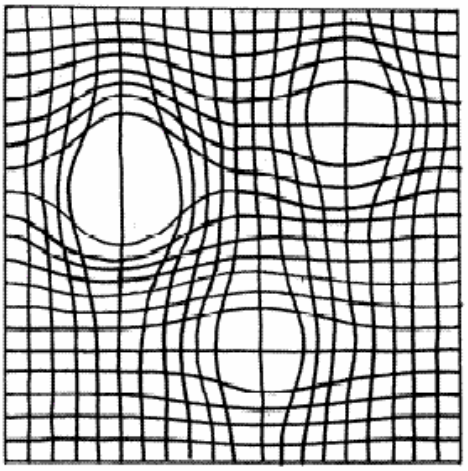
From http://www.cs.ubc.ca/~tmm/courses/cpsc533c-03-spr/0324.fengdongdu.ppt

Unified Theory

- 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.

From http://www.cs.ubc.ca/~tmm/courses/cpsc533c-03-spr/0324.fengdongdu.ppt

Stretchable Rubber Sheet



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.

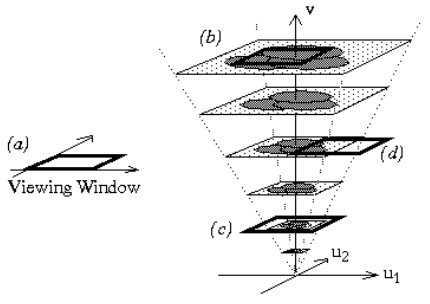
From http://www.cs.ubc.ca/~tmm/courses/cpsc533c-03-spr/0324.fengdongdu.ppt

Panning and Zooming

- Panning
  - Smooth movement of camera across scene (or scene moves and camera stays still)
- Zooming
  - Increasing or decreasing the magnification of the objects in a scene
- Useful for changing focal point

Space-Scale Diagrams
(Furnas & Bederson 95)

- User has a fixed-sized viewing window
- Moving it through 3D space yields all possible sequences of pan & zoom



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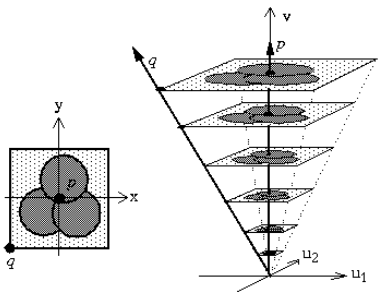
Space-Scale Diagrams
(Furnas & Bederson 95)

- A point is transformed to a ray
- Circular regions become cones



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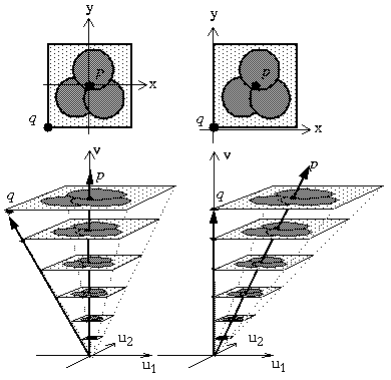
Space-Scale Diagrams
(Furnas & Bederson 95)

- If you move the origin of the 2D plane, the properties of the original 2D picture do not change
- Therefore, the absolute angles between the rays should not be assigned any meaning



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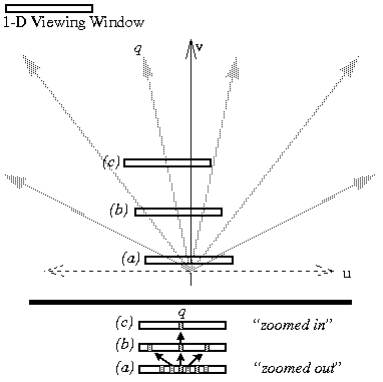
Space-Scale Diagrams
(Furnas & Bederson 95)

- We can think of this in terms of 1D too
- When zoomed out, you can see wider set of points



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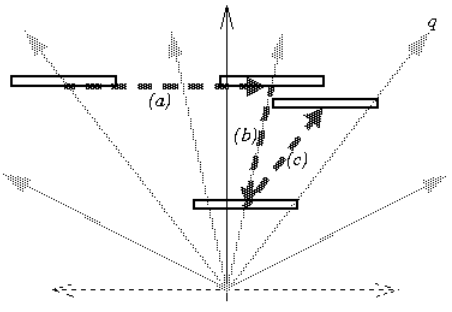
Space-Scale Diagrams
(Furnas & Bederson 95)

- Pure pan (a)
- Pure zoom (b)
- Pan and zoom keeping q in same position in the viewing window (c)



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Semantic Zooming

- Geometric (standard) zooming:
  - The view depends on the physical properties of what is being viewed
- Semantic Zooming:
  - When zooming away, instead of seeing a scaled-down version of an object, see a different representation
  - The representation shown depends on the meaning to be imparted.

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  - http://www.csr.uvic.ca/~mstorey/
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Readings

- “A Review and Taxonomy of Distortion-Oriented Presentation Techniques,” Leung & Apperley, 1994
- “Information Visualization Using 3D Interactive Animation,” Robertson, Card, & Mackinlay, 1993
- “Pad++: A Zooming Graphical Interface for Exploring Alternate Interface Physics,” Bederson & Hollan, 1994
- “Data Mountain: Using Spatial Memory for Document Management,” Robertson, et al, 1998
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- SPACE-SCALE DIAGRAMS: UNDERSTANDING MULTISCALE INTERFACES, George W. Furnas, Benjamin B. Bederson