Overview and Detail +
Focus and Context

CS 7450 - Information Visualization
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John Stasko

Fundamental Problem

- **Scale** - Many data sets are too large to visualize on one screen
  - May simply be too many cases
  - May be too many variables
  - May only be able to highlight particular cases or particular variables, but viewer's focus may change from time to time

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Large Scale

- One of the fundamental challenges in information visualization
  - How to allow end-user to work with, navigate through, and generally analyze a set of data that is too large to fit in the display
  - Potential solutions lie in
    - Representation
    - Interaction
    - Both

One Solution :^)

You can just buy more pixels

Problem: You'll always eventually run out of pixels

Overview

- Providing an overview of the data set can be extremely valuable
  - Helps present overall patterns
  - Assists user with navigation and search
  - Orients activities

- Generally start with overview
  - Shneiderman mantra

Details

- Viewers also will want to examine details, individual cases and variables

- How to allow user to find and focus on details of interest?

- Generally provide details on demand

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Providing Both

- Overview + detail displays can be combined via either time or space
  - Time - Alternate between overview and details sequentially in same place
  - Space - Use different portions of screen to show overview and details

- Each has advantages and problems
- Hybrid approaches exist

Specific Problem

- Develop visualization and interface techniques to show viewers both overview + detail, and allow flexible alternation between each

- Potential Solutions????
  - Discuss….

One Common Solution

- Pan/Scroll
  - Provide a larger, virtual screen by allowing user to move to different areas

- Still a problem
  - Clunky interaction
  - Only get to see one piece

Another Solution

- Zoom
  - Zoom out shows an overview of data space then zooming in allows viewer to examine details
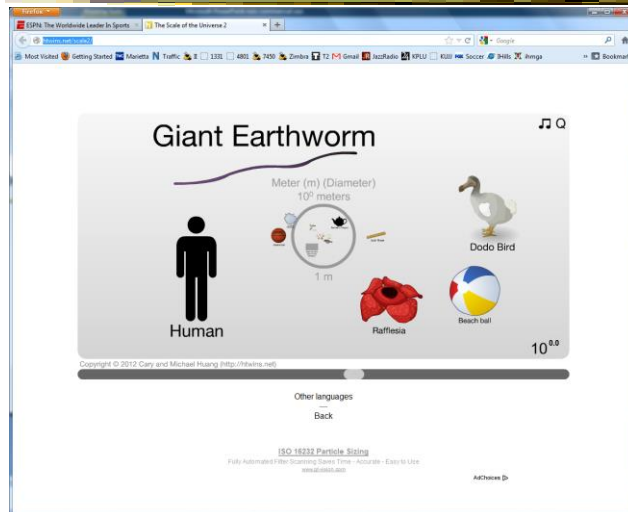
Zooming

Powers of 10

http://micro.magnet.fsu.edu/primer/java/scienceopticsu/powersof10/index.html
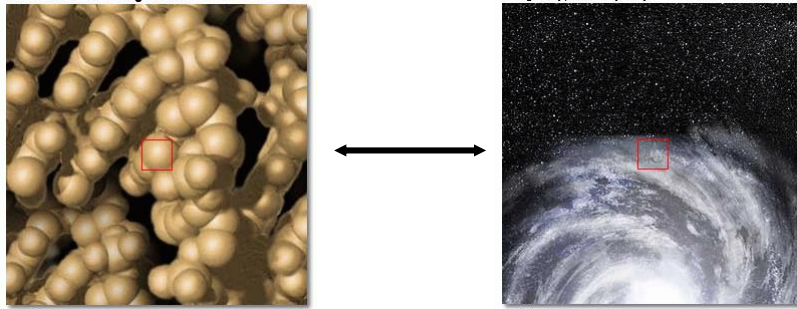
Similar Idea

http://htwins.net/scale2/

Pad -> Pad++ -> Jazz ->Piccolo

- Environments for supporting flexible, smooth zooming and panning on structured graphics world
  - Pad - Perlin & Fox, NYU
  - Pad++ - Bederson & Hollan, Bellcore & New Mexico
  - Jazz - Bederson, Maryland
  - Piccolo, Bederson, Maryland

Toolkit Characteristics

- Support library for building applications
- Infinite plane, panning in x-y, zooming in-out
- 2.5-D, not 3-D
- Important concepts
  - Portals
  - Lenses
  - Sticky objects
  - Semantic zooming

Example: Web History

Web
traversal
history

PadPrints

Hightower et al
UIST '98

Video
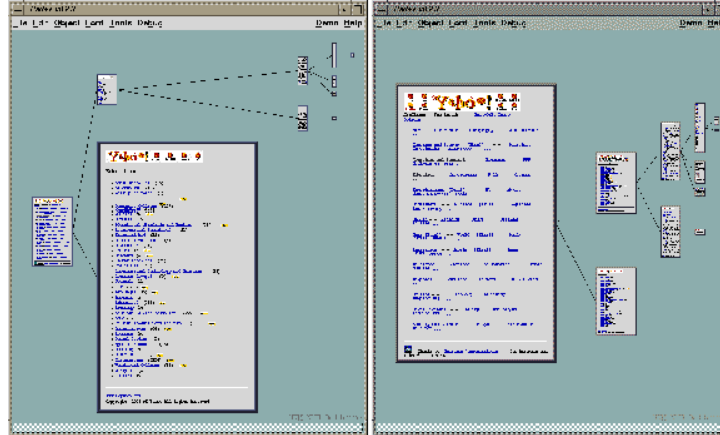
Browsing Images

PhotoMesa

Uses panning and
zooming to browse
a photo collection

Bederson
UIST '01
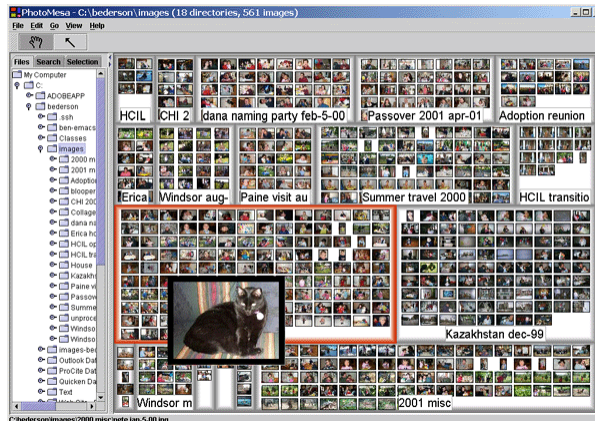
Demo & Video:
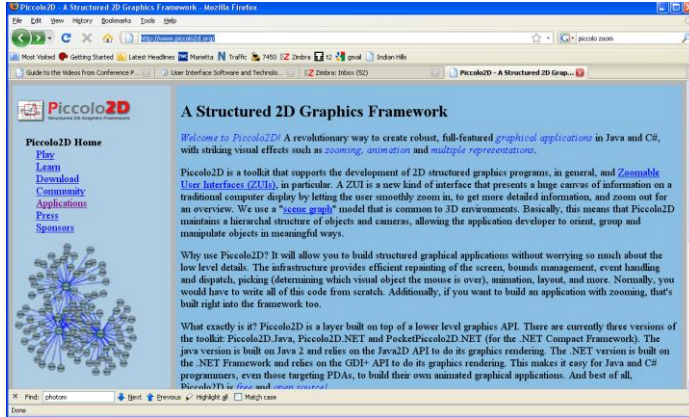www.cs.umd.edu/hcil/photomesa

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Current Status

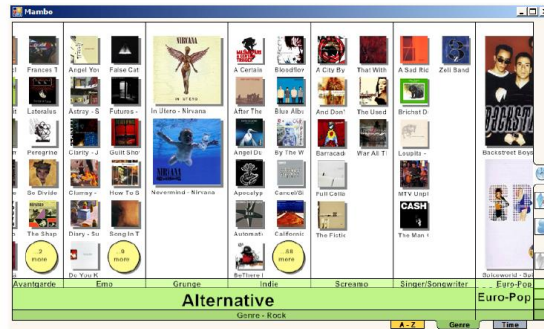Piccolo has an active user base

Other Systems

- Let's see some other examples...

FacetZoom

- Combine (hierarchical) facets with zooming UI for exploration

Video

Dachselt et al
CHI '08

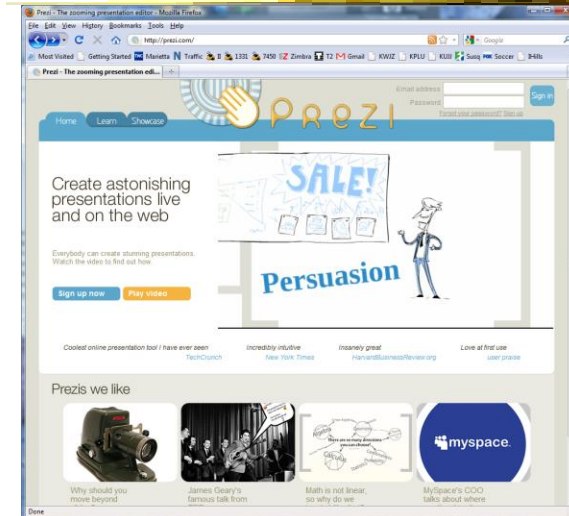# Giving Presentations

http://prezi.com

Zooming Reflections

Interview with Ben Bederson, CACM 55(12), Dec. 12, pp. 18-19

Regarding PhotoMesa: "I used all kinds of tricks to help you organize your images, but in the end it was not a good idea. It has this essential problem that its goal was to spatially organize tens of thousands of images, but nobody wants to do that."

ZUIs wanted to mimic spatial organization, such as people do on their desks. Bederson says, "But the reality is people don't have 10,000 papers on their desks. You can't remember the position of 10,000 things. For these kinds of problems, you can't beat visual scanning of a one-dimensional list."

Regarding Prezi: "It's cool. The first time you see it you say 'Wow, this will change everything.' But there is little real benefit and a real cost." He says the cost comes from needing to sit thru the animated transitions, each of which takes a small amount of time. "It's a lot of distraction that ultimately annoys people."

Other Alternatives

- Allow viewer to examine cases and/or variables in detail while still maintaining context of those details in the larger whole
- Concession
  - You simply can't show everything at once
- Be flexible, facilitate a variety of user tasks

Nature of Solutions

- Not just clever visualizations
- Navigation & interaction just as important

- Information visualization & navigation

Confound

Devices with even smaller screens are becoming more popular!

An Example

detail ⟶   overview ⟶

Overview and detail (from *Civilization V* game)

Survey of Techniques

- Application concern: viewing and editing large images
- Expanding the notion of the one dimensional scroll bar: zooming, diagonal panning, multiple detailed views
- List of visualization/interaction solutions…

Plaisant et al
IEEE Software '95

1. Detail-only

- Single window with horizontal and vertical panning

- Works only when zoom factor is relatively small

- Example: Windows

2. Single window with zoom and replace

- Global view with selectable zoom area which then becomes entire view
- Variations can let users pan and adjust zoomed area and adjust levels of magnification
- Context switch can be disorienting

- Example: CAD/CAM
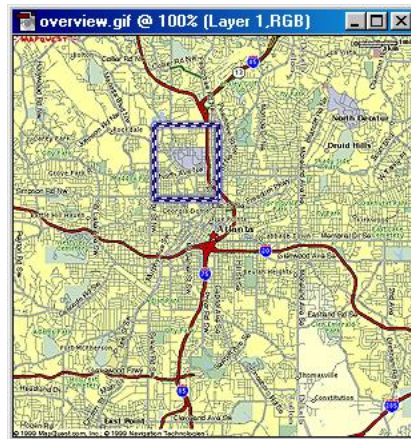
3. Single coordinated pair

- Combined display of the overview and local magnified view (separate views)
- Some implementations reserve large space for overview; others for detail
- Issue: How big are different views and where do they go?

4. Tiled multilevel browser

- Combined global, intermediate, and detail views
- Views do not overlap

- Good implementations closely relate the views, allowing panning in one view to affect others
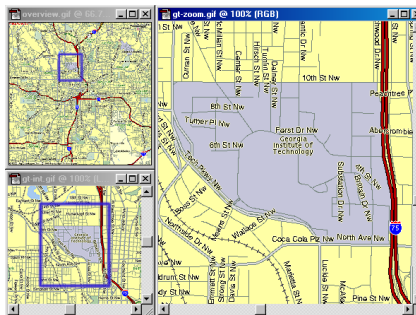
5. Free zoom and multiple overlap

- Overview presented first; user selects area to zoom and area in which to create detailed view

- Flexible layout, but users must perform manual window management
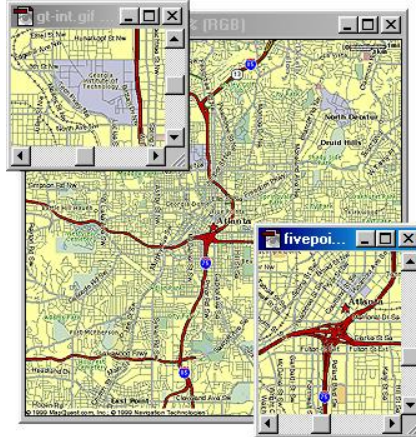
6. Bifocal magnified

- "Magnifying glass" zoomed image floats over overview image

- Neighboring objects are obscured by the zoomed window

7. Fish-eye view

- Magnified image is distorted so that focus is at high magnification, periphery at low
- All in one view
- Distortion can be disorienting

- More details coming...
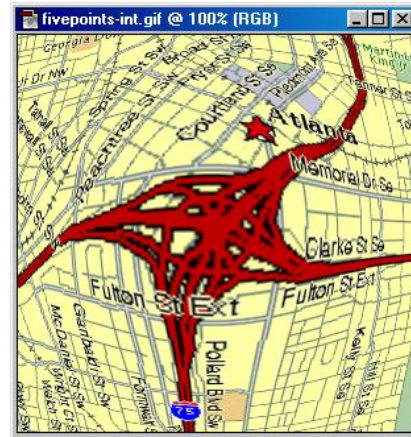
Examples

- Let's look at some specific techniques…

Magnifier Problem Fix

DragMag Image Magnifier

More text

hello

hello
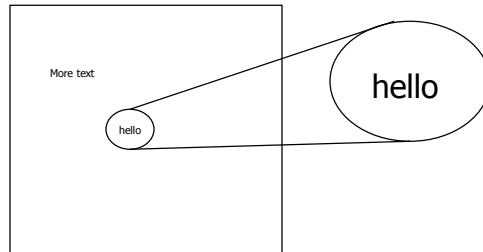
Bifocal magnified display without problem of obscuring the neighboring items

Video

Ware and Lewis
CHI '95

Important Issue

- The "overview" display may need to present huge number of data elements
- What if there simply isn't enough room?
  - The number of data elements is larger than the number of pixels
  - (Recall Table Lens question?)

- Approaches?

Two Main Approaches

- 0. Interactive display (add scrolling)
  - Is it still an overview?
- 1. Reduce the data
  - Eliminate data elements
    - But then is it still an overview?
  - Aggregate data elements
- 2. Reduce the visual representation
  - Smart ways to draw large numbers of data elements

Drawing the Overview

Information Mural

What do you do when your data set is too large for your overview window?
--- More data points than pixels
--- Don't want to fall back on scrolling

Jerding and Stasko
InfoVis '95, IEEE *TVCG* '98

Information Mural

Use techniques of computer graphics (shading and antialiasing) to more carefully draw overview displays of large data sets

Think of each data point as ink and each screen pixel as a bin

Data points (ink) don't fit cleanly into one bin, some ink may go into neighboring bins

Can map density to gray or color scale

Mural Example

Object-oriented code executions

Detail

Overview
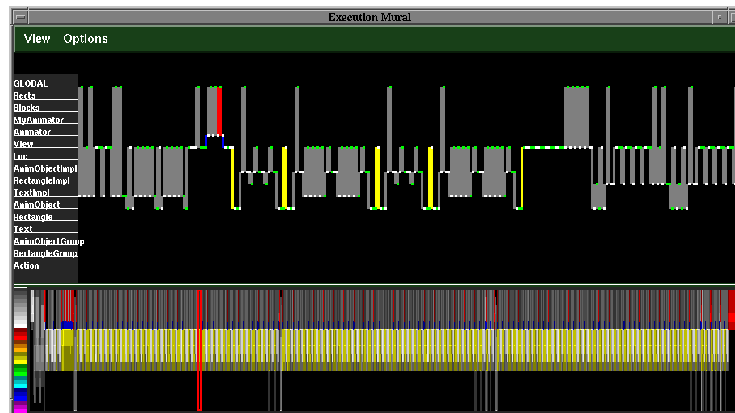
Focus
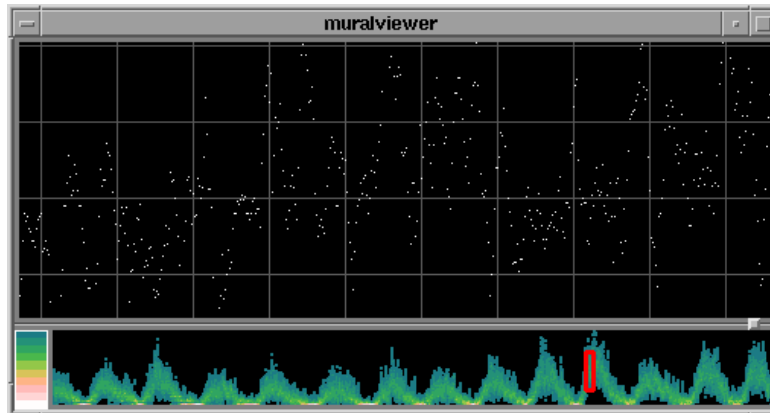
Mural Example

Sunspot activity over 150 years

Mural Example

Parallel
Coordinates

normal

muralized
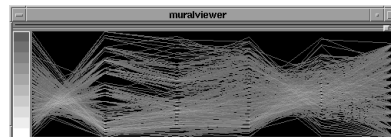
colorized
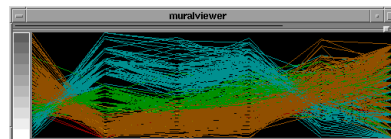
Mural Example

LaTeX
source
file

Challenge

- Have context/overview seamlessly and smoothly co-exist with focus/detail
- Why?
  - Easier to move between the two, helps assimilate view updates, less jarring, …

- Not all overview and detail techniques are good at this

Focus + Context Views

- Same idea as overview and detail, with one key difference:
  - Typically, the overview and the detail are combined into a single display
  - Mimics our natural vision systems more closely

How?

- What techniques have we seen so far that would help accomplish focus+context?

Possible Methods

- Filtering
- Selective aggregation
- Micro-macro readings
- Highlighting
- Distortion

Prototypical Example

- When people think about focus+context views, they typically think of the *Fisheye View* (distortion)
- Introduced by George Furnas in 1981 report, more famous article is 1986 SIGCHI paper

Fisheye of Source Code

```
  1 #define DIG 40
  2 #include <stdio.h>
...4 main()
  5 {
  6      int c, i, x[DIG/4], t[DIG/4], k = DIG/4, noprint = 0;
...8      while((c=getchar()) != EOF){
  9          if(c >= '0' && c <= '9'){
..16      } else {
 17          switch(c){
 18              case '+':
..27              case '-':
..38              case 'c':
>>39                  for(i=0;i<k;i++) t[i] = x[i];
 40                  break;
 41              case 'q':
..43              default:
..46          }
 47          if(!noprint){
..57          }
 58      }
 59      noprint = 0;
 60  }
 61 }
```

Figure 4. A fisheye view of the C program. Line numbers are in the left margin. "..." indicates missing lines.

Furnas
CHI '86

Definition

- Fisheye View -

    "Provide[s] detailed views (focus) and overviews (context) without obscuring anything...The focus area (or areas) is magnified to show detail, while preserving the context, all in a single display."

    -(Shneiderman, *DTUI*, 1998)

Everyday Life Example

Kinda Fisheye - Natural 3D Perspective

Why is it called Fisheye?

- Fisheye Camera Lens

Real fisheye
camera lens
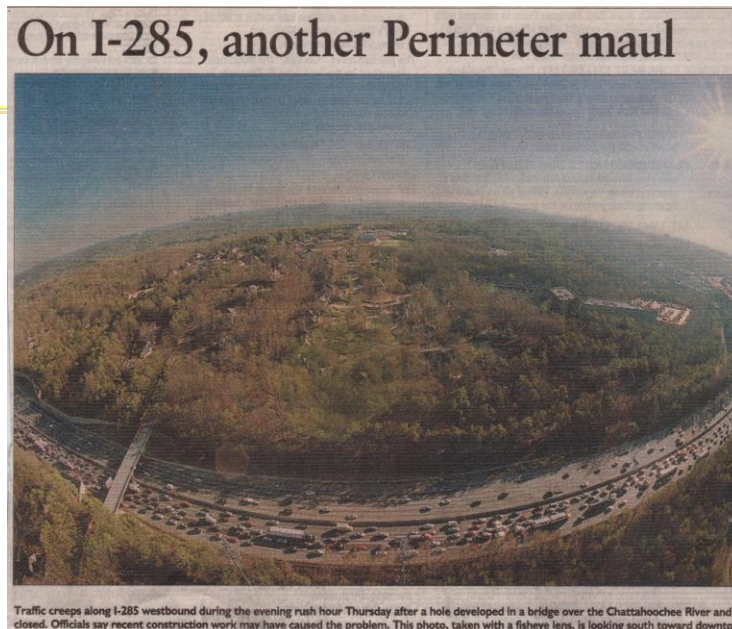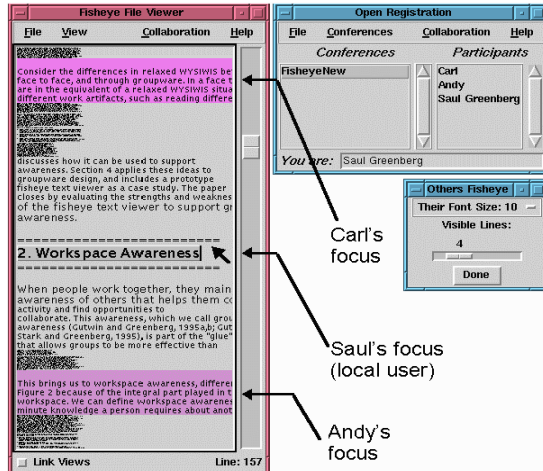

On I-285, another Perimeter maul

Atlanta Journal

Traffic creeps along I-285 westbound during the evening rush hour Thursday after a hole developed in a bridge over the Chattahoochee River and th closed. Officials say recent construction work may have caused the problem. This photo, taken with a fisheye lens, is looking south toward downtow

Applications

Shared text editor for CSCW

Carl's focus

Saul's focus (local user)

Gutwin and Greenberg
HCI '96

Andy's focus

Video

Graphical Fisheye Views

- Apply fisheye techniques to 2D graph
- Experiment with a variety of distortion factors
- Interactive tool that allows user to browse display and change focus

Sarkar and Brown
CACM '94

Graphical Fisheye Views

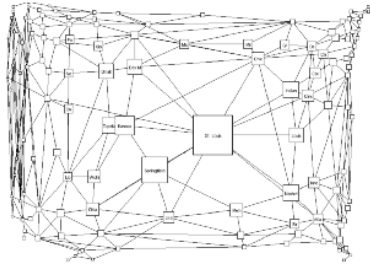Figure 2: A fisheye view of the graph in Figure 1. The focus is on St. Louis. (The values of the fisheye parameters are *d* _ 5, *c* _ 0, *c* _ 0, *VWcutoff* _ 0; the meanings of these parameters are explained in Sections 4 and 6.)
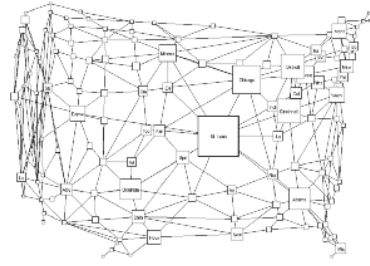
Figure 3: A fisheye view of the graph in Figure 1, with less distortion than in Figure 2. The values of the fisheye parameters are *d* _ 2, *c* _ 0.5, *c* _ 0.5, *VWcutoff* _ 0.

Example

Original

Example
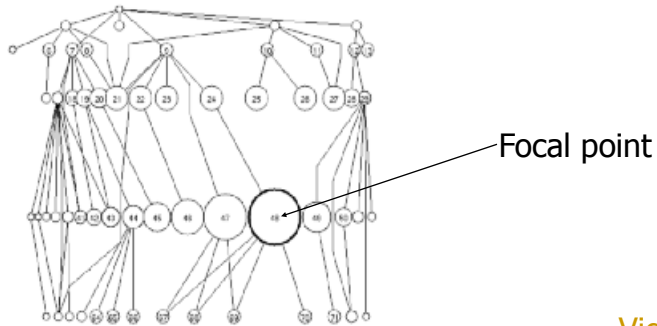
Focal point

Video

Fisheye Terminology

- Focal point
- Level of detail
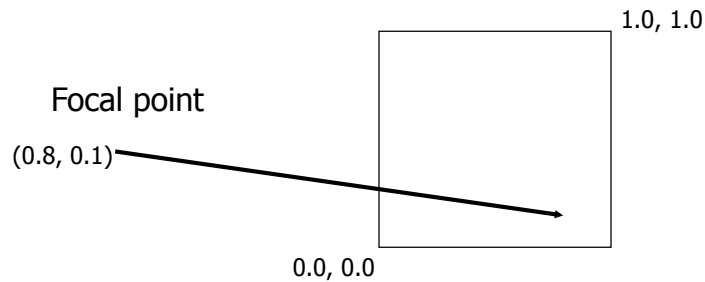- Distance from focus
- Degree of interest function

Focal Point

- Assume that viewers focus is on some item, some coordinate, some position,...

Focal point

(0.8, 0.1)

1.0, 1.0

0.0, 0.0

Level of Detail

- Some intrinsic value or quantity on each data element
- How important is it to you in a general sense?

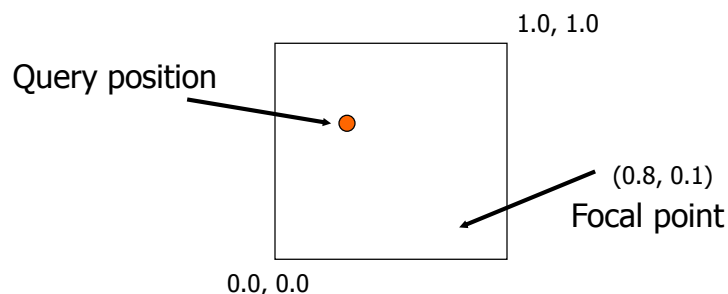- Simplest example is that all data items have same level of detail

Distance from Focus

- Calculation of how far each data item is from the focal point
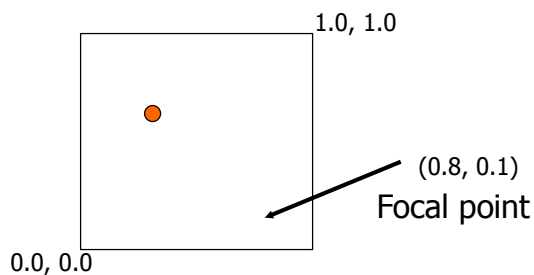
Query position

1.0, 1.0

(0.8, 0.1)
Focal point

0.0, 0.0

Degree of Interest Function

- Function that determines how items in display are rendered

Degree of Interest = Level of Detail - Distance from Focus
Level of Detail / Distance from Focus

1.0, 1.0

(0.8, 0.1)
Focal point

0.0, 0.0

DoI Function

- Can take on various forms
  - Continuous - Smooth interpolation away from focus
  - Filtering - Past a certain point, objects disappear
  - Step - Levels or regions dictating rendering
    0<x<.3 all same, .3<x<.6 all same
  - Semantic changes - Objects change rendering at different levels

Bifocal Display

- Interesting application of fisheye view
- View office documents
- Take items in periphery and fold back in 3-space
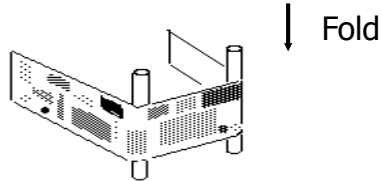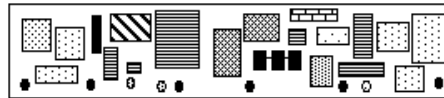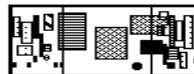- Project onto front viewing screen

Spence & Apperly
BIT '82

Bifocal Display

Fold

Project
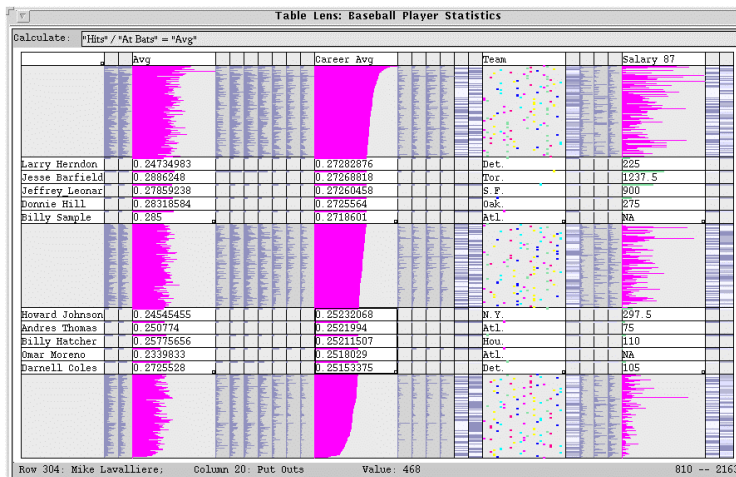
Table Lens

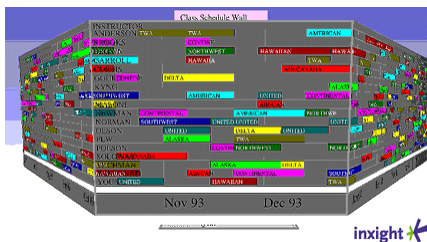From Xerox PARC and Inxight

A bifocal display

Rao & Card
CHI '94

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Perspective Wall

- Computerized, automated 3D implementation of Bifocal display
- Map work charts onto diagram, x-axis is time, y-axis is project

Mackinlay, Robertson, Card
CHI '91

Other 3D Approaches
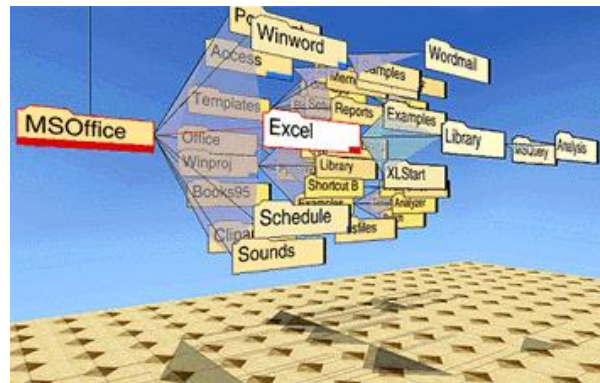
Cone Trees

3D views of hierarchies such as file systems

Robertson, Mackinlay, Card
CHI '91

Fisheye Application

- The Problem
  - Menus have too many items
  - Especially a menu of data items (fonts)
  - Scrolling arrows & bars
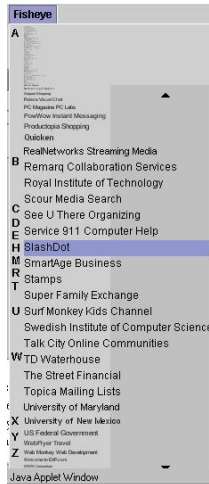 - Hierarchical groups

Bederson
UIST '00

Existing Options

Fisheye Menus

- Dynamically change size of menu item & provide focus area around the pointer
- Items near cursor displayed at full size
- Items further away on either side are smaller
- Uses a distortion function so items will always fill menu

Focus Lock

- Problem of small movements resulting in change in focus
- Focus lock by moving to the right side of menu
- Focus region is highlighted and pointer can move up & down selecting within this area
- Moving above or below the region on the right increases the area of the region
- Controls the trade-off between number of items at full size versus those rendered smallest

Demo:
http://www.cs.umd.edu/hcil/fisheyemenu

Apply to Calendars

- DateLens
- Helping people better manage their calendars and appointments on a handheld display
- Uses "fisheye view"

Bederson et al
ACM ToCHI '04

Particulars

- Who – Everyday people
- Problem – How to show a potentially large amount of appointment information in a small number of screen pixels (and allow flexibility for different tasks)
- Data – Set of appointments

Premise

- At different points in time, you want different perspective on your appts.
  - See how my month looks
  - What's happening later this week
  - Am I double-booked this afternoon

Technique

- Adopts fisheye view technique
  - Focus item(s) shown in more detail while context still visible, but simplified
- Interaction is key with smooth transitions

Different Perspectives
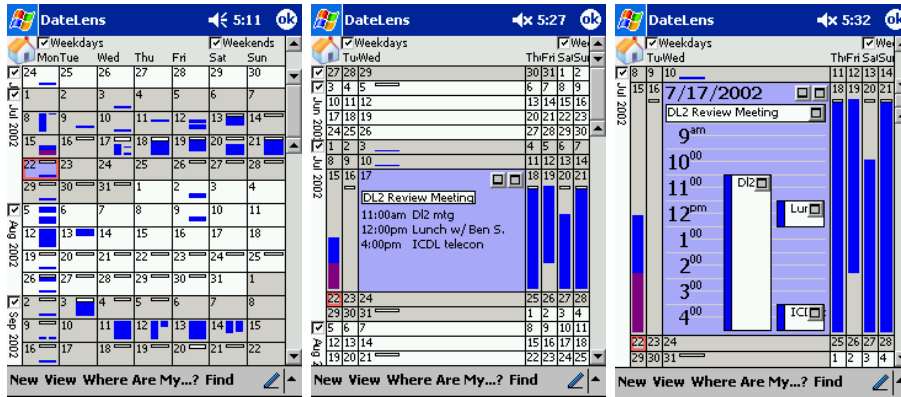
Month view   Zooming to a week   Zooming to a day

Video

Panacea?

- Are there any disadvantages of focus+context or fisheye techniques?

Disadvantages

- Distortion can be annoying
- Can be very difficult to implement
- Any change in focal point potentially requires recalculation of DoI for all objects and hence re-rendering of all objects -> Expensive!

Excellent Survey

- Review and Taxonomy of Distortion-Oriented Presentation Techniques
    - Surveys systems
    - Presents unified theory

Leung and Apperly
ToCHI '94

HW 4

- Questions?
- Most time-consuming one, so plan ahead

Project Advice

- Work on design ideas (variety!)
- Should have your data
  - Work on getting it into a usable form

Upcoming

- User Tasks & Analysis
  - Reading:
    - Brehmer & Munzner '13

- Storytelling
  - Reading:
    - Segel & Heer '10

References

- Spence and CMS books
- All referred to articles
- S. Meier, Civilization II. MicroProse:1998 http://www.civ2.com
- Demonstration maps generated at MapQuest, http://www.mapquest.com

- Shneiderman, B. *Designing the User Interface,* 1998

- http://www.csi.uottawa.ca/ordal/papers/sander/main.html
- http://www.cpsc.ucalgary.ca/grouplab/papers/1996/96-Fisheye.GI/gi96_fisheye.html